

Southwestern golf courses provide riparian habitat for birds

Maintaining native vegetation on desert golf courses can increase their effectiveness as habitat for native birds.

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Most studies of birds in urban areas have reported an increase in density and a decrease in avian species richness and/or diversity. However, a few studies have reported increased bird species richness or diversity in areas with low levels of development.

In the southwestern United States, riparian habitats act as oases for migratory and resident birds and normally have the greatest diversity of breeding birds. However, an estimated 95% of natural western riparian habitats have been lost or degraded over the past century, and many of the bird species associated with these systems have been extirpated or have experienced severe declines. Golf courses in the Southwest have the potential to provide habitat similar to riparian systems, with permanent water sources and deciduous trees that provide cover, shade, nest sites and food.

The goals of our study were: to determine how the presence of a golf course affects the native bird community through comparisons of abundance, species richness, diversity, evenness and productivity between five golf courses and five undisturbed reference areas assumed to represent the original bird communities; to determine whether golf courses support high numbers of typically riparian bird species; and, if possible, to identify the features of golf courses that are most conducive to supporting high numbers of native and riparian bird species.

Study sites

Golf courses

Our study sites were five golf courses and five paired reference sites in the high desert region of Albuquerque, N.M. Courses were chosen to represent a range of vegetation types, course features (for example, water sources) and landscape settings. The golf courses were



Photo by M. Merola-Zwartjes

The reference site for the University of New Mexico Championship Course was a large undeveloped area of mainly desert grassland and small shrubs.

Albuquerque Country Club, Four Hills Country Club, Paradise Hills Golf Club, Paa-Ko Ridge Golf Club and the University of New Mexico Championship Course.

Albuquerque CC is in a residential area of downtown Albuquerque, across from the riparian forest that lines the Rio Grande. This traditional 106-acre course is primarily turf-grass with large, isolated trees between the fairways. The course has no understory and no natural areas or water hazards, although an irrigation ditch runs along one side.

Four Hills CC is a 153-acre course in a residential area of eastern Albuquerque at the edge of the Sandia Mountain foothills. The course has two large ponds, one of which is partially surrounded by riparian vegetation (for example, cattails, *Typha* species; willows,

Salix species). A few large out-of-play areas retain primarily native vegetation (for example, blue grama, *Bouteloua gracilis*; cholla cactus, *Opuntia imbricata*; rabbitbrush, *Chrysothamnus nauseosus*).

Paradise Hills GC was established in a residential area on Albuquerque's west mesa in 1963. This 133-acre course is primarily parklike and has no remnant native vegetation or understory. It has one large pond partially surrounded by cattails and some large cottonwoods (*Populus* species).

Paa-Ko Ridge was completed in 2000 in the eastern foothills of the Sandia Mountains. Its 217 acres are in the midst of expansive pinyon-juniper (*Pinus edulis-Juniperus monosperma*) woodlands. The surrounding area is largely undeveloped except for low-

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Photo by Lee Kerney, U.S. Fish & Wildlife Service

American robin (*Turdus migratorius*)

density housing. The only turf is on the fairways inserted between large areas of natural woodland. Vegetation was just beginning to grow around the perimeters of three ponds constructed on the Paa-Ko course toward the end of our study.

The UNM Championship Course in southern Albuquerque is in a low-density industrial area near the airport. This 212-acre course has large areas of remnant native vegetation including bunchgrasses and shrubs such as yucca (*Yucca* species), rabbitbrush

and fourwing saltbush (*Atriplex canescens*) between the more traditional fairways separated by rows of trees. The course has two large ponds, each surrounded with riparian vegetation.

Reference sites

A paired reference site was selected for each golf course. Reference sites were nearby natural areas that reflected as much as possible the habitat conditions that would have been present before the construction of the comparison course. The purpose of these reference sites was to provide an avian community “baseline.” Birds on the reference sites were assumed to represent the original bird community for its paired golf course.

