COMPOSITION AND ABUNDANCE OF BIRD POPULATIONS IN RIPARIAN HABITATS OF THE CALIFORNIA DESERTS¹

A. Sidney England², Larry D. Foreman³, and William F. Laudenslayer, Jr.⁴

1981

Abstract.—Avian population variables including diversity, density, and species richness in desert riparian habitats were analyzed using 73 breeding bird surveys, 62 winter bird-population studies, and biweekly surveys at 15 sites. Breeding bird surveys indicated that desert Cottonwood/Willow had the highest number of breeding and visiting species and the highest bird diversity among desert habitats, while Willow had the highest bird density. Winter bird-population studies showed that desert Cottonwood/Willow also had the highest species richness and diversity during winter, but Palm and Palo Verde/Ironwood had higher bird densities. All population variables were higher in desert riparian habitats than in non-riparian desert habitats in winter and breeding seasons. Results from desert habitats were compared to 27 breeding bird surveys and 18 winter bird-population studies conducted in cismontane California riparian habitats. Avian density, diversity, and species richness generally were greater in cismontane riparian habitats. A small number of resident ground granivorous bird species were found to comprise a large proportion of all individuals using desert riparian habitats especially during the summer. Biweekly surveys showed that species richness varied considerably during the year; the 15 sites surveyed fall into four general patterns. Ecological factors such as size of riparian zone, presence of overstory and shrub vegetation, availability of water, visibility, and geographic location may affect total and breeding species numbers. Results are discussed with respect to ecological factors and land management implications.

INTRODUCTION

In 1976 the United States Congress charged the Bureau of Land Management with responsibility for preparing a comprehensive management plan for Public Lands in the deserts of California. As part of this effort, the California Desert Plan Program conducted extensive inventories and studies of many

resources and uses found in the planning area. The wildlife staff began the inventory by compiling existing data including museum records, checklists, unpublished field notes and BLM sight records, and published articles. It was soon realized that little quantitative information existed on birds in the California deserts. Most publications prior to 1970 were primarily annotated species accounts confined to specific areas (e.g., Clark Mountain - Miller 1940, Providence Mountains - Johnson et al. 1948, Joshua Tree National Monument - Miller and Stebbins 1964) and did not cover many of the widely distributed habitats. Data collected by bird-watchers also were restricted to a few sites (e.g., Morongo Valley, Furnace Creek Ranch) during selected seasons, and frequently only unusual species were recorded.

A twofold inventory design was used to collect basic descriptive data on the distribution, abundance, and seasonal variation of birds in California desert habitats. First, permanent study plots were established throughout the deserts and were censused during the breeding and winter seasons

¹Paper presented at California Riparian Systems Conference. (University of California, Davis, September 17-19, 1981).

²Wildlife Biologist, California Desert District, Bureau of Land Management, 1695 Spruce St., Riverside, Calif. 92507.

³District Wildlife Biologist, California Desert District, Bureau of Land Management, 1695 Spruce St., Riverside, Calif. 92507.

⁴Regional Wildlife Ecologist, U.S. Forest Service, Tahoe National Forest, Hwy. 49 and Coyote St., Nevada City, Calif. 95959.

using standard spot-mapping techniques. The advantages of this method included compatibility with similar surveys conducted by others, relative repeatability, and accessibility to results by others through publication in American Birds.

The second approach was a yearlong survey of selected desert riparian sites. This concentrated effort was warranted by the rarity of these habitats in the California deserts, general knowledge of the importance of riparian habitats to birds and other desert wildlife, and management concern arising from competing land uses. This year-round approach at specific sites allowed investigation of temporal changes in species richness and abundance not practical with spot-mapping techniques. It also permitted comparison of several habitat types of various sizes including very small oases which are typical of most desert riparian areas but are seldom addressed in riparian studies.

This paper presents inventory findings relevant to avian use of desert riparian habitats. The following specific questions are discussed:

1. How do abundance and species richness vary by season and between desert riparian habitats?
2. How important are desert riparian habitats relative to non-riparian desert habitats?
3. How do avian use patterns in desert riparian habitats compare to cismontane California riparian habitats?
4. What factors affect species richness in desert riparian habitats?

Answers to questions such as these are needed for management of riparian habitats in the California deserts.

METHODS

Study Area

For the purposes of this analysis, California deserts include all of the Mojave and Colorado Deserts within California and that portion of the Great Basin Desert within California east of the White and Inyo Mountains. Riparian habitats along the Colorado River and the perimeter of the Salton Sea are excluded.

Breeding and Winter Bird Surveys

Quantitative data on breeding and winter birds were collected using the spot-mapping technique prescribed by the National Audubon Society for breeding bird censuses (Svensson 1970, Van Velzen 1972) and winter bird-population studies (Kolb 1965). From 1976 through 1978, Bureau of Land Management employees and contractors conducted 62 winter bird-population studies and 73 breeding bird censuses in a wide variety of desert habitats. Findings from these surveys were combined with other published studies using standardized National

Audubon Society techniques in California desert habitats and cismontane California riparian habitats.

