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AVIAN USE OF A DESERT RIPARIAN ISLAND AND ITS ADJACENT SCRUB HABITAT

ROBERT C. SZARO
AND
MARTIN D. JAKLE

ABSTRACT.—A riparian bird community in central Arizona contributed from 23 to 33% of the birds along the adjacent desert washes, and from 7 to 15% of the birds in the adjacent desert upland. Conversely, the desert bird community contributed only from 1 to 1.5% of the birds in the riparian island. Bird density ranged from 336 to 446 birds/40 ha in the riparian core and edge in 1981 and 1982. Bird density in the adjacent desert decreased with distance from the edge of the riparian island to a low of 101 birds/40 ha in 1981, to 137 birds/40 ha in 1982, in the segment 600 to 1,000 m from the riparian edge.

Riparian woodlands in the southwestern United States are extremely important to bird populations (Carothers et al. 1974, Stamp 1978, Ohmart and Anderson 1982. These woodlands are often considered isolated habitat islands, yet adjacent areas may be important in determining riparian bird population densities and composition (Stevens et al. 1977, Shurcliff 1980, Szaro 1980). Neighboring areas can include many different vegetation types, each with its own complement of breeding birds that are potentially capable of competitively restricting riparian birds (Carothers et al. 1974). Differences in availability of food and nest sites in adjacent habitats may further affect riparian bird density and species richness, even in the same riparian type (Goldberg et al. 1979). Conversely, riparian birds may influence bird population densities and species composition in the environs (Conine et al. 1978, Hehnke and Stone 1978, Wegner and Merriam 1979).

We sought to determine the extent to which the bird communities of a riparian island and the surrounding desert scrub influence each other. We examined several questions concerning the interaction between the two communities: (1) which bird species, if any, are found exclusively in either habitat? (2) what is the contribution, in terms of densities and species richness, of the bird populations in either habitat to each other? (3) how far do riparian or desert birds venture into other habitats? and (4) are there any differences in summer versus permanent resident use of the habitats? Answers to these questions will advance our understanding of the role that riparian habitat islands play in determining bird community structure in the arid southwestern United States.

STUDY AREA

We conducted our study on the Tonto National Forest on Queen Creek, about 3.7 km upstream from the mouth of Whitlow Canyon and about 16 km west of Superior, Arizona. The area consists of a 15-ha stand of Goodding willow (*Salix gooddingii*) and salt cedar (*Tamarix pentandra*), surrounded by Sonoran Desert scrub (Szaro and DeBano 1985). The riparian stand is rectangular, approximately 350 m by 450 m. A border of vegetation approximately 35 m wide along the edge of the stand is composed of salt cedar, seep willow (*Baccharis glutinosa*), and velvet mesquite (*Prosopis juliflora*). Two washes extend northward, perpendicular to the long edge of the stand. Their vegetation primarily consists of catclaw (*Acacia greggii*), velvet mesquite, desert hackberry (*Celtis pallida*), creosote bush (*Larrea tridentata*), seep willow, and foothill palo verde (*Cercidium microphyllum*). On the upland benches, which extend from the riparian area parallel to the washes, the vegetation is foothill palo verde, saguaro cactus (*Cereus giganteus*), jumping cholla (*Opuntia fulgida*), jojoba (*Simmondsia chinensis*), Engelmann prickly pear (*O. phaeacantha*), creosote bush, teddy bear cholla (*O. bigelovii*), and ocotillo (*Foquiera splendens*). For a more complete description of the vegetation, see Szaro and DeBano (1985).

METHODS

Birds were counted by the variable-circular plot method (Reynolds et al. 1980). We chose sixty sampling points, with 10 points in the interior of the riparian stand, 10 points around the perimeter of the stand, 10 points in each of