For Albuquerque CC, the reference site was the Rio Grande floodplain forest protected in a City of Albuquerque Open Space area across the road from the course. This forest is dominated by large cottonwoods with a dense understory. The Four Hills Open Space in the nearby foothills served as the reference site for Four Hills GC. This area was characterized by sparsely distributed pinyons and junipers among native grama grasses and shrubs and cacti such as rabbitbrush and cholla. For Paradise Hills, we used the desert grasslands of the Boca Negra Open Space unit near Petroglyph National Monument. This area was characterized by desert bunchgrasses and scattered shrubs such as fourwing saltbush and sand sage (*Artemisia filifolia*) with occasional junipers. For Paa-Ko, nearby pinyon-juniper woodlands in the Cibola National Forest served as the reference site. An extensive area of undeveloped land directly across from the UNM Championship Course served as its reference site. This area was primarily desert grassland with occasional small shrubs (for example, fourwing saltbush, rabbitbrush).

With the exception of Paa-Ko, all reference sites were located within 0.6 mile (1 kilometer) of their paired golf course. The Paa-Ko reference site was several miles from the course, but the terrain and habitat type are largely uninterrupted between the two, and they sit at approximately the same elevation.

Methods

Bird surveys

We conducted point counts at each site every three to four weeks during the breeding

COSMOPOLITAN OR INTRODUCED SPECIES

American crow	(<i>Corvus brachyrhynchos</i>)
American robin	(<i>Turdus migratorius</i>)
Brewer's blackbird	(<i>Euphagus cyanocephalus</i>)
Brown-headed cowbird	(<i>Molothrus ater</i>)
Common grackle	(<i>Quiscalus quiscula</i>)
Domestic duck*	
European starling*	(<i>Sturnus vulgaris</i>)
Great-tailed grackle	(<i>Quiscalus mexicanus</i>)
House finch	(<i>Carpodacus mexicanus</i>)
House sparrow*	(<i>Passer domesticus</i>)
Mourning dove	(<i>Zenaidura macroura</i>)
Ring-necked pheasant*	(<i>Phasianus colchicus</i>)
Rock dove*	(<i>Columba livia</i>)

*Introduced or nonnative species.

Table 1. Cosmopolitan and introduced species found on at least one of the five golf courses or their reference sites.

season from mid-April through July in 2001 and 2002, making a total of eight counts for each site over the two years. Counts at each golf course and its paired reference site were always taken within the same seven-day period. We recorded all birds heard or seen within a five-minute period at each station and recorded the distance to each bird detected.

Data analysis

For our estimates of bird abundance, species richness and composition, we used all individuals heard or seen within about 110 yards (100 meters) of the observer. We did not treat individual points as independent observations at each site, but pooled all observations into a single count for each survey day. Numbers of individuals observed were averaged for each of eight surveys to derive an index of abundance (mean number of individuals observed/survey) for each site.

Species richness is the total number of species observed at each site over all eight surveys because equal numbers of points and equal numbers of surveys at each site ensured equivalent sampling effort. Discussions of species composition include only the species observed during the point counts (from a total of eight surveys over two years, each survey representing a total effort of five five-minute point counts). The results are not intended to represent the total avian community composition of a site.

We classified the individuals observed in our samples as either native or cosmopolitan/introduced (nonnative) species (Table 1). A *cosmopolitan* species is widespread, abundant and frequently increases in association with human habitation. An *introduced* or *nonnative* species is any species that originated outside of North America. The classification of *native* is intended to represent relatively more specialized native species.

We used two references to classify birds as *riparian associates*, which are species frequently associated with, but not necessarily inhabitants of, riparian areas in the southwestern United States.

Results

Avian abundance

Birds were more abundant on golf courses than on their respective reference sites in all cases but one, Albuquerque CC (Figure 1).



Photo by Dave Menke, U.S. Fish & Wildlife Service

Barn swallow (*Hirundo rustica*)

Species richness

Total species richness was greater on the golf courses at Four Hills, Paradise Hills, Paa-Ko and UNM (Figure 2). Only Albuquerque CC had fewer bird species than its paired reference site. Native species richness (excluding cosmopolitan species) was higher at all five golf courses relative to their reference sites, although only marginally so at Albuquerque CC (data not shown).

