

AVIFAUNA OF VEKOL VALLEY, MARICOPA COUNTY, ARIZONA

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ABSTRACT: From 2018 to 2025, I conducted regular bird surveys along 20 km of Vekol Valley Road, an underbirded area of Lower and Upper Sonoran Desert habitat with spreader dike retention ponds, located in southern Maricopa County, Arizona. The purpose was to update studies from 2001 by the Drylands Institute and from a 2008 Arizona Field Ornithologists 1-day field expedition. Since those 2 surveys, there had been almost no coverage of the area. My team of volunteers documented 152 species, bringing the cumulative total for that area to 169 species. We also updated the breeding status of several species since the publication of the Arizona Breeding Bird Atlas in 2005, including the desert subspecies of Purple Martin (*Progne subis hesperia*), Rufous-Winged (*Peucaea carpalis*) and Cassin's Sparrows (*P. cassinii*), and Indigo (*Passerina cyanea*) and Varied Buntings (*P. versicolor*).

Conducting bird surveys in underbirded (or previously unvisited) areas is important because it helps fill critical knowledge gaps in avian distribution, establishes foundational population baselines, and often yields discoveries of rare or new species that inform targeted conservation efforts (Sullivan et al. 2009). Arizona is the sixth largest state (295,233 km²) in the United States, and in many areas and habitats avian distribution and density is not well known. Some important recent efforts to fill these gaps have been and are being effected (Jenness 2023, 2025, 2026; Bowker and Sullivan 2024; O'Donnell et al. 2025; AZIBA 2026).



Figure 1. Survey area was in Vekol Valley (dark green) in the Sonoran Desert National Monument (light green).

One of many underbirded locations is Vekol Valley, an extensive area of Lower and Upper Sonoran Desert habitat with spreader dike retention ponds. It is located in southern Maricopa, northwestern Pinal, and northern Pima counties (Figure 1). This area was studied in 2001 by the Drylands Institute (Felger et al. 2001) and in 2008 during a 1-day expedition organized by Arizona Field Ornithologists (AZFO; Tomoff 2008).

However, since those 2 studies, there has been little coverage of Vekol Valley by field ornithologists or amateur birders. For example, eBird had only 3 species logged for Vekol Valley between 1900 and 2017. Witzeman and Corman (2017)'s only reference to Vekol Valley was for the presence of Rufous-winged Sparrow (*Peucaea carpalis*) and Varied Bunting (*Passerina versicolor*) southwest of the Valley in the Sand Tank Mountains. Similarly, Corman and Wise-Gervais (2005) reported species only in the nearby Sand Tank Mountains. Other than at Sand Tank Mountains (A. Lauria, pers. comm), the Arizona Game and Fish Department has not conducted surveys near Vekol Wash. From 2018 to 2025, I organized bird surveys to this area with the help of 11 volunteers. Until the last year of the survey, I tried to go at least once a month. This was not always possible due to changing road conditions. The number of visits varied each year: 2025 (4), 2024 (16), 2023 (9), 2022 (10), 2021 (17), 2020 (38), 2019 (41), 2018 (7). Here, I report data we collected from sites along a 20-km stretch of Vekol Wash, ranging from desert wash and mesquite habitat to retention ponds. We documented 152 species, adding 149 new species to eBird, populating its bar chart data throughout the year. We upgraded the breeding status of several species, including some near the northern limit of their range in Arizona. We compared changes between our surveys and prior studies, given 2 decades of drought since the 2001 Drylands Institute Survey (DIS), and provided updated baseline data to be used for future studies.

STUDY SITE AND METHODS

Vekol Valley, located south-southwest of the Phoenix metropolitan area (32°45'N, 112°14'W), is 700 km² of mostly Lower and Upper Sonoran Desert bordered by several mountains and hills. These include Haley and Booth hills to the north, White Hills and Mariposa and Sand Tank mountains to the west, and Vekol and Table Top mountains to the east. The area extends 24 km south and 11 km north of Interstate 8 (I-8). Much of the Sonoran Desert National Monument is located in Vekol Valley, and our survey locations were all within the Monument.

Vekol Wash is the main drainage through Vekol Valley, accessed via Vekol Road (I-8 exit 144). Vekol Road extends north of I-8 for several kilometers but soon becomes unpaved and inaccessible. South of I-8, Vekol Wash runs parallel to a dirt road for 24 km before entering Pima County and the Tohono O'odham Nation. South of I-8, Vekol Valley elevations range from 427 to 492 m. The elevations of the surrounding mountains are between 1,036 and 1,386 m.