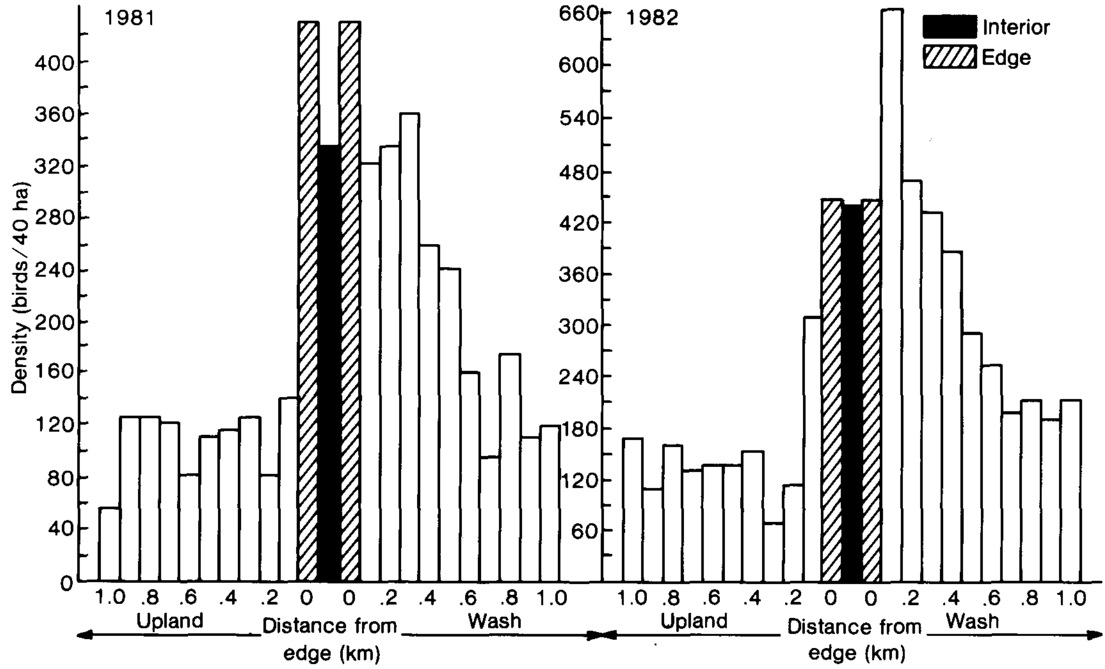

FIGURE 1. Overall bird abundance versus distance from riparian edge in 0.1-km increments along desert wash and upland habitats.

two desert washes, and 10 points in each of two desert upland sites. Desert upland and wash points were positioned on one-km lines that were perpendicular to the riparian site at 100-m intervals outward from the riparian edge. Each point was visited ten times during the height of the breeding season from 12 April to 21 May 1981 and 1982. All counts began one-half hour after sunrise and continued until twenty points were censused by a single observer in a single count period. Each observer visited all 60 points on three consecutive days, with both observers visiting each point five times in order to eliminate observer bias.

After arriving at each point, we waited for a 1-min rest period before counting for a 5-min period. All birds seen or heard and their distances from the point were then recorded. Distances were estimated with the aid of an optical range finder. Bird densities were plotted for each 5-m band from 0 to 100 m from the point, and for each 10-m band from 100 to 200 m from the point. The inflection point was determined by choosing the outer edge of the band where the density of individuals of a given species in the next outermost band was less than 50% of the previous band. The effective detection distance, the distance from the center point to the inflection point, was determined by pooling all observations for a species within a habitat type over the entire sampling period. That is, separate effective detection distances were calculated for riparian interior, riparian edge, desert wash, and desert upland points. Individual point densities were then determined using this effective detection distance. Mean species densities and standard errors for each habitat type were then calculated from the individual point densities. Effective detection distances, and ultimately density estimates, were determined for all species with a minimum of 10 records during the study period.

Similarity in species composition between habitats was calculated using Sorensen's index (Mueller-Dombois and Ellenberg 1974):

$$\text{similarity} = 2W \times 100/a + b,$$

where W is the number of species that the two habitats share in common, and a + b is the total number of species found in each habitat.

RESULTS

Bird densities were significantly higher (Tukey's studentized range test, $P < 0.05$) in the more structurally diverse habitats, such as the riparian interior, riparian edge, and the first 500 m of the desert wash, than in the structurally simpler habitats of the second 500 m of the desert wash and the desert upland (Fig. 1). In fact, bird density on the desert upland was less than one-third of that found in the riparian edge and interior habitats (Table 1). In contrast to the immediate drop in bird density from the riparian edge to the desert upland, density decreased gradually along the desert wash until it reached that found on the desert upland (Fig. 1).

By classifying the species as permanent residents, summer residents, and migrants/winter residents, some interesting patterns emerged. First, summer residents were the most important density component in all habitats (Table 2). Their densities were highest in the riparian interior and decreased with increasing distance from the riparian stand. Second, species richness of permanent residents in the riparian interior or edge was half that found in the desert habitats (Table 3). Third, the differences in species richness of permanent residents were not reflected in density estimates. Even though the riparian edge had the fewest (eight) and the first 500 m of the desert wash had the greatest (16) number of permanent resident species, densities of permanent residents in these areas were similar and were almost double those found in the other habitats. Fourth, migrants/winter residents were the smallest component of overall bird density in all habitats (Table 2), but their importance is underestimated because many species (25 in 1981, 28 in 1982) were not seen frequently enough to determine their density. Fifth, habitat use differed markedly between summer and permanent residents. Most summer residents, nine out of 13 (69%), reached their highest density in the riparian edge and interior, as compared to only five out of 19 (26%) of the permanent residents. In contrast, only two summer residents (15%), while 11 permanent residents (58%), had their highest density in the desert habitats. Finally, almost all of the riparian breeding birds, both summer and permanent residents, were seen in the adjacent desert habitats. The Bewick's Wren (scientific names of this and other species are given in Table 1) and Cooper's Hawk were the only permanent residents found in the riparian habitats that were not seen often enough in the desert to allow for the calculation of density estimates, but both were seen on several occasions in those habitats. Similarly, the only summer residents not seen in the desert habitats were the Summer Tanager, Common Yellowthroat, and Song Sparrow. In contrast, between 56 and 69% of breeding, permanent resident species in the desert habitats were not found in the riparian edge or interior. Moreover, except for Wilson's Warbler, all migrants/winter residents were specific to either riparian or desert habitats.