Species diversity

Three of the golf courses (Paradise Hills,

Paa-Ko and UNM) had greater diversity than their paired reference sites (data not shown). There was no difference between diversity for Four Hills and its comparison area; the reference site for the Albuquerque CC had greater diversity than the course.

At three of the five golf courses, cosmopolitan or introduced bird species greatly outnumbered native birds. Paradise Hills had the greatest overall index of abundance, but only 24% of the birds observed were native species (Figure 3). Four Hills and UNM also had low proportions of native species (31% and 29%, respectively); at Albuquerque CC, 51% of the individuals observed were natives. By contrast, 76% of the birds observed at Paa-Ko Ridge GC were native species. The proportion of native species observed was greater at the reference sites than at all of the golf courses except Paa-Ko, where there was no significant difference (Figure 3).

For all courses except Albuquerque CC, the majority of bird species observed were either shared by the avian community on the golf course and its paired reference site or were found only on the golf course (Table 2). All of the reference sites except Paa-Ko had some subset of the avian community that was unique. At Paa-Ko, the 25 species observed

BIRD SPECIES ABUNDANCE

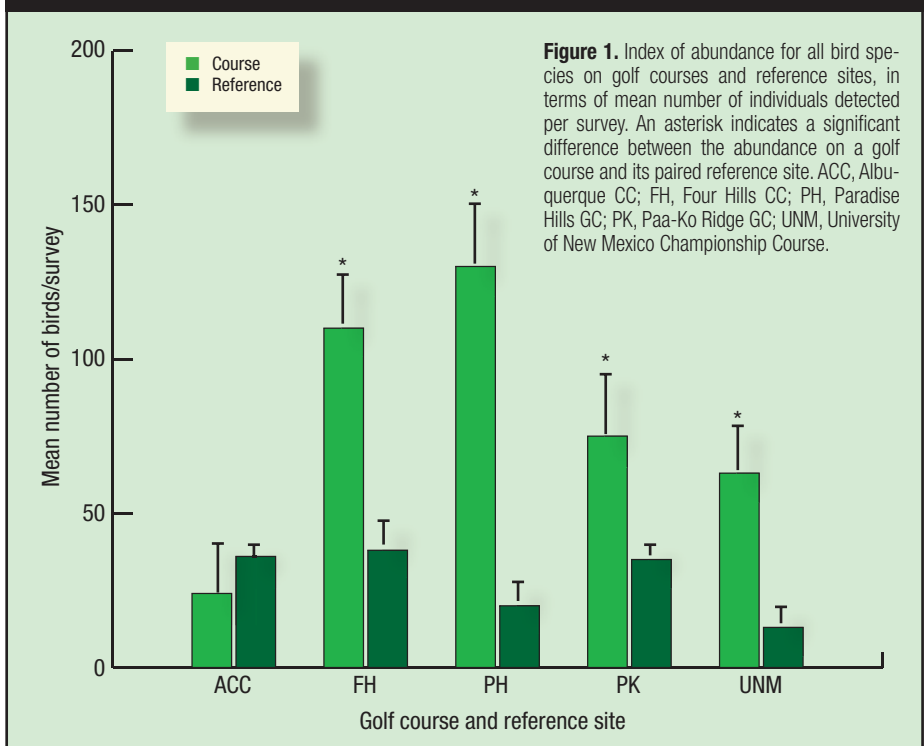
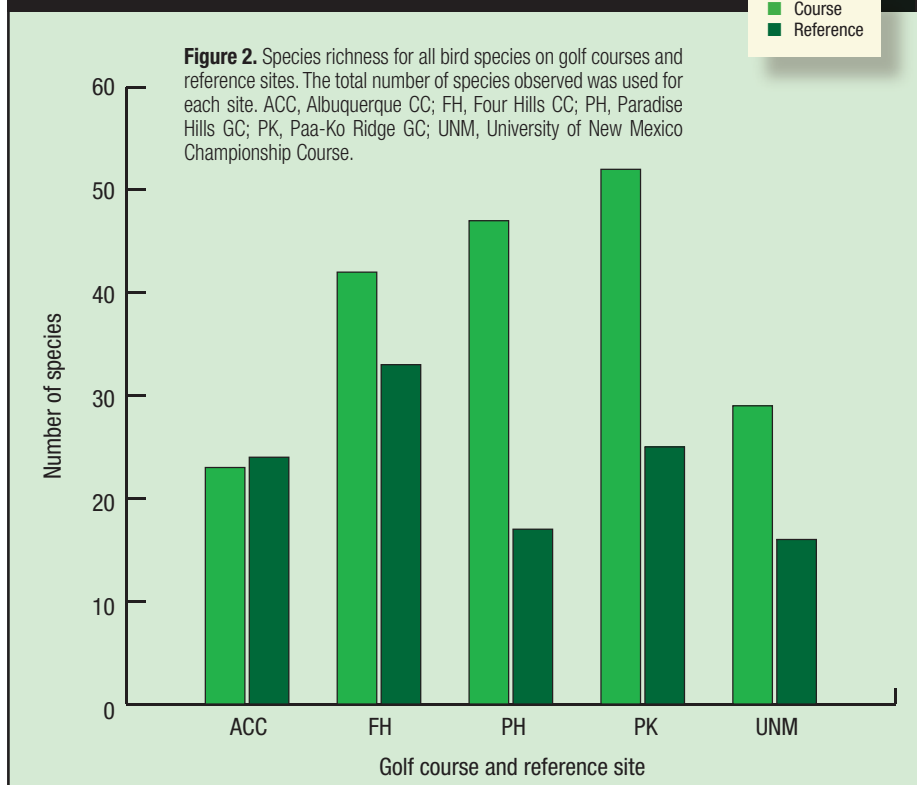


