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Multivariate relationships between riparian birds and environmental variables

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MULTIVARIATE RELATIONSHIPS
BETWEEN RIPARIAN BIRDS
AND ENVIRONMENTAL VARIABLES

A Thesis

Presented to

The Faculty of the Department of Biological Sciences
San Jose State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Kirk Lynn

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ABSTRACT

MULTIVARIATE RELATIONSHIPS BETWEEN RIPARIAN BIRDS AND ENVIRONMENTAL VARIABLES

by Kirk Lynn

Relationships between ground-foraging Emberizids caught in mist nets and habitat variables at a riparian site in Santa Clara County, California were examined. Initial independence analyses on adjacent mist nets verified independence of data prior to multivariate analyses. Principal Components Analysis revealed significant habitat variables while reducing the total number to satisfy Canonical Correlation Analysis requirements.

Much ground cover, tall understory height, much Baccharis cover, and short berry height were correlated with high numbers of Melospiza melodia, M. lincolnii, and Zonotrichia atricapilla. These findings indicate the importance of cover in protection from predation. Other factors such as competitive pressures, resource partitioning, and prey abundance may also influence riparian bird habitat selection and use.

Future work should be long-term and geographically diverse. Careful use of mist nets combined with other techniques should be employed. An understanding of important factors in riparian ecosystems is essential in their preservation.

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Introduction

Riparian areas are significant ecosystems because of their richness in natural resources. Although they represent only a small fraction of the vegetation in the western United States, these areas provide habitats for more species of breeding birds than any other vegetation type in North America (Knopf and Samson 1988). Riparian habitats support high avian species diversity because they provide food, cover, water, many niches due to high plant diversity and structural heterogeneity, and high edge-to-area ratios resulting from their linear shape (Brown 1985, Thomas 1979). Often edge areas take the form of agricultural-riparian interfaces. Many birds are attracted by the combination of a ready food supply from farms and cover from predation and available nest sites from riparian areas, thus leading to high species richness (Anderson et al. 1984). Many bird species use riparian areas as wintering grounds and migratory corridors, leading to success in survival and propagation (Laymon 1984, Motroni 1984). Knowledge of avian habitat use within riparian zones in applying strategies for riparian protection and preservation is needed to maintain this success.

Habitat selection in birds has been described as a balance between the migratory urge and the territorial urge (Hildén 1965); selection occurs when innately determined environmental stimuli exceed a threshold level whereby the bird settles in an area. Relevant factors involved in habitat selection include vegetation structure, competition, and productivity (Cody 1981). Many specific habitat variables have been cited as

important for survival (depending on the species): food (Hutto 1985, Meents et al. 1982); moisture (Douglas et al. 1992, Smith 1977, Swift et al. 1984); plant species composition, richness, and size (Anderson et al. 1983, Rice et al. 1984, Stauffer and Best 1980); canopy cover and height (James 1971); and vegetation density (Reed 1986, Whitmore 1975). Habitat variables represent an integral part of a bird species' niche, whether directly (shelter, nesting area, protection from predation) or indirectly (prey availability) (Rotenberry 1981).

This is an "exploratory" study to determine if certain habitat characteristics are potentially related to avian distributions in a riparian area. The twenty-three habitat variables measured (Table 1) were based on factors considered relevant to the subject bird species' use, such as feeding and nest construction. Specific plant species were included based on local predominance. The more general habitat features (canopy cover, mean understory height, percent bare ground) were deemed more significant based on their universal applicability across bird species. The seven bird species in this study, the House Finch (Carpodacus mexicanus), Lincoln's (Melospiza lincolni), Song (M. melodia), Fox (Passerella iliaca), Golden-Crowned (Zonotrichia atricapilla), Puget Sound White-Crowned (Z. leucophrys pugetensis), and Gambel's White-Crowned Sparrow (Z. l. gambelii), were chosen to determine if closely related species differed in their resource use. These species are closely related in two ways. One is by genetic taxonomic relatedness. The sparrow species comprise the largest available group of closely related species, with the House Finch more distantly related (Sibley and Monroe 1990). The

other similarity is that they are all ground foragers. Unlike the other species, however, the House Finch consumes virtually no insects, feeding mainly on seeds and fruit (Ehrlich 1988). Because of these differences, the House Finch was used as an outlier for contrast with the other species. This study thus examined if related species with common ecological requirements used the same available habitat resources, or if habitat partitioning due to competition was occurring.