Avian diversity, population density, and species richness values were calculated for each survey. Diversity was computed using the Shannon-Wiener Index (Shannon and Weaver 1949):

$$H' = - \sum_{i=1}^s (p_i \ln p_i)$$

For comparisons among desert riparian habitats, between riparian and non-riparian desert habitats, and between desert and cismontane riparian habitats, surveys were grouped into the following 11 habitat types based on the visually dominant plant(s) occurring on each study plot:

Habitat type	Visually dominant plants
Cottonwood/ Willow	Desert - Fremont cottonwood (<u>Populus fremontii</u>), willow (<u>Salix</u> sp.)
-	Cismontane - Fremont cottonwood, willow, valley oak (<u>Quercus lobata</u>)
Willow	Willow
Palm	California fan palm (<u>Washingtonia filifera</u>)
Mesquite	Mesquite (<u>Prosopis glandulosa</u>), screw bean (<u>P. pubescens</u>)
Palo Verde/ Ironwood	Palo verde (<u>Cercidium floridum</u>), desert ironwood (<u>Olneya tesota</u>), smoke tree (<u>Dalea spinosa</u>)
Catclaw	Catclaw (<u>Acacia greggii</u>), black-banded rabbit brush (<u>Chrysomallus paniculatus</u>)
Sycamore/ Live Oak	Sycamore (<u>Plantanus racemosa</u>), coast live oak (<u>Q. agrifolia</u>)
Desert Woodland	Single-leaved pinyon (<u>Pinus monophylla</u>), limber pine (<u>P. flexilis</u>), Utah juniper (<u>Juniperus osteosperma</u>), turbinella oak (<u>Q. turbinella</u>)
Desert Scrub w/Overstory	Joshua tree (<u>Yucca brevifolia</u>), Mojave yucca (<u>Y. schidigera</u>), desert ironwood, ocotillo (<u>Fouquieria splendens</u>)
Desert Scrub	Creosote bush (<u>Larrea tridentata</u>), burrobush (<u>Ambrosia dumosa</u>), shadscale (<u>Atriplex confertifolia</u>)

Average number of breeding and wintering species, average density, and average species diversity were computed for each habitat type. Breeding bird density and diversity values used only breeding males. Average number of species visiting census plots during the breeding season also was calculated; these data were not available for all censuses. Overall density, diversity, and species richness also were averaged for all desert habitats, all "perennial" desert riparian habitats, all "ephemeral" desert riparian habitats, and cismontane riparian habitats. For the purposes of

Table 1.—Location and description of 15 "perennial" desert riparian study sites surveyed between November 1977 and January 1979.

Study site	Location	County	Elev. (m)	Size (ha)	Habitat ¹ Structure	Habitat Type ²	General Landform
Cottonwood Creek	White Mtns.	Mono	1,600	5.1	SO	Cottonwood/willow	Montane
Sam Spring	Deep Spgs. Valley	Inyo	1,700	1.8	SO	Willow/locust	Valley
Darwin Falls	Argus Mtns.	"	900	5.6	SO	Willow	Montane
Chris Wicht Camp	Panamint Mtns.	"	900	2.9	SO	Cottonwood/willow	Montane
Linekila Spring	Panamint Mtns.	"	1,200	3.0	S	Willow	Montane
Brewery Spring	Panamint Mtns.	"	1,400	4.6	S	Willow	Montane
Kane Spring	Newberry Mtns.	S.B. ³	975	2.1	S	Mesquite/catclaw	Valley
Old Woman Springs	Johnson Valley	"	975	36.4	SOP	Cottonwood/willow ⁴	Valley
Salt Creek	Salt Spring Hills	"	160	9.8	SO	Mesquite/salt cedar	Valley
Horse Thief Springs	Kingston Range	"	1,400	1.0	SO	Cottonwood/willow	Montane
Dove Spring	New York Mtns.	"	1,450	0.8	S	Dwarf ash/hackberry	Montane
Cottonwood Spring	Granite Mtns.	"	1,300	0.2	SO	Cottonwood/willow	Montane
Bonanza Spring	Clipper Mtns.	"	600	1.8	S	Arrowweed/salt cedar	Valley
Mopah Spring	Turtle Mtns.	"	670	0.8	S	Palm/mesquite	Valley
Iron Mtn. Pump. Stn.	Iron Mtns.	"	290	24.8	SOP	Suburban woodland ⁴	Valley

¹S = shrub; SO = shrub with tree overstory; SOP = shrub with tree overstory and pond(s).

²Cottonwood (*Populus fremonti*), willow (*Salix* sp.), locust (*Robinia pseudoacacia*), catclaw (*Acacia greggii*), mesquite (*Prosopis glandulosa*), salt cedar (*Tamarix* sp.), dwarf ash (*Fraxinus anomala*), hackberry (*Celtis douglasii*), arrowweed (*Pluchea sericea*), palm (*Washingtonia filifera*).

³S.B. = San Bernardino County.

⁴Consists primarily of man-created habitat with numerous ornamentals.

this paper, the continuum of riparian habitats present in the California deserts has been divided into "perennial" and "ephemeral" types. "Perennial" riparian habitats typically have water at or near the surface throughout the year (e.g., springs, seeps, streams, etc.). "Ephemeral" riparian habitats occur in washes where surface water typically is available for relatively short periods following storms.