Figure 1. Index of abundance for all bird species on golf courses and reference sites, in terms of mean number of individuals detected per survey. An asterisk indicates a significant difference between the abundance on a golf course and its paired reference site. ACC, Albuquerque CC; FH, Four Hills CC; PH, Paradise Hills GC; PK, Paa-Ko Ridge GC; UNM, University of New Mexico Championship Course.

BIRD SPECIES RICHNESS



on the reference site were also observed on the golf course, and an additional 27 species were observed only on the golf course. No species were unique to the reference site in this pairing.

On golf courses we observed 65 species of birds that were not detected on reference sites during our observations. We assume these species have been added to the avian community of the golf course (Table 3). Of the 65 species, 48 (74%) species are considered riparian associates. The overall percentage of riparian associates was 40.5%. A few riparian associates are also cosmopolitan/introduced species (for example, mallard, domestic duck, brown-headed cowbird). If these species are removed from the calculations, the percentage of individuals that were riparian-associated species was 24.8% overall.

Several introduced and/or cosmopolitan species were also unique to golf course communities in our samples, and seven native species were observed on reference sites but not on the golf courses.

Discussion

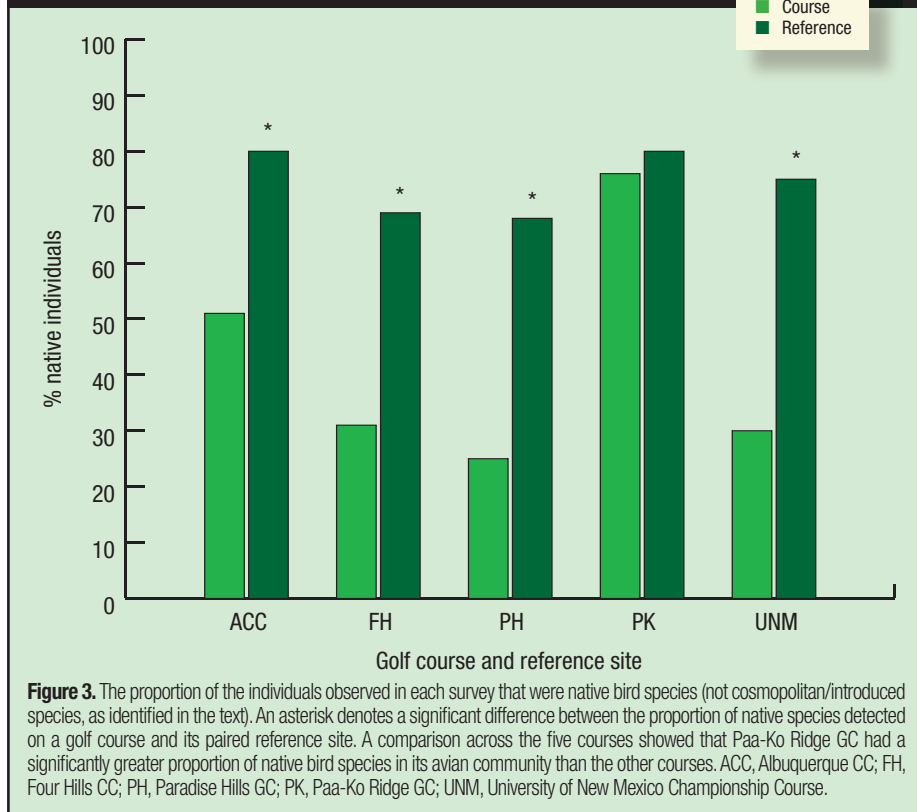
Golf courses supported a greater number of birds than surrounding natural areas, a common response throughout studies of avian responses to urbanization. We also found increased avian species richness and increased diversity on most of the golf courses (Figure 2).

More-specialized native bird species decreased as seen in other studies of urbanization effects. We found that a few widespread and abundant species (for example, house sparrows and common grackles) made up 69% to 76% of the individuals detected on three of the five courses. The reference sites were composed primarily of native bird species, which were more even in their distributions (Figure 3).

Unlike many other studies, our study found greater species richness of native birds on all five of the courses we studied (data not shown). Of birds that were observed only on golf courses, 54 (83%) were native species that we did not consider cosmopolitan or introduced species (Table 3).

