SIMILARITIES IN RIPARIAN BIRD COMMUNITIES AMONG ELEVATIONAL ZONES IN SOUTHEASTERN WYOMING

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Abstract

I examined trends in bird species richness and overall bird abundance in riparian habitats among elevations varying from 6740 ft. to 9800 ft. in southeastern Wyoming. Bird species diversity ranged from a low of three bird species and 23 pairs in subalpine shrub willow habitat to a maximum of 21 species and 101 pairs in lowland cottonwood habitat. Bird communities were less diverse at higher elevations probably because of the reduced vegetational complexity and increased environmental severity at high elevations. Few bird species found in subalpine riparian habitats contained unique (but depauperate) avifaunas. Despite loss of a tree overstory, bird species composition on mid-elevation shrub sites was more similar to lowland cottwood habitats than to subalpine shrub areas. Similarity in bird species composition was greatest within elevational zones. Based on these results, general recommendations for managing riparian habitats in different elevational zones are offered.

Introduction

In the central Rocky Mountains, the distributional ranges of riparian plant species are partitioned into elevational zones (Johnston 1984, Cannon and Knopf 1984). Cottonwoods (Populus spp.) typically dominate riverine floodplains at lower elevations, whereas a variety of shrub species, in particular willow (Salix spp.), occupy streamside communities above 8000 ft. (2600 m). In the Medicine Bow National Forest of southeastern Wyoming, riparian vegetation in the subalpine spruce-fir zone is typically comprised of one willow species which forms a structurally simple community. Above timberline, streamside habitats are dominated by boggy Carex - Deschampsia meadows and shrub thickets composed of S. glauca.

Although riparian habitats contain highly diverse faunas and are critical to the survival of many rare and uncommon species (see review, Johnson and Jones 1977), few studies have examined animal distributional patterns along riparian elevational gradients. By determining the extent of faunal variation associated with elevational changes, habitat management strategies can be more accurately recommended for dissimilar riparian zones. Knopf's (1985) comparison of upland bird communities to riparian bird communities along an altitudinal cline in Colorado showed that on a local basis, number of bird species was highest at lower riparian sites but that regionally, birds were most diverse in upland sites. Knopf (1985) also found that riparian bird communities were most unique at the extremes of the elevational continuum. Although other studies of elevational gradients have revealed that bird communities became simpler at higher elevations, with decreases in rare species and increasing dominance by a few species (Able and Noon 1976, Sabo 1980), Knopf's (1985) study did not support such trends.

Because plant species composition and habitat structure in riparian communities are highly variable within, as well as across, elevational zones (Johnston 1984, Olson and Gerhart 1982), I examined patterns of bird species richness and abundance along a cline similar to that of Knopf's, but differing with respect to location, plant species associations, and elevational range. Knopf's study areas began as low as 3650 ft. and ranged to 8350 ft. My study sites ranged from 6740 ft. 9800 ft.; thus they encompassed a narrower range, but began and ended at higher elevations. By concentrating on a shorter vegetational spectrum and increasing the number of study sites, trends in bird species numbers may be found that were lacking in Knopf's wideranging regional study. In this study, I asked the questions: (1) are there trends in bird species richness and overall bird abundance related to plant association patterns, and (2) how similar are bird communities among different riparian plant associations along an elevational cline? Based on my results, I also provide general recommendations to maintain and improve riparian habitats for bird populations.

Methods

Study Area. Ten study grids of 20 acres (8.1 ha) each were established in the summer of 1981 in riparian habitats in (or within 10 km) of the Medicine Bow National Forest of southeastern Wyoming. Study sites were distributed over an elevational range of 3060 ft. (933 m), encompassing a continuum of riparian plant species and plant associations (Table 1). Based on preliminary surveys, three to four plots were established in three elevational zones: Zone 1 = low-elevation cottonwood plots (sites 1, 2, 3,); Zone 2 = mid-elevation mixed shrub plots (sites 4, 5, 6); Zone 3 = high-elevation willow plots (sites 7, 8, 9, 10). Within each zone, plant associations were similar or identical and were regarded as replicate sites for each zone. Johnston's (1984) plant association guide was used to classify habitats on each site based on

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Table 1. Plant associations and elevation on each bird-censusing site.

