Wilson Bull., 99(4), 1987, pp. 642–654

VALUE OF SUBURBAN HABITATS TO DESERT RIPARIAN BIRDS

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ABSTRACT.—Bird populations were monitored over 20 consecutive months in suburban Tempe, Arizona, to assess the value of this artificial habitat for native riparian bird species. Of 104 species detected, 60 were transient migrants, 25 were permanent or summer residents that probably bred locally, and 19 were winter residents. Total density varied from 1423 to 3237 birds/40 ha; four nonriparian residents (Rock Dove [*Columba livia*], Inca Dove [*Columbina inca*], European Starling [*Sturnus vulgaris*], House Sparrow [*Passer domesticus*]) comprised from 52% to 72% of the total each month. Compared with nearby native riparian habitats (cottonwood-willow and mesquite), the suburban plots appeared to support significantly higher total bird densities in every month. Ten native species occurred in significantly higher density on the suburban transects than in outlying riparian habitats in at least one season. Overall, 53% of the riparian breeding species, and 85% of the winter residents also occurred in suburban Tempe. Absence of other riparian species from the suburban sites may be attributed either to interference by abundant, urban-adapted species or an inability to exploit nonnative tree species. Other suburban sites containing native willows and cottonwoods support populations of several obligate riparian species not found in Tempe. We suggest that well-vegetated suburban habitats have much potential in mitigating against the rapid loss of native riparian vegetation in the Southwest. *Received 8 Jan. 1987, accepted 7 May 1987.*

Urban and other artificial environments have been viewed as natural experiments in which the response of native bird communities to drastic habitat alterations can be investigated (Emlen 1974). Insights into the origin and organization of the urban avifauna of North America have come from studies in Illinois (Graber and Graber 1963), Massachusetts (Walcott 1974), Ohio (Beissinger and Osborne 1982), Arizona (Emlen 1974), Washington (Gavareski 1976), and British Columbia (Lancaster and Rees 1979). The uniformity of conclusions from these diverse regions is striking: urbanized habitats can support high densities of breeding birds, but are dominated numerically by a few nonnative and nonmigratory generalists. Comparison of present-day urban sites with nearby natural habitats has shown that native breeding species will persist in or recolonize areas that either retain some character of the natural vegetation or provide substitutes for specific habitat requirements, such as shrub cover or nest

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cavities (Linehan et al. 1967, Gavareski 1976, Beissinger and Osborne 1982).

In the southwestern United States, many native bird species are closely associated with desert riparian forests and particularly sensitive to habitat loss (Carothers et al. 1974, Johnson et al. 1977). Water-use practices and large scale clearing of natural vegetation for agriculture have resulted in a drastic reduction in riparian habitats and the bird species that depend on them. When urbanization follows land clearing, vegetation cover may increase again through planting. Preliminary data from the Colorado River Valley (Anderson and Ohmart 1976, 1977) and the Phoenix region (S. B. Terrill, pers. obs.) indicated that suburban areas may support many native species, including some considered sensitive to riparian habitat loss. Our goals in this study were to: (1) quantify avian populations throughout the year in a well-vegetated suburb; (2) compare these population trends with those in nearby riparian habitats; and (3) evaluate the potential value of these man-made habitats to native bird species in the arid southwest.

STUDY AREA AND METHODS

We established two 0.8 km transects in a relatively well-vegetated section of Tempe, Arizona (elev. 355 m). One was along a quiet suburban street (Ash St., between 13th St. and University Ave.), bordered on both sides by landscaped front yards in which mature plantings included pecan (*Carya illinoensis*), mulberry (*Morus alba*), palms (*Washingtonia robusta* and *W. tilifera*), ash (*Fraxinus pennsylvanica*), and firethorn (*Pyracantha fortuneana*). A few native cottonwoods (*Populus fremontii*), palo verdes (*Cercidium* spp.), and cacti were scattered along the transect. The second transect was along an unpaved lane paralleling a dirt-lined irrigation ditch, two blocks south of Apache Blvd. between McAllister and Mill avenues. Eight mature willow trees (*Salix goodingi*) grew along the ditch, which contained water during 10% of the census visits. This transect was bordered in part by several open dirt or grassy lots, a small orchard of pecans, several citrus trees (*Citrus* spp.), figs (*Ficus cariaca*), and two large honey mesquite trees (*Prosopis glandulosa*). The remainder was adjacent to fenced back yards with variable vegetation cover. We chose these transects not as representative of suburban Tempe, but rather to indicate the potential value of more densely vegetated urban areas to birds.