Of the 41 species whose abundance we determined, 18 had significantly higher densities in the riparian area (Tukey's studentized range test, $P < 0.05$, while 16 had significantly higher densities in the desert (Table 1). Densities of three species, Mourning Dove, Black-chinned Hummingbird, and Brown-crested Flycatcher, were not significantly different (Tukey's studentized range test, $P > 0.05$) between habitats. The Harris' Hawk, Cardinal, Lesser Goldfinch, and Brown-headed Cowbird had their highest densities in riparian and desert wash habitats.

Those bird species with higher riparian densities than desert densities fell into three groups: (1) no density difference in edge or interior (nine species), (2) higher density in the edge (six species), and (3) higher density in the interior (three species; Table 1). Ten of these species (Cooper's Hawk, Willow Flycatcher, Bewick's Wren, Ruby-crowned Kinglet, Solitary Vireo, Warbling Vireo, Yellow-rumped Warbler, Common Yellowthroat, Summer Tanager, and Song Sparrow) were found only in riparian habitats. These species contributed only between 9.8 and 12.2% of overall bird density in the riparian edge or interior. Eight species (Yellow-breasted Chat, Bell's Vireo, Yellow Warbler, Wilson's Warbler, Ladder-backed Woodpecker, Lucy's Warbler, White-winged Dove, and Abert's Towhee) had their highest densities in riparian habitats and contributed 65.7 to 77.0% (range for both habitats in both 1981 and 1982) of overall bird density in the riparian edge or interior. These same species comprised from 23.2 to 33.4% of the birds in the desert wash and from 6.5 to 14.6% of the birds in the desert upland.

Use of the adjacent desert habitats by riparian-preferring species was primarily limited to the desert wash. Yellow-breasted Chats were seen in both the interior of the riparian stand and up to 300 m up the desert wash, but not on the upland areas. Bell's Vireos used the edge and only the first 200 m of the desert wash. Abert's Towhees were seen all along the wash and infrequently on the upland. Yellow Warblers used the riparian interior, edge, and only the first 100 m along the wash. Ladder-backed Woodpeckers were seen 1.0 km from the riparian stand along the wash, but only 0.5 km on the upland. Densities of Lucy's Warbler declined gradually from the interior to the edge and then along the wash. In contrast, warbler densities dropped precipitously from the edge to the upland.

Bird species with higher densities in the desert than in the riparian habitat fell into groups similar to those preferring riparian habitats, i.e., (1) no density difference for wash or upland (eight species), (2) higher density along the wash (seven species), and (3) higher density on the upland (one species). In contrast to the riparian-preferring species, the 16 species that had significantly higher densities in the desert (Tukey's studentized range test, $P < 0.05$), only Gambel's Quail was found in the riparian edge in sufficient numbers to estimate its density

TABLE 1. Bird abundance in desert riparian and scrub habitats (birds/40 ha ± SE).