Site	Elevation (ft.)	Plant association[a]	Dominant vegetation
1	6,740	Poan3/Saex-Befo	Populus angustifolia/Salix exigua - Betuala fontinalis
2	6,980	Poan3/Saex-Befo	Populus angustifolia/Salix exigua - Betula fontinalis
3	7,400	Poan3-Potr/Sali[b]	P. angustifolia - P. tremuloides, mixed tree and shrub willow (Salix sp.)
4	7,500	Alte-Befo/Sali	Alnus tenuifolia - Betula fontinalis/mixed shrub willow (Salix spp.)
5	8,100	Sage-Sali/Caca	S. geyeriana - other shrub willow (Salix spp.)/Calamagrostis canadensis
6	8,300	Sage-Sali/Caca	S. geyeriana - Salix spp./ C. canadensis
7	8,500	Sapl/Dece	S. planifolia - S. wolfii/Deschampsia caespitosa, Carex spp.
8	9,150	Sapl/Dece	S. planifolia/D. caespitosa, Carex spp.
9	9,750	Sapl/Dece	S. planifolia/D. caespitosa, Carex spp.
10	9,800	Sapl/Dece	S. planifolia/D. caespitosa, Carex spp.

[a]Where possible, plant associations were listed according to Johnston (1984)
[b]Plant association is similar to site J51 in Olson and Gerhart (1982:141).

dominance of understory and overstory plant species. Dominance of shrubs and trees was computed using the point-centered quarter method (see Mueller-Dombois and Ellenberg 1974). Forty random sampling points established at grid intersections on each plot were used in these analyses. Because some plant associations could not be classified according to Johnston (1984), I also referred to Olson and Gerhart (1982) for further information on Wyoming riparian habitats. Plant associations and elevations at each site were listed in Table 1. Willow species were identified using the taxonomic keys of Argus (1957) and Nelson (1974) as well as University of Wyoming herbarium facilities.

I used the following criteria to select sites: (1) the stream bottom was large and level enough to establish a 20 acre grid (thus habitat types specifically adapted to steep narrow stream courses were excluded); (2) each study area was accessible by road in June so that enough time was permitted for a sufficient number of bird counts; (3) there was little or no evidence of livestock grazing or browsing based on presence of manure, foraging effects, or livestock themselves; (4) little or no human recreational activity was apparent; and (5) each site had similar topography and year-round running streams. Flooding was an additional disturbance, but because the degree of flooding was unpredictable, it was not used as a criterion in selecting plots. Not all the above criteria were met on each plot, particularly with respect to livestock disturbance. Four of the ten plots were grazed to some extent. Sites 5 and 6, which were located in plant associations dominated by mixed shrub willows (Table 1), were on a rest rotation grazing system; on site 2, winter grazing was permitted with cattle removed in May; and on site 4, the riparian edge was moderately grazed and browsed. Recreational fishing was also common on some sites but was considered a minor disturbance because effects on vegetational structure and bird territories were not detected. Sites 1 and 3 were severely flooded in 1983 so that bird

Table 2. Mean species richness and mean total number of breading pairs (all species) on each study site, 1982-84. Homogeneous subsets of means determined from Duncan's multiple range tests share common underlines (P < 0.05).[a]

Species Richness

Site 1	Site 2	Site 6	Site 3	Site 5	Site 4	Site 7	Site 8	Site 10	Site 9
21.0	20.7	19.3	17.0	15.3	13.0	9.3	4.5	3.3	3.0

Number of Pairs

Site 1	Site 2	Site 6	Site 3	Site 5	Site 7	Site 4	Site 10	Site 8	Site 9
116.3	100.7	96.0	79.3	78.0	67.1	61.0	29.0	26.3	23.0

[a]See Table 1 for description of plant associations on each site.

censusing was halted for two weeks. Although a few ground-nesting birds lost their nests in the floods, they retained their territories and built new nests when water levels dropped, and thus no effects on bird numbers were evident.

Bird Censusing. Bird populations were counted on the ten study grids using the spot-map method (Robbins 1970). Breeding birds were counted from mid-May to late July of 1982, 1983, and 1984. A minimum of eight visits were conducted on each study grid each year. Abundance was estimated as the number of territorial pairs per species on each 20 acre (8.1 ha) plot. Species richness was reported as the number of species known to be breeding on each study site based on nest searches and territorial data. Bird census data for each species will be reported elsewhere (Finch, in prep.). In this paper, abundance data was used to estimate overall number of breeding pairs.

Analysis. Jaccard similarity index (Goodall 1978) was used on presence-absence data (years averaged) to calculate percent similarity in bird species composition between all pairs of plots. One-way ANOVA with *a posteriori* pairwise comparisons was performed on bird species richness and overall abundance data to determine if numbers of species and pairs differed significantly among plots. Pairwise comparisons were computed using Duncan's Multiple Range Test. Data for each year were used as plot replicates in the ANOVA's. The Bartlett-Box F-test was used to test the assumption of homogeneity of variances in the sample data. Bartlett-Box's test was not significant for either the species richness or the abundance data so the assumption of homogeneity was met.