Biweekly Surveys

Data on avian temporal and habitat use patterns were collected at fifteen locations selected to represent the wide range of "perennial" riparian habitat types and sizes found in the California deserts (table 1). Study sites were established at each location; sites ranged in size from 0.2 to 36.4 ha. One feature common to all sites was year-round presence of surface water. Censuses were conducted by systematically walking through each site recording all birds detected; individuals seen in riparian vegetation were recorded separately from individuals in adjacent non-riparian habitat. Two plots were visited per day, one during the three hour period following dawn and one during the three hour period preceding sunset. Length of visits varied with size of study site and number of birds found. Each study site was visited approximately biweekly during the following periods: November 6, 1977 to January 28, 1978, April 9, 1978 to June 17, 1978, and July 16, 1978 to January 3, 1979.

Biweekly survey results and literature review were used to assign each species at each site to one or more of eight seasonal status designations. Year-round, summer, and winter residents were species found throughout these time periods. Spring and fall migrants passed through the sites relatively quickly. Summer and winter transients included species that moved through the site but, unlike migrants, remained for extended periods on the way to or from breeding areas (e.g., Great Blue Heron) and species that occurred widely in the desert but were irregular in riparian habitats (e.g., Red-tailed Hawk, Roadrunner). Vagrants differed from migrants because they were well outside their normal distributions (e.g., Brown Thrasher, Rose-breasted Grosbeak).

Breeding status in riparian habitat at a study site was considered "confirmed" if nesting activity was observed or if recently fledged young of species not found in adjacent desert habitats were seen. Breeding was considered "probable" at a site if the species was known from literature or other study sites to breed in desert riparian habitats and was present at the site throughout the breeding season.

Total number of species observed at each site on all visits and total number of breeding species (confirmed plus probable) at each site were plotted against study site size. Sites with shrubs only, shrubs with tree overstory, and shrubs with tree overstory and ponds were examined separately to

determine the effects of habitat structure on total number of species and number of breeding species.

Temporal species richness patterns were analyzed by plotting number of species observed per visit at each site against time. If more than one visit occurred at a site in a single biweekly sampling period, the average number of species was used. Species richness/time curves for each site were inspected visually and combined into groups with similar patterns. Characteristic curves for each group were constructed by averaging the total number of species observed in each sampling period.

Total number of individuals counted on each visit to each site were graphed against time for analysis of temporal abundance patterns. If multiple visits occurred at a site in a single sampling period, the average number of individuals was used. Abundance curves were inspected visually to determine gross abundance patterns.

Common bird names are those found in the fifth edition of the A.O.U. Checklist of Birds of North America (1957) as amended by Supplements (1973, 1976).

RESULTS

Breeding and Winter Bird Surveys

Ninety-nine breeding bird censuses and 80 winter bird-population studies were compiled for use in this analysis. Of these 179 surveys, 134 were in California desert habitats (45 riparian and 89 non-riparian) and 45 were in cismontane California habitats. Distribution of surveys among habitats and results of the analysis are presented in table 2.

Among desert riparian habitats, Cottonwood/Willow, Willow, and Palo Verde/Ironwood supported the highest numbers and greatest densities of breeding species. Diversity of breeding species also was highest in these habitats. Cottonwood/Willow supported approximately two to five times more breeding species than any other desert riparian habitat. The number of visiting species on breeding bird censuses was higher in all "perennial" desert riparian habitats than in "ephemeral" habitats. Results from winter bird-population studies indicated that Cottonwood/Willow, Palm, and Palo Verde/Ironwood supported more species than other desert riparian habitats. Winter densities were highest in Willow, Palm, and Palo Verde/Ironwood. With the exception of visiting species during the breeding season, all values for Palo Verde/Ironwood, an "ephemeral" desert riparian habitat, fell within the ranges of values for "perennial" habitats. Comparisons between Catclaw and other habitats were complicated by the lack of replicate samples.

Comparing data (table 2) between desert riparian and non-riparian habitats showed that density, diversity, and species richness were higher in all desert riparian habitats during the winter. Breed-

ing bird densities were higher in all desert riparian habitats than in non-riparian habitats. The number of breeding species in Desert Woodland was comparable to Willow and Palo Verde/Ironwood and exceeded Palm and Mesquite. Desert Scrub with Overstory supported approximately the same number of breeding species as Mesquite and was higher than Palm. Breeding species richness was higher in all desert riparian habitats than in Desert Scrub. Only Desert Woodland was comparable to desert riparian habitats in number of visiting species during the breeding season.

Cismontane riparian habitats generally supported more species as well as more individuals than desert riparian habitats (table 2); diversity values were greater in cismontane habitats during both seasons. Breeding bird surveys indicated only desert Cottonwood/Willow supported breeding species numbers comparable to cismontane riparian habitats. Only in desert Cottonwood/Willow and Willow were breeding densities similar to cismontane riparian habitats. However, the number of visiting species was greater in nearly all desert riparian habitats than in cismontane desert riparian habitats. Cismontane Cottonwood/Willow exceeded all desert riparian habitats in species richness and density in winter, while Sycamore/Live Oak was comparable to several desert riparian habitats.

Figure 1.—Total number of species observed as a function of plot size and vegetation structure at 15 "perennial" desert riparian study sites surveyed between Nov. 1977 and Jan. 1979. Data points for sites with ponds were adjusted to exclude species dependent on open water before computing the regression equation for plots with overstory trees ($y = 1.05x + 69$).

Table 2.--Avian diversity, population density, and species richness in riparian and non-riparian desert habitats and in ciemontane riparian habitats. (Mean $\pm$ 1 standard error.)