Each transect was censused by the variable-width line transect method (Emlen 1971, 1977) during three mornings each month from September 1979 through June 1981. The study encompassed two complete winters and two breeding seasons. Approximately 85% of the censuses were conducted by the authors, with the remainder by five additional observers. Densities of all bird species were computed separately for each census based on the distribution of detections among lateral strips 15–30 m in width. We took the maximum density of detections in successively wider strips and extrapolated this to number/40 ha (see Anderson et al. 1977, Engel-Wilson et al. 1981). Estimates from the six censuses (for both transects) were averaged to yield one monthly density value for each bird species.

We compared these densities with those from cottonwood-willow and mesquite-dominated habitats near the confluence of the Salt and Verde rivers, approximately 20 km northeast of Tempe, surveyed by Stamp and Ohmart (1976). The census technique and

density calculations were identical to our own, and Terrill censused extensively in both studies, thus facilitating our comparison. Average seasonal density estimates for each habitat were compared using a Student's *t*-test for small, unequal sample sizes (Sokal and Rohlf 1969). Although the riparian and suburban habitats were censused in different years, our extensive visits to these sites over a 5-year period did not detect any major changes in avifaunal composition. Year-to-year fluctuations in abundance are to be expected; therefore, our statistical comparisons must be treated with caution. The qualitative conclusions from these comparisons, however, are not diminished by these weaknesses.

Because of the irregular seasonal status of many southwestern birds, we use breeding resident, rather than "summer" resident, to denote species that migrate to the region in spring to breed, and nonbreeding resident to denote those that occur for part of the year but do not breed. Similarly, we denote April to June as the breeding season and November to January as the season when birds are most clearly wintering. These designations follow Phillips et al. (1964) and Monson and Phillips (1981).

RESULTS

We detected a total of 104 species on the two transects, 60 of which occurred only as transients or rare visitors. Among the 44 permanent or seasonal residents (Table 1), four were classified as nonriparian by Ohmart and Anderson (1982). These are the exotic Rock Dove (scientific names are in Table 1), European Starling, and House Sparrow, as well as the native Inca Dove, the spread of which into the southwestern United States closely paralleled human settlement (Phillips et al. 1964, Rea 1983). The latter three species each attained minimum year-round densities of >300 birds/40 ha and peaked at between 500 and 900 birds/40 ha in some months.

Of the remaining native species, the Northern Mockingbird and House Finch were the most abundant year-round, usually exceeding 100 birds/40 ha. White-winged and Mourning doves were also abundant in spring and summer. Other native species that attained relatively high and stable densities in the suburban sites included Gila Woodpecker, Verdin, Abert's Towhee, and Northern Cardinal. Black-chinned Hummingbird was common in summer, and Northern (Red-shafted) Flicker, Yellow-rumped Warbler, and White-crowned Sparrow were relatively common in winter.

The number of permanent resident species (including nonriparian) remained nearly constant (13–15) throughout the study period (Fig. 1). The number of breeding residents peaked at seven in June–August 1980 and nine in May 1981, whereas nonbreeding residents peaked at 14 species in November 1979 and 17 in January 1981. Transient species outnumbered all other groups in September of both years (21–22 species), with smaller peaks in April–May.

Total density throughout the study period ranged from 1423 birds/40 ha in November 1979 to 3237 birds/40 ha in April 1981 (Fig. 2). Four nonriparian species accounted for 52–72% of the total density during all months. Densities of both riparian and nonriparian species were highest

TABLE 1

DENSITY (BIRDS/40 HA) OF BREEDING AND WINTERING RESIDENTS IN SUBURBAN TEMPE, ARIZONA, COMPARED WITH NATIVE RIPARIAN HABITATS