Results and Discussion

Numbers of Species and Pairs. Bird species richness and total number of pairs were highest on low-elevation sites dominated by narrowleaf cottonwood (P. angustifolia) and coyote willow (S. exigua) (Table 2). The three-year mean values on the cottonwood sites ranged from a low of 17.0 bird species and 79. 3 pairs on site 3 to a high of 21 species and 116.3 pairs on site 1. During the three-year study, species richness reached a maximum in 1982 of 23 breeding species on site 2, and overall abundance peaked at 130 pairs in 1982 on site 1. Of the three cottonwood sites, numbers of species and pairs were significantly lower ($P < 0.05$) on site 3 than on sites 1 and 2 (Table 2). Water levels were regulated for irrigation purposes upstream from site 3, and consequently site 3 was severely flooded for prolonged periods during the summer. For example, in 1983 (a peak flood year) site 3 was under water for three weeks. Site 3 hosted a decadent cottonwood community with little evidence of cottonwood rejuvenation. Heavy, prolonged flooding, as well as loss of cottonwoods due to flooding, may explain the decrease in bird numbers compared to the other cottonwood sites.

Mid-elevation shrub habitats (sites 4, 5, 6) ranged from a mean low of 13 species and 61 pairs on the plot dominated by thin-leaf alder (A. tenuifolia) (site 4) to a high of 19.3 species and 96 pairs on a mixed shrub willow area (site 6). Bird numbers on this latter site were not substantially different ($P > 0.05$) than those on the severely flooded cottonwood site indicating similar habitat potential to support birds on the two sites. Although this study was not designed to evaluate the effects of rest-rotational grazing on the two mixed shrub willow sites (5 and 6), Duncan's test demonstrated that these moderately

Table 3. Percent similarity in bird species compositon between pairs of study sites.[a]

Zone[b]	Plant Association [c]	Site	Site 1	2	3	4	5	6	7	8	9
1	Poan3/Saex-Befo	1									
1	Poan3/Saex-Befo	2	64								
1	Poan3-Potr/Sali	3	42	44							
2	Alte-Befo/Sali	4	36	33	35						
2	Sage-Sali/Caca	5	29	27	48	35					
2	Sage-Sali/Caca	6	26	10	40	25	61				
3	Sapl/Dece	7	15	11	14	18	30	26			
3	Sapl/Dece	8	0	0	5	0	11	9	44		
3	Sapl/Dece	9	0	0	6	0	5	5	33	75	
3	Sapl/Dece	10	0	0	6	0	5	5	33	75	100

[a]Jaccard's Index was used to compute similarity values based on presence or absence of bird species.
[b]Elevational zones are 1 = 6,740 - 7,400 ft.; 2 = 7,500 - 8,300 ft.; 3 = 8,500 - 9,800 ft.
[c]See Table 1 for descriptions of plant associations.

grazed sites contained significantly greater ($P < 0.05$) numbers of birds than ungrazed sites at higher elevations. Thus, mixed shrub willow communities, regardless of livestock effects, had greater capability to sustain birds than subalpine willow habitats. Habitat structure and plant species composition were more diverse in mid-elevation shrub willow communities than in subalpine communities, and avian numbers were higher as a response (Finch 1985). More bird species preferred to breed in habitats with larger shrub size, canopy height, and number of vegetation layers. Subalpine habitats were probably avoided by most riparian bird species because preferred habitat features were not available.

Plant communities above 8500 ft. (Sites 7, 8, 9, 10) were heavily dominated (> 90% shrub cover) by S. planifolia and were simple in habitat structure and plant species diversity. Within this elevational zone, bird numbers were highest on site 7, the lowest S. planifolia site. Species richness on this site was greater than sites above it ($P < 0.05$), but bird abundance was comparable to the alder-dominated site (site 4) ($P > 0.05$). Areas above site 7 were highly homogeneous ($P > 0.05$), being consistently low in both species richness and bird abundance. Lincoln's sparrow (Melospiza lincolnii) dominated these subalpine sites (52% of all birds), followed by Wilson's warbler (Wilsonia pusilla) (28%), and white-crowned sparrow (Zonotrichia leucophrys) (20%).

Similarity Among Sites. In general, percent similarity in bird species composition was higher within elevational zones than between zones (Table 3). Similarity values were highest in Zone 3 ranging from 33 percent to 100 percent shared species among the four S. planifolia plots (Table 3). These subalpine sites shared fewest bird species with cottonwood sites in Zones 1 (range = 0-15%). The three cottonwood sites were also highly similar among themselves (range = 42-64%), as were the three mid-elevation shrub sites within Zone 2 (range = 25-61%). Mid-elevation shrub sites shared more species with cottonwood sites (range = 10-48%) than with subalpine willow sites (range = 0-30%). For example, species that foraged and nested in lower canopies (i.e. shrubs) such as yellow warbler (Dendroica petechia), veery (Catharus fuscescens), and American robin (Turdus migratorius) reached highest densities in cottonwood habitats but were common in mid-elevation shrub willow as well (Finch 1985). Most of these species were absent in subalpine habitats presumably because of low habitat diversity (Finch 1985). Nevertheless, although depauperate in number of species, subalpine willow was unique because it shared few species with other riparian habitats.