The desert habitat varies from Lower Sonoran (Little Colorado subdivision) dominated by creosote bush (*Larrea tridentata*) paralleling the wash, then transitioning to Upper Sonoran characterized by saguaros (*Carnegiea gigantea*) toward the foothills and mountains (Dimmitt 2015). Vekol Valley has diverse species of cacti, including buckhorn (*Cylindropuntia acanthocarpa*), chainfruit (*C. fulgida*), and cane (*C. spinosior*) chollas (Felger et al. 2001). Many additional shrub species and other cacti, including barrel cacti (*Ferocactus emoryi* and *F. wislizeni*), fishhook cactus (*Mammillaria grahamii*), and strawberry hedgehog cactus (*Echinocereus engelmannii*) increase with elevation. In Vekol Wash, a dry and sandy streambed most of the year, trees and shrubs include velvet mesquite (*Neltuma velutina*), palo verde (*Parkinsonia florida*), whitethorn (*Acacia constricta*) and catclaw (*A. greggii*) acacias, and desert ironwood (*Olneya tesota*), with the ratios varying between survey sites. Many other annual plants and perennial shrubs have been recorded along the wash (Felger et al. 2001). Near the border of Maricopa and Pima counties, a tobosa grass (*Hilaria mutica*) habitat occurs that has decreased considerably in area due to a decades-long drought beginning in the early 1990s (Felger et al. 2001).

Vekol Wash, once a tributary of the Santa Cruz River, is fed by many side washes, yet only flows and retains water after heavy winter or summer rains. In the 1930s and 1940s, the federal Soil Conservation Service built "spreader dikes" to manage the heavy intermittent flow of rainwater through the wash and, ostensibly, to restore degraded rangeland vegetation upstream of the dikes for cattle grazing and erosion control. However, they have become impoundments that fill during monsoon rains and became fruitful habitat for many species of wildlife (AZGFD 2026). Channels off the main wash or adjacent smaller washes were excavated and dirt was mounded to create circular or rectangular retention ponds that captured runoff and retained water, which ranchers used for their cattle. The spreader dike at Vekol-South Well was approximately 50 m west of Vekol Wash and measured 40 m x 46 m (Figure 2). The 12 spreader



Figure 2. Spreader dike at Vekol-South Well (Survey Site 1) showing water retained after rainfall. Vegetation is mostly velvet mesquite, palo verde, ironwood, and whitethorn and catclaw acacias. Vekol Valley, Maricopa County, Arizona, 2 December 2019. Photo by Robert W. Bowker



Figure 3. Survey Site 1 at Vekol-South Well showing building remains and habitat (spreader dike shown in Figure 2 is hidden by trees). Little Table Top, Antelope Peak, and Black Mountain are in background, 13 December 2020. Photo by Robert W. Bowker



Figure 4. Survey Site 2, a wash running east-west across Vekol Road, 13 April 2020. Photo by Robert W. Bowker



Figure 5. Survey Site 3, a mesquite stand west of Vekol Road, with creosote bush habitat in foreground and mesquite in background, 13 April 2020. Photo by Robert W. Bowker

dikes farther south, at Vekol-Maricopa, were larger. For example, spreader dike 2, roughly rectangular, was 140 m x 51 m; most of the other spreader dikes at Vekol-Maricopa were at least as large.

This survey focused on 2 locations: Vekol-South Well and Vekol-Maricopa. Vekol-South Well was divided into 3 survey subareas: Site 1 was 13 km south of I-8 and included a spreader dike, building remains, and the surrounding habitat (Figure 3); Site 2 was a wash 3.9 km north of the spreader dike (Figure 4); Site 3 was a mesquite stand 1.6 km south of the spreader dike (Figure 5). In 2018 and 2019, we explored dikes 2, 6, and 7 of the 12 spreader dikes at the Vekol-Maricopa site (Figure 6). However, access to this site was unreliable after heavy rains in late 2019. We did not continue surveys at that location, but we include data on species detected there.



Figure 6. Additional site, Vekol-Maricopa spreader dike 2, surveyed during 2018 and 2019, showing retained water and vegetation, 16 December 2025. Photo by Robert W. Bowker

Between August 2018 and June 2025, I visited Vekol-South Well 100 times by myself and 41 times with experienced colleagues, logging 492 field hours. I surveyed Vekol-Maricopa 24 times, 10 times with experienced colleagues, logging 43 field hours. The frequency of visits varied year to year, depending on scheduling and road conditions, ranging from a low of 4 visits/year to a high of 41 visits/year (mean = 18). The survey method was a combination of traveling and stationary counts. We included birds observed while driving to survey sites from the I-8 exit, and any new species during the return drive. We did point counts at 3 sites at Vekol-South Well (and occasionally at 3 of the 12 spreader dikes at Vekol-Maricopa in 2018 and 2019). At each of the 3 Vekol-South Well sites, we walked 0.9-1.2 km for 25-40 minutes and tallied all birds. In addition, if water was present in the Vekol-South Well spreader dike, we spent 1-3 hours doing a stationary count. The total observation time of a survey varied seasonally (shorter in winter) and with the presence or absence of water in the spreader dikes. Most visits occurred from shortly before sunrise to 1030 MST. Only 3 visits occurred in the late afternoon and evening (1600-2030).