Habitat Type	Breeding Bird Censuses ¹				Winter Bird-population Studies ²			
	Resident		Visitor		Resident		Diversity	
	Sample ³ Size	No. Species	Density (birds/40 ha)	Diversity (H')	Sample ³ Size	No. Species	Density (birds/40 ha)	Diversity (H')
DESERT RIPARIAN	24	16.1 $\pm$ 2.1	295.2 $\pm$ 63.4	2.08 $\pm$ 0.12	21	25.3 $\pm$ 2.4	537.9 $\pm$ 164.0	2.05 $\pm$ 0.11
"PERENIAL"	16	16.7 $\pm$ 3.0	332.2 $\pm$ 89.0	2.04 $\pm$ 0.17	13	23.7 $\pm$ 3.1	438.5 $\pm$ 125.9	1.95 $\pm$ 0.15
Cottonwood/Willow	5	30.0 $\pm$ 5.3	349.8 $\pm$ 143.6	2.66 $\pm$ 0.34	2	39.0 $\pm$ 13.0	239.5 $\pm$ 72.5	2.37 $\pm$ 0.33
Willow	5	13.4 $\pm$ 2.9	574.2 $\pm$ 11.7	2.04 $\pm$ 0.20	5	18.4 $\pm$ 2.6	588.4 $\pm$ 278.3	2.01 $\pm$ 0.24
Palm	2	5.5 $\pm$ 0.5	133.0 $\pm$ 38.0	1.36 $\pm$ 0.03	2	34.0 $\pm$ 3.0	794.0 $\pm$ 289.0	2.27 $\pm$ 0.31
Mesquite	4	9.8 $\pm$ 1.7	107.5 $\pm$ 32.3	1.61 $\pm$ 0.15	4	17.5 $\pm$ 1.9	172.8 $\pm$ 42.7	1.51 $\pm$ 0.25
"EPHEMERAL"	8	14.9 $\pm$ 1.8	221.0 $\pm$ 67.0	2.16 $\pm$ 0.14	8	27.9 $\pm$ 3.9	699.5 $\pm$ 389.1	2.22 $\pm$ 0.15
Palo Verde/Ironwood	7	15.3 $\pm$ 2.0	237.3 $\pm$ 75.1	2.22 $\pm$ 0.14	7	29.6 $\pm$ 4.0	775.1 $\pm$ 440.7	2.31 $\pm$ 0.14
Catclaw	1	12.0	107.0	1.74	1	16.0	170.0	1.58
CISHONTANE RIPARIAN	27	26.6 $\pm$ 1.3	456.5 $\pm$ 61.4	2.78 $\pm$ 0.07	18	40.4 $\pm$ 3.1	779.2 $\pm$ 117.4	2.76 $\pm$ 0.08
Cottonwood/Willow	17	26.4 $\pm$ 1.9	419.1 $\pm$ 94.5	2.73 $\pm$ 0.11	8	51.4 $\pm$ 4.2	978.5 $\pm$ 229.5	3.01 $\pm$ 0.12
Sycamore/Live Oak	10	27.0 $\pm$ 1.4	520.0 $\pm$ 41.7	2.86 $\pm$ 0.05	10	31.6 $\pm$ 1.9	619.7 $\pm$ 87.8	2.57 $\pm$ 0.07
OTHER DESERT HABITATS								
Woodland	5	13.4 $\pm$ 0.8	72.2 $\pm$ 14.9	2.19 $\pm$ 0.10	5	13.8 $\pm$ 0.4	107.6 $\pm$ 44.8	1.48 $\pm$ 0.21
Scrub w/Overstory	20	10.0 $\pm$ 0.9	36.0 $\pm$ 5.3	1.64 $\pm$ 0.11	15	13.4 $\pm$ 1.5	69.1 $\pm$ 10.3	1.35 $\pm$ 0.19
Scrub	23	3.4 $\pm$ 0.4	20.5 $\pm$ 4.1	0.68 $\pm$ 0.13	21	9.4 $\pm$ 1.0	81.6 $\pm$ 21.1	1.19 $\pm$ 0.12

¹Source: Loaty, G. (ed.) 1967. 31st breeding bird census. #35. Am. Birds 21:611-675; Van Velzen, W.T. (ed.) 1972. 36th breeding bird census. #58-60. Am. Birds 26:937-1006; Van Velzen, W.T. (ed.) 1973. 37th breeding bird census. #79-82, 100. Am. Birds 27:955-1019; Gaines, D. 1974. West. Birds 5:61-80; Van Velzen, W.T. (ed.) 1974. 38th breeding bird census. #107, 108, 110, 111, 129. Am. Birds 28:987-1054; Bur. Land Mgmt. 1977. Unpubl. field data. Riverside, CA; Gaines, D.A. 1977. Inst. of Ecology Pub. No. 15., Univ. of Calif., Davis; Tomoff, C.S. 1977. Rep. for contract CA-060-CT7-987, Bur. Land Mgmt., Riverside, CA; Van Velzen, W.T. (ed.) 1977. 40th breeding bird census. #111, 113, 125, 128, 129. Am. Birds 31:24-93; Bur. Land Mgmt. 1978. Unpubl. field data. Riverside, CA; Franzreb, K.E. 1978. West. Birds 9:9-20; Van Velzen, W.T. (ed.) 1978. 41st breeding bird census. #94-98, 108, 110, 111, 116, 125, 128-130, 134-142, 145-147. Am. Birds 33:49-125; Van Velzen, W.T. (ed.) 1979. 42nd breeding bird census. #119, 120, 132-136, 139, 140, 142-157. Am. Birds 33:54-114; Van Velzen, W.T. (ed.) 1980. 43rd breeding bird census. #121, 133, 134, 142-145, 148, 149, 152, Am. Birds 34:41-106; Van Velzen, W.T. (ed.) 1981. 44th breeding bird census. #161, 174, 175. Am. Birds 35:46-112.