Species	Riparian affinity[a]	April–June		November–January	
		Density	Status[b]	Density	Status[b]
Sharp-shinned Hawk (*Accipiter striatus*)	F			3 ± 3	P
American Kestrel (*Falco sparverius*)	F			3 ± 2	P
Gambel's Quail (*Callipepla gambelii*)	F		– –		– –
Rock Dove (*Columba livia*)	N	70 ± 19[c]	+ +	88 ± 16	+ +
White-winged Dove (*Zenaida asiatica*)	F	113 ± 68	0		
Mourning Dove (*Z. macroura*)	F	196 ± 59	+	30 ± 32	+
Inca Dove (*Columbina inca*)	N	405 ± 40	+ +	387 ± 130	+ +
Yellow-billed Cuckoo (*Coccyzus americanus*)	O		– –		
Greater Roadrunner (*Geococcyx californianus*)	F	V[b]	– –		
Black-chinned Hummingbird (*Archilochus alexandri*)	F	33 ± 7	0		
Anna's Hummingbird (*Calypte anna*)	F	8 ± 8	0	12 ± 8	+ +
Gila Woodpecker (*Melanerpes uropygialis*)	F	22 ± 8	–	23 ± 3	0
Red-naped Sapsucker (*Sphyrapicus nuchalis*)	F			3 ± 2	0
Ladder-backed Woodpecker (*Picoides scalaris*)	F		– –		
Northern Flicker (*Colaptes auratus*)	F		– –	21 ± 5	+
Ash-throated Flycatcher (*Myiarchus cinerascens*)	F	2 ± 2	–		
Brown-crested Flycatcher (*M. tyrannulus*)	F	V	– –		
Western Kingbird (*Tyrannus verticalis*)	F	2 ± 5	P		
Cliff Swallow (*Hirundo pyrrhonota*)	F	3 ± 6	P		
Verdin (*Auriparus flaviceps*)	F	53 ± 16	+	33 ± 6	+
Cactus Wren (*Campylorhynchus brunneicapillus*)	F	7 ± 7	0	1 ± 1	0

TABLE 1
CONTINUED

Species	Riparian affinity[a]	April–June		November–January	
		Density	Status[b]	Density	Status[b]
Bewick's Wren (*Thryomanes bewickii*)	O		− −	3 ± 2	0
House Wren (*Troglodytes aedon*)	F			2 ± 1	P
Ruby-crowned Kinglet (*Regulus calendula*)	F			15 ± 10	−
Blue-gray Gnatcatcher (*Polioptila caerulea*)	F			2	P
Black-tailed Gnatcatcher (*P. melanura*)	F		− −		− −
Western Bluebird (*Sialia mexicana*)	F				− −
Hermit Thrush (*Catharus guttatus*)	F			3 ± 2	P
American Robin (*Turdus migratorius*)	F			5 ± 8	0
Northern Mockingbird (*Mimus polyglottos*)	F	196 ± 37	+	83 ± 31	+ +
Curve-billed Thrasher (*Toxostoma curvirostre*)	F	12 ± 7	+	7 ± 2	+
Crissal Thrasher (*T. dorsale*)	O		− −		
Cedar Waxwing (*Bombycilla cedrorum*)	F			2	P
Phainopepla (*Phainopepla nitens*)	F		− −		− −
Loggerhead Shrike (*Lanius ludovicianus*)	F		− −	3 ± 3	0
European Starling (*Sturnus vulgaris*)	N	316 ± 97	+	305 ± 117	+
Bell's Vireo (*Vireo bellii*)	O		− −		
Solitary Vireo (*V. solitarius*)	F			1 ± 2	P
Orange-crowned Warbler (*Vermivora celata*)	F			8 ± 5	P
Lucy's Warbler (*V. luciae*)	O	1 ± 1	−		
Yellow Warbler (*Dendroica petechia*)	O	V	− −		
Yellow-rumped Warbler (*D. coronata*)	F			79 ± 31	+