We counted the number of individuals for most species. However, for larger flocks of Mourning (*Zenaida macroura*) and White-winged Doves (*Z. asiatica*) and Turkey Vultures (*Cathartes aura*), we estimated numbers by 10s, 20s, and 50s. I photodocumented 93% of the species, with 2 species documented by audio recordings only. All images and recordings were posted on Cornell University's eBird website (eBird 2025).

I recorded numbers for every species detected at Vekol-South Well and Vekol-Maricopa. Only Vekol-South Well had enough visits to determine community profiles. I compared the mean number of bird species present when the Vekol-South Well spreader dike was dry to when it held water using Student's t-test, where the standard threshold, $p > 0.05$, confirms statistical significance.

RESULTS

All species documented in Vekol Valley are listed in the appendices. This includes data for both Vekol-South Well and Vekol-Maricopa, and eBird reports of species not detected during our surveys. For Vekol-South Well and Vekol-Maricopa, we observed 150 and 93 species and totaled 21,615 and 2,172 individuals, respectively. We detected 150 species at Vekol-South Well, a much smaller area in a shorter period of time. Two species detected only at the Vekol-Maricopa site brought the total to 152. The combined total from all historical and recent surveys of Vekol Valley is 169 species.

We documented 27 species not recorded in the 2001 DIS, spanning diverse avian families (Table 1). The DIS recorded 12 species we did not detect: Ring-necked Duck (*Aythya collaris*), Northern Shoveler (*Spatula clypeata*), Wilson's Snipe (*Gallinago delicata*), Green Heron (*Butorides virescens*), Burrowing Owl (*Athene cunicularia*), Gray Vireo (*Vireo vicinior*), Canyon Wren (*Catherpes mexicanus*), Mountain Bluebird (*Sialia currucoides*), Swainson's Thrush (*Catharus ustulatus*), House Sparrow (*Passer domesticus*), Mountain Chickadee (*Poecile gambeli*), and European Starling (*Sturnus vulgaris*). The 2008 AZFO survey found 4 species we did not detect: Ring-necked Duck, Northern Shoveler, Wilson's Snipe, and Ferruginous Hawk (*Buteo regalis*). We observed 93 species at the Vekol-Maricopa site in 24 visits covering all 12 months, of which only Harris's Hawk (*Parabuteo unicinctus*) and Long-eared Owl (*Asio otus*; Figure 7) were unique to the Vekol-Maricopa site.

Combining Vekol-South Well and Vekol-Maricopa data, nonpasserines comprised 31.7% of the 152 species (Appendix 1). The proportion of the 47 nonpasserines was raptors (vultures, hawks, owls, and falcons), 40.4%; waterbirds (ducks, shorebirds, and kingfishers), 21.3%; doves, 10.6%; woodpeckers, 8.5%; hummingbirds and swifts, 8.5%; roadrunners and cuckoos, 4.2%; and nighthawks and nightjars, 4.2%. Gambel's Quail (*Callipepla gambelii*), Mourning and White-winged Doves, and Turkey Vulture accounted for 88.4% of all nonpasserine individuals (Appendix 2).

Five families (Appendix 3) accounted for 62.5% of passerine species with numbers ranging from 19 species of Emberizidae (sparrows, juncos, and towhees) to only 1 of Laniidae (shrikes), Remizidae (verdins), Alaudidae (larks), Regulidae (kinglets), Bombycillidae (waxwings), and Ptiliogonidae (Phainopeplas; Appendix 4). Within the Emberizidae, White-crowned Sparrow (*Zonotrichia leucophrys*) was the most numerous. Only Abert's Towhee (*Melospiza aberti*) and Black-throated (*Amphispiza bilineata*) and Rufous-winged Sparrows were year-round residents.

Despite being mainly a winter resident, Phainopepla (*Phainopepla nitens*) was the single most abundant species of all passerines. Other common winter residents included White-crowned, Black-throated, Rufous-winged, Brewer's (*Spizella breweri*), and Lincoln's (*Melospiza lincolni*) Sparrows; Dark-eyed Junco (*Junco hyemalis*); and Green-tailed (*Pipilo chlorurus*) Towhees.

In March, migrants and spring-summer residents began to arrive. Lucy's Warbler (*Oreothlypis luciae*) and Bell's Vireo (*Vireo bellii*) arrived in March, followed in April and May by White-winged Dove, Turkey Vulture, Lesser Nighthawk (*Chordeiles acutipennis*), Hooded Oriole (*Icterus cucullatus*), and Brown-crested Flycatcher (*Myiarchus tyrannulus*). By late May to early June, Varied Bunting and Blue Grosbeak (*P. caerulea*) arrived. By May, most of the Passerellidae, except year-round residents, were absent.