Methods

The study site was located 8-10 km from the mouth of Coyote Creek, alongside Coyote Creek Riparian Station, in Santa Clara County, California (Fig. 1). A revegetation plot and an overflow channel leading to a levee are adjacent to Coyote Creek. This area of Coyote Creek contains many mist nets used for ongoing studies of avian riparian corridor use and wildlife habitat use of riparian restoration sites. During the Spring 1996 season (1 April - 30 June) birds were captured in mist nets by personnel of Coyote Creek Riparian Station to assess relative abundance of bird species. Collections were made weekly in 5-hr periods starting ½ hr before sunrise to coincide with high bird activity. For this project, only 32 mm mesh mist nets measuring 12 m x 2 m at 1 m height from the ground were used. All bird data were standardized for net hours set (total hours varied due to weather and scheduling). Recaptures were included in bird totals.

Several habitat variables were measured within 16m x 10m plots at each net site to describe the immediate environment surrounding each net. Variables were selected based on relevance to the feeding and nesting ecology of the subject species, and on the predominant existing vegetation. These included percent understory cover, mean understory height, relative abundance of arthropods, percent canopy cover, and total tree trunk mass at each site. Understory cover (understory defined as vegetation $\leq$ 3m height) was measured by randomly selecting thirty points within the study plot and recording the

type and height of vegetation present. Mean height was computed for predominant plant species and for plants in general. Arthropods were collected using 16 cm x 10 cm posterboard pieces covered with Tanglefoot (brand name for adhesive tree resin) and placed at four random points for 48 hrs. Upon collection, arthropods were identified into four general categories: flying (non-Coleoptera), Coleoptera, other and unidentifiable. The “other” category consisted primarily of the groups Formicidae, Arachnida, and Orthoptera. For each site, abundance estimates were made by summing counts for each category and for arthropods in general. Five points were selected within each plot to measure canopy cover. Measurements were made at 1 m height with a densiometer (a convex mirror covered with fifty equally spaced dots). Canopy cover was defined as the proportion of dots obscured by occluding canopy. Canopy measures were averaged for each site. Within each plot, all living adult trees were identified and measured for diameter at breast height (dbh); these measurements were summed for each species at each site as a measure of tree trunk mass.

Because nets were already in place before this study was initiated, certain limitations were placed on randomization schemes. Twelve randomly arrayed solitary nets were available and included in this study (Fig. 1). There were four transect groups (lettered nets) each containing three adjacent single nets. A single net was selected randomly from each transect group. There were also three net lanes (9330, 9385, 9515), each of 9-11 adjacent nets, totalling twenty-nine individual nets. Random selection of nets from these twenty-nine nets was complicated because adjacent nets were not likely

to be independent measures of birds caught. Independence of data is a prerequisite for multivariate analyses, including canonical correlation analysis (Morrison et al. 1993, Smith 1981). A figure for the minimum distance between nets ensuring independence was needed.

The minimum distance at which the individual nets could be considered independent was determined from Spring 1995 data by plotting similarity (Bray-Curtis Similarity Index, Wolda 1981) of the bird species composition between net pairs versus net distance apart. The minimum distance was defined as the point where the similarity between net pairs decreased sharply (the most negative slope). Nets could then be selected randomly, but separated by this minimum distance.

The similarity indices showed that nets were independent if they were at least four nets apart. The plotted calculation for the similarity indices between nets within the net lanes showed a sharp decrease at about 0.4 (Figs. 2-4). This corresponded to a minimum net distance of four nets apart. Using this criterion, six nets were chosen randomly, with the restriction they be at least four individual nets apart. These were considered independent, and data were collected and analyzed as with the other sixteen nets.

Multivariate statistical analyses were used to examine the relationships between bird abundances and habitat variables. All variables were tested for skewness and transformed appropriately if necessary. To minimize collinearity, Pearson product moment correlations were computed for all possible pairs of variables. From each group of correlated variables ($r \geq 0.6$), one variable was selected for analysis based on statistical

results or deemed biological significance (see Results, p. 10).