Species	Status@	Year	Riparian		Desert wash		Desert upland	
			Interior	Edge	0–500 m	600–1,000 m	0–500 m	600–1,000 m
Cooper's Hawk	*PR*	1981	2.6 ± 1.14		†		†	
(*Accipiter cooperii*)		1982	2.5 ± 1.30		†			
Harris' Hawk	*PR*	1981	1.1 ± 0.75	1.1 ± 0.54	0.4 ± 0.20		0.3 ± 0.26	
(*Parabuteo unicinctus*)		1982	0.6 ± 0.59	0.9 ± 0.35	0.6 ± 0.59			
Gambel's Quail	*PR*	1981	†	6.3 ± 2.30$^{b\&}$	44.0 ± 8.65^{a}	16.4 ± 5.23^{b}	2.8 ± 2.10^{b}	6.9 ± 5.70^{b}
(*Callipepla gambellii*)		1982		4.2 ± 2.32^{b}	31.5 ± 4.41^{a}	25.2 ± 10.80^{ab}	8.4 ± 4.64^{ab}	8.4 ± 5.37^{ab}
White-winged Dove	SR	1981	11.0 ± 2.77^{ab*}	16.3 ± 2.65^{a}	4.6 ± 1.83^{bc*}	3.5 ± 1.29^{bc}	4.2 ± 1.38^{bc}	2.8 ± 1.03^{c}
(*Zenaida asiatica*)		1982	28.3 ± 9.14^{a}	30.7 ± 8.56^{a}	12.4 ± 3.78^{ab}	1.8 ± 0.90^{b}	7.7 ± 4.22^{b}	4.1 ± 1.54^{b}
Mourning Dove	SR	1981	3.6 ± 1.32	3.1 ± 1.13	6.0 ± 1.50*	2.5 ± 0.75*	4.6 ± 2.53	1.8 ± 0.80
(*Zenaida macroura*)		1982	6.8 ± 2.47	5.1 ± 1.90	14.8 ± 3.65	15.9 ± 4.66	7.7 ± 4.13	7.7 ± 3.63
Black-chinned Hummingbird	SR	1981	24.5 ± 8.48	32.6 ± 11.03	26.9 ± 6.82	12.8 ± 4.45	32.6 ± 7.91	18.4 ± 5.99
(*Archilochus alexandri*)		1982	30.6 ± 7.93	23.8 ± 7.30	12.4 ± 4.36	21.2 ± 7.41	11.8 ± 3.93	11.8 ± 5.28
Costa's Hummingbird	SR	1981			1.4 ± 1.42		4.2 ± 2.46	1.4 ± 1.42
(*Calypte costae*)		1982			2.4 ± 2.36		9.4 ± 3.85	7.1 ± 3.61
Gila Woodpecker	*PR*	1981	†		5.1 ± 1.28^{a}	1.0 ± 1.02^{b}	0.5 ± 0.50^{b}	
(*Melanerpes uropygialis*)		1982		†	6.8 ± 1.46^{a}	0.9 ± 0.85^{b}	0.9 ± 0.85^{b}	
Ladder-backed Woodpecker	*PR*	1981	15.6 ± 6.61^{a}	2.1 ± 1.39^{b}	4.8 ± 1.76^{ab}	2.4 ± 1.70^{b}	4.0 ± 1.33^{ab}	
(*Picoides scalaris*)		1982	20.8 ± 8.48^{a}	3.5 ± 2.30^{b}	5.3 ± 2.93^{ab}	†	2.7 ± 1.77^{b}	
Northern Flicker	*PR*	1981			0.5 ± 0.24	0.5 ± 0.24	1.0 ± 0.43	0.5 ± 0.34
(*Colaptes auratus*)		1982			1.3 ± 0.75	0.3 ± 0.26	0.8 ± 0.40	0.8 ± 0.56
Willow Flycatcher	M	1981	2.0 ± 1.36*	3.1 ± 1.56	†			
(Empidonax traillii)		1982	8.7 ± 2.88^{a}	1.7 ± 1.73^{b}				
Ash-throated Flycatcher	SR	1981	†	†	4.6 ± 1.40*	6.7 ± 2.01	6.4 ± 1.56*	6.8 ± 1.44*
(*Myiarchus cinerascens*)		1982			0.6 ± 0.6	3.0 ± 1.59	1.8 ± 1.20	1.8 ± 1.20
Brown-crested Flycatcher	SR	1981	3.6 ± 0.98	3.6 ± 1.17	3.3 ± 1.14	3.3 ± 1.04	3.0 ± 1.00	0.3 ± 0.03*
(*Myiarchus tyrannulus*)		1982	1.0 ± 1.00	3.0 ± 2.13	5.5 ± 1.74	4.0 ± 1.45	4.5 ± 2.17	7.5 ± 2.01
Verdin	*PR*	1981			23.1 ± 4.51^{a*}	14.3 ± 4.25^{ab}	7.2 ± 3.84^{b}	9.6 ± 4.08^{ab}
(*Auriparus flaviceps*)		1982			45.1 ± 7.96^{a}	29.2 ± 7.07^{ab}	14.6 ± 5.75^{b}	17.3 ± 7.67^{b}
Cactus Wren	*PR*	1981			2.6 ± 0.67	2.4 ± 0.83	5.6 ± 1.51	6.0 ± 1.58
(*Campylorhynchus brunneicapillus*)		1982			2.0 ± 0.73	3.0 ± 0.91	6.6 ± 1.98	4.6 ± 1.66

TABLE 1. Continued.

