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A WINTER PASSERINE ECOLOGY STUDY IN THE RIVER OF NO RETURN WILDERNESS, CENTRAL IDAHO

College of Forestry, Wildlife
and Range Sciences

BY

SUSAN LEE TANK

APRIL 1983

M.S. THESIS

Forest, Wildlife and Range
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ABSTRACT

A winter passerine ecology study was conducted during 1980 and 1981 in the Big Creek Drainage of the River of No Return Wilderness, central Idaho. A fixed-radius technique was used to sample the avian population in each of 5 vegetation types. Attendant vegetation sampling was conducted in the late spring/early summer of each year and consisted primarily of nested subplots around each bird census station. The total number of detections and bird species composition varied among vegetation types and years, primarily as a result of differences in environmental conditions, food availability and abundance. The 5 vegetation types also differed in plant species composition and structural characteristics. There were significant differences in bird detections among vegetation types. No strong relationships were shown to exist between avian detections and environmental variables or time of day. Step-wise discriminant analysis indicated that bird presence/absence was most strongly related to the structural features of the vegetation that related to food resources.

This thesis is dedicated to my parents, Gerhard and Nancy Tank, whose love, and support of my academic endeavors over the years, has meant more to me than I can express. And to the memory of Arlow Lewis and Donna. Happy trails to them both.

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INTRODUCTION

Most avian research in temperate North America has been conducted during the breeding season. The literature contains a wealth of information on breeding bird populations and their habitat relationships. Conversely, studies that focus on non-game birds outside the breeding season are comparatively few. Recent legislation, such as the National Forest Management Act of 1976 (90 Stat 2949) and increased public awareness, has drawn attention to non-game bird species and to the importance of obtaining information on their year-round habitat use. The National Forest Management Act calls for providing a "...diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives..." (United States Statutes at Large 1978).

Studies involving winter passerine populations have been conducted in various parts of the U.S., though as yet, not extensively. The difficulty of such work is summarized by Robbins (1972): "It is, of course, impossible to obtain exact counts of birds present at a given time within a heavily forested habitat in mid-winter." In contrast to conditions during the breeding season, birds in winter do not engage in territorial defense, nest building, courtship displays, and other behaviors associated with attachment to specific sites and vegetation communities (Brewer 1978; Blake 1982). Rather, bird activities are directly related to survival in a harsh environment, in particular, locating food sources (Kricher 1975; Smith 1980; Morse 1971; Welty 1981; Grubb 1975; Kendeigh 1949). Birds forage freely throughout available habitat in winter (Austin and Smith 1972), such that presence and location of species and individuals may vary in study plots from day to day. Thus, all the birds present within a given area, such as a study plot, will likely not be detected at any given time (Robbins 1978).

The literature lacks standardized census procedures for dealing with the special problems of winter population studies. There is no concensus as to the number of times each site should be censused, time of the day, and perhaps more importantly, what census method to use. These and other concerns relating to estimating bird numbers were recently addressed at an International Bird Symposium held in Asilomar, California in 1980 (Studies in Avian Biology No. 6 1981).

Winter bird studies conducted in areas of relatively undisturbed habitat, limited access, harsh climatological conditions, and/or rugged terrain are particularly scarce (Dawson 1981). These conditions are typical of wilderness areas and other similar preserves (Gottfried and Franks 1975; Rotenberry et al 1979). As stated by Kolb (1965), "It is true that there is a pressing need for studying all the biotic phenomena in primeval areas, for, as such areas rapidly disappear we lose forever a baseline for all future ecological studies."

This study was designed to provide baseline information on the habitat use of winter resident passerines in such a preserve, the River of No Return Wilderness of central Idaho. The results of this study may apply to the prediction and evaluation of impacts of habitat alterations resulting from management activities in previously unaltered areas. The objectives of this study were to 1) characterize the winter bird community in the Big Creek Drainage near the Taylor Ranch by determining the bird species composition, diversity and equitability in each of 5 major vegetation communities; 2) describe the vegetation structure and floristics of the sampled sites; 3) identify distribution and activity patterns in relation to habitat and environmental variables.

The hypotheses tested during this study were that there are differences in bird species composition (based on the number of detections) among the 5 vegetation types; that site use (as reflected in the number of detections) is related to temperature, wind velocity, percent cloud cover, or time of day; and finally, that a relationship exists between selected habitat variables, tree density, shrub height classes, etc., and bird presence/absence.

STUDY AREA

The River of No Return Wilderness, formerly the Idaho Primitive Area, is administered by the Payette National Forest and encompasses 931175 ha (Fig.1). It is bordered on the north and south by the Main Salmon River and the Middle Fork of the Salmon, respectively. The study area is located along Big Creek, a major tributary of the Middle Fork of the Salmon. Operations were conducted out of the Taylor Ranch (Fig. 2), a wilderness research faciltiy acquired by the University of Idaho in 1970.

The Taylor Ranch is located at the bottom of a deep canyon, at an elevation of 1169 m. It is accessible only by air during the winter months and by air or foot travel during the snowfree months. The area is characterized by rugged terrain and severe winter weather. Average temperature and precipitation recorded at the Taylor Ranch between January and April 1977 were -.53 C and 1.30 cm respectively (Climatological Data Annual Summary 1977).

The high topographic diversity of the study area results in a mosaic of vegetation types. North slopes are dominated by stands of Douglas-fir (*Pseudotsuga menziesii*) (all plant names follow Hitchcock and Cronquist 1973) of varying canopy density. Southern exposures range from steep talus slopes, to open bunchgrass, to scattered Douglas-fir and ponderosa pine (*Pinus*

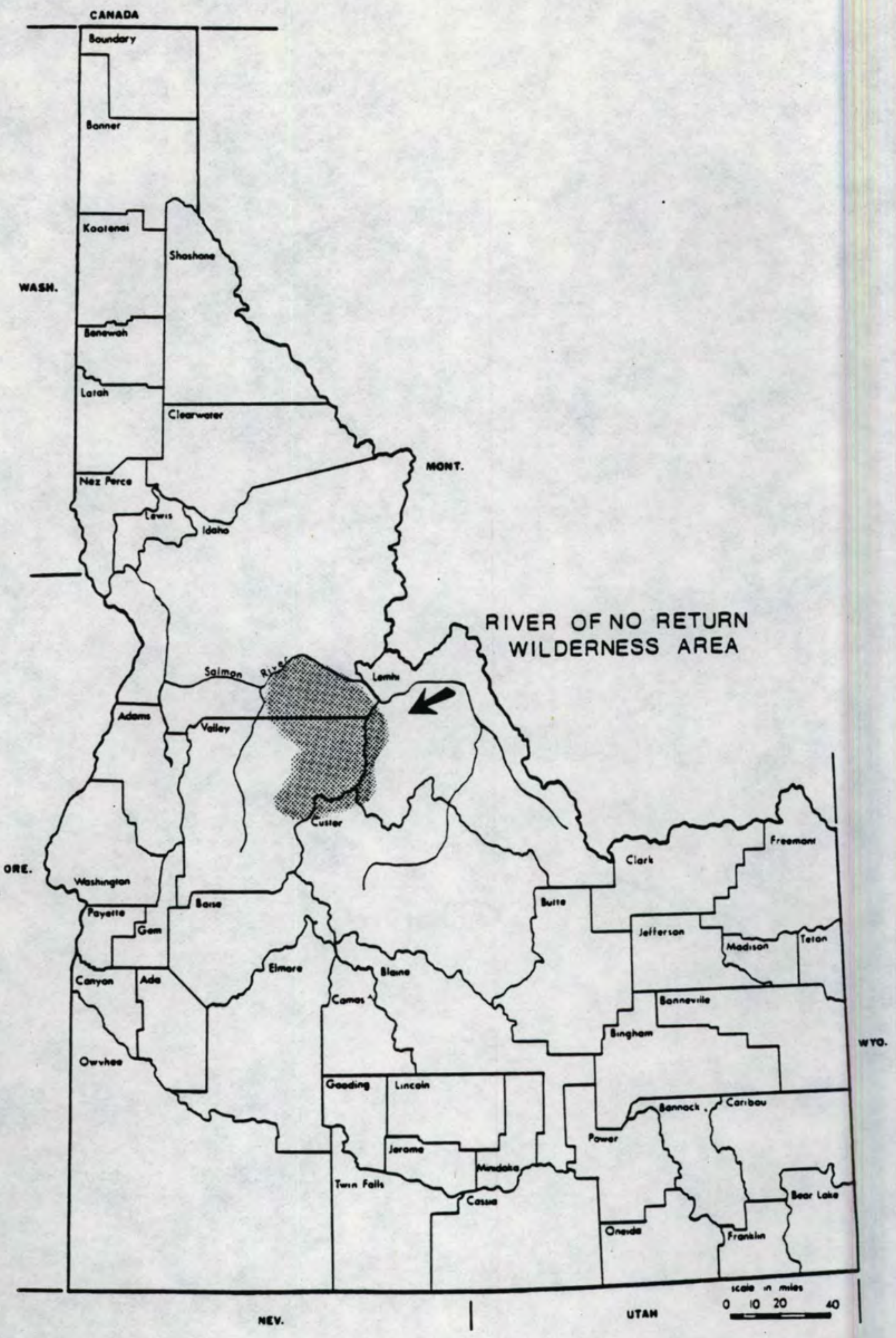

Figure 1. Location of the
River of No Return Wilderness
Area in the State of Idaho.