Table 1. Species detected during the 2018-2025 Vekol Wash surveys not detected in the 2001 Drylands Institute Study.

Cinnamon Teal (<i>Spatula cyanoptera</i>)	Peregrine Falcon (<i>Falco peregrinus</i>)
Eurasian Collared-Dove (<i>Streptopelia decaocto</i>)	Woodhouse's Scrub-Jay (<i>Aphelocoma woodhouseii</i>)
Ruddy Ground Dove (<i>Columbina talpacoti</i>)	Bank Swallow (<i>Riparia riparia</i>)
Yellow-billed Cuckoo (<i>Coccyzus americanus</i>)	Rufous-backed Robin (<i>Turdus rufopalliat</i>)
Solitary Sandpiper (<i>Tringa solitaria</i>)	Cedar Waxwing (<i>Bombycillia cedrorum</i>)
Greater Yellowlegs (<i>Tringa melanoleuca</i>)	Pine Siskin (<i>Spinus pinus</i>)
White-faced Ibis (<i>Plegadis chihi</i>)	Lawrence's Goldfinch (<i>Spinus lawrencei</i>)
Black-crowned Night Heron (<i>Nycticorax nycticorax</i>)	White-throated Sparrow (<i>Zonotrichia albicollis</i>)
Great Egret (<i>Ardea alba</i>)	Bronzed Cowbird (<i>Molothrus aeneus</i>)
Gray Hawk (<i>Buteo plagiatus</i>)	American Redstart (<i>Setophaga ruticilla</i>)
Zone-tailed Hawk (<i>Buteo albonotatus</i>)	Summer Tanager (<i>Piranga rubra</i>)
Long-eared Owl (<i>Asio otus</i>)	Indigo Bunting (<i>Passerina cyanea</i>)
Belted Kingfisher (<i>Megasceryle alcyon</i>)	Painted Bunting (<i>Passerina ciris</i>)
Crested Caracara (<i>Caracara plancus</i>)	

We found both Varied Buntings and Rufous-winged Sparrows in Vekol Valley, which is near the northwestern limit of their Arizona nesting ranges (Corman and Wise-Gervais 2005). Except for 2018, we observed numerous pairs of Varied Buntings during the breeding season, typically triggered by summer monsoon rains in July and August. On one occasion we observed a male exhibiting territorial behavior by engaging in “shadow boxing” with mirrors or metal on my vehicle (Figure 8), which is evidence of probable breeding (Roerig 2013). Indigo Buntings (*P. cyanea*) were more abundant at the Vekol-Maricopa site, where singing males suggested probable breeding.

On some surveys we observed Purple Martins (*Progne subis*) flying to and from the Vekol-South Well spreader dike, where they swooped over the water for insects and water. They typically arrived from the southeast and departed in the same direction toward the Table Top Mountains, where there are large stands of saguaros. The desert subspecies (*P. s. hesperis*) primarily nests in saguaro cavities (Corman and Wise-Gervais 2005).



Figure 7. Long-eared Owl, one of the species detected during our 2018-2025 surveys that was not detected during the 2001 Drylands Institute Studies, 27 April 2019. Photo by Robert W. Bowker



Figure 8. Varied Bunting male that engaged in shadow boxing with his reflection, indicating probable breeding, 12 July 2019. Photo by Robert W. Bowker

On the first visit (August 2018), we observed Cassin's Sparrows (*P. cassinii*) along Vekol Road from Vekol-South Well to the Vekol-Maricopa sites. Many males were skylarking and singing courtship songs, suggesting attempted breeding (Schnase et al. 1991). We observed only 1 in 2019 and none during the remainder of the study. This species tends to be irruptive with rainfall (Corman and Wise-Gervais 2005), and in 2018 it was abundant throughout southern Arizona (eBird 2025).

As expected, migration months had the highest species counts. High species counts were April ($n = 84$), May ($n = 75$), August ($n = 75$), September ($n = 103$), and October ($n = 74$). The most abundant fall migrant was White-winged Dove, mainly July through September, which greatly inflated counts (July: 2,850, August: 3,211, September: 2,690). However, 31 of the 150 species (20.6%) recorded at Vekol-South Well were observed only once or twice. These low detections ranged from 18 species in April to single detections of 5 species in February (mean = 12 species).

Several irregular species included Lawrence's Goldfinch (*Spinus lawrencei*), Cedar Waxwing (*Bombacillia cedrorum*), American Robin (*Turdus migratorius*), Cassin's Sparrow, and Lark Bunting (*Calamospiza melanocorys*). They appeared in 2018 and 2019 when water was retained in the spreader dike and were among the 20 most abundant species in the first 2 years of our surveys. Lawrence's Goldfinch was also detected in 2020 (a single individual), and a couple dozen in 2021, but not thereafter. American Robin was detected once in 2021 and 2023. Cedar Waxwing, Cassin's Sparrow, and Lark Bunting were not detected after 2019.