TABLE 1
CONTINUED

Species	Riparian affinity[a]	April–June		November–January	
		Density	Status[b]	Density	Status[b]
Yellow-breasted Chat (*Icteria virens*)	O		– –		
Summer Tanager (*Piranga rubra*)	O	V	– –		
Northern Cardinal (*Cardinalis cardinalis*)	F	19 ± 6	0	11 ± 4	+
Blue Grosbeak (*Guiraca caerulea*)	O		– –		
Green-tailed Towhee (*Pipilo chlorurus*)	F			V	– –
Abert's Towhee (*P. aberti*)	O	49 ± 18	0	23 ± 11	–
Lincoln's Sparrow (*Melospiza lincolnii*)	F			3 ± 2	P
White-crowned Sparrow (*Zonotrichia leucophrys*)	F			23 ± 23	0
Dark-eyed Junco (*Junco hyemalis*)	F			2 ± 2	P
Red-winged Blackbird (*Agelaius phoeniceus*)	F			18 ± 20	P
Great-tailed Grackle (*Quiscalus mexicanus*)	F	53 ± 23	+ +	14 ± 4	+ +
Bronzed Cowbird (*Molothrus aeneus*)	F	24 ± 7	+ +		
Brown-headed Cowbird (*M. ater*)	F	48 ± 32	0		
Hooded Oriole (*Icterus cucullatus*)	O	3 ± 4	0		
Northern Oriole (*I. galbula*)	O	3 ± 4	–		
House Finch (*Carpodacus mexicanus*)	F	266 ± 57	+	126 ± 49	+
Lesser Goldfinch (*Carduelis psaltria*)	O	V	– –		
House Sparrow (*Passer domesticus*)	N	789 ± 98	+ +	406 ± 117	+ +

[a] From Ohmart and Anderson (1982); O = Obligate riparian, F = Facultative riparian, N = nonriparian.
[b] Comparison with highest density in either cottonwood-willow or mesquite habitat 20 km NE of Tempe (data from Stamp and Ohmart 1976). + + = occurred only in suburban; + = significantly higher density in suburban (*t*-test, $P < 0.05$); – = significantly lower in suburban (*t*-test, $P < 0.05$); – – = recorded on riparian but not on suburban transects, 0 = no significant difference between suburban and native habitats; P = not recorded by Stamp and Ohmart but known to occur in small numbers in riparian habitats (pers. obs.); V = visitor only to suburban habitat.
[c] Mean density ± SD.

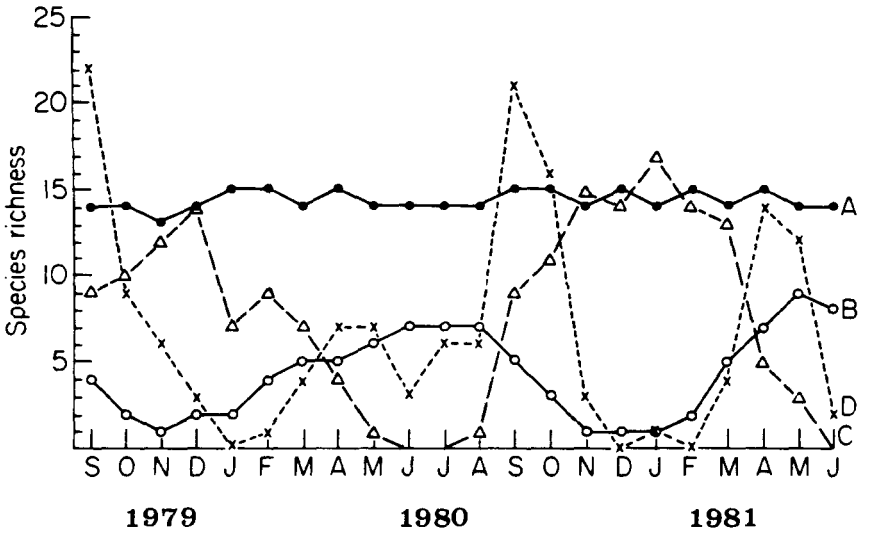

FIG. 1. Monthly bird species richness in suburban Tempe, Arizona: A—Permanent residents; B—Breeding residents; C—Nonbreeding residents; D—Transients.

during the spring breeding season and fell sharply in late fall and early winter, essentially paralleling population trends in mature cottonwood/willow habitat (Stamp and Ohmart 1976). Postbreeding flocks of Inca Doves, starlings, and House Sparrows caused a second peak for nonriparian species each September.

The largest proportion of individuals on the plots at all times were permanent residents (Fig. 3). In the two successive years, permanent resident density dropped 49–54% from September to the winter low, then roughly doubled again by the following April. Breeding resident density rose gradually through late winter and spring, while density of nonbreeding residents was dropping gradually from a November-December peak. Average monthly density of transients was relatively low with a maximum of 111 birds/40 ha recorded in September 1979; counts on single days, however, produced estimates as high as 260 birds/40 ha.