Zone 1 and Zone 2 sites had about 85 percent more species than Zone 3 sites. Therefore, homogeneity among low and middle sites is less likely because more combinations of different species were possible.

In addition, many rare and uncommon species occurred only once in some low and mid-elevation plots, causing similarity values to decrease when presence/absence data were used. Thus, similarity values as low as 30 percent were more probable for pairs of low- or mid-elevation plots than for high elevation pairs.

Conclusions and Recommendations

Samson and Knopf (1982) indicated that between-habitat (beta) diversity comparisons were more important in assessing habitat significance to birds than within-habitat evaluations. My investigation demonstrated that bird species richness and composition, as well as total avian abundance, were more similar within riparian habitat zones than between habitat zones. Of the plant associations examined in this study, low-elevation cottonwood habitats contained more bird species, but subalpine habitats were also important because they contained bird species that did not occur in other zones. Thus, I concur with Knopf (1985) that riparian avifaunas were most unique at elevational extremes in the Front Range of the Rockies. Contrary to Knopf's (1985) findings, this and other studies (Finch 1985, Finch in prep.) have revealed that rare species were lost at higher elevations, replaced by increased dominance of a few species (Lincoln's sparrows, Wilson's warblers, and white-crowned sparrows). Greater severity of environmental conditions and reduced habitat diversity at my higher elevation sites probably explains the consistent trend toward community simplicity that was lacking in Knopf's study.

Habitat management models designed for the Rocky Mountains that assume similarity in bird species diversity and composition among different riparian shrub associations are too simplistic. For example, habitats dominated by S. planifolia contained a unique but depauperate assemblage of bird species that differed greatly from all other riparian habitats, and thus should be managed differently. Elevation alone is an excellent predictor of bird species composition, as well as number of birds and species in streamside habitats of southeastern Wyoming, and can be used to predict appropriate management designs along a riparian altitudinal gradient.

At high elevations (> 9000 ft.), severe winters and short growing seasons create a difficult environment for most plant and animal species (Kuramoto and Bliss 1970, Douglas 1972). Riparian plant communities specifically adapted to high altitudinal conditions may be irreparably damaged from man-made disturbances, and experiments designed to test the effects of various disturbances such as livestock grazing and browsing should be conducted before a management scheme is instigated. However, "improving" habitat to increase species diversity is probably an inappropriate goal in subalpine riparian communities because harsh environmental conditions form a natural barrier to wildlife immigration and plant establishment.

Because many bird species were shared in common between Rocky Mountain shrub willow and cottonwood sites at elevations below 8500 ft. (note that elevational limits are variable), management of shared species should be similar. To increase density and diversity of lower canopy birds like yellow warbler, MacGillivray's warbler (Oporornis tolmiei), and song sparrow (Melospiza melodia), riparian shrub densities and structure can be manipulated via cattle grazing (Knopf and Cannon 1982, Cannon and Knopf 1984, Krueger and Anderson 1985a), introduction of native shrub species (e.g., in Southwest, Anderson and Ohmart 1985), and beaver dam management (Apple 1985). Along high velocity streams in Colorado and Wyoming, checkdams can be used to widen and deepen the floodplain, thus providing enough soil nutrients and moisture for shrub (and tree) establishment. Dams built by beavers serve the same purpose, as well as reduce bank erosion (Parker et al. 1985).

In riparian habitats that have lost a cottonwood or aspen overstory, revegetation practices are recommended (Anderson and Ohmart 1985). Because several years must elapse before revegetated sites are suitable for high canopy bird species, temporary wildlife improvements can also be made. For example, nest boxes can be attached to large shrubs to attract secondary cavity-nesting species that may already forage on such areas (e.g. northern flicker Colaptes auratus, house wren Troglodytes aedon, and black-capped and mountain chickedees, Parus atricapillus and P. gambeli, respectively). Introduction of nest platforms can also improve treeless riparian areas for some raptors and waterfowl. Improvement practices are recommended specifically for sites in need of restoration because they have been damaged by mining, overgrazing, flooding, etc., or because they have lower wildlife diversity than the potential for that specific habitat type. In healthy non-degredated riparian ecosystems, the best management action is habitat protection rather than alteration because the most suitable plant and animal species are those that are already present.

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