We also saw several species rare to this area only when water was present in the spreader dikes. These included Killdeer (*Charadrius vociferus*), Spotted Sandpiper (*Actitis macularius*), White-faced Ibis (*Plegadis chihi*), Black-crowned Night Heron (*Nycticorax nycticorax*), Great Egret (*Ardea alba*), Zone-tailed Hawk (*Buteo albonotatus*), Dusky Flycatcher (*Empidonax oberholseri*), Rufous-backed Robin (*Turdus rufopalliatus*), Pine Siskin (*Spinus pinus*), Common Yellowthroat (*Geothlypis trichas*), and American Redstart (*Setophaga ruticillia*). American Barn Owl (*Tyto furcata*) and Peregrine Falcon (*Falco peregrinus*) were the only unusual species we observed when no standing water was present. Avian diversity increased significantly ($t = 2.241$, $df = 10$, $P < 0.05$) with the presence of water in the spreader dikes.

DISCUSSION

Our study took advantage of spreader dikes when standing water was present, with observation periods extended from less than an hour in the absence of water to over 2 hours. However, vegetation remained abundant for several weeks after the water had drained and evaporated, continuing to attract birds. Close observation of this vegetation showed water droplets on the grasses in the early morning. Nevertheless, we consistently found more species when standing water was present. The t-test showed that the probability of getting these results by random chance alone is less than 5% ($P < 0.05$). However, this value might have been even lower if we had more precise survey techniques, data on the presence of vegetation, and exact rainfall figures for the area.

Previous reports on the flora and fauna of Vekol Valley (Felger et al. 2001) used different methodologies than our avian survey. The 2001 DIS included: 1) use of museum records from University of Arizona, 2) interviews with biologists who had done field work in Vekol Valley, 3) more extensive areas and habitats including Table Top and Sand Tank mountains, and 4) field surveys conducted by larger teams of professionals. My study relied only on our field surveys with 2 or fewer volunteers at a time. In addition, our study covered only 3%, or ~21 km² of the 700 km² of Vekol Valley, primarily surveyed 2 sites, and did not survey adjacent mountains. With these differences, the DIS documented 157 species compared to our 152 species. Other observers who reported from these 2 areas during the study period reported an additional 4 species (eBird 2025).

Witzeman and Corman (2017) did not refer to Vekol Valley except for the presence of Varied Bunting and Rufous-winged Sparrow at the Sand Tank Mountains southeast of Gila Bend and southwest of the Vekol Valley survey area. During our surveys, we detected these 2 species at Vekol-South Well, but nowhere north along Vekol Road. Four additional species were detected at the Vekol-Maricopa site: Indigo Bunting, Crested Caracara (*Caracara plancus*), Long-eared Owl (the latter 2 species rare in Maricopa County), and Purple Martin. These species were also known from the Sand Tank Mountains (Corman and Wise-Gervais 2005, Witzeman and Corman 2017).

The 2008 AZFO field expedition included 8 volunteer surveyors who explored the tobosa grass and mesquite stands at the southernmost spreader dikes near the border of Maricopa and Pima Counties (Tomoff 2008). They detected 42 species, including 4 species mentioned in the Results that we did not detect. We did not explore that far south of the wash because we did not have access via 4-wheel drive to the last spreader dikes when there was sufficient water to attract waterfowl. We did detect many species of waterbirds in low numbers at Vekol-South Well, including Cinnamon Teal (*Spatula cyanoptera*), White-faced Ibis, Black-crowned Night Heron, Great Egret, Great Blue Heron, Killdeer, Spotted and Solitary Sandpipers (*Tringa solitaria*), Greater Yellowlegs (*T. melanoleuca*), and Belted Kingfisher (*Megasceryle alcyon*). The larger size of the multiple Vekol-Maricopa spreader dikes (Tomoff 2008) likely attracted more waterbirds than we detected at the smaller single Vekol-South Well spreader dike.

Comparing our results to the Atlas surveys conducted in the 1990s (Corman and Wise-Gervais 2005) shows that several species may have increased their ranges within Arizona. These include Purple Martin, Rufous-winged Sparrow, and Indigo and Varied Buntings. Corman and Wise-Gervais (2005) noted that the desert subspecies of Purple Martin, Rufous-winged Sparrow, and Varied Bunting were known to breed in this part of the state only in the Sand Tank and Saucedo mountains. Our observations suggest that 2 of these 3 species are breeding in the area we surveyed, and Purple Martins are possibly breeding in the nearby Table Top Mountains.