Species	Status@	Year	Riparian		Desert wash		Desert upland	
			Interior	Edge	0–500 m	600–1,000 m	0–500 m	600–1,000 m
Bewick's Wren	*PR*	1981	0.5 ± 0.51	2.6 ± 1.74				
(*Thryomanes bewickii*)		1982	2.6 ± 1.30[b]	6.8 ± 1.81[a]				
Ruby-crowned Kinglet	WR	1981	2.1 ± 1.39	7.3 ± 3.48				
(*Regulus calendula*)		1982	3.5 ± 2.31	3.5 ± 2.31	†			
Black-tailed Gnatcatcher	*PR*	1981		†	7.7 ± 4.45	3.6 ± 1.53	1.0 ± 0.68	4.6 ± 2.33
(*Polioptila melanura*)		1982			9.3 ± 4.09	2.6 ± 1.30	1.7 ± 1.70	3.4 ± 1.39
Bendire's Thrasher	*PR*	1981				0.9 ± 0.64		
(*Toxostoma bendirei*)		1982					0.5 ± 0.50	0.5 ± 0.50
Curve-billed Thrasher	*PR*	1981			1.5 ± 0.50	1.8 ± 1.02	1.2 ± 0.66	3.6 ± 1.40
(*Toxostoma curvirostra*)		1982			1.5 ± 1.07	1.5 ± 1.07	0.5 ± 0.50	2.0 ± 1.11
Bell's Vireo	SR	1981	†	23.2 ± 2.99[a]	9.3 ± 4.91[b]			
(*Vireo bellii*)		1982	†	26.7 ± 2.09[a]	11.9 ± 4.83[b]			
Solitary Vireo	M	1981	12.7 ± 3.90*	4.2 ± 3.16	†			
(*Vireo solitarius*)		1982	2.4 ± 2.40	2.4 ± 2.40	†			
Warbling Vireo	M	1981	2.8 ± 2.83	2.8 ± 1.89				
(*Vireo gilvus*)		1982	2.4 ± 2.36	2.4 ± 2.36				
Lucy's Warbler	SR	1981	167.0 ± 13.47[a]	100.5 ± 17.45[b]	46.3 ± 6.69[c]	18.3 ± 4.90[cd]*	5.6 ± 3.76[d]	6.4 ± 3.32[d]
(*Vermivora luciae*)		1982	212.2 ± 21.09[a]	87.2 ± 21.09[b]	78.3 ± 21.10[b]	43.8 ± 3.16[bc]	12.0 ± 6.69[c]	4.0 ± 2.03[c]
Yellow Warbler	SR	1981	25.0 ± 6.42[a]*	38.5 ± 8.35[a]*	1.0 ± 1.04[b]			
(*Dendroica petechia*)		1982	50.2 ± 10.78[b]	76.2 ± 3.82[a]	5.2 ± 2.65[c]			
Yellow-rumped Warbler	WR	1981	8.5 ± 5.66	2.8 ± 2.83				
(*Dendroica coronata*)		1982	4.7 ± 4.72	7.1 ± 5.04				
Common Yellowthroat	SR	1981		5.7 ± 3.13				
(*Geothlypis trichas*)		1982		4.7 ± 3.14				
Wilson's Warbler	M	1981	8.5 ± 3.14[b]	28.3 ± 6.75[a]	9.9 ± 3.03[b]	11.4 ± 2.84[b]*	†	†
(*Wilsonia pusilla*)		1982	4.3 ± 2.17[b]	21.8 ± 5.3[a]	9.4 ± 5.32[b]		†	
Yellow-breasted Chat	SR	1981	4.6 ± 1.71[b]	23.9 ± 4.11[a]	6.7 ± 3.57[b]			
(*Icteria virens*)		1982	2.1 ± 0.54[b]	24.0 ± 3.77[a]	7.0 ± 4.18[b]			
Summer Tanager	SR	1981	8.0 ± 2.67	5.6 ± 2.40	†			
(*Piranga rubra*)		1982	15.9 ± 6.50	9.3 ± 6.86				

TABLE 1. Continued.