We found strong support for our hypothesis that golf courses would provide habitat for riparian birds. More than 70% of the species observed only on golf courses were riparian associates (Tables 1, 2). The numbers of individuals in this group were relatively low, but 25% of the birds observed on golf courses

NATIVE BIRD SPECIES



were riparian associate species not represented on the reference sites.

Our results support the hypothesis that avian species richness and/or diversity does not respond to urbanization in a linear fashion but peaks at a level of intermediate disturbance or development, such as golf courses, where most of the land is still vegetated, some areas of native habitat may remain and trees and ponds are common. Under such a scenario, habitat diversity and food resources for some birds may increase.

Any increase in habitat diversity is likely to increase bird species richness. Golf courses may provide resources that are not available in the surrounding natural areas, such as riparianlike habitats: ponds, tall broad-leaved trees, multiple understory vegetation layers and abundant water with emergent vegetation.

In general, we found that the golf courses offering remnant areas of native shrubby vegetation, variable ground cover, greater stem densities and vertical foliage structure, ponds and riparian vegetation (Four Hills, Paradise Hills, Paa-Ko and UNM) supported greater numbers of native bird species than the surrounding desert landscape.

When development such as a golf course occurs in an area with high habitat diversity, the loss of bird diversity is likely (2). Our study suggests that in the structurally simple desert landscape, the additional resources and habitat complexity provided by golf courses increase avian abundance and species richness, including native species richness. For example, at three sites (Four Hills, Paradise Hills and UNM), the golf course added habitat diversity (high canopy trees) that attracted canopy species and bark-gleaners that would otherwise not be present.

High numbers of birds do not necessarily reflect high-quality habitat, however, nor can we assume that they represent self-sustaining populations. Measures of physiological condition or productivity would offer greater insight into the viability of riparian bird populations on golf courses.