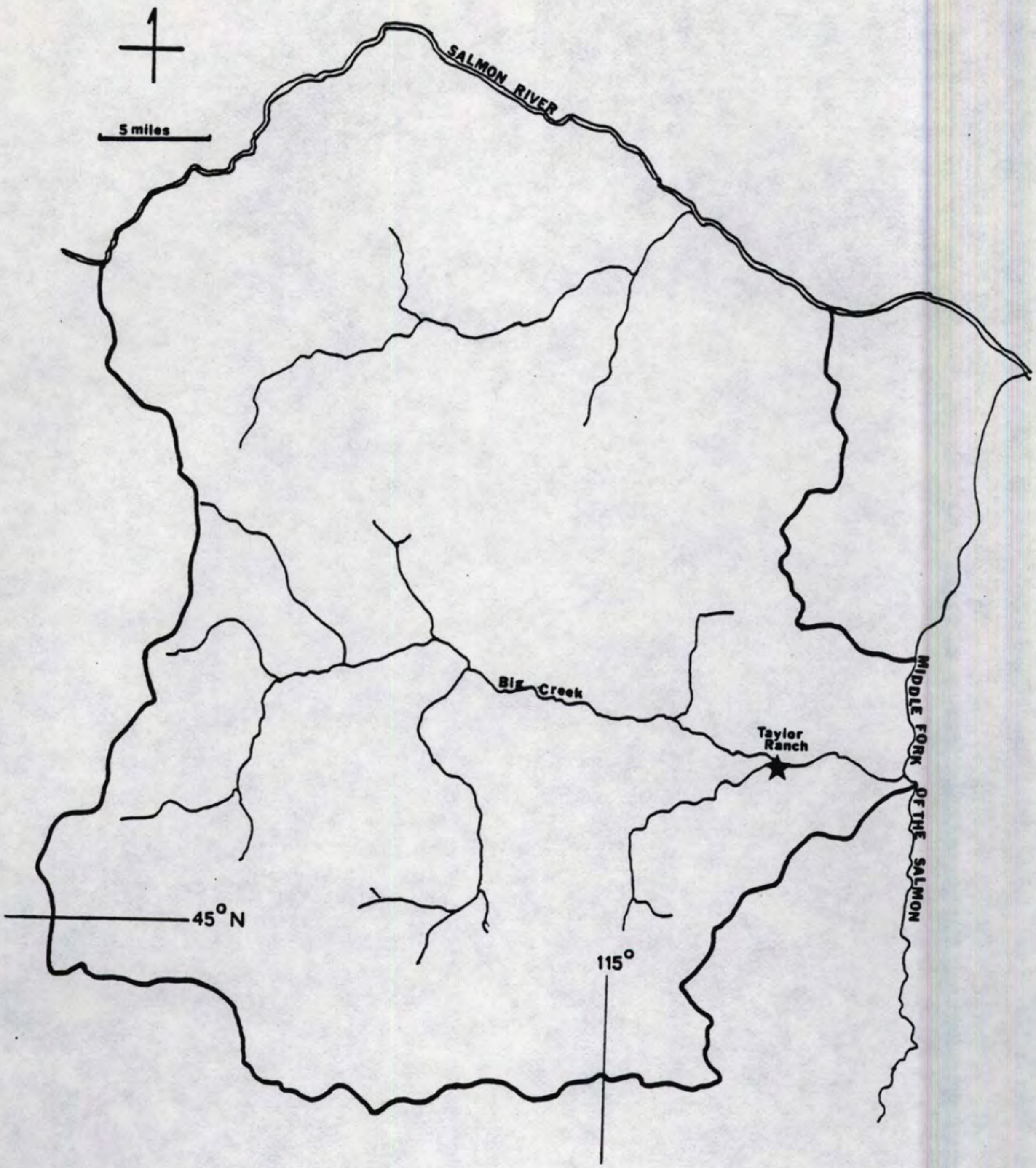

Figure 2. Idaho Primitive Area, now included in the River of No Return Wilderness.

ponderosa). East-west exposures support sagebrush (Artemisia tridentata var. vaseyana), forbs, and a predominance of bunchgrass, (Agropyron spicatum), (Festuca idahoensis), with some Douglas-fir present in the draws. Creek bottoms are characterized by black cottonwood (Populus trichocarpa), Douglas-fir, water birch (Betula occidentalis), thinleaf alder (Alnus incana), and Rocky Mountain maple (Acer glabrum). Small acreages, including the Taylor Ranch airstrip, have been seeded to pasture grasses and are utilized for livestock grazing and annual haying.

METHODS

Five vegetation types were selected as being representative of the major plant communities in the Taylor Ranch area. These included riparian, open Douglas-fir, closed Douglas-fir, sagebrush/grass and bunchgrass communities.

Avian Sampling

A fixed-radius technique or fixed area count (Dawson 1981) was used to obtain avian data. Transect lines totalling 2000 m were established within each of the 5 vegetation types. Transects 1000 m in length were used when large, homogeneous areas of habitat were available. Otherwise, up to 4 transects 500 m in length were established. Permanent bird count stations were established every 100 m and marked with colored flagging or flagged metal stakes.

Counts conducted in 1980 began in late January and terminated soon after spring migrants and summer residents began arriving in mid-April. Sampling was conducted in 1981 between mid-January and early April. Counts were restricted to daylight hours (0630 to 1600). No counts were conducted during conditions of rain or snow or if wind velocity exceeded 6 km per hour.

Observations were recorded during a 3-minute period for all birds detected within a 50 m radius around each station.

Rate of progress between stations was maintained as constant as possible, even under adverse travel conditions of steep, snowy, and often icy terrain. Information recorded for each bird observation included station number, time of day, species of bird detected, distance (m) from observer, and the type of detection made (audible, visual or both). Temperature, wind velocity and percent cloud cover were recorded at every sixth station. Foraging information was collected for all visual detections during the winter of 1980, but was discontinued in 1981 due to the low frequency of visual detections. Each vegetation type was visited 10 times in 1980 and 7 times in 1981. Direction travelled along transects was reversed on successive visits to reduce sampling bias.

Vegetation Sampling

Vegetation sampling was conducted after spring green-up. Each bird station served as plot center for a 50 m radius vegetation sampling plot. Subplots were used to sample vegetation strata within the main plot (Fig.3). A random compass heading determined where the individual vegetation subplots would lie within the 50 m radius main plot circumscribed around each bird station. Shrub sampling was conducted within each of the following height classes: 1 = <1.5m; 2 = 1.5 - 3.1m; 3 = 3.1 - 4.6m; 4 = 4.6 - 6.1m; 5 = 6.1 - 9.1m; 6 = 9.1 - 12.2m; and 7 = 12.2 - 15.2m. Three sizes of subplots were used in the riparian, open Douglas-fir and closed