Species	Status@	Year	Riparian: Interior	Riparian: Edge	Desert wash: 0–500 m	Desert wash: 600–1,000 m	Desert upland: 0–500 m	Desert upland: 600–1,000 m
Northern Cardinal	*PR*	1981	1.6 ± 1.10	8.8 ± 4.17	6.6 ± 2.29	1.5 ± 0.78	2.0 ± 1.13	1.0 ± 0.68
(*Cardinalis cardinalis*)		1982	1.3 ± 1.30^{b}	10.6 ± 4.33^{ab}	15.3 ± 4.34^{a}	8.5 ± 3.35^{ab}	2.6 ± 1.29^{b}	0.9 ± 0.85^{b}
Green-tailed Towhee	M	1981		†	5.0 ± 1.83*		1.9 ± 1.35	
(*Pipilo chlorurus*)		1982		†	15.8 ± 4.22^{a}	4.2 ± 2.81^{b}	1.0 ± 1.0^{b}	2.1 ± 1.42^{b}
Brown Towhee	*PR*	1981			5.6 ± 2.39^{ab}	7.2 ± 2.23^{a}*	0.8 ± 0.8^{b}	0.8 ± 0.8^{b}
(*Pipilo fuscus*)		1982			5.3 ± 4.05	1.3 ± 1.3		1.3 ± 1.3
Abert's Towhee	*PR*	1981	14.5 ± 4.10^{b}	45.7 ± 6.2^{a}	10.7 ± 2.83^{b}	1.3 ± 1.26^{b}		2.5 ± 2.52^{b}
(*Pipilo alberti*)		1982	19.0 ± 7.93^{b}	62.3 ± 14.43^{a}	21.0 ± 7.65^{b}	4.2 ± 2.80^{b}		
Brewer's Sparrow	M	1981			20.7 ± 5.84^{a}*	1.6 ± 1.60^{b}	2.4 ± 1.70^{b}	1.6 ± 1.60^{b}
(*Spizella breweri*)		1982			59.7 ± 18.40^{a}	5.3 ± 3.53^{b}	23.9 ± 15.67^{ab}	10.6 ± 6.80^{b}
Black-throated Sparrow	*PR*	1981			0.8 ± 0.80^{b}	2.4 ± 1.70^{b}	15.1 ± 4.01^{a}	12.0 ± 5.60^{ab}
(*Amphispiza bilineata*)		1982			1.3 ± 1.30^{c}	4.0 ± 2.83^{bc}	17.3 ± 3.98^{ab}	23.9 ± 6.19^{a}
Song Sparrow	SR	1981	†	17.7 ± 8.78^{a}				
(*Melospiza melodia*)		1982		17.3 ± 5.16	†			
White-crowned Sparrow	WR	1981			14.3 ± 6.14			
(*Zonotrichia leucophrys*)		1982			33.2 ± 8.67^{a}	8.0 ± 4.05^{b}	†	†
Brown-headed Cowbird	*PR*	1981	8.3 ± 3.40^{b}	27.0 ± 9.45^{a}	10.4 ± 3.15^{ab}	4.0 ± 2.45^{ab}	2.4 ± 1.22^{b}	2.4 ± 1.22^{b}
(*Molothrus ater*)		1982	3.5 ± 2.31	13.9 ± 5.04	16.0 ± 10.2	4.0 ± 3.98	6.6 ± 5.33	5.3 ± 4.05
House Finch	*PR*	1981			9.6 ± 5.66	1.6 ± 1.07	3.2 ± 1.76	9.6 ± 5.01
(*Carpodacus mexicanus*)		1982			2.6 ± 2.66	9.3 ± 6.28	1.3 ± 1.3	8.0 ± 4.05
Lesser Goldfinch	*PR*	1981	5.2 ± 3.55	11.4 ± 4.77	6.2 ± 3.18	4.2 ± 2.77	†	†
(*Carduelis psaltria*)		1982	13.9 ± 5.66	8.7 ± 3.87	17.3 ± 6.32	13.9 ± 8.09	8.7 ± 4.65	†
Total density		1981	335.9 ± 23.84^{b}*	428.8 ± 30.66^{a}	302.7 ± 23.93^{b}*	131.4 ± 14.38^{c}*	113.8 ± 12.83^{c}	100.9 ± 19.06^{c}
		1982	437.0 ± 22.08^{a}	445.5 ± 33.05^{a}	442.3 ± 47.61^{a}	211.2 ± 15.60^{b}	154.1 ± 34.91^{b}	137.0 ± 16.97^{b}
Species richness		1981	22	25	30	24	24	20
		1982	22	25	30	25	24	23

@ Residency status, SR = summer resident, WR = winter resident, *PR* = permanent resident, M = migrant.
† Indicates fewer than ten observations.
[&] Means in the same row that do not have a letter in common were significantly different at $P < 0.05$ by Tukey's studentized range test.
* Yearly differences significantly different $P < 0.05$, *t*-test.

TABLE 2. Mean bird species densities and percent total density of summer residents, permanent residents, migrants and winter residents by habitat categories.

Habitat	Permanent residents (%)	Summer residents (%)	Migrants and winter residents (%)
Riparian woodland			
Interior	58.0 (15.0)[a]	297.2 (76.9)	31.3 (8.1)
Edge	107.2 (24.5)	289.4 (66.2)	40.6 (9.3)
Desert wash			
0–500 m	114.5 (30.7)	174.0 (46.7)	84.0 (22.6)
600–1,000 m	57.1 (33.3)	99.0 (57.8)	15.3 (8.9)
Desert upland			
0–500 m	36.2 (27.0)	78.6 (58.7)	14.6 (10.9)
600–1,000 m	42.2 (35.5)	69.7 (58.6)	7.2 (6.1)

[a] Mean birds per 40 ha for 1981 and 1982 (percent of birds found in habitat category).