²Source: Ryder, R.A. (ed.) 1972. 25th winter bird-population study. #23. Am. Birds 26:658-688; Ryder, R.A. (ed.) 1973. 26th winter bird-population study. #40. Am. Birds 27:666-703; Ryder, R.A. (ed.) 1974. 27th winter bird-population study. #45, 46, 48, 49. Am. Birds 28:695-733; Ryder, R.A. and A. Ryder (eds.) 1975. 28th winter bird-population study. #35. Am. Birds 29:751-788; Ryder, R.A. and A. Ryder (eds.) 1976. 29th winter bird-population study. #48-52, 54-57, 67. Am. Birds 30:1040-1075. Gaines, D.A. 1977. Inst. of Ecology Pub. No. 15., Univ. of Calif., Davis; Ryder, R.A. and A. Ryder (eds.) 1978. 30th winter bird-population study. #48-51. Am. Birds 32:22-48; Ryder, R.A. and A. Ryder (eds.) 1979. 31st winter bird-population study. #23-27, 39-42, 47-55, 58-61, 63-66, 68-94. Am. Birds 33:18-53; Boyd, R.L. and C.L. Cink (eds.) 1980. 32nd winter bird-population study. #29, 42. Am. Birds 34:25-41; Cink, C.L. and R.L. Boyd (eds.) 1981. 33rd winter bird-population study. #23, 28, 29, 41. Am. Birds 35:21-45.

³Sample size = (No. of surveys per plot). Sample size applies only to residents; values for visitors are smaller.

Table 3. Breeding and seasonal status summary for avian species found at 15 "Perennial" desert riparian sites surveyed between November 1977 and January 1979.

Study Site	Number of Species									No. Breeding Species ²			Species Richness Pattern ³
	Overall	Resident			Transient		Migrant		Vagrant	Total	C	P	
		Su	W	Yr ¹	Su	W	Sp	F					
Cottonwood Creek	75	19	6	(1)	10	17	32	30	1	15	8	7	C
Sam Spring	74	15	5	(2)	9	12	21	44	0	11	4	7	A
Darwin Falls	75	13	14	(3)	6	10	31	40	4	10	9	1	A
Chris Wicht Camp	59	9	4	(0)	5	9	23	29	3	6	5	1	A
Limekiln Spring	42	7	4	(0)	5	4	6	22	2	4	2	2	D
Brewery Spring	41	6	6	(0)	7	3	11	19	0	4	2	2	D
Kane Spring	43	8	5	(2)	9	11	22	16	0	3	2	1	B
Old Woman Springs	122	19	22	(10)	11	20	48	75	4	17	9	8	A
Salt Creek	80	10	8	(1)	9	18	31	46	4	7	3	4	A
Horse Thief Springs	82	15	8	(2)	11	9	33	45	2	12	5	7	D
Dove Spring	44	8	4	(1)	9	5	17	15	1	5	0	5	C
Cottonwood Spring	64	7	3	(0)	22	10	21	28	3	2	0	2	D
Bonanza Spring	46	7	5	(3)	6	8	29	20	0	3	2	1	B
Mopah Spring	50	10	3	(2)	7	12	20	18	0	7	4	3	B
Iron Mtn. Pump. Stn.	121	14	14	(7)	14	24	33	80	8	13	4	9	D

¹Yr = Year-round resident species. These numbers are included in both summer (Su) and winter (W) resident totals.

²C = Confirmed; P = Probable.

³See figure 3 for graphs describing four (A-D) species richness patterns.

Biweekly Surveys

A grand total of 190 bird species were observed at all sites on all visits combined. The total number seen at each site ranged from 41 at Brewery Spring to 122 at Old Woman Springs (table 3). Considerably more species were seen at the two large, man-created sites (Old Woman Springs and Iron Mountain Pumping Station) than at any other site. More species were recorded at sites supporting shrub vegetation with tree overstory than at sites with shrub vegetation only (fig. 1). The total number of species observed at sites having shrub vegetation with tree overstory increased with plot size (fig. 1); sites with ponds were included in this regression after excluding species dependent on open water. An analysis using average number of species per visit in place of total number of species produced similar results.

The number of confirmed breeding species ranged from zero at Dove and Cottonwood Springs to nine at Old Woman Springs and Darwin Falls (table 3). Total breeding species (confirmed and probable) ranged from two at Cottonwood Spring to 17 at Old Woman Springs. Sites having shrub vegetation with tree overstory generally supported more total breeding species than sites with shrub vegetation only (fig. 2). However, Cottonwood Spring, a site with shrub vegetation and tree overstory, had the lowest breeding species total. This may have been because it had the smallest area of all sites, consisted of only three cottonwood trees, and had almost no shrub understory. Mopah Spring was classified as a site

with shrub vegetation only but fell within the range of breeding species for sites with tree overstory. The vegetation at this site was predominantly shrubs but also included five palm trees and a number of large Palo Verde.