We were unable to find data for birds in Vekol Valley before the spreader dikes were constructed in the 1930s and 1940s (Felger et al. 2001). They were built to catch rain runoff and prolong the availability of water for cattle. Before that time, water in the washes would have percolated and evaporated much faster than when retained in spreader dikes. Presumably these structures, with longer periods of standing water, attract more avian wildlife to the area.

Our surveys, along with data from eBird, contribute to the current status of birds found in and moving through Vekol Valley. Our surveys made 3 contributions: 1) We increased the number of known bird species in a segment of underbirded Vekol Valley; 2) We suggest the expansion of breeding ranges for 3 species; and 3) Despite decades of drought and an extreme desert habitat, we demonstrated that Vekol Wash hosts an impressive diversity of birds, including migrant, nesting, and wintering species. Our findings provide a baseline body of data that may prove useful to future studies of changes in avian frequency and distribution.

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APPENDIX 1. Nonpasserine groups and passerine families showing number of species and percentages found at Vekol Wash, 2018-2025.

Nonpasserines (31.7%)	#Species	%
Raptors (hawks, falcons, owls)	19	40.4
Waterbirds (ducks, shorebirds, kingfishers)	10	21.3
Pigeons and Doves	5	10.6
Apodiformes (hummingbirds, swifts)	4	8.5
Picidae (woodpeckers, flickers, sapsuckers)	4	8.5
Cuculidae (roadrunners, cuckoos)	2	4.2
Nighthawks and Nightjars	2	4.2
New World Quail	1	2.1
Passerines (68.3%)	#Species	%
Emberizidae (sparrows, towhees, juncos)	19	18.4
Tyrannidae (flycatchers, kingbirds, pewees)	14	13.5
Parulidae (warblers)	12	11.7
Icteridae (blackbirds, orioles)	10	9.7
Cardinalidae (cardinals, buntings, tanagers, grosbeaks)	10	9.7
Hirundinidae (swallows, martins)	7	6.7
Mimidae (mockingbirds, thrashers)	5	4.9
Turdidae (robins, thrushes, bluebirds, solitaires)	5	4.9
Vireonidae (vireos)	4	3.9
Troglodytidae (wrens)	4	3.9
Fringillidae (finches)	4	3.9
Corvidae (ravens, jays)	2	1.9
Poliophtilidae (gnatcatchers)	2	1.9
Laniidae (shrikes)	1	1.0
Remizidae (verdins)	1	1.0
Regulidae (kinglets)	1	1.0
Bombycillidae (waxwings)	1	1.0
Ptiliogonatidae (phainopeplas)	1	1.0

APPENDIX 2. Nonpasserine bird species documented in surveys for both Vekol-South Well (SW) and Vekol-Maricopa (M), 2018-2025. Total counts are in bold in the last row. Relative Abundance (RA) is the percent of that species relative to the other species listed. Species reported in eBird, but not detected in this survey, are indicated with an asterisk. Species = 47.

Common Name	Species	SW	SW: RA (%)	M
Cinnamon Teal	<i>Spatula cyanoptera</i>	16	0.12	-
Gambel's Quail	<i>Callipepla gambelii</i>	1,646	12.62	119
Common Ground Dove	<i>Columbina passerina</i>	175	1.34	124
Ruddy Ground Dove	<i>Columbina talpacoti</i>	2	0.02	-
White-winged Dove	<i>Zenaida asiatica</i>	3,528	27.06	139
Mourning Dove	<i>Zenaida macroura</i>	3,948	30.28	345
Eurasian Collared-Dove	<i>Streptopelia decaoto</i>	24	0.18	1
Greater Roadrunner	<i>Geococcyx californianus</i>	61	0.47	15
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>	2	0.02	3
Lesser Nighthawk	<i>Chordeiles acutipennis</i>	249	1.91	16
Common Poorwill	<i>Phalaenoptilus nuttallii</i>	12	0.09	*
Vaux's Swift	<i>Chaetura vauxi</i>	9	0.07	1
Black-chinned Hummingbird	<i>Archilochus alexandri</i>	7	0.05	*
Anna's Hummingbird	<i>Calypte anna</i>	4	0.03	-
Costa's Hummingbird	<i>Calypte costae</i>	17	0.13	*
Killdeer	<i>Charadrius vociferus</i>	1	0.01	*
Spotted Sandpiper	<i>Actitis macularius</i>	1	0.01	1
Solitary Sandpiper	<i>Tringa solitaria</i>	3	0.02	-
Greater Yellowlegs	<i>Tringa melanoleuca</i>	7	0.05	-
White-faced Ibis	<i>Plegadis chihi</i>	1	0.01	-
Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	1	0.01	-
Great Egret	<i>Ardea alba</i>	1	0.01	-
Great Blue Heron	<i>Ardea herodias</i>	3	0.02	-
Black Vulture	<i>Coragyps atratus</i>	26	0.20	146
Turkey Vulture	<i>Cathartes aura</i>	2,395	18.37	1
Sharp-shinned Hawk	<i>Accipiter striatus</i>	19	0.15	2
Cooper's Hawk	<i>Astur cooperii</i>	53	0.41	5
Northern Harrier	<i>Circus hudsonius</i>	9	0.07	4
Harris's Hawk	<i>Parabuteo unicinctus</i>	*	-	7
Gray Hawk	<i>Buteo plagiatus</i>	2	0.02	-
Swainson's Hawk	<i>Buteo swainsoni</i>	10	0.08	4
Zone-tailed Hawk	<i>Buteo albonotatus</i>	1	0.01	-
Red-tailed Hawk	<i>Buteo jamaicensis</i>	60	0.46	10
American Barn Owl	<i>Tyto furcata</i>	1	0.01	*
Western Screech-Owl	<i>Megascops kennicottii</i>	7	0.05	2
Great Horned Owl	<i>Bubo virginianus</i>	12	0.09	4