(Table 1). Moreover, unlike the riparian habitat where those species that had their highest densities in that habitat comprised most of the bird population, the birds with highest densities in the desert comprised only from 45.5 to 49.7% of the birds in the desert wash, and from 44.8 to 62.5% of the birds in the desert upland.

Sorenson's similarity index indicated that bird species composition was similar in the riparian interior and edge zones, and also in the desert wash and upland zones (Table 4). The riparian and desert zones were much less similar.

DISCUSSION

Bird community structure in a given habitat depends not only on that community, but also on bird species composition and density in adjacent habitats (Shurcliff 1980). The large numbers of riparian species that were observed regularly by Goldberg et al. (1979) throughout the spring and summer in adjacent habitats demonstrates the importance of adjacent habitats to riparian breeding birds. Of the bird species breeding in their four study sites in central and southeastern Arizona, 16 out of 19 (84%), 13 out of 24 (54%), nine out of 22 (41%), and 11 out of 21 (52%) were found regularly in the adjacent habitats. In our study, we found eight out of 18 (44%) of the species with their highest densities in the riparian edge and interior regularly along the desert wash and/or upland habitats.

Conine et al. (1978) categorized 62 bird species that were found in riparian situations along the lower Colorado River into four groups, based on the maximum distance traveled from riparian habitat into adjacent agricultural areas: (1) those that did not travel into adjacent agricultural areas (21 species, 34%); (2) those that traveled from 0 to 0.4 km (16 species, 26%); (3) those that traveled from 0.4 to 2.0 km (eight species, 13%); and (4) those that traveled from 2.0 to 2.4 km (17 species, 27%). Our findings corroborate Conine et al. (1978): ten species remained exclusively in the riparian habitat (both interior and edge) (38%), an additional four species traveled between 0 to 0.4 km (15%), and 12 species traveled more than 0.4 km (46%).

The effect of a riparian bird community on those in adjacent habitats should be at least partially determined by competitive restrictions imposed by the resident birds in those habitats (Carothers et al. 1974). Riparian birds

TABLE 3. Species richness by resident status.

Habitat	Permanent residents	Summer residents	Migrants and winter residents
Riparian woodland			
Interior	8	8	6
Edge	8	11	6
Desert wash			
0–500 m	16	10	4
600–1,000 m	15	6	4
Desert upland			
0–500 m	15	7	2
600–1,000 m	13	7	2

TABLE 4. Sorensen's similarity index of bird community composition.

Habitat	Riparian		Desert wash		Desert upland	
	Interior	Edge	0–500 m	600–1,000 m	0–500 m	600–1,000 m
Riparian woodland						
Interior	100					
Edge	89	100				
Wash						
0–500 m	54	58	100			
600–1,000 m	46	47	89	100		
Upland						
0–500 m	43	44	87	90	100	
600–1,000 m	36	38	81	88	89	100

are known to substantially affect bird community structure in adjacent agricultural or second-growth fields and pastures that both offer abundant food and typically do not have their own complement of nesting birds (Carothers et al. 1974, Conine et al. 1978). For example, along the Sacramento River, there were 95% fewer birds and 32% fewer species on agricultural lands from which adjacent riparian vegetation had been removed than on agricultural lands in association with riparian vegetation (Hehnke and Stone 1978). In contrast to the depauperate bird community on agricultural land, desert scrub communities have their own complement of bird species that potentially could limit the influx of riparian species (Hensley 1954, Austin 1970, Tomoff 1974). Yet, this was not the case in our study. We found most (75%) of the riparian breeding birds in either desert upland and/or desert wash habitats. In most cases, these birds occurred primarily along the desert wash that many researchers consider a xeric riparian type.

In addition, many typical desert scrub birds preferred the desert wash habitat to desert upland (Table 1). Only the Black-throated Sparrow had higher densities on the desert upland. In fact, all other desert breeding species were classed as facultative riparian species by Ohmart and Anderson (1982); that is, these species use riparian habitat but are not totally dependent on it. For example, Gila Woodpeckers used only saguaro cacti along the edge of the washes as nesting sites, and foraged extensively along the wash. Few desert species, however, made much use of the willow riparian edge and/or interior. Besides Gambel's Quail, only the Gila Woodpecker, Black-tailed Gnatcatcher, Ash-throated Flycatcher, and Green-tailed Towhee were found in low numbers in the riparian edge. Both the Mourning Dove and Northern Cardinal were in both desert and riparian habitats. Doves were equally abundant in all habitats, while cardinals preferred edge and wash habitats. We therefore disagree with Goldberg et al. (1979), who found no indication that the riparian habitat was critical in determining the composition of the breeding bird community on the adjacent habitat. At least for the first 1 km from the edge of the riparian stand, the riparian bird community at our site affected desert bird community composition and density.