Because of the limited number of observations, all variables could not be included in the analysis (twenty-five observations would support an analysis with five variables - see Tabachnick and Fidell 1996). To avoid Type I error, the number of bird species studied was reduced to four, chosen based on the relative abundance of data available for each species. This was reduced to three after calculating Pearson product moment correlations (see Results, p. 10, and Table 3). Twenty-three habitat variables were also reduced to four. Five sets of variables were each collapsed into one variable using scores from a Principal Components Analysis. Variable sets were formed based on either biological (tree dbh, arthropods, general features, cover) or calculation (mean understory height) similarities. The “tree dbh” set included measurements from Fremont Cottonwood (Populus fremontii), Box Elder (Acer negundo), Willow (Salix spp., summed), Elderberry (Sambucus mexicana), and all others (summed). The “arthropods” set included totals for Formicidae, Orthoptera, Arachnida, Coleoptera, and flying insects (non-Coleoptera). The “general features” set included percent canopy cover, mean understory height, and percent bare ground. The “cover” set included percent understory cover of Poison Hemlock (Conium maculatum), berry (Rubus spp.), grass (various spp.), coyotebush (Baccharis pilularis), and Italian Thistle (Carduus pycnocephalus). The “mean understory height” set included calculations for the same taxa as in the “cover” set. The PCA component 1 scores were then used in conjunction with an initial group Canonical Correlation Analysis (CCA) to determine which of the five variable sets might

be related to the bird species abundances.

For the final Canonical Correlation Analysis, individual variables were selected from sets which showed a statistical relationship to bird abundance (Table 1). Variables with the highest loadings were selected first from sets with the highest loadings, with some leeway for biological significance. An attempt was made to include variables from as many sets as possible. Again, only one variable was selected from groups of correlated variables (habitat or bird) so as to prevent overemphasis of positively correlated variables or canceling out of negatively correlated variables. To facilitate interpretation of results, actual values (not factor scores) from four habitat variables with the highest loadings in the previous analyses were used in the CCA as a final analysis of the relationships. Factor 1 scores from this CCA were plotted and interpreted.

Results

PCA revealed that all habitat variable sets explained at least 25% of the variance among net sites (Table 1), with the “general features” and “cover” sets considerably more significant.

The results from the CCA with the variable sets (Table 1, $r = -0.904$, $p = 0.013$) led to the selection of habitat variables for the final CCA. In choosing variables for the final CCA, selections were first made from variable sets with the highest initial CCA loadings, with weight added for variables with biological significance. Therefore, Baccharis cover was selected due to its high loadings. The next set, “general features”, was deemed biologically significant, so two variables there were chosen: mean understory height and percent bare ground. Canopy cover was not used because it was correlated with Baccharis cover (Table 3). Finally, mean Conium height was selected from the set with the next highest CCA loading. However, subsequent CCA with bird capture data revealed this variable as statistically insignificant, so mean berry height was used in its place (this variable was significant in CCA).

Canonical correlation analysis revealed higher numbers of birds caught associated with certain habitat variables (Table 2, $r = -0.882$, $p = 0.004$, Fig. 5). Each bird species (Song, Lincoln’s, and Golden-crowned Sparrow) was caught more frequently in areas of little bare ground, tall mean understory height, much Baccharis cover, and short mean berry height (listed in descending significance based on canonical loadings in Table 2).

Conversely, relatively fewer birds of all three species were caught in areas with much bare ground, short mean understory height, little Baccharis cover, and tall mean berry height.

Pearson product moment correlation analysis showed that within the data certain relationships existed (Table 3). Certain bird species numbers caught were positively correlated with other bird species. Similarly, several habitat variables were also correlated, positively and negatively. These results affected the selection of variables for analysis, as only one from each group could be used (see Methods). Since correlations meant that other variables could have been substituted for the variables selected for the final analysis, interpretations of results were also affected. For example, the House Finch was correlated with both Song and Lincoln's Sparrows. The two sparrow species were selected for the final CCA to see if results within the guild would be consistent. The House Finch was substituted later (for the two sparrow species) in a CCA to compare with the other bird species, with similar results ($r = -0.831$, $p = 0.004$, Table 2).