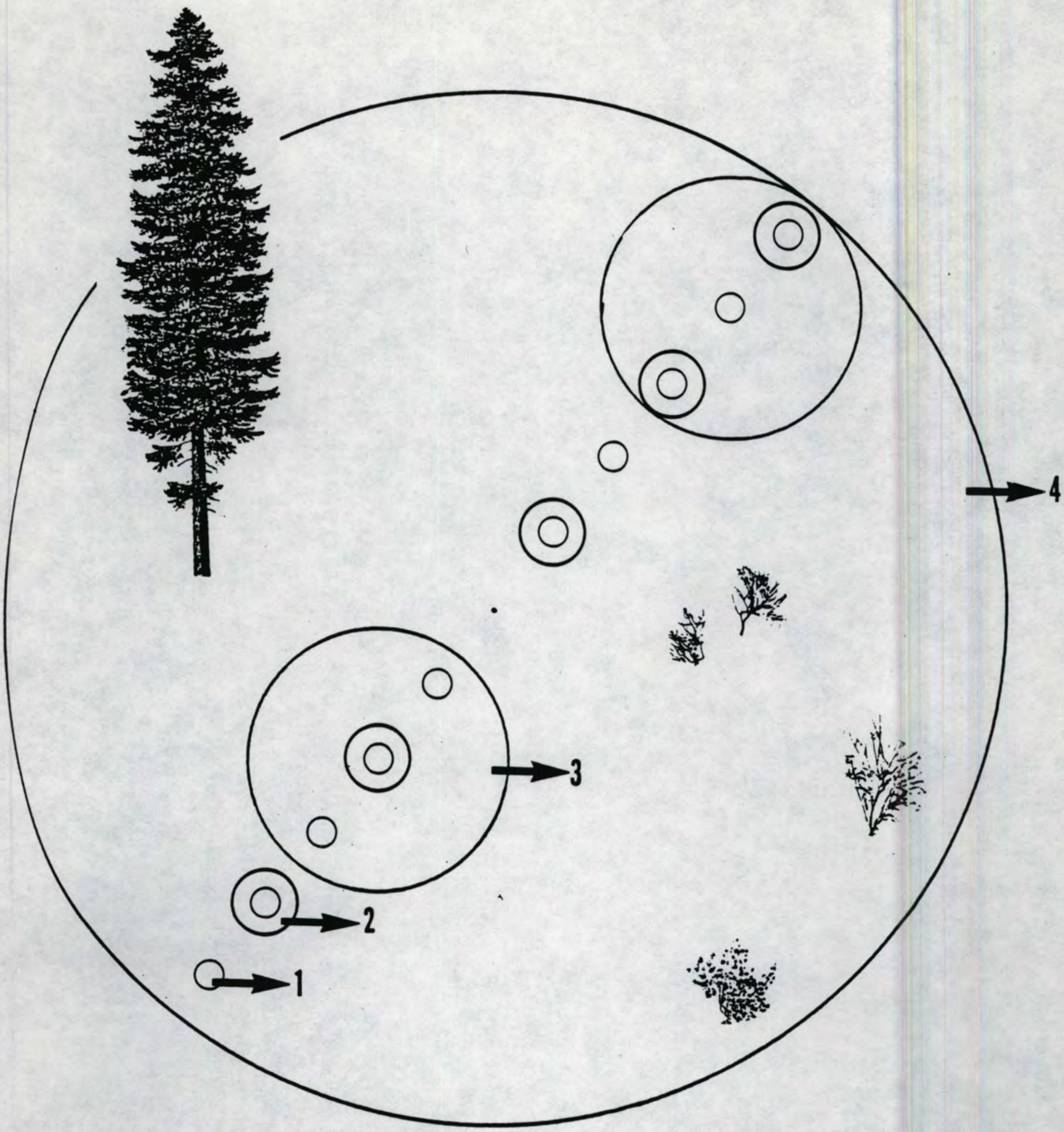

Figure 3. Schematic of nested plots used in vegetation sampling in each of 5 vegetation types. Numbers designate plots of differing radii and the life forms sampled: 1=4m^2, shrubs <1.5m; 2=5.6m^2, shrubs >1.5m; 3=12.6m^2, trees; 4=50m, the size of each bird census plot within which the vegetation plots were established.

Douglas-fir types: 4 m² circular plots for shrubs in height class 1; 5.6 m² circular plots for the remaining 6 height classes; and 12.6 m² circular plots for trees. Two sizes of subplots were used in the bunchgrass and sagebrush/ grass types: 5.6 m² circular plots for low shrubs, and 12.6 m² circular plots for taller shrubs. A total of 220 low shrub subplots, 110 tall shrub subplots and 44 tree subplots were established in the riparian, open Douglas-fir and closed Douglas-fir types. A total of 110 low shrub subplots and 44 tall shrub subplots were established in the bunchgrass and in the sagebrush/grass types.

Species, number, and height class were recorded for each shrub within a subplot. Trees were classified as saplings, poles or mature trees according to their diameter at breast height (DBH). A sapling had a DBH greater than 10.3 cm, a pole was from 10.5 to 28.2 cm, and a mature tree DBH was greater than 28.2 cm.

Field measurements of trees followed those recommended for determination of tree crown volume by Mawson et al. (1976). Variables measured included crown profile class, crown plan class, total height, bole height, plan radius, diameter and crown density class.

Grass/forb plots were established at or near each bird census station. All plants within a 4 m² radius circular plot were identified to establish a species list for each vegetation type.

ANALYSIS

A univariate test for normality indicated that the avian data was strongly non-normal. Square-root and log transformations ($X'=\sqrt{X+0.5}$; $X'=\log(X+1)$) (Zar 1974) failed to normalize the data. Therefore, unless stated otherwise, non-parametric procedures were used for data analysis.

An Extension of the Median Test (Daniel 1978; Siegel 1956) was used to test the null hypothesis that there were no differences in the number of bird detections among the 5 vegetation types.

Chi-square contingency tables were used to test the null hypothesis that the activity level of birds, as indicated by the number of detections, was not related to temperature, wind velocity, cloud cover, or time of day (Daniel 1978; Ott 1977; Helwig and Council 1976).

The Shannon-Wiener information formula ($H'=-\sum \log p^2$) assessed bird species diversity for each vegetation type (Whittaker and Levin 1975: 169). Simpson's (1949) index was used to derive niche breadth indices for all species ($1/\sum p_i{}^2$, p=the proportion of total detections of a species in each vegetation type) (Whittaker and Levin 1975:1969). The degree of overlap between bird species in their use of vegetation types was determined by using Horn's overlap (overlap=$R=H_{max}-H_{obs}$ / $H_{max}-H_{min}$) (Horn 1966).

Testing the null hypothesis that no relationship exists between habitat variables and bird presence/absence required several steps. First, the vegetation data was determined to be non-normal by a univariate normality test. No attempts at transformation were made. The bunchgrass and sagebrush/grass vegetation types had much lower numbers of detections compared to the other three types, and were therefore eliminated from further analyses. Canopy volume was calculated using Program HTVOL, a fortran program designed to determine tree crown volume (Mawson et al. 1976). Next, in order to determine which vegetation variables effectively discriminated between the riparian, open Douglas-fir and closed Douglas-fir types, the 21 vegetation characteristics measured or secondarily derived (canopy volume) were entered into a stepwise discriminant analysis. Two functions were generated by this procedure (Appendix 2). The variables from each function were then ranked in order from highest to lowest canonical coefficient. From this ranked list a total of 12 vegetation variables were ultimately selected for inclusion in further discriminant tests. These included mean DBH, mean tree height, number of trees, mean tree crown density, mean sapling height, mean pole height, canopy volume, number of shrubs in height class 2 (1.5-3.1 m), number of shrubs in height class 1 (0-1.5 m), mean pole crown density, mean sapling crown density, and number of poles.

Lastly, stepwise discriminant analysis was performed on the combined avian/vegetation data to test whether specific vegetation variables contributed to bird presence/absence (Nie et al. 1975). Only the most abundant bird species in each winter were included. These were mountain chickadees and golden-crowned kinglets in 1980, and mountain chickadees, red-breasted nuthatches and pine siskins in 1981. Stepwise discriminant analysis was performed on 2 subsets of the bird data (year and bird species; and year, vegetation type, and bird species), for a total of 20 separate tests. The same set of 12 vegetation variables was used in each test. The non-normality of avian and vegetation data used in the stepwise discriminant procedures places restrictions on the quantitative interpretation of these analyses.

RESULTS

Avian Composition and Diversity

Seven and 12 species were detected in 1980 and 1981 respectively. Those species observed in both years were the Clark's nutcracker (*Nucifraga columbiana*), mountain chickadee (*Parus gambeli*), black-billed magpie (*Pica pica*), brown creeper (*Certhia americana*), golden-crowned kinglet (*Regulus satrapa*), and dipper (*Cinclus mexicanus*). Steller's jays (*Cyanocitta stelleri*) were detected only in 1980. Additional species observed in 1981 included the dark-eyed junco (*Junco hyemalis*), red-breasted nuthatch, (*Sitta canadensis*), pine siskin (*Carduelis pinus*), red crossbill (*Loxia curvirostra*), black-capped chickadee (*Parus atricapillus*), and song sparrow (*Melospiza melodia*). (American Ornithologists' Union 1982).

Total number of detections and bird species composition varied among vegetation types and years (Table 1). In 1980, 6 species were detected in the riparian type, 6 in the open Douglas-fir, 6 in the closed Douglas-fir, 4 in the sagebrush/grass, and 3 in the bunchgrass. During 1981, 11 species were observed in the riparian, 9 in the open Douglas-fir, 8 in the closed Douglas-fir, 4 in the sagebrush/grass, and 2 in the bunchgrass (Table 2).

Results of the Extension of the Median test indicate that there were significant differences in bird detections among

Table 1. Bird species and total numbers detected in 10 sampling periods from 5 vegetation types in winter 1980.

Species	Riparian	Open Douglas-fir	Closed Douglas-fir	Sagebrush-grass	Bunch-grass
Mountain chickadee	55	46	22	8	0
Golden-crowned kinglet	40	47	8	3	1
Clark's nutcracker	3	2	3	8	2
Black-billed magpie	0	2	2	4	14
Steller's jay	8	7	2	0	0
Brown creeper	4	1	2	0	0
Dipper	5	0	0	0	0
TOTAL	115	105	39	23	17

Table 2. Bird species and total numbers detected in 7 sampling periods from 5 vegetation types in winter 1981.