Common Name	Species	SW	SW: RA (%)	M
Elf Owl	<i>Micrathene whitneyi</i>	10	0.08	*
Long-eared Owl	<i>Asio otus</i>	-	-	6
Belted Kingfisher	<i>Megasceryle alcyon</i>	3	0.02	-
Gila Woodpecker	<i>Melanerpes uropygialis</i>	391	3.00	49
Ladderback Woodpecker	<i>Dryobates scalaris</i>	213	1.63	71
Northern Flicker	<i>Colaptes auratus</i>	35	0.27	8
Gilded Flicker	<i>Colaptes chrysoides</i>	50	0.38	11
Crested Caracara	<i>Caracara plancus</i>	2	0.02	2
American Kestrel	<i>Falco sparverius</i>	17	0.13	1
Peregrine Falcon	<i>Falco peregrinus</i>	1	0.01	-
Prairie Falcon	<i>Falco mexicanus</i>	4	0.03	1
Sum of Individuals		13,039	100%	1,098

APPENDIX 3. Most-observed passerine families: Emberizidae (19), Tyrannidae (14), Parulidae (12), Icteridae (10), and Cardinalidae (10), documented in surveys for both Vekol-South Well (SW) and Vekol-Maricopa (M), 2018-2025. Total counts are in bold in the last row. Species reported in eBird, but not detected in this survey, are indicated with an asterisk. Species = 65.

Common Name	Species	SW	SW: RA (%)	M
Rufous-winged Sparrow	<i>Peucaea carpalis</i>	191	3.66	18
Cassin's Sparrow	<i>Peucaea cassinii</i>	35	0.67	17
Black-throated Sparrow	<i>Amphispiza bilineata</i>	435	8.34	48
Lark Sparrow	<i>Chondestes grammacus</i>	123	2.36	12
Lark Bunting	<i>Calamospiza melanocorys</i>	13	0.25	-
Chipping Sparrow	<i>Spizella passerina</i>	98	1.88	30
Brewer's Sparrow	<i>Spizella breweri</i>	233	4.47	65
Dark-eyed Junco	<i>Junco hyemalis</i>	36	0.69	4
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>	860	16.49	54
White-throated Sparrow	<i>Zonotrichia albicollis</i>	2	0.04	-
Sagebrush Sparrow	<i>Artemisiospiza nevadensis</i>	7	0.13	*
Vesper Sparrow	<i>Pooecetes gramineus</i>	40	0.77	4
Savannah Sparrow	<i>Passerculus sandwichensis</i>	5	0.10	*
Song Sparrow	<i>Melospiza melodia</i>	-	-	1
Lincoln's Sparrow	<i>Melospiza lincolni</i>	64	1.23	6
Canyon Towhee	<i>Melospiza fusca</i>	30	0.58	5
Abert's Towhee	<i>Melospiza aberti</i>	548	10.51	40
Green-tailed Towhee	<i>Pipilo chlorurus</i>	53	1.02	1
Spotted Towhee	<i>Pipilo maculatus</i>	2	0.04	*