Our data indicate that within our study sites, native cavity-nesting species are absent from traditional golf courses as resident breeders. Native birds appear to use the golf courses for foraging and other activities, but we do not know whether these courses are capable of supporting self-sustaining populations of native birds.

Although overall species richness and diversity increased on golf courses, the original native bird community suffered negative consequences. At the four traditional golf courses — Albuquerque CC, Four Hills, Paradise Hills and UNM — loss of native species ranged from 17% to 32%. Seven species of desert specialists were excluded from golf course habitats altogether, including two species of management concern, the burrowing owl and black-throated sparrow, and a species that is experiencing population declines throughout its range, the western meadowlark.

Paa-Ko

Paa-Ko Ridge GC was exceptional in both the abundance and diversity of native bird species. The course is based on the natural topography of the Sandia foothills, turf is minimized and the out-of-play areas are indistinguishable from the surrounding pin-juniper woodlands.

Compared with its reference site, Paa-Ko was the only course that had greater abundance, species richness and diversity, and com-

parable evenness of native species; 76% of the individuals observed at Paa-Ko were native species. No native species were excluded from the Paa-Ko course, and 27 species were added to the community (a few were invasive species). Paa-Ko was also the only course where native cavity-nesters used our nest boxes, and the productivity at the golf course was comparable to that of its reference site.

The greater native species richness at Paa-Ko and the continued dominance of native bird species is likely attributable to the extensive areas of undisturbed native vegetation on the course, which have been associated with increased numbers of native bird species and the ability to exclude invasive avian species. Some low-density housing has recently been constructed in association with the golf course, but otherwise the landscape is largely undisturbed. The course may provide a valuable natural experiment in whether such a naturalistic course can maintain its ecological integrity over the long-term, as several thousand new homes are planned for future development nearby.

Summary

Golf courses in the high desert area of Albuquerque have the potential to support large numbers of native bird species and may mitigate somewhat the loss of riparian systems in the Southwest. These golf courses do not function as true riparian habitats, however, in terms of excluding invasive bird species. Most of the traditional courses support large numbers of birds that are relatively widespread and abundant species, including some that may be considered pests.

The conservation value of golf course habitats in this region could be improved

CLASSIFICATION OF BIRD SPECIES

Golf Course	No. of bird species			% individuals unique to golf courses	
	Unique to golf course	Shared	Unique to reference site	All riparian associates	Riparian associates without cosmopolitan/introduced species
Albuquerque CC	10 (30%)	13 (38%)	11 (32%)	40%	37%
Four Hills CC	23 (42%)	19 (34%)	13 (24%)	38%	14%
Paradise Hills GC	36 (68%)	11 (21%)	6 (11%)	27%	19%
Paa-Ko Ridge GC	27 (52%)	25 (48%)	0 (0%)	64%	49%
UNM Championship Course	25 (61%)	9 (22%)	7 (17%)	53%	29%

Table 2. Numbers and percentage of all bird species that were observed only on the golf course, found on both the course and its paired reference site, or only on the reference site for all golf course-reference site pairs, and percentage of individuals on golf courses that were riparian associate species (Table 3) based on breeding-season point-counts in 2001 and 2002 in the Albuquerque, N.M., area.