A seasonal status summary for avian species found at each site is presented in table 3. The largest group of species observed during the biweekly surveys was migrants. At 10 of 15 sites, more species were present during fall migration. The number of spring migrant species approximately equalled or exceeded fall migrants at the other five. Year-round resident species were uncommon at nearly all sites. Only Old Woman Springs and Iron Mountain Pumping Station, both large and diverse man-created habitats, supported a significant proportion of year-round residents relative to the number of summer and winter residents. Summer residents were more common than winter residents at 9 of 15 sites and approximately equal at the remaining six sites.

Species richness graphs for each site were classified into one of four general species richness patterns (table 3, fig. 3) based on shape (i.e., relative position and height of peaks). Five sites were classified as Pattern A, summer and winter lows with nearly equivalent spring and late summer/fall peaks. Three sites were Pattern B, high spring peak and relatively low late summer/fall peak. The Pattern C curve, spring high declining steadily to a winter low, included only Cottonwood Creek and Dove Spring. The remaining five sites

(Pattern D) were similar to Pattern A except that the spring species richness peak was distinctly lower than the late summer/fall peak. All patterns with late summer/fall peaks (A, B, & D) reached highest values between mid-August and late October. Species richness Patterns A, B, and D reached spring peaks from mid-April to early May; pattern C reached the spring peak in late May. All patterns reached winter lows from late December to early January and began to increase in mid-January.

Figure 4 displays the results from three springs selected to represent the range of avian abundance patterns. Abundance was considerably more erratic than species richness because abundance was affected more by time of survey, weather conditions, and encounters with large flocks. Highest abundances were reached in summer and fall at 13 of 15 sites (fig. 4A & B). Nine were highest from mid-July to late August (fig. 4A); six of these had peak abundances two to six times greater than any other time of year. The remaining four curves with highest abundances in summer/fall also had peaks from mid-July to late August, but these were exceeded by peaks from early September to mid-October (fig. 4B). Kane Spring and Darwin Falls had lows in summer and peak abundances in early December (fig. 4C).

Most major abundance peaks were due to large numbers of summer, winter, or year-round resident ground granivores (i.e., California, Gambel's and Mountain Quail, Chukar, Mourning Dove, Horned Lark at Old Woman Springs only, House Sparrow, House Finch, Black-throated Sparrow, Dark-eyed Junco, Brewer's Sparrow at Cottonwood Creek only, White-crowned and Golden-crowned Sparrows). These species accounted for 50% to 90% of the height of summer/fall abundance peaks (fig. 4A & B). Most sites showed a small increase in bird numbers during spring migration. This peak generally was not dominated by resident ground granivores and was

Figure 2.—Total number of breeding species (confirmed and probable) as a function of plot size and vegetation structure at 15 "perennial" desert riparian study sites surveyed between Nov. 1977 and Jan. 1979. Results from study sites with ponds are shown with and without species dependent on open water.

Figure 3.—Avian species richness patterns at 15 "perennial" desert riparian study sites surveyed between Nov. 1977 and Jan. 1979. Type A - Nearly equivalent peaks in spring and late summer/fall. Type B - High spring peak and relatively low late summer/fall peak. Type C - Peak in spring declining steadily to winter low. Type D - Low spring peak and relatively high late summer/fall peak.

more evident when these species were removed (fig. 4A, B, & C). Late fall/early winter populations varied in the proportion of resident ground granivores. White-crowned Sparrow, a ground granivore, was a common winter resident (fig. 4C). However, two foliage insectivores, Ruby-crowned Kinglet and Yellow-rumped Warbler, frequently were more abundant than resident ground granivores (fig. 4A & B).

DISCUSSION

Importance of Desert Riparian Habitats

The presence of trees or arborescent shrubs in riparian and non-riparian desert habitats is an important variable influencing the breeding avifauna. Although quantitative data on habitat structure are not provided, the pattern of increasing breeding bird diversity, density, and species richness parallels the presence of trees and arborescent shrubs. Among desert riparian habitats, Cottonwood/Willow, Willow, and Palo Verde/Ironwood typically have the greatest overstory canopy and thus have a wider availability of perches, nest sites, and foraging substrates. These habitats support more breeding species at higher densities and have a higher breeding species diversity than habitats with less overstory (table 2). California fan palms supply a vertical habitat component but do not have the dense canopy provided by trees and arborescent shrubs. To a lesser degree, Desert Scrub with overstory habitats dominated by Joshua tree or ocotillo also have a vertical component but lack much of the structural complexity that provides foraging and nesting substrates. However, overstory canopy is important in non-riparian desert habitats during the breeding season. Overstory vegetation decreases from Desert Woodland to Desert Scrub with Overstory to Desert Scrub;

Figure 4.—Avian abundance patterns at three "perennial" desert riparian study sites surveyed between Nov. 1977 and Jan. 1979. Upper line on each graph includes all species; lower line excludes selected resident ground granivores.

number of breeding species, density, and diversity decline in a similar manner (table 2).

During the winter, birds are less dependent on trees and arborescent shrubs for perching and nesting. At this time, density, diversity, and species richness in riparian and non-riparian habitats are not as well correlated with presence or absence of overstory canopy. Among riparian habitats, Palm had the highest bird densities in winter; species richness values were comparable to Cottonwood/Willow and exceeded all other desert habitats. This observation may be explained by the fact that California fan palms are restricted to the Colorado Desert which is warmer in the winter than the Mojave and Great Basin Deserts. Among non-riparian habitats, Desert Woodland and Desert Scrub with Overstory supported nearly equal numbers of species, while bird densities in Desert Scrub exceeded Desert Scrub with overstory.