Species	Riparian	Open Douglas-fir	Closed Douglas-fir	Sagebrush-grass	Bunch-grass
Mountain chickadee	28	18	16	2	2
Golden-crowned kinglet	1	2	0	0	0
Clark's nutcracker	4	7	17	2	0
Black-billed magpie	0	0	0	1	1
Brown creeper	4	3	1	0	0
Dipper	3	0	0	0	0
Song sparrow	3	0	0	0	0
Dark-eyed junco	9	7	17	2	0
Red-breasted nuthatch	16	24	52	0	0
Pine siskin	8	123	125	0	0
Red crossbill	1	9	9	0	0
Black-capped chickadee	2	1	3	0	0
TOTAL	79	194	226	6	3

vegetation types ($p<.001$ in 1980 and 1981). There was a difference at the .001 level between the riparian and bunchgrass type, open Douglas-fir and sagebrush/grass type, and the open Douglas-fir and bunchgrass type over both winters. There were also differences between the riparian and sagebrush/grass type ($p<.001$ in 1980, $p<.01$ in 1981), between the riparian and closed Douglas-fir type ($p<.025$ in 1980), and between the bunchgrass and closed Douglas-fir type and the sagebrush/grass and closed Douglas-fir type ($p<.001$ in 1981). There were no significant differences between riparian and open Douglas-fir, open Douglas-fir and closed Douglas-fir, or bunchgrass and sagebrush/grass types for either year.

Bird species diversity (H') was calculated for each vegetation type and year (Table 3). Highest diversity in 1980 resulted for the sagebrush/grass type ($H'=1.30$), followed by the closed Douglas-fir, riparian, open Douglas-fir and the bunchgrass types. In 1981, the riparian type had the highest diversity ($H'=1.92$), followed by the sagebrush/grass, closed Douglas-fir, open Douglas-fir, and bunchgrass types. These results differ from the diversity rankings obtained by using species richness (number of species) as an indicator of diversity. In that case, the 1980 rankings were riparian=open Douglas-fir=closed Douglas-fir, followed by the sagebrush/grass and bunchgrass types, respectively. In 1981, diversity was greatest for the riparian type, followed by the open Douglas-fir, closed Douglas-fir, sagebrush/grass and bunchgrass

Table 3. Shannon-Wiener Diversity Indices (H') for 2 winters of bird sampling in 5 vegetation types.

Species	Year 1980	 1981
Riparian	1.25	1.92
Open Douglas-fir	1.10	1.28
Closed Douglas-fir	1.30	1.31
Sagebrush-grass	1.30	1.33
Bunchgrass	.58	.64

types.

The highest niche breadth index in 1980 was for the Clark's nutcracker (3.60). This species used the broadest range of habitats of the 7 species detected that year. Dippers, found only in the riparian type, had the lowest niche breadth index (1.00). In 1981 the mountain chickadee had the broadest habitat range (3.17). Both the song sparrow and dipper were restricted to a single vegetation type (Table 4).

Horn's values calculated for 1980 indicated that mountain chickadees and golden-crowned kinglets had the highest degree of overlap (95%) in their use of vegetation types. The black-billed magpie and dipper used no vegetation types in common (Table 5). In 1981, the highest degree of overlap (100%) occurred between song sparrows and dippers, as both were detected only in the riparian type. The species with the lowest degree of overlap with all other species was the black-billed magpie, which was detected almost exclusively in the bunchgrass type (Table 6).

Table 4. Niche breadth indices ($1/\Sigma p_i^2$) for bird species detected during 2 winters of sampling.

Species	Year 1980	 1981
Steller's jay	2.47	--
Clark's nutcracker	3.60	3.00
Mountain chickadee	3.01	3.17
Black-billed magpie	2.20	2.00
Brown creeper	2.33	2.46
Dipper	1.00	1.00
Golden-crowned kinglet	2.52	1.80
Song sparrow	--	1.00
Dark-eyed junco	--	2.90
Red-breasted nuthatch	--	2.39
Pine siskin	--	2.13
Red crossbill	--	2.21
Black-capped chickadee	--	2.57

Table 5. Horn's overlap values (%) for bird species detected during winter 1980 sampling.

	Clark's nutcracker	Mountain chickadee	Black-billed magpie	Brown creeper	Dipper	Golden-crowned kinglet
Steller's jay	48.11	27.76	10.68	62.31	56.33	32.39
Clark's nutcracker		14.97	45.71	36.20	25.00	15.20
Mountain chickadee			5.60	10.85	9.62	95.32
Black-billed magpie				4.97	0	6.51
Brown creeper					86.95	10.98
Dipper						9.75

Table 6. Horn's overlap values (%) for bird species detected during winter 1981 sampling.

	Mountain chickadee	Black-billed magpie	Brown creeper	Dipper	Song sparrow	Golden-crowned kinglet	Dark-eyed junco	Red-breasted nuthatch	Pine siskin	Red crossbill	Black-capped chickadee
Clark's nutcracker	41.86	2.17	74.13	24.24	24.24	42.10	56.53	22.74	4.73	81.42	48.07
Mountain chickadee	0	.58	26.04	12.16	12.16	9.29	72.87	70.43	16.43	43.52	17.60
Black-billed magpie			0	0	0	.94	0	0	0	0	0
Brown creeper				68.57	68.57	64.52	32.96	10.68	1.75	42.33	52.17
Dipper					100.00	42.86	12.50	2.85	.06	3.40	52.17
Song sparrow						42.86	12.50	2.85	.06	3.40	52.17
Golden-crowned kinglet							10.75	3.64	.725	22.62	42.10
Dark-eyed junco								3.64	12.99	76.80	34.78
Red-breasted nuthatch									38.93	37.56	11.94
Pine siskin										8.69	2.23
Red crossbill											42.93

Habitat Composition and Structure

The 5 vegetation types differed in plant species composition and structural characteristics. The predominant low shrub species (0-1.5 m) in the riparian type included wild rose (Rosa sp.), Oregon grape (Berberis repens), and snowberry (Symphoricarpos albus). In the open Douglas-fir type this layer included snowberry, ninebark (Physocarpus malvaceus), and white spiraea (Spiraea betulifolia). The low shrub component in the closed Douglas-fir type was virtually the same as that of the open Douglas-fir type, but occurred at lower density levels. Fewer low shrubs were present in the bunchgrass type and included chokecherry (Prunus virginiana), gooseberry (Ribes velutinum) and syringa (Philadelphus lewisii). The low shrub component in the sagebrush/grass type included big sagebrush (Artemisia tridentata var. vaseyana), an occasional gooseberry and wax currant (Ribes cereum). A complete list of plant species is presented in Appendix 1.

The 2 Douglas-fir vegetation sites in this study were Pseudotsuga menziesii/Physocarpus malvaceus habitat types (Steele et al. 1981). The sagebrush/grass site was determined to be a Artemisia tridentata var. vaseyana/Agropyron spicatum habitat type, (Hironaka and Fosberg 1979), and the bunchgrass site was a mosaic, probably of Festuca idahoensis/Agropyron spicatum and Agropyron spicatum/Poa sandbergii types (Tisdale 1979). The riparian habitats in this area have not been formally described.

The riparian and sagebrush/grass types had 100% frequency of the low shrub height class. The open Douglas-fir and closed Douglas-fir types were intermediate in low shrub density, and the bunchgrass type had the lowest density of low shrubs (Table 7).

The predominant tall shrub species (>1.5 m) in the riparian type included red ozier dogwood (Cornus stolonifera), serviceberry (Amelanchier alnifolia), wild rose, and syringa. Wax currant, bitterbrush (Purshia tridentata), ninebark, and serviceberry dominated the tall shrub category in open Douglas-fir. In closed Douglas-fir, serviceberry, ninebark, syringa and wax currant were the most common tall shrubs.

Overall, the riparian type had the greatest density of tall shrubs. All shrub height classes (1 through 7) were represented in this type (Table 7). The other 4 vegetation types had shrubs only up to and including height class 3 (3.1-4.6 m).

The tree overstory in the riparian type consisted mainly of Douglas-fir and black cottonwood. The open Douglas-fir overstory consisted of that species, with traces of ponderosa pine. The overstory in the closed Douglas-fir type was 100% Douglas-fir. Bunchgrass and sagebrush/grass types essentially had no tree component

Table 7. Frequency (%) of shrub and tree size classes sampled in 5 vegetation types during the spring/summer of 1981.

	Tree Size Class			Shrub Height Class[1]						
Vegetation Type	Sapling	Pole	Tree	1	2	3	4	5	6	7
Riparian	45.5	45.5	91.0	100.0	100.0	95.5	77.3	86.4	68.2	13.6
Open Douglas-fir	63.6	50.0	91.0	95.0	100.0	40.9	0	0	0	0
Closed Douglas-fir	68.2	86.4	100.0	95.0	100.0	31.8	0	0	0	0
Sagebrush-grass	0	0	0	100.0	95.0	81.8	0	0	0	0
Bunchgrass	0	0	0	45.5	27.3	9.0	0	0	0	0

[1] 1 = 1.5 m
2 = 1.5 - 3.1 m
3 = 3.1 - 4.6 m
4 = 4.6 - 6.0 m
5 = 6.1 - 9.1 m
6 = 9.1 - 12.2 m
7 = 12.2 - 15.2 m

Greatest development of conifers, including mature trees, poles and saplings, occurred in the closed Douglas-fir type. The open Douglas-fir and riparian types contained lower tree densities and a more open pole and sapling understory. Canopy volume did not parallel this trend. The riparian type had the highest average volume, (25,396 m^3/ha), followed by the open Douglas-fir type (25,156 m^3/ha), and the closed Douglas-fir type (16,062 m^3/ha).