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BIRDS ON GOLF COURSES

Common name	Species	Common name	Species
American coot [†]	<i>Fulica americana</i>	Killdeer	<i>Charadrius vociferus</i>
American crow	<i>Corvus brachyrhynchos</i>	Lark sparrow	<i>Chondestes grammacus</i>
American goldfinch [†]	<i>Carduelis tristis</i>	Lesser goldfinch	<i>Carduelis psaltria</i>
American kestrel	<i>Falco sparverius</i>	Lincoln sparrow [†]	<i>Melospiza lincolni</i>
American robin	<i>Turdus migratorius</i>	Mallard [†]	<i>Anas platyrhynchos</i>
American wigeon [†]	<i>Anas americana</i>	Mountain bluebird	<i>Sialia currucoides</i>
Ash-throated flycatcher	<i>Myiarchus cinerascens</i>	Mountain chickadee	<i>Parus gambeli</i>
Barn swallow	<i>Hirundo rustica</i>	Northern flicker	<i>Colaptes auratus</i>
Black phoebe [†]	<i>Sayornis nigricans</i>	Northern rough-winged swallow	<i>Stelgidopteryx serripennis</i>
Black-crowned Night Heron [†]	<i>Nycticorax nycticorax</i>	Pied-billed grebe [†]	<i>Podilymbus podiceps</i>
Black-headed Grosbeak	<i>Pheucticus melanocephalus</i>	Pine siskin	<i>Carduelis pinus</i>
Blue grosbeak	<i>Guiraca caerulea</i>	Red-winged blackbird ^{††}	<i>Agelaius phoeniceus</i>
Blue-gray gnatcatcher	<i>Polioptila caerulea</i>	Rock Dove	<i>Columba livia</i>
Brewer's blackbird ^{††}	<i>Euphagus cyanocephalus</i>	Ruby-crowned kinglet	<i>Regulus calendula</i>
Broad-tailed hummingbird	<i>Selasphorus platycercus</i>	Ruddy duck [†]	<i>Oxyura jamaicensis</i>
Brown-headed cowbird	<i>Molothrus ater</i>	Rufous hummingbird	<i>Selasphorus rufus</i>
Bullock's oriole ^{††}	<i>Icterus bullockii</i>	Say's phoebe	<i>Sayornis saya</i>
Bushtit	<i>Psaltriparus minimus</i>	Spotted sandpiper [†]	<i>Actitis macularia</i>
Canada goose [†]	<i>Branta canadensis</i>	Summer tanager	<i>Piranga rubra</i>
Cedar waxwing	<i>Bombycilla cedrorum</i>	Swainson's hawk	<i>Buteo swainsoni</i>
Chipping sparrow	<i>Spizella passerina</i>	Violet-green swallow	<i>Tachycineta thalassina</i>
Cliff swallow	<i>Hirundo pyrrhonota</i>	Warbling vireo	<i>Vireo gilvus</i>
Common grackle ^{††}	<i>Quiscalus quiscula</i>	Western bluebird	<i>Sialia mexicana</i>
Cooper's hawk	<i>Accipiter cooperi</i>	Western kingbird	<i>Tyrannus verticalis</i>
Curve-billed thrasher	<i>Toxostoma curvirostre</i>	Western tanager [*]	<i>Piranga ludoviciana</i>
Domestic duck ^{††}	<i>species unknown</i>	Western wood-pewee [*]	<i>Contopus sordidulus</i>
Downy woodpecker ^{††}	<i>Picoides pubescens</i>	White-breasted nuthatch [†]	<i>Sitta carolinensis</i>
Dusky flycatcher [†]	<i>Empidonax oberholseri</i>	White-crowned sparrow	<i>Zonotrichia leucophrys</i>
European starling ^{††}	<i>Sturnus vulgaris</i>	Wilson's warbler [*]	<i>Wilsonia pusilla</i>
Evening grosbeak [†]	<i>Coccothraustes verspertinus</i>	Yellow warbler [†]	<i>Dendroica petechia</i>
Great-tailed grackle ^{††}	<i>Quiscalus mexicanus</i>	Yellow-headed blackbird [†]	<i>Xanthocephalus xanthocephalus</i>
Hairy woodpecker	<i>Picoides villosus</i>	Yellow-rumped warbler [*]	<i>Dendroica coronata</i>
House sparrow	<i>Passer domesticus</i>		

^{*}These species were identified in more than one golf course-reference site pair.

[†]This subset of species was observed on a golf course, but not on its paired reference site, nor on any of the other four reference sites.