Comparison with riparian habitats.—Because our primary purpose for quantifying the suburban bird community was to make comparisons with nearby riparian communities, we drew heavily on similar data gathered in cottonwood and mesquite habitats by Stamp and Ohmart (1976). During the April–June breeding season, 43 nontransient species were detected on either riparian or suburban transects (Table 1). Of these, the Rock Dove, Inca Dove, Great-tailed Grackle, Bronzed Cowbird, and House Sparrow may be considered "suburban" species that did not breed in the

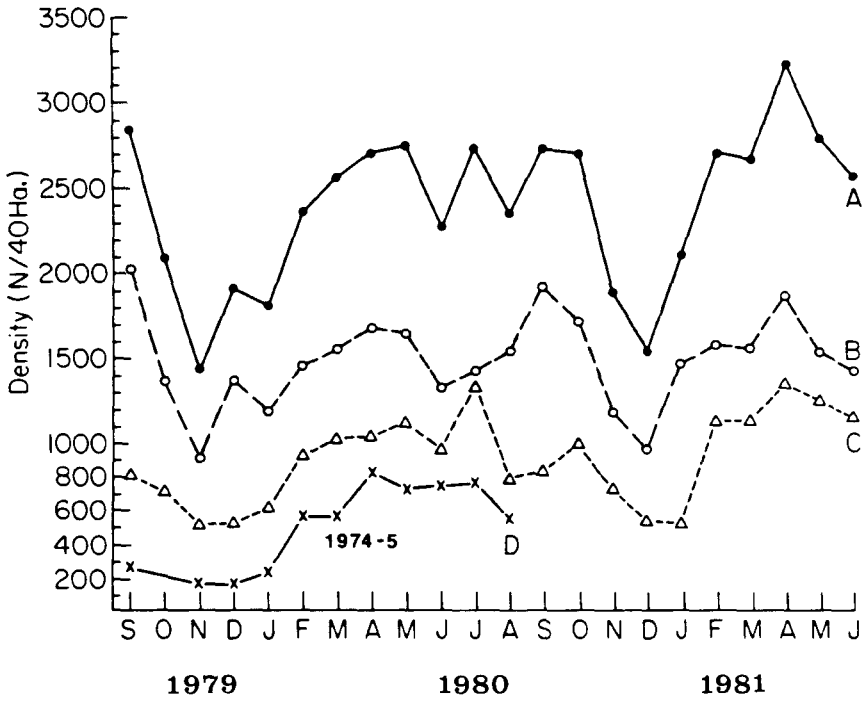

FIG. 2. Monthly bird density in suburban Tempe, Arizona: A—Total density; B—Non-riparian species (Rock Dove, Inca Dove, European Starling, House Sparrow); C—Native riparian species; D—Total density in cottonwood-willow habitat 20 km NE of Tempe (data from Stamp and Ohmart 1976).

native habitats. European Starlings, although much more abundant in town, did nest in some riparian areas. Other native species (Mourning Dove, Anna's Hummingbird, Verdin, Northern Mockingbird, Curve-billed Thrasher, Brown-headed Cowbird, House Finch) occurred in significantly higher densities in the suburban community (Table 1) and thus, appear to be well adapted to that environment. Densities of six additional species (Table 1) were not significantly different between suburban and riparian habitats. Gila Woodpecker, Ash-throated Flycatcher, Lucy's Warbler, and Northern Oriole occurred in Tempe, but in significantly lower densities than in riparian habitat; of these, only the woodpecker regularly nested in town. Finally, 17 riparian species were absent from Tempe, including obligate riparian birds such as Yellow-billed Cuckoo, Bell's Vireo, Yellow Warbler, and Summer Tanager. Overall, 53% of the species detected on riparian transects also occurred on the suburban plots.