Overall, based on the number of different tree size classes and shrub height classes represented in each type, the riparian type had the most structural diversity. This is followed by the closed Douglas-fir, open Douglas-fir, sagebrush/grass and lastly, the bunchgrass type.

Avian Detections In Relation to Environmental Variables

No strong relationships of avian detections to environmental variables or time of day were shown by the tests performed. A majority of the chi-square tests performed were invalid because over 20% of the cells had expected values less than 5. Twenty-seven percent of the tests run had significant chi-square values at the .05 level, and were related primarily to percent cloud cover and time of day. The pattern of these relationships, however, appeared random. Results differed by year: 41% of the significant results were from 1980, and 59% were from 1981. Also, 76% of the significant results showed a strong relationship to bird absence (i.e. when censusing I had 0 detections) rather than to bird presence (24%).

The tests that showed a significant relationship to bird presence occurred primarily in the Douglas-fir types. In closed Douglas-fir in 1981, greater number of bird detections occurred between the hours of 0630 and 1130 than between 1130 and 1600. The same was observed after combining the open Douglas-fir with the closed Douglas-fir type. When 3 time classes were entered into the analysis rather than 2, the results showed that the greatest number of detections for that combined type came between 1000 and 1300, followed by 0630 to 1000 and 1300 to 1600, respectively. Again in 1981 for the combined Douglas-fir type, the greatest number of bird detections occurred with cloud cover of 75-100%, followed by 0-25% and 25-75%, respectively. The remainder of the analyses showed relationships to bird absence rather than bird presence.

The means of bird detection (audible, visual, or both) varied by type and by year. In 1980 and 1981, most detections were audible (52% and and 38%, respectively). In 1980, visual detections were the second most common method of detection (27%) and the combined audio-visual method was third (21%). This was reversed for 1981 - only 26% were visual while 36% were audio-visual.

Avian Orientation to Habitat Variables

Results of the stepwise discriminant analyses identified relationships of bird presence/absence in the riparian, open Douglas-fir and closed Douglas-fir types to certain vegetation variables (Appendix 3). Of the 20 tests performed, 8 generated significant results (p<.05). Five tests which were significant at the .05 level were influenced by low numbers of bird detections and were not evaluated. Six tests were not significant at the .05 level, and 1 selected no variables for testing.

Mountain chickadee presence/absence in 1980 was discriminated most strongly by the mean DBH and tree crown density variables. Chickadee presence appears related to high values of mean DBH and pole crown density, and low values of tree crown density and number of poles. In the open Douglas-fir type in 1980, the number of trees and the number of shrubs in height class 2 (1.5-3.1 m) were the 2 strongest variables discriminating presence/absence. Presence was associated with high numbers of trees, and with low numbers of poles and shrubs in height class 2.

Golden-crowned kinglet presence in 1980, regardless of vegetation type, was most strongly related to the number of shrubs in height class 1. This was the only discriminating variable produced for kinglet presence. Number of shrubs in height class 2 and canopy volume were the strongest discriminating variables for kinglet presence/absence in the riparian type in 1980. Kinglet presence appeared to be related to high numbers of shrubs in height classes 1 and 2, high sapling and pole crown densities, and low values for canopy volume and number of poles.

Red-breasted nuthatch presence/absence in 1981 was discriminated most strongly by the number of shrubs in height class 2 and canopy volume. The presence of nuthatches was related to high values of canopy volume, number of poles and tree crown density, and low numbers of shrubs in height class 2 and sapling crown density. The number of shrubs in height class 2 and canopy volume were the strongest discriminators of nuthatch presence/absence in the open Douglas-fir type in 1981. Presence was associated with high canopy volume, tree crown density and pole height values, and low numbers of shrubs in height class 1 and low pole crown densities.

Pine siskin presence/absence in 1981 was most strongly discriminated by the number of shrubs in height class 2 and mean sapling crown density. Siskin presence was associated with high sapling and tree crown densities, and pole height, and low numbers of shrubs in height class 2, low pole crown density, and low tree height. In the open Douglas-fir type in 1981, mean sapling and pole crown densities were the strongest discriminating variables for siskin presence/absence. High values of sapling and tree crown densities, pole height and number of poles, and low pole crown density, low canopy volume and low mean DBH were associated with bird presence.

DISCUSSION

Avian Composition and Diversity

Species observed in the Big Creek Drainage differed greatly between the 2 winters of the study. Six species studied in 1981 did not appear the previous year until spring. Two explanations, one related to winter weather conditions and the other to food production, may have application to this finding.

The winter environment can affect geographic distribution patterns of birds as well as local patterns of occurrence. Winter environmental conditions may act to encourage the range expansion of some species, or severely limit the range expansion of others (Graber and Graber 1979). A series of mild winters, for example, may allow some southern species to expand their range northward. Conversely, mild winters may discourage some marginal species from migrating at all. Extremely harsh winter weather conditions can prohibit range expansion, or cause the range "retraction" of some species. This is brought about by the mortality of dispersing individuals (Graber and Graber 1979).

Annual variations in winter weather conditions, particularly snowfall, may cause between year differences in the bird species wintering in an area. Weather conditions in the Big Creek Drainage differed greatly between the 2 years of the study. Although average temperatures were higher in 1980, there was a persistent snow cover throughout the sample period. Average 1981 temperatures were cooler, but more importantly, there was no snow cover at all. This difference in snow cover may explain why the dark-eyed junco, a ground foraging species, was absent in 1980 but common in 1981. The food of this bird, primarily seeds, would have been relatively unavailable under the persistent snow cover of winter 1980.

A second explanation for between-year differences in species occurrence in this study involves food production. Although not quantified, a good cone crop could have occurred in the Big Creek Drainage in 1981, and may explain the presence of pine siskins, red-breasted nuthatches, and red crossbills that year. The pine siskin, red-breasted nuthatch, and red crossbill (all present in 1981 only), and the Clark's nutcracker (present both winters but in reduced numbers in 1980), are altitudinal migrants. For these species, a good cone crop provides a favorable food supply. According to Bent (1968), pine siskins wander during the non-breeding season. "But when food is plentiful, many observers have noted that siskins will remain in one particular area over a long space of time." Burleigh (1972) notes that the presence of siskins in Idaho is at best "erratic". There are usually small flocks present in Idaho in the winter, though in some years siskins may be totally absent, while other years they are abundant and in large flocks.

The red-breasted nuthatch also takes advantage of an abundant food source and in the winter can be "...found feeding in a region where trees...have seeded abundantly the past season." (Bent 1964). Both Bent (1964) and Burleigh (1972) relate the presence and relative abundance of the red-breasted nuthatch in winter to a good cone crop. When cone crops are low, the numbers of nuthatches are low, too. Cone crop is an important factor for red crossbills as well, and they will move elevationally in search of an abundant food source (Smith 1980; MacArthur 1964).

Corvids, like Clark's nutcracker, are dependent on cone crops and will search them out over large areas. The Clark's nutcracker is an altitudinal migrant and wanders during the fall and winter (Bent 1964; Burleigh 1972). Habitat is not as important to them as a reliable food source is, and they will stay in an area until that food source is depleted (Smith 1980; Burleigh 1972). Bock and Lepthien (1976) found that Clark's nutcracker population explosions generally occurred the year after a good cone crop. The increased food supply enabled more birds to survive the winter and breed successfully, which resulted in a larger population the following winter.

It seems apparent from the literature that an abundant and reliable food source is very important for pine siskins, red-breasted nuthatches, red crossbills and Clark's nutcrackers, as oftentimes their presence and numbers are related closely to it. Because this parameter was not actually measured, I can only speculate that the presence/increased numbers of these species in the study area in 1981 was related specifically to an abundant cone crop.

Relative diversity of birds in the vegetation types of the study area, as measured by H', did not agree with diversity rankings based on species richness alone. H' incorporates both evenness and species richness, as stated by Tramer (1969): "...diversity within a collection of communities might vary as a function of changes in either its richness component (number of species) or its evenness component (distribution of relative abundances of the species), each of which represents an alternative response." Variations in these ecological descriptors have been related to environmental conditions. According to Rotenberry (1978) and Tramer (1969), variations in species richness come when environmental conditions are "predictable" during the spring and summer, and that variations in evenness come under "unpredictable" harsh climatic conditions during the fall and winter. In the study area, the high H' values associated with the sagebrush-grass and open Douglas-fir types in 1980 were a result of the high evenness of detections. The riparian type, on the other hand, had the same number of species as the sagebrush-grass but in a less even distribution, resulting in a low H'. The uneven weighting of golden-crowned kinglet and mountain chickadee detections in proportion to the other species contributed to this low H' and therefore to the differences noted between the quantitative and qualitative results. Kricher (1975) noted similar trends in his winter diversity indices, resulting in part from the relative abundance of a few species rather than several.