Besides the possible presence of trees or arborescent shrubs, water at or near the surface in riparian habitats generally supports denser vegetation than is found in non-riparian desert areas. By providing more food and cover, this denser vegetation in part supports the higher bird densities found in desert riparian habitats during breeding and winter seasons.

Surface water also is an important habitat component influencing bird use, especially during the summer months. Smyth and Coulombe (1971) have shown that granivorous birds including Gambel's Quail, Mourning Dove, White-winged Dove, House Finch, and Black-throated Sparrow drank regularly at Upper Carrizo Spring in the Santa Rosa Mountains of southern California. Insectivorous and frugivorous birds were seen drinking less regularly or not at all. Our study found that 13 species of summer, winter, or year-round resident ground granivores accounted for a large majority of birds seen at 15 "perennial" riparian areas (fig. 4). Nine of these species were present during the summer, but only two species (House Sparrow and House Finch) nested almost exclusively in riparian vegetation. The rest of these birds presumably were drawn to the spring largely for water during the hot, dry summer months.

The importance of desert riparian habitats to birds is not limited to large sites. Relatively small sites are used by many species over the course of a year (fig. 1); this is especially true for sites with tree overstory. Small sites with tree overstory generally support more breeding species than sites with shrub vegetation only (fig. 2). However, the number of breeding species does not show the correlation with plot size found for total number of species (fig. 1). Cottonwood Spring, the smallest site with overstory vegetation, almost completely lacked shrub cover under the three cottonwoods and supported fewer breeding species than any other site. However, Horse Thief Springs, the next larger site with overstory, had numerous large cottonwoods and patches of tall dense shrubs. It supported among the highest numbers of breeding birds.

Small sites also can support large numbers of individuals. The Cottonwood Creek site is approximately five times larger than Horse Thief Springs (table 1). However, Horse Thief Springs supported numbers of birds comparable to Cottonwood Creek during spring and winter and considerably more in summer and fall (fig. 4). Local factors including surrounding habitat, geographic location, topography, and availability of water in adjacent areas may affect why some sites support more birds than would be expected considering size alone.

The species composition of bird populations in desert riparian habitats is extremely dynamic. This is reflected in the species richness patterns illustrated in (fig. 3). The typical pattern has peaks in spring and fall with lows in summer and winter. Relatively few species are resident in desert riparian habitats; most are either transients, migrants, or vagrants (table 3). Breeding species typically are present only during the spring when food and water are most available and temperatures are relatively mild. However, peak number of individuals frequently is composed of relatively few species (fig. 4). At 9 of 15 sites sampled biweekly, peak abundance preceded peak species richness by approximately one month.

Explanations for variations in species richness patterns (fig. 3, table 3) must be tentative since they are based on one year's data collected at biweekly intervals. Four of five sites with lower species richness in the spring than in the late summer/fall were in high elevation, montane locations. These sites remain colder and less productive later in the spring and may be cooler, more moist and support food longer than lower elevation and valley sites in the late summer/fall. These reasons could explain the observed pattern. However, two high elevation montane sites, Cottonwood Creek and Dove Spring, had the highest species richness in the spring and declined throughout the year to winter lows. The reasons for this pattern are less obvious, especially since the number of migrant species recorded at each site was nearly the same in spring and fall (table 3). Iron Mountain Pumping Station, a low elevation valley site, also showed a low spring peak relative to the fall. However, this site had an extremely high fall peak that may have been due to migrants being attracted to this large, highly visible site for food and water.

Medium to large sites in valleys and low elevation montane sites had nearly equal species richness peaks in late summer/fall and spring. Small, low elevation sites situated in valleys had high spring peaks and relatively low fall species richness peaks. Low species richness in the late summer/fall may have been due to lack of resources at very small, hot sites and lower probability that migrating birds could find these oases. Elevation, size, and visibility appear to be variables affecting the number of bird species using desert riparian habitats during migration.

In the breeding season, more visiting species are found in desert riparian habitats than in cismontane riparian habitats (table 2). This

pattern probably is due to the isolated nature of desert riparian sites and the relative unsuitability of adjacent desert habitats for many birds. Water, cover, and food usually are more available in habitats surrounding cismontane than desert riparian habitats. In the desert, many species found in adjacent habitats must visit riparian habitats. In addition, most studies of birds at desert riparian habitats census the entire habitat at the site. In cismontane locations, riparian habitat frequently is more widely distributed and study plots usually include only a piece of the available habitat. Therefore, a greater portion of the species using riparian habitat may be found at desert sites.

Management Implications

Riparian habitat associated with permanent water is very limited in the desert. However, washes, which are included in the preceding analysis, are more numerous in the desert. As we and others have shown, riparian habitats play a vital role in the desert ecosystem by providing water, food, and cover for resident and transient riparian birds, migrating birds, and non-riparian birds, such as quail and doves.

Contrasting with the high value and low quantity of riparian habitat in the desert is the common and highly intensive use of these areas for non-wildlife purposes. For example, livestock and feral burros often congregate or linger in riparian habitats to take advantage of the shade, forage, and drinking water. Recreationists are attracted to riparian habitats in the desert by the shade and high visual quality. Washes are used as vehicular thoroughfares because they lack major obstacles. Mining operations frequently use the water in riparian habitats in mining or mineral processing. Riparian habitats are focal points of cultural resources such as historic and Native American sites.