In winter (November–January), 39 species were found on either riparian

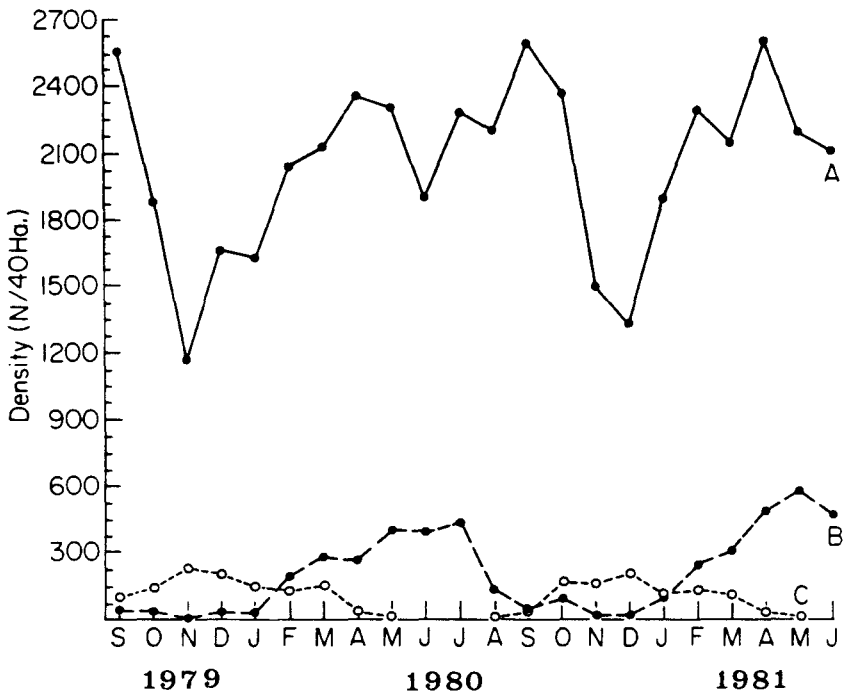

FIG. 3. Monthly density of permanent and seasonal residents in suburban Tempe, Arizona: A—Permanent residents; B—Breeding residents; C—Nonbreeding residents.

or suburban transects (Table 1). Species considered "suburban" were similar to those above except that in addition, Anna's Hummingbird and Northern Mockingbird occurred only in Tempe at this season. Species occurring in significantly higher densities in Tempe were also similar to those in the breeding season with the addition of winter residents, Northern (Red-shafted) Flicker and Yellow-rumped Warbler. Yellow-bellied Sapsucker, Cactus Wren, Bewick's Wren, Loggerhead Shrike, and White-crowned Sparrow were found in roughly equal densities in the two areas, whereas Ruby-crowned Kinglets and Abert's Towhees were in significantly lower numbers on the suburban plots. In addition, 11 uncommon species were found wintering in Tempe, which although not detected on riparian transects, are known to occur in small numbers in these areas (pers. obs.). The only riparian species absent from Tempe were Gambel's Quail, Western Bluebird, Black-tailed Gnatcatcher, Phainopepla, and Green-tailed Towhee. Thus, roughly 85% of the wintering riparian species used the suburban habitat to some extent at that season.

DISCUSSION

Suburban community composition.—The presence of abundant food, surface water, and a benign climate undoubtedly combine to sustain the extremely high density of birds noted in Tempe. Similarly, Emlen (1974) noted a 26-fold increase in summer density from desert to urban habitats at Tucson, Arizona, largely accounted for by introduced species. In spite of the very large urban-species component of the Tempe community, native nonurban species attained higher total density there year-round than in even the most productive native habitat, cottonwood-willow (Fig. 2).

Urban studies in other regions have identified specific features of these habitats that limit their bird assemblages. In general, permanent residents have responded more positively to unnatural aspects such as artificial food sources, than have migratory breeders (Linehan et al. 1967, Lancaster and Rees 1979). For example, Walcott (1974) documented a large shift in species dominance from summer residents to permanent residents over a century (1860–1964) in Cambridge, Massachusetts, as did Aldrich and Coffin (1980) after 37 years in Virginia. Similarly, we found both native and introduced permanent residents to far outnumber seasonal visitors throughout the year in Tempe. In fragmented forest tracts of eastern North America, migratory species also have fared less well than have residents (Whitcomb et al. 1981), due in part to higher rates of nest predation, particularly near suburban areas (Wilcove 1985).

The importance of increased surface water due to human activities was noted by Emlen (1974) at Tucson and by Davies (1977) in arid Australia, but was not found to be significant in more humid regions (e.g., Lancaster and Rees 1979). Food supply is also generally enhanced in man-made habitats, particularly for ground-foraging and granivorous species. Migratory, foliage-gleaning insectivores have often been the most reluctant to colonize urban habitats, responding when they do to natural features such as native plant species, vegetation structure, and the presence of woodlots (Linehan et al. 1967, Lancaster and Rees 1979, Beissinger and Osborne 1982). Understanding what combination of factors limits the occurrence of this latter group of birds in southwestern urban environments is critical to the problem of making these areas more attractive to native riparian specialists.