Discussion

Principal Components Analysis revealed the habitat variable groups “general features”, “cover” and to a lesser extent “mean height” as most associated with bird numbers. Other studies have found similar results with these variables (Folse 1981, James 1971, Reed 1986, Whitmore 1975). The “arthropods” group did not account for much of the variance in the analysis, although previous work is mixed. Brush and Stiles (1986) were able to predict bird density and habitat use from foliage arthropod counts in pine and oak forests. Conversely, Folse (1981) found grassland bird community structure more likely associated with habitat than food supply. Raley and Anderson (1990) did match this study’s apparent finding of Coleoptera as the most preferred arthropod prey. Perhaps the birds search for prey where it is most detectable, not where it is most abundant (Getty and Pulliam 1993).

The fact that three sparrow species (Song, Lincoln’s, Golden-crowned) within the ground-foraging guild are associated with the same habitat features is corroborated by Cody (1968), who found them to occupy overlapping vegetation height ranges. Vesper Sparrows in grasslands were found in short, dense (high cover) vegetation to conceal nests from predators (Reed 1986). Possibly the bird species in this study prefer areas that provide nest cover. Yahner (1986) found that ground foragers were associated with high species-specific shrub density, as in this study. Both American Kestrels and Swainson’s Hawks hunt more efficiently in areas of little cover; this was attributed to increased

visibility (Bechard 1982, Toland 1987). More dead Song and Savannah Sparrows were counted in mowed areas than in heavy cover (Watts 1990). The results of the above studies are consistent with the finding that ground-foraging riparian birds prefer areas with much ground cover and tall understory vegetation. Vegetative cover provides safety and possible thermal advantages (energy savings) in house sparrows (Grubb and Greenwald 1982). Areas with much cover may also signify sites of possible ambush, and birds may avoid immediate proximity (Lima et al. 1987). In this study, distance to cover was not observed or measured; therefore, it is unclear whether the species examined consider cover an absolute preference. It is important to remember when comparing variables from different studies that the significance of any variable is dependent on the particular environment and its structure (Whitmore 1975). Specific habitat features that appear significant in one area may reflect local conditions or species.

The value of the Pearson correlations is to illustrate how the seeming import of a significant variable may just reflect its relation to an actual biologically meaningful variable. These latter variables may not have ended up in the final analysis due to statistical noise or anomalies. For example, the statistical significance of Baccharis cover may be due to its negative correlation with canopy cover, i.e., it was found most abundantly in the overflow channel, away from Coyote Creek and most trees. Canopy cover has been cited as an important variable in bird-habitat studies (James 1971, Whitmore 1975). A high standard deviation of understory height provides important structural complexity (Stauffer and Best 1980, Swift et al. 1984). Grass cover and mean

grass height may indicate preferred areas for nest sites or foraging (Reed 1986). The fact that House Finches were positively correlated with two sparrow species (Table 3) indicates that as the outlier there were no differences between them and the sparrow species in their relationships with the significant habitat variables. This was corroborated by subsequent CCA.

Avian habitat selection is based on costs and benefits (food abundance), and microhabitat is then chosen depending on competitive pressures and mate availability (Hutto 1985). "Niche-gestalt" (James 1971) refers to the form of vegetation characterizing the habitat of a bird species, as chosen from a predetermined search image. It is derived by researchers from the correspondence of bird occurrence and vegetational requirements. This study suggests the niche-gestalt of ground-foraging riparian birds consists of significant ground cover combined with tall understory vegetation.

The distribution of birds in an environment can be attributed to competitive pressures. Competition can explain seasonal changes in bird and insect numbers (Hutto 1985), affect distribution and abundance of birds in riparian ecosystems (Bock et al. 1992), and separate dominant individuals from subordinates by intraspecific interactions (Davis 1973, Petit and Petit 1996, Rappole 1995, Van Horne 1983). The effects of competition and predation in preferred patches can result in suboptimal patches having higher densities (Fretwell 1972). Resident birds dominate direct competition (Berthold 1993). In this study, Song Sparrows are resident species (Zeiner et al. 1990), and they were the most numerous species caught in the nets. Perhaps they were caught more

because they outcompeted other species for preferred feeding areas. An analysis correlating prey abundance and individual nets would be illustrative of the value of certain habitats, and could support the above proposition. Competition does not explain all avian habitat use patterns among co-existing species, however. Martin and Thibault (1996) found that ecological behavior partitioning among Sylviid Warblers accounted for their coexistence. When resources are abundant, interspecific interactions may not be significant (Rice et al. 1983).