Many of these uses are in conflict with wildlife or maintenance of the riparian community. Riparian habitats are generally recognized as vital to desert resident and migrant birds. Knowledge of the importance of riparian habitats is vital to land managers as they attempt to resolve use conflicts. Resolution of these conflicts should consider the breadth of resources which are critical to birds. Among these are the availability of surface water and the presence of a tree overstory and dense ground cover. Proper management should be aimed at maintaining or enhancing all of the individual components making up the riparian zone.

In addition, the geographic distribution of riparian habitats should be taken into account when assessing conflicts. Species such as Brown Towhee and Lazuli Bunting breed only in riparian habitats in the Mojave and Great Basin deserts. Others including Verdin, Abert's Towhee, and Black-tailed Gnatcatcher are restricted to riparian habitats in the Colorado Desert. An adequate distribution of well-managed riparian habitat is essential especially to the maintenance of species with small distributions in the California deserts.

Results from biweekly surveys indicate that late December and early January is the time of lowest species richness (fig. 3) and bird abundance (fig. 4) at desert riparian sites. Winter bird-population studies conducted primarily in January and February show that mid to late winter species richness and abundance is higher. Thus, if it is necessary to create a disturbance such as building a fence or installing a management facility, construction during late December and early January is likely to have a lesser impact than at other times. Of course, activities which impair habitat will be harmful to birds regardless of the season.

Human development and artificial habitats may be beneficial to the avifauna. Results of the biweekly surveys (table 3) show that the two sites with the highest overall species occurrence (Old Woman Springs and Iron Mountain Pumping Station) are to a large degree man-made habitats. Old Woman Springs (122 species) includes a reservoir, residences, gardens, and ornamental trees mixed with native vegetation. Iron Mountain Pumping Station (121 species) is an entirely artificial site made up of residential areas, parks, and a reservoir. These two sites also were especially high in number of year-round resident, fall migrant, and vagrant species. Besides having diverse structure including tall trees, buildings, dense shrubery, open water, etc., these sites were exceptionally large (36.4 ha and 24.8 ha, respectively). The low elevation of each site (975 m and 290 m, respectively) made them conducive to winter residents and winter transients. Thus, if properly mixed with native vegetation, artificial habitats can create structural diversity and provide nest and perch sites which would otherwise not be available.

There are a few sites in the desert which are unusually rich in bird species. These frequently become focal points for birdwatchers (e.g., Morongo Valley, Furnace Creek Ranch). Such sites are normally large and diverse and support a substantial tree overstory. However, as knowledge of these sites increases, the importance of smaller, less renowned riparian sites can become obscured. Large sites have special management significance not only for the rarity of some of the birds found there but also for the high level of public interest in the integrity of the site. However, this should not overshadow the importance of the numerous other riparian sites and the contribution they make to supporting the desert avifauna.

ACKNOWLEDGEMENTS

We thank the many biologists who conducted and published breeding bird surveys and winter bird-population studies used in this report. Scott P. Horton developed the biweekly data collection methodology, selected study sites, and conducted initial surveys. Steven W. Cardiff performed biweekly surveys at one site. Kristin E. Berry supervised the wildlife program of the BLM California Desert Plan Staff. The final and several draft manuscripts were typed by Tracy Cortez. Figures were prepared by Clara Stapp.

LITERATURE CITED

- American Ornithologists' Union. 1957. Checklist of North American birds. 691 p. A.O.U., Baltimore, Md.
- American Ornithologists' Union. 1973. Thirty-second supplement to the American Ornithologists' Union checklist of North American birds. Auk 90:411-419.
- American Ornithologists' Union. 1976. Thirty-third supplement to the American Ornithologists' Union checklist of North American birds. Auk 93:875-879.
- Johnson, D.E., M.D. Bryant, and A.E. Miller. 1948. Vertebrate animals of the Providence Mountains area of California. Univ. Calif. Publ. Zool. 48:221-376.
- Kolb, E. 1965. The Audubon winter bird-population study. Aud. Field Notes 19:432-434.
- Miller, A.E. 1940. A transition island in the Mohave Desert. Condor 42:161-163.
- Miller, A.E. and R.C. Stebbins. 1964. The lives of desert animals in Joshua Tree National Monument. 452 p. Univ. Calif. Press, Berkeley.
- Shannon, C.E. and W. Weaver. 1963. The mathematical theory of communication. Univ. Ill. Press, Urbana, Ill.
- Smyth, M. and E.N. Coulombe. 1971. Notes on the use of desert springs by birds in California. Condor 73:240-243.
- Svensson, S. 1970. An international standard for a mapping method in bird census work recommended by the International Bird Census Committee. Aud. Field Notes 24:722-726.
- Van Valzen, W.T. 1972. Breeding-bird census instructions. Am. Birds 26:1007-1010.

Bureau of Land Management
Library
Bldg. 50, Denver Federal Center
Denver, CO 80225

Bureau of Land Management
Library
Bldg 50, Denver Federal Center
Denver, CO 80225

QL
684
.C2
E58

Borrower's

Composition and abun
in riparian habita
deserts.

Date	
Loaned	Borrower