As indicated by niche breadth indices, bird species in the Big Creek Drainage varied according to the range of habitats used. For instance, Clark's nutcracker and mountain chickadee had relatively high niche breadth indices. The Clark's nutcracker forages widely and would therefore be termed a habitat generalist. The mountain chickadee, opportunistic in its use of food sources and habitats, forages for insects as well as seeds (Peterson 1964). This species' food requirements are not met by any one food item in a particular habitat.

Some species are oriented to or restricted to riparian zones. Dippers feed on aquatic insects and other invertebrates (Peterson 1964), and as such, detections were restricted to riparian areas. Song sparrows were detected only in the riparian type. A preference for thickets and brushy habitat (Peterson 1964; Burleigh 1972) may have been the restricting factor for this species.

Black-billed magpies forage most effectively in grassy, open areas, though they may require trees for roosting and other activities. Although "river thickets" are cited as magpie habitat (Peterson 1964; Bent 1964), detections in the riparian type were rare. Magpie diet includes insects, vegetable matter, and whatever animal matter (such as carrion) is available during the winter months. This species is also recognized as an elevational migrant (Bent 1964). An interesting association was noted in 1980 between magpies and big game animals in the Big Creek Drainage. Bighorn sheep (*Ovis canadensis*) and mule deer (*Odocoileus hemionus*) (Walker 1975) were common on the bunchgrass slopes, and mule deer occurred in the sagebrush/grass type. Groups of black-billed magpies foraged around these animals and their droppings, and even pecked on their backs. Similar observations documented by Bent (1964) confirm that magpies eat dung-inhabiting insects, and will pick ectoparasites (such as ticks) off the backs of domestic stock and big game animals. Sightings of mule deer and bighorn sheep were greatly reduced in 1981, presumably because of low snowpack at the higher elevations. I speculate that the low number of sheep and deer in the bunchgrass and sagebrush/grass types accounted for the reduced number of magpies detected that year.

The high Horn's overlap value calculated for mountain chickadees and golden-crowned kinglets in 1980 verified my field observations in that these species usually occurred together. Both species foraged on timbered sites, although in 1980 I occassionally observed them foraging in the sagebrush, particularly in and around shrubs with persistent fruits. Both are birds of coniferous forests (Bent 1964; Burleigh 1972), though their food preferences differ, and both are altitudinal migrants during the fall and winter (Bent 1964). Mountain chickadees forage on insects as well as seeds, while golden-crowned kinglets are more often found foraging on insect eggs and spiders during the winter (Smith 1980; Peterson 1964).

Bird species diversity and habitat use varied between years of this study, partially as a result of differences in species presence and numbers each year. Variations in detection results were further influenced by winter weather conditions and food availability, as the sampling was conducted in 2 diverse years. In order to make further statements regarding these relationships, additional winter sampling would be necessary.

Avian Detections In Relation to Environmental Variables

Substantial documentation exists which shows that environmental variables, such as wind velocity, percent cloud cover, temperature, and relative humidity, do influence the activity level of birds in winter. Results of my analysis failed to show significant or consistent relationships between avian observations and environmental variables. This result was likely due to sampling deficiencies. Two major problems encountered were low numbers of bird detections, and inadequate distribution of these detections among classes of environmental variables sampled. The following discussion details environmental factors that may have accounted for both low and irregular distribution of detections among environments sampled.

Shaver (1933) found that wind velocity, unlike wind direction, had a direct effect on the local movements of bird populations. This observation was probably due to increased wind-chill, and subsequent effects on thermoregulation. Crist (1966) reported greater attendance at bird feeders when wind velocity was less than 6.2 kph. Attendance decreased as a function of increasing wind speed. Air temperature, alone or in combination with wind velocity, affects activity levels and behavior of winter birds. The lower critical temperature for birds is 12 C (Grubb 1975; Gottfried and Franks 1975). Winter temperatures are generally much lower than the body temperature range of birds (Kricher 1975). Birds may therefore be expected to display behaviors that enhance their thermoregulatory abilities. Selection of sunny patches as foraging sites on cold, sunny days has been documented (Grubb 1975, 1977; Brewer 1978; Moen 1968; Morse 1970). Basking behavior by perched birds has also been observed (Morse 1970). Shaver (1933) found no correlation between winter bird activity and duration of sunshine during the day, and concluded that birds were most influenced by wind velocity and air temperature. At night, birds may alter their "thermal balance" by fluffing up their feathers and orienting themselves out of the wind while roosting (Moen 1968).

Winter temperatures affect metabolic processes of birds. Energy stores are stressed to meet the extra demand for heat production (Kendeigh 1969; Helms 1968). Food intake increases as temperatures drop (Welty 1982; Kendeigh 1949). Although maximum body fat reserves occur in winter, a harsh winter environment requires generation of extra heat to maintain "existence metabolism" (Welty 1982). Birds in the winter must also expend energy to remain alert for possible attack, to interact socially, and to locate nightly cover (Kendeigh 1949). In addition, a reserve must be maintained in case of extreme cold. According to Gottfried and Franks (1975), "... wintering birds may metabolize up to 15% of their body weight during the night." Some birds can lower their body temperature and go into a torpor-like state in order to avoid burning up calories unnecessarily at night (Steen 1958).

Cloud cover does not appear to be an important factor influencing winter bird activity (Robbins 1981b). Crist (1966) did observe the highest percentage of birds at his feeder when skies were clear, but he did not sort out possible effects of wind velocity and air temperature. Although the actual results appear random, a greater number of bird detections in 1981 occurred under overcast skies. Heavier cloud cover can have an insulating effect, increasing ambient air temperatures over cloud-free winter days, which in turn may affect avian activity levels.

Weather influences microhabitat selection and associated behavior of birds in winter. Foraging lower in the vegetation stratum, on the larger tree branches, on the tree trunk, and even on the lee side of trees, are behaviors associated with cold and windy conditions (Grubb 1975, 1977, 1978; Morse 1970). Contrasting behaviors are associated with warmer, calmer weather conditions. Tree species selected as foraging sites may also be affected by wind velocity (Grubb 1975, 1977, 1978). Colquhoun (1940) found that winter birds may exhibit huddling behavior within protective cover during periods of high wind. Differing weather conditions between north and south slopes may result in differential use of exposures (Robbins 1978). Shields and Grubb (1974) found high population densities on the warmer, drier, less windy south slopes than on the harsher north slopes, even though the latter had greater food abundance.

Gross habitat use patterns may also be affected by harsh winter weather (Kricher 1975; Kendeigh 1934), as extended periods of severe weather can displace local populations. Birds may leave an area of high food preference and shelter for a less preferred one (Graber and Graber 1979).

Bird activity levels and behaviors change throughout the day in response to changing environmental conditions. Identification of daily patterns would enable researchers to make the best decisions with regard to time of day for conducting avian sampling. Both Grubb (1978) and Conner and Dickson (1980) suggested that time of day for winter counts is not as critical as it is during the breeding season. Afternoon counts, especially in the northern U.S., were judged acceptable. Activity patterns reported in the literature are variable, however. Engstrom and James (1981), Robbins (1972, 1981a), and Ketterson (1978) all found winter birds to be more active early in the morning. Shields and Grubb (1974), Brewer (1978), and Kricher (1975) conducted their sampling through the mid-morning. Shields (1977) reported peak activity levels in the late morning hours, although for some species, highest coefficients of detectability occurred late in the day. Colquhoun (1940) suggested sampling throughout the morning because relatively low variation in bird detectability occurs during the "short winter days". Robbins (1972) cautions researchers that reduced afternoon counts may be a result of decreased activity levels, i.e. detectability, and should not be accepted as indicative of population levels unless time-of-day effects are accounted for. The results of this study indicated that bird activity in the Douglas-fir types in 1981 was highest from mid to late morning. Although time of day was not tested with any environmental variables, it seems reasonable to expect that a relationship does exist between bird detections and time of day and weather conditions.

It appears from the literature that environmental conditions, especially during the winter months, have a profound effect on avian activity levels. Though the low number of bird detections in this study did not allow for adequate testing of this hypothesis, further sampling in the Big Creek Drainage might well yield results that approximate those of other winter studies.