The use of mist nets in bird ecology studies has been criticized. One criticism is that most nets are set too low to sample the upper canopy (Rappole 1995). Jenni and Leuenberger (1996) found several problems with using mist nets: it is easier for large birds to escape, wind helps birds jump out, and capture efficiency varies with bird activity patterns. Remsen and Good (1996) state that mist net studies incorrectly assume negligible effects of : the proportion of flights at net level, territoriality, average flight distance, number of flights per sample period, degree of net avoidance, and the “catchability” of birds. However, this study examined within-species bird-habitat correlations of ground-foraging birds, not interspecific relative abundances. Patterns of resource use in this study are assumed to reflect habitat preferences within conspecifics, controlled for interspecific differences in flight behavior, net avoidance, and “catchability”. Results were compared across species only after habitat correlations were determined. The questionable assumptions of normal distributions of heights of bird occurrence and random directionality of flights by Remsen and Good in their computer

simulations may also affect their applicability to this study.

Future mist net studies should consider several factors possibly affecting results. The mesh size can determine the size of the birds caught (Heimerdinger and Leberman 1966, Pardieck and Wade 1992). Jenni and Leuenberger (1996) suggest placing nets equally exposed to sun and wind, with nets covering the entire vegetation height. Direct behavioral observations in addition to abundance data can confirm conclusions regarding habitat use and selection (Morrison et al. 1993). Mist nets in combination with point counts or song counts can be used to improve estimates (Rappole et al. 1993, Wallace et al. 1996, Wunderle and Waide 1993).

The selection of the appropriate variables to measure is essential to sound ecological work. Many bird-habitat studies have cited the importance of plant species over physiognomy (Anderson et al. 1983, Douglas et al. 1992, Holmes 1981, Rice et al. 1983, Rice et al. 1984, Wiens and Rotenberry 1981). The “tree dbh” data set in this study, which was species-specific, may not have been useful because the relative sparsity of trees around most mist nets may have led to statistical insignificance regardless of their biological importance. Variables may seem important simply because they are measured where many birds are found (Anderson 1981). In selecting a bird guild to study, it is important to choose species based on the similar use of environmental resources, not on the basis of taxonomic relatedness (Jaksic 1981).

Variations in scale in terms of time and space can confound results. Data should be collected over several seasons or years to detect variation in bird-habitat relationships

or abundances (Anderson and Ohmart 1977, Anderson et al. 1981, Cody 1974, Diehl 1986, Miles 1990, Morrison et al. 1993, Rice et al. 1981, Rice et al. 1983, Whitmore 1979, Wiens 1981). Geographic variation may be observed by studying similar sites in different locations (Noon 1981). Inappropriate plot size and the use of plot-based samples can obscure within-plot habitat selection or partitioning and preclude making generalizations on species interrelationships (Rotenberry and Wiens 1981). One possible solution would be to evaluate plots of different sizes to determine if the above processes were occurring. This study examined only a small window of time (one season) and one riparian area in generating hypotheses for future work. Definitive future studies need to involve at least several seasons and a range of riparian areas to account for anomalies in avian ecology, productivity, or climate.

Interpretations of results can be problematic. High density in a habitat may not indicate habitat quality. Statistical correlations do not necessarily mean causation or selection (Johnson 1981, Wiens and Rotenberry 1981). It is important to remember the parameters of this study. The data and results apply specifically to the locale and season in which they were obtained.

The application of effective management strategies for California riparian forests is critical. These forests have been greatly reduced in the last century by development, livestock grazing, upstream reservoir construction, levee channelization, and clearing for agriculture (Carothers 1977, Smith 1980). Their use as recreation sites and as important ecological areas for wildlife requires knowledge of their biological relationships (Katibah

1984). Multivariate analyses can be used to answer: 1) what effect habitat alterations have on a bird species, 2) what distinctions among differing habitats account for bird numbers, and 3) how to make a particular habitat suitable for a bird species (Whitmore 1981). This study indicated that allowing much ground cover and understory growth will provide suitable habitats for riparian ground-foraging birds. In this and similar studies, confirmation that co-occurrence of birds and habitat characteristics has a sound ecological basis and is not due to indirect relationships would need to be determined before management strategies are implemented.