First, it is of interest to consider the recency with which typically urban bird species have enjoyed success in the Southwest, as chronicled by Phillips et al. (1964), Monson and Phillips (1981), and Rea (1983). All were unrecorded in Arizona prior to 1900, with the most recent invaders to the Phoenix area being the Great-tailed Grackle (1950s) and Anna's Hummingbird (1960s). It is evident, therefore, that what we now consider

to be a major component of suburban bird communities in the region constitutes a relatively recent addition to the local avifauna. The impact of these population increases on other local species, and particularly on potential colonists from native habitats, is also very recent. It is likely that abundant starlings, House Sparrows, and cowbirds disrupt the breeding of many cavity- and small open-nesting species, although direct evidence from our study sites is lacking.

Besides possible interference by urban-adapted species, there is evidence that vegetation composition may affect the presence of certain specialized riparian birds. Several migratory, summer-breeding species, including Yellow-billed Cuckoo, Yellow Warbler, Yellow-breasted Chat, and Summer Tanager, are highly dependent on mature cottonwood-willow stands in the Southwest (Hunter 1984, Ohmart and Anderson, unpublished data). That the absence of these and other species from suburban habitat in Tempe may be attributable to the scarcity of native tree species among suburban plantings is further supported by data from Willow Valley estates near Bullhead City, Arizona (Anderson and Ohmart 1977). This mobile home community is planted almost entirely with native willows and cottonwoods, and the surrounding land has largely been cleared for agriculture. About half of the riparian breeding bird species absent from Tempe are represented here, including virtually all the cavity-nesters, as well as the Yellow Warbler and Summer Tanager. In addition, qualitative observations in Tempe show that the few native willows, cottonwoods, and mesquite trees were heavily used for foraging and nesting, whereas disproportionately few birds were observed in exotic mulberries or eucalyptus. Thus, many riparian bird species can be attracted to human habitations by planting native tree species.

Value of suburban habitats to riparian birds.—In addition to the permanent and seasonal residents discussed above, we noted over 50 species of transients on the Tempe transects. These included virtually all regularly occurring terrestrial migrants of the region, as well as species such as Blackpoll Warbler (*Dendroica striata*), Canada Warbler (*Wilsonia canadensis*), and Scarlet Tanager (*Piranga olivaceus*), that are extremely rare in Arizona. The attractiveness of natural and artificial desert oases to migrants is well known. Urban areas can provide such an oasis in regions where virtually all natural vegetation has been removed and therefore may be important to many southwestern migrant species.

In summary, we have shown that roughly half of the local riparian breeding avifauna use habitat in suburban Tempe, and we suggest that more species might be attracted if certain native trees were planted. In winter, an even greater proportion of local native species probably find the suburban habitat to be suitable. Finally, the planted urban vegetation

appears to be relatively important for migrants. Thus, these areas may not be complete barriers to species dispersing along southwestern river valleys, as suggested by Rea (1983). The presence of humans or their structures does not seem to inhibit the occurrence of many species.

Considering the present emphasis on preservation and management of riparian ecosystems, the potential for managing suburban areas for native birds should not be overlooked. Managers of parks, recreation sites, and private residences can enhance the value of these areas to birds by incorporating selected native trees in their plantings. Unfortunately, we have rarely seen this done. Finally, large-scale revegetation of previously cleared land has been shown to be efficient and effective for reestablishing native bird communities (Anderson et al. 1978). Such efforts may be instrumental in maintaining populations of specialized or declining bird species in regions where little riparian vegetation remains.

ACKNOWLEDGMENTS

We thank T. Brush, V. Hink, W. Howe, C. Hunter, and A. Laurenzi for help in censusing the transects. L. Terrill helped in preparation of the manuscript. G. S. Mills, P. Stettenheim, and R. Szaro reviewed an earlier draft of the manuscript and improved it greatly. Comments by R. D. Ohmart, K. P. Able, S. Martindale, S. Hackett, J. V. Remsen, S. Beissinger, S. Rothstein, and an anonymous reviewer also were very helpful. We thank R. D. Ohmart for allowing the use of unpublished data. This study was conducted in our spare time and cost no money.

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