Avian Orientation to Habitat Variables

Most of the literature on avian habitat selection comes from studies conducted during the breeding season. Structural characteristics of the vegetation strongly influence habitat selection by breeding birds (Emlen 1956; Recher 1969; Anderson 1972; Kilgore 1971; James 1971; Karr and Roth 1971; Kendeigh 1948; Ulfstrand 1975; Willson 1974; Meslow 1976; Noon and Able 1978; Shugart and Patten 1972; MacArthur and MacArthur 1961; MacArthur et al. 1962; Lack 1933; Miller 1942). Bird species diversity is highly correlated with foliage height diversity (MacArthur and MacArthur 1961; MacArthur 1964; Kilgore 1971; Karr 1968; Karr and Roth 1971; MacArthur et al. 1962; Recher 1969; Willson 1974; Pielou 1966; Balda 1975; Holmes et al. 1979). Researchers have also found specific factors such as foliage volume (Karr and Roth 1971; Balda 1975), successional stage of the site (Anderson 1972; Willson 1974), and number of tree and shrub species present (Ulfstrand 1975; Beedy 1981) to be important factors of habitat selection. Franzreb and Ohmart (1978) summarize the environmental aspects of avian habitat selection in the following manner:

> Habitat conditions that may influence bird

> species occurrence and abundance include food availability and quality, cover, nest sites, foliage volume, amount of open ground, tree density, amount of canopy and climate. In addition, species can respond to many foliage related characteristics with respect to habitat selection including, but not limited to, the life form of the vegetation...the height of the vegetation...the presence of certain vegetative strata...and the amount of foliage present.

Although habitat relationships of breeding birds are better understood, factors or mechanisms to explain winter habitat relationships have been suggested. The mechanisms proposed indicate that simple habitat characteristics, as measured in this study, may be inadequate to explain the complex habitat relationships of birds in winter.

Kilgore (1971) has suggested that although bird species diversity has been linked to foliage height diversity in deciduous forests, the same relationship does not necessarily apply to coniferous forests. He suggests instead that foliage density and life form of the vegetation are more important habitat characteristics in the coniferous forest environment. Factors such as protected roost sites, flocking (as a defense mechanism and also to conserve body heat), and especially food distribution and availability, are important aspects of habitat selection by winter birds (Verner 1975; Spindler and Kessel 1980). Hilden (1965) proposes that during the winter season, "...the food factor is decisive in the habitat selection of birds."

Low bird species diversity and equitability during the winter months have been linked to low food availability and harsh climatic conditions (Kricher 1972). Analysis of several years of Audubon Christmas counts indicated to Bock and Lepthien (1974) that during the winter, "... habitat complexity has relatively little to do with broad winter patterns of bird species diversity in North America." They suggested instead that climate and high (site) productivity have greater influence during the winter months than structural features of the habitat.

The winter season, because of the harsh conditions that often exist, may ultimately act to limit the size of a bird population (Kricher 1975; Fretwell 1969, 1972; Grubb 1977; Lack 1954; Ricklefs 1980; Alatalo 1980; Shaver 1933). According to Willson (1974), the number of birds on the breeding grounds each year may be a reflection of the number of birds which survive the winter, rather than a reflection of selection of a particular habitat. Lack (1968) goes as far as to say that for some species, population size is "...probably determined by the available food on the winter grounds, and ecological factors operating on the breeding grounds may have no influence."

Food supply, and its interactions with environmental conditions, may be the most important factor affecting activities and local distribution patterns of wintering birds (Smith 1980; Lack 1954; Kricher 1975). Food supplies may be limited, and the short days do not allow for extensive foraging (Lack 1954). Birds may have fewer foraging sites to choose from during the winter, but they optimize their use of them (Alatalo 1980). Small winter birds may spend most of their waking hours foraging (Morse 1971). Snow and ice or freezing rain can act to conceal food and therefore render it unavailable to birds (Lack 1954). Foraging activities may be delayed by foul weather conditions or induced by favorable conditions (Gottfried and Franks 1975). These complex interactions obscure any relationships that may exist between specific habitat characteristics and habitat use patterns of wintering birds.

Results of my discriminant analyses for birds of the Big Creek Drainage may be interpreted in the context of food availability. Mountain chickadees were associated with sites where growth was concentrated in the canopy of either mature trees and poles (overall 1980) or mature trees only (open Douglas-fir 1981). The overstory canopy would offer good foraging sites for seeds and insects, the primary forage of this species. Golden-crowned kinglets were associated with sites that had trees but low vertical diversity. Foraging sites would be available for these insectivorous birds on sites with good coniferous canopy cover. Red-breasted nuthatch presence was associated with older successional stages where growth was concentrated in the canopy. Presence of this species in the Douglas-fir canopy, if directly related to cone abundance, should come as no surprise, as this is where the cones are located. Sites of pine siskin presence were open canopied. Pine siskins feed in large flocks outside of the breeding season; the open canopied sites associated with their presence may have facilitated flock movement from tree to tree. Again, the canopy layer of the vegetation would provide the main source of seeds and insects upon which these birds forage.

CONCLUDING REMARKS

A winter passerine ecology study was conducted during the winters of 1980 and 1981 in the Big Creek Drainage of the River of No Return Wilderness, Central Idaho. Several hypotheses were tested during this study. The null hypothesis that there were no differences in bird species composition (based on the number of detections) among 5 vegetation types was not accepted, as results of Extension of the Median tests indicated strong differences between 3 types. The null hypothesis that site use (as reflected in the number of detections) was not related to temperature, wind velocity, percent cloud cover or time of day was accepted, as chi-square analyses yielded few significant relationships. And finally, the null hypothesis that a direct relationship does not exist between selected habitat variables and bird presence/absence was accepted because stepwise discriminant analysis, although showing a relationship to vegetation variables, selected those which were most strongly related to the birds' food sources. In other words, the wintering passerines did not appear to be selecting habitat based on habitat structure, but rather, based on food availability <u>within</u> that structure. Interactions between foraging site use and environmental variables was not tested. The literature however, indicates that winter birds are most affected by the interactions of food availability and environmental variables. Site use by winter birds tends to be complex rather than the result of any single factor.

More year-round studies, and of several years duration, must be conducted to provide a better understanding of habitat use by birds. What little is known of the effect of the winter environment on bird populations suggests a strong relationship to nesting success and population densities in the spring. Although conditions during the winter months make avian sampling difficult at best, information from that season is vital to our full understanding of bird populations in the wild.

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Appendix 1. Plant species lists by vegetation type

RIPARIAN SPECIES LIST

Grasses

Agropyron spicatum
Bromus tectorum
Calamagrostis rubescens
Carex geyeri
Carex microptera
Elymus sp.
Festuca idahoensis
Koeleria niticola
Poa pratensis
Poa sandbergii
Poa sp.
Trifolium pratense L.
Trifolium sp.

Forbs

Achillea millifolium
Antennaria microphylla
Arenaria macrophylla
Arnica cordifolia
Aster sp.
Balsamorhiza sagittata
Brodiaea douglasii
Capsella bursa-pastoris
Chenopodium albun
Clematis columbiana
Clematis ligusticifolia
Collinsia parviflora
Cornus canadensis
Crepis atrabarba
Crepis sp.
Disporum trachycarpum
Equisetum arvense
Fragaria vesca
Galium aparine
Heracleum lanatum
Hydrophyllum fendleri
Lomatium dissectum
Mentha sp.
Montia arenicola
Montia perfoliata

Osmorhiza sp.
Silene menziesii
Smilacena racemosa
Smilacena stellata
Solidago sp.
Taraxicum officinale
Taraxicum sp.
Thalictrum occidentale
Viola orbiculata

Shrubs

Acer glabrum
Alnus incana
Amelanchier alnifolia
Berberis repens
Betula occidentalis
Cercpcarpus ledifolius
Crataegus douglasii
Cornus stolonifera
Philadelphus lewisii
Physocarpus malvaceus
Prunus virginiana
Ribes cereum
Ribes setosum
Ribes velutinum
Rosa sp.
Rubus parviflora
Salix rigida
Salix scouleriana
Sambucus sp.
Spiraea betulafolia
Symphoricarpos alba
Vaccinium sp.

Trees

Populus trichocarpa
Pseudotsuga menziesii

OPEN DOUGLAS-FIR SPECIES LIST

Grasses

Agropyron spicatum
Bromus tectorum
Calamagrostis rubescens
Festuca idahoensis
Haplopappus acaulis
Koeleria nitida
Poa pratensis
Stipa commata

Forbs

Achillea millifolium
Antennaria anaphaloides
Antennaria microphylla
Arabis sp.
Arnica sororia
Balsamorhiza sagittata
Brodiaea douglasii
Chenopodium albun
Collinsia grandiflora
Collinsia parviflora
Collomia linearis
Crepis atrabarba
Descurainia pinnata
Draba memorosa
Erigeron pumilus
Eriogonum umbellatum
Fragaria vesca
Frasera albicaulis
Fritillaria atropurpurea
Galium aparine
Geum triflorum
Heuchera cylindrica
Hieraceum albertinum
Leptodactylon pungens
Lithospermum ruderale
Lomatium foeniculaceum
Lomatium triternatum
Mentzelia albicaulis
Mertensia viridis
Microseris troximoides
Microsteris gracilis
Penstemon albertinus

Penstemon deustus
Penstemon humilus
Phacelia heterophylla
Phacelia linearis
Phlox longifolia
Sedum stenopetalum
Silene douglasii
Viola sp.