Summary

The use of multivariate statistics in wildlife habitat studies often relies on certain restrictions concerning data. Among those restrictions are independence of data and a sufficient number of observations recorded per measured variable. A similarity index was used in this study to determine appropriate distance intervals for independence of data. Other multivariate studies may need to use the same technique if also using preexisting sampling sites in order to maximize sample size and insure independence of data arranged in a series. For example, preliminary data collected from a linear substrate such as a riverbank may need to be analyzed to determine appropriate distance intervals for sampling. Principal components analysis was used to select the most significant variables from a large set of variables in order to input an acceptably low number of

variables (compared with number of observations) for multivariate analysis.

This study found that three ecologically and taxonomically related sparrow species (Song, Lincoln's, and Golden-crowned) were similarly correlated with four habitat variables (little bare ground, tall mean understory height, much Baccharis cover, short mean berry height) at Coyote Creek, California. An outlier bird species (House Finch) showed similar results. It is possible that resources are superabundant, suppressing competitive interactions, or that resource partitioning is occurring through ecological and behavioral differences in foraging, such as using only certain portions of the same types of vegetation. It is possible that the biological significance of high ground cover (= little bare ground) and tall understory height is that they contribute to protection from predation (of nests and individuals), while short berry height allows for visibility against predation. The significance of much Baccharis cover may be tied to its correlation with little canopy cover as important in bird habitats; the other three variables may also reflect relationships with biologically meaningful variables.

Future work in this field should address problems inherent in these studies. Careful selection of variables, long-term and geographically diverse parameters, and judicious use of techniques such as mist net counts should increase the robustness of results. A focus on subjects such as predation, competition, and management strategies should prove helpful in disclosing the important factors involved in riparian ecosystems. Preservation of these habitats will ensure their availability for the enjoyment of birds and humans for future generations.

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Figure 1. Diagram of study area. Numbers and letters indicate nets.

Figure 2. Results of preliminary independence analysis - net lane 9330.

Figure 3. Results of preliminary independence analysis - net lane 9385.

Figure 4. Results of preliminary independence analysis - net lane 9515.

Figure 5. Bird-habitat relationships from the final CCA (Factor 1 scores).

Table 1. Habitat variable results from multivariate analyses.

		<u>PCA</u>		<u>CCA</u> (Group)
	<u>Variable</u>	<u>Loading</u>	<u>% Variance Explained</u>	<u>Loading</u>
Mean Height	<u>Conium</u>	0.793	31.393	0.588
	Berry	0.663		
	Grass	-0.199		
	<u>Baccharis</u>	-0.391		
	<u>Carduus</u>	0.555		
Tree Mass (Σ dbh/ site)	<u>P. fremontii</u>	-0.371	25.526	0.265
	<u>A. negundo</u>	0.040		
	Salix spp.	-0.649		
	<u>S. caerulea</u>	0.747		
	All Others	0.398		
General Features	Canopy Cover	0.767	47.095	0.708
	Mean Understory Height	-0.782		
	Percent Bare Ground	0.821		
Cover	<u>Conium</u>	0.685	40.618	0.788
	Berry	0.438		
	Grass	-0.647		
	<u>Baccharis</u>	-0.847		
	<u>Carduus</u>	0.484		
Arthropods	Formicidae	-0.629	30.183	0.277
	Orthoptera	-0.164		
	Arachnida	0.588		
	Flying Insects	0.092		
	Colcoptera	0.856		

Table 2. Final CCA results.

<u>Variable</u>	<u>Loading</u>	<u>Variable</u>	<u>Loading</u>
Song Sparrow	0.727	House Finch	0.429
Lincoln's Sparrow	0.933		
Golden-crowned Sparrow	0.420		
<u>Baccharis</u> cover	-0.324		-0.878
Mean Understory Height	-0.380		-0.357
Percent Bare Ground	0.930		0.436
Mean Berry Height	0.307		0.553

Table 3. Pearson correlations of bird species numbers and habitat variables.

	<u>Variables</u>	<u>r</u>
Birds	Golden-Crowned x Puget Sound White-Crowned Sparrow	0.667
	House Finch x Lincoln's Sparrow	0.745
	House Finch x Song Sparrow	0.653
Habitat Variables	<u>Baccharis</u> cover x canopy cover	-0.693
	canopy cover x grass cover	-0.631
	grass cover x mean grass height	0.736
	<u>Baccharis</u> cover x mean tree dbh	-0.696
	mean tree dbh x std deviation tree dbh	0.730
	mean understory height x std deviation understory height	0.821
	mean berry height x berry cover	0.888