Table 3. Bird species that were observed on golf courses, but not on their paired reference sites, based on sampling from breeding season point counts on five golf courses and five paired reference sites in 2001 and 2002 in the Albuquerque, N.M., area. Species in bold are often associated with riparian areas or wetlands (8,24)

to support greater numbers of native birds and exclude more invasive exotics or pest species by increasing the complex vertical structure and diversity of plant species composition in out-of-play areas, and, in particular, by increasing the extent and usage of native plants. Golf courses dominated by native vegetation may support significant numbers of native bird species, lower maintenance needs and reduce the strain on the limited water resources, potentially lessening the conflict between course irrigation requirements and diminishing water supplies in the desert.

Whether golf course habitats in the desert have the potential to support viable populations of native and riparian species of birds remains to be tested. Our data showing increased species richness of native birds and high numbers of riparian species demonstrate that these golf courses may provide valuable stopover habitat for the numerous species of migratory birds that use riparian corridors in the Southwest. The potential for desert golf courses to serve as surrogate riparian areas has important conservation implications, as many migratory birds in the western United States are experiencing population declines associated with the loss of riparian habitats.

Acknowledgments

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References

1. Beissinger, S.R., and D.R. Osborne. 1982. Effects of urbanization on avian community organization. *Condor* 84:75-83.
2. Blair, R.B. 1996. Land use and avian species diversity along an urban gradient. *Ecological Applications* 6:506-519.
3. Emlen, J.T. 1974. An urban bird community in Tucson, Arizona: derivation, structure, regulation. *Condor* 76:184-197.
4. Lancaster, R.K., and W.E. Reese. 1979. Bird communities and the structure of urban habitat.

THE RESEARCH

says . . .

- **We compared the** avian communities on five golf courses in the Albuquerque, N.M., area to those of five paired natural areas that served as reference sites.
- **Bird abundance increased** on four of the five golf courses. Compared to their reference areas, total species richness and species diversity was higher on the golf courses in three of five cases, and native species richness was higher on all the courses.
- **Of the bird** species unique to the golf course communities, 72% were riparian associates.
- **On all the** golf courses except Paa-Ko, most of the individuals were relatively common generalist species. Paa-Ko, which was dominated by native vegetation, had greater native bird species richness, diversity and abundance compared to its reference site and to the other courses.
- **Golf courses have** the potential to support riparian bird communities, but their conservation potential can be enhanced through the addition of habitat complexity and structure using native plants.

Canadian Journal of Zoology 47:2358-2368.

5. Terman, M.R. 1997. Natural links: naturalistic golf courses as wildlife habitat. *Landscape and Urban Planning* 38:183-197.

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At the time of this research, Michele Merola-Zwartjes (Michele_Zwartjes@fws.gov) was a research wildlife

NEST BOX COMPARISON

	Albuquerque CC		Four Hills CC		Paa-Ko Ridge GC	
	Course	Reference	Course	Reference	Course	Reference
Nests initiated						
2001	0	7	9	8	6	5
2002	0	4	10	4	10	10
Successful nests (%)*						
2001	na	67	67	100	75	67
2002	na	100	100	100	80	100
Number fledged						
2001	na	7	19	12	13	10
2002	na	8	24	3	28	26
Total	na	15	43	15	41	36
Native species (%)						
2001	na	100 [†]	0 [‡]	100 [§]	100	100 [#]
2002	na	100	0	100	100	100

*A nest was successful if it produced at least one fledgling.

[†]Boxes used by ash-throated flycatchers and Bewick's wrens (*Thyromanes bewickii*).

[‡]Boxes used by house sparrows only.

[§]Boxes used by ash-throated flycatchers and Bewick's wrens.

^{||}Boxes used by ash-throated flycatchers, western bluebirds and mountain bluebirds.

[#]Boxes used by ash-throated flycatchers, Bewick's wrens, western bluebirds and juniper titmice (*Baeolophus griseus*).

Table 4. Results of nest box comparisons from the Albuquerque CC, Four Hills CC, Paa-Ko Ridge GC and their reference sites, based on monitoring of 11 nest boxes at each site in 2001 and 2002.