Shrubs

Acer glabrum
Amelanchier alnifolia
Artemisia tridentata var. vaseyana
Berberis repens
Cercocarpus ledifolius
Physocarpus malvaceus
Purshia tridentata
Ribes cereum
Rosa sp.
Salix scouleriana
Spiraea betulifolia
Symphoricarpos alba

Trees

Pinus ponderosa
Pseudotsuga menziesii

CLOSED DOUGLAS-FIR SPECIES LIST

Grasses

Agropyron spicatum
Bromus tectorum
Calamagrostis rubescens
Festuca idahoensis
Koeleria nitida
Poa pratensis
Poa sp.

Forbs

Achillea millefolium
Antennaria microphylla
Arnica cordifolia
Balsamorhiza sagittata
Brodiaea douglasii
Crepis atrabarba
Cystopteris fragilis
Fragaria vesca
Frasera albicaulis
Galium aparine
Geum triflorum
Goodyera oblongifolia
Heuchera cyclindrica (?)
Heuchera parviflora
Lomatium foeniculaceum
Mertensia viridis
Microsteris gracilis
Penstemon albertinus
Phlox longifolia
Potentilla sp.
Sedum stenopetalum

Shrubs

Acer glabrum
Amelanchier alnifolia
Cercocarpus ledifolius
Philadelphus lewisii
Physocarpus malvaceus
Prunus virginiana
Purshia tridentata

Ribes cereum
Salix scouleriana
Spiraea betulifolia
Symphoricarpos alba
Symphoricarpos oreophilus

Trees

Pseudotsuga menziesii

SAGEBRUSH-GRASS SPECIES LIST

Grasses

Agropyron spicatum
Bromus tectorum
Festuca idahoensis
Festuca sp.
Koeleria nitida
Poa sandbergii
Stipa commata
Vulpia octoflora

Forbs

Achillea millefolium
Antennaria microphylla
Arabis microphylla
Arnica sororia
Astragalus atropubescens
Astragalus inflexus
Balsamorhiza sagittata
Brodiaea douglasii
Castilleja longispica
Chaenactis douglasii
Collinsia parviflora
Collomia linearis
Crepis atrabarba
Cryptantha ambigua
Descurainia pinnata
Draba memorosa
Erigeron pumilus
Eriogonum heracleoides
Eriogonum sp.
Frasera albicaulis
Galium aparine
Hackelia cinerea or Cryptantha intermedia
Hieraceum albertinum
Lappula redowski
Linanthus septentrionalis
Lithophragma parviflora
Lithospermum ruderale
Lomatium foeniculaceum
Lomatium triternatum
Microseris gracilis
Microseris mutans
Phacelia linearis

Phlox longifolia
Silene antirrhina
Sisymbrium altissimum
Stenphanomeria sp. (prob.)
Tragopogon dubius
Tridoanis perfoliata (prob.)

Shrubs

Acer glabrum
Amelanchier alnifolia
Artemisia tridentata vaseyana
Cercocarpus ledifolius
Chrysothamnus nauseosus
Crataegus douglasii
Philadelphus lewisii
Purshia tridentata
Ribes cereum
Ribes velutinum
Rosa sp.
Symphoricarpos alba

BUNCHGRASS SPECIES LIST

Grasses

Agropyron spicatum
Bromus tectorum
Festuca sp.
Koeleria nitida (?)
Poa sandbergii
Vulpia octoflora

Forbs

Achillea millefolium
Agoseris heterophylla
Allium simillimum
Apocynum androsaemifolium
Arabis microphylla
Artemisia ludoviciana
Astragalus atropubescens
Astragalus inflexus
Balsamorhiza sagittata
Brodiaea douglasii
Camalina microcarpa
Castilleja longispica
Chaenactis douglasii
Collinsia grandiflora
Collinsia parviflora
Collomia linearis
Cryptantha ambigua
Cryptantha intermedia (?)
Descurainia pinnata
Draba memorosa
Epilobium sp.
Erigeron corymbosus
Erigeron pumilus
Eriogonum microthecum
Eriogonum stricta
Galium aparine
Gilia aggregata
Hackelia cinerea (?)
Lappula redowski
Leptodactylon pungens
Lithophragma parviflora
Lithospermum ruderale
Lomatium foeniculaceum
Lomatium sp.

Lomatium triternatum
Lupinus sericeus
Mentzelia albicaulis
Microseris mutans
Microsteris gracilis
Mimulus nanus
Phacelia hastata
Phacelia linearis
Phlox longifolia
Physaria geyeri
Sisymbrium altissimum
Stephanomeria sp.
Tragopogon dubius

Shrubs

Amelanchier alnifolia
Artemisia tridentata vaseyana
Cercocarpus ledifolius
Chrysothamnus nauseosus
Eriogonum microthecum
Philadelphus lewisii
Prunus virginiana
Purshia tridentata
Ribes cereum
Ribes velutinum

Appendix 2. Vegetation parameters measured during vegetation sampling in the spring/summer 1981, and their resultant standardized canonical discriminant function coefficients. Classes equal each of 3 vegetation types in which sampling took place.

	Standardized canonical discriminant function coefficients	
Vegetation Variables	Function 1	Function 2
* Number of shrubs in height class 1	0.22074	-0.55637
* Number of shrubs in height class 2	0.68017	0.08966
Number of shrubs in height class 3	0.13011	-0.13545
Number of shrubs in height class 4	-0.00276	0.25293
Number of shrubs in height class 5	0.28256	-0.03181
Number of shrubs in height class 6	0.43553	-0.04283
Number of shrubs in height class 7	0.09564	0.12620
Average shrub height class	0.24755	-0.09350
* Mean sapling height	0.81071	-0.39340
* Mean sapling crown density	-0.45140	0.41717
* Mean pole height	-0.53019	-0.55457
* Mean pole crown density	0.45169	0.41717
* Mean tree height	-0.01193	0.91812
* Mean DBH	0.21605	-1.87646
* Mean tree crown density	-0.14755	0.75221
Number of saplings	0.02552	-0.28339
* Number of poles	-0.41046	0.39877
* Number of mature trees	-0.11191	0.79349
* Canopy volume	0.62268	0.54221
Average canopy volume	-0.40998	-0.29367
Total number of trees	-0.37814	-0.10844

* Vegetation variables included in discriminant analysis for bird presence/absence.

Appendix 3. Discriminant analysis summaries for bird species detected during winter sampling in 1980 and 1981, which generated significant ($p < .05$) results in discriminant analysis.

Species	F to Enter or Remove	Wilk's Lambda	Significance
A. Mountain Chickadee, 1980			
1. Mean DBH	2.6665	.960	.107
2. Mean tree crown density	4.1108	.901	.037
3. Mean pole crown density	1.7504	.876	.041
4. Number of poles	3.6991	.826	.019
B. Mountain Chickadee, Open Douglas-fir, 1980			
1. Number of trees	4.725	.809	.042
2. Number of shrubs in ht. class 2	5.398	.630	.012
3. Number of poles	2.254	.560	.013
C. Golden-crowned Kinglet, 1980			
1. Number of shrubs in ht. class 1	6.387	.909	.014
D. Golden-crowned Kinglet, Riparian, 1980			
1. Number of shrubs in ht. class 1	8.364	.705	.009
2. Canopy volume	2.258	.630	.0125
3. Mean sapling crown	2.439	.555	.0124
4. Number of shrubs in ht. class 2	11.610	.498	.014
5. Number of poles	2.675	.427	.011
6. Mean pole crown density	3.277	.350	.007
E. Red-breasted Nuthatch, 1981			
1. Number of shrubs in ht. class 2	5.411	.922	.023
2. Canopy volume	5.353	.850	.006
3. Number of poles	1.418	.831	.009
4. Mean sapling crown density	1.836	.807	.010
5. Mean tree crown density	2.465	.775	.008
F. Red-breasted Nuthatch, Open Douglas-fir, 1981			
1. Number of shrubs in ht. class 1	2.343	.895	.142
2. Canopy volume	2.936	.775	.090
3. Mean pole crown density	1.992	.698	.084
4. Mean tree crown density	2.131	.620	.073
5. Mean pole height	4.340	.488	.030
G. Pine Siskin, 1981			
1. Number of shrubs in ht. class 2	8.889	.878	.004
2. Mean sapling crown density	6.020	.806	.001
3. Mean pole crown density	4.193	.755	.0005
4. Mean tree crown density	3.750	.711	.0003
5. Mean tree height	6.283	.644	.0001
6. Mean pole height	1.710	.626	.0001

Appendix 3 (cont.)

Species	F to Enter or Remove	Wilk's Lambda	Significance
H. Pine Siskin, Open Douglas-fir, 1981			
1. Mean sapling crown density	4.699	8.10	.042
2. Mean pole crown density	3.060	.697	.033
3. Mean pole height	4.850	.549	.011
4. Number of poles	3.508	.455	.007
5. Canopy volume	2.516	.394	.006
6. Mean tree crown density	2.522	.337	.006
7. Mean DBH	5.614	.240	.002