How much did the bird community in the riparian island in our study affect the surrounding bird community of the adjacent desert scrub? In similar desert habitats near Silverbell, Arizona, densities of breeding birds in 1970 were 148 and 228 birds/40 ha, with 11 and 12 breeding species, respectively (Tomoff 1974). We found similar densities in our study for the 600–1,000 m segment of the desert wash and the two upland segments. Species richness was much greater in our plots, however, owing primarily to the influx of riparian species. Breeding species richness in our study was 22, 23, and 19 on the 600–1,000 m segment of the desert wash and the two upland segments, respectively. In two desert wash areas in Organ Pipe Cactus National Monument, breeding bird densities of 176 and 216 birds/40 ha (Hensley 1954) were considerably lower than the densities of 302.7 and 442.3 that we found in 1981 and 1982 in the 0–500 m segment of the desert wash. Even eliminating migratory and winter resident species, breeding bird densities of 252.8 and 324.2 birds/40 ha were much higher in our study (Table 1). Moreover, in contrast to the 25 breeding species that we found in the wash, Hensley (1954) found only 12 and 16 breeding species in desert scrub washes in Organ Pipe Cactus National Monument. For the desert upland 600–1,020 m segment of the desert wash, the primary contribution of the riparian bird community is in terms of increasing species richness.

In conclusion, first, we found 10 species exclusively in the riparian stand (interior and edge combined) and 15 species exclusively in the desert scrub habitat (wash and upland for both segments combined). Second, riparian bird species contributed substantially to both total bird density and species richness in the adjacent desert wash and upland. Third, and conversely, desert bird species made almost no use of the riparian stand and had almost no impact on the riparian bird community. Fourth, summer residents were the most important density component in all habitats, even though there were almost twice as many permanent resident species as there were summer residents species in the desert habitats.

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United States Department of Agriculture Forest Service, Rocky Mountain Forest and Range Experiment Station, Arizona State University Campus, Tempe, Arizona 85287.
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RECENT PUBLICATIONS

The herons handbook.—James Hancock and James Kushlan. 1984. Harper & Row, New York. 288 p. $24.95. This guide to herons and bitterns is based on Hancock and Elliott's *The Herons of the World,* a lavish and expensive monograph published in 1978. Now conveniently sized and affordable, the present book "has been updated and revised with the intention of producing an easy reference to identification, behavior, and classification. It includes all of the original species plates [by Robert Gillmor and Peter Hayman] as well as a new series of four plates showing all of the confusing white heron species in their adult plumages, and differentiating between races and seasonal appearances. A distribution map is provided for each species, and . . . a worldwide map depicting the distribution, as currently understood, for each of the 30 subspecies of the Green-backed Heron [*Butorides striatus*]." Introductory general chapters on the classification, courtship, feeding, and identification of these birds are followed by the species accounts. These are a good source of basic natural history, and perhaps even more valuable for current data on distribution and populations. The book has proved useful for identification in regions where field guides are inadequate or lacking. A practical and attractive volume, it is a good value for the money. References, index.

The Marsh Hen/a natural history of the Clapper Rail of the Atlantic coast salt marsh.—Brooke Meanley. 1985. Tidewater Publishers, Centreville, Maryland. 123 p. Paper cover. $8.95. Source: Cornell Maritime Press, Inc., P.O. Box 456, Centreville, MD 21617. The basic biology of the Clapper Rail (*Rallus longirostris*) has received less attention than its management as a game bird. Meanley here redresses the balance, drawing on his long field experience and the literature. After characterizing the species and distinguishing it from the King Rail (*R. elegans*), he examines its habitat, food habits, reproduction, molting, migration, wintering habits, predation, and environmental hazards. Copious details are reported in a clear, matter-of-fact manner. No attempt is made, however, to discuss more broadly the ecology of these rails or the threatened loss of coastal marshes. Appendices treat the subspecies of Clapper Rails and field methods for handling them. Illustrations, references, index.

The parasitic cowbirds and their hosts.—Herbert Friedmann and Lloyd F. Kiff. 1985. Proceedings of the Western Foundation of Vertebrate Zoology, Vol. 2, No. 4. 78 p. Paper cover. $10.00. Source: WFVZ, 1100 Glendon Ave., Los Angeles, CA 90024. Three species of *Molothrus* cowbirds are not restricted in their selection of potential brood hosts. This paper presents complete, up-to-date catalogues of hosts for each of these species, together with comments on certain of the hosts. It compiles many data that have come to light since the authors' (and S. I. Rothstein's) 1977 report (noted in Condor 79:286). The introduction discusses cowbird fecundity, which is the biological basis for the whole problem of brood parasitism with its unusually high rate of mortality, especially of eggs. A valuable summary of information and a source of important new ideas on the parasitic breeding habits of cowbirds. References.