Common Name	Species	SW	SW: RA (%)	M
Ash-throated Flycatcher	<i>Myiarchus cinerascens</i>	328	6.29	83
Brown-crested Flycatcher	<i>Myiarchus tyrannulus</i>	92	1.76	21
Cassin's Kingbird	<i>Tyrannus vociferans</i>	2	0.04	-
Western Kingbird	<i>Tyrannus verticalis</i>	58	1.11	9
Olive-sided Flycatcher	<i>Contopus cooperi</i>	2	0.04	1
Western Wood-Pewee	<i>Contopus sordidulus</i>	12	0.23	4
Willow Flycatcher	<i>Empidonax traillii</i>	2	0.04	*
Hammond's Flycatcher	<i>Empidonax hammondi</i>	6	0.12	1
Gray Flycatcher	<i>Empidonax wrightii</i>	9	0.17	9
Dusky Flycatcher	<i>Empidonax oberholseri</i>	1	0.02	-
Western Flycatcher	<i>Empidonax difficilis</i>	18	0.35	*
Black Phoebe	<i>Sayornis nigricans</i>	52	1.00	9
Say's Phoebe	<i>Sayornis saya</i>	28	0.54	7
Vermilion Flycatcher	<i>Pyrocephalus rubinus</i>	7	0.13	2
Orange-crowned Warbler	<i>Leiothlypis celata</i>	36	0.69	3
Lucy's Warbler	<i>Leiothlypis luciae</i>	206	3.95	82
Nashville Warbler	<i>Leiothlypis ruficapilla</i>	14	0.27	1
MacGillivray's Warbler	<i>Geothlypis tolmiei</i>	8	0.15	5
Common Yellowthroat	<i>Geothlypis trichas</i>	1	0.02	-
American Redstart	<i>Setophaga ruticilla</i>	1	0.02	-
Northern Yellow Warbler	<i>Setophaga aestiva</i>	64	1.23	7
Yellow-rumped Warbler	<i>Setophaga coronata</i>	291	5.58	19
Black-throated Gray Warbler	<i>Setophaga nigrescens</i>	14	0.27	*
Townsend's Warbler	<i>Setophaga townsendi</i>	19	0.36	3
Hermit Warbler	<i>Setophaga occidentalis</i>	1	0.02	*
Wilson's Warbler	<i>Cardellina pusilla</i>	80	1.53	10
Yellow-breasted Chat	<i>Icteria virens</i>	18	0.35	23
Yellow-headed Blackbird	<i>Xanthocephalus xanthocephalus</i>	12	0.23	-
Western Meadowlark	<i>Sturnella neglecta</i>	5	0.10	*
Hooded Oriole	<i>Icterus cucullatus</i>	151	2.90	16
Bullock's Oriole	<i>Icterus bullockii</i>	33	0.63	7
Scott's Oriole	<i>Icterus parisorum</i>	2	0.04	2
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	25	0.48	2
Bronzed Cowbird	<i>Molothrus aeneus</i>	14	0.27	-
Brown-headed Cowbird	<i>Molothrus ater</i>	161	3.09	11
Great-tailed Grackle	<i>Quiscalus mexicanus</i>	8	0.15	-
Summer Tanager	<i>Piranga rubra</i>	2	0.04	*
Western Tanager	<i>Piranga ludoviciana</i>	44	0.84	5
Northern Cardinal	<i>Cardinalis cardinalis</i>	164	3.15	8

Common Name	Species	SW	SW: RA (%)	M
Pyrrhuloxia	<i>Cardinalis sinuatus</i>	53	1.02	4
Black-headed Grosbeak	<i>Pheucticus melanocephalus</i>	31	0.59	4
Blue Grosbeak	<i>Passerina caerulea</i>	83	1.59	27
Lazuli Bunting	<i>Passerina amoena</i>	190	3.64	23
Indigo Bunting	<i>Passerina cyanea</i>	14	0.27	3
Varied Bunting	<i>Passerina versicolor</i>	76	1.46	1
Painted Bunting	<i>Passerina ciris</i>	1	0.02	-
Sum of Individuals		5,214	100%	717

APPENDIX 4. Less-represented passerine families: Hirundinidae (7), Mimidae (5), Turdidae (5), Vireonidae (4), Troglodytidae (4), Fringillidae (4), Corvidae (2), Polioptilidae (2), Laniidae (1), Remizidae (1), Alaudidae (1), Regulidae (1), Bombycillidae (1), and Ptiliognatidae (1), documented in surveys for both Vekol-South Well (SW) and Vekol-Maricopa (M), 2018-2025. Total counts are in bold in last row. Species reported in eBird, but not detected in this survey, are indicated with an asterisk. Species = 39.

Common Name	Species	SW	M
Bank Swallow	<i>Riparia riparia</i>	4	*
Tree Swallow	<i>Tachycineta bicolor</i>	12	-
Violet-green Swallow	<i>Tachycineta thalassina</i>	6	-
Northern Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>	20	1
Purple Martin	<i>Progne subis</i>	20	5
Barn Swallow	<i>Hirundo rustica</i>	5	-
Cliff Swallow	<i>Petrochelidon pyrrhonota</i>	18	-
Curve-billed Thrasher	<i>Toxostoma curvirostre</i>	62	8
Bendire's Thrasher	<i>Toxostoma bendirei</i>	13	-
Crissal Thrasher	<i>Toxostoma crissale</i>	164	29
Sage Thrasher	<i>Oreoscoptes montanus</i>	12	-
Northern Mockingbird	<i>Mimus polyglottos</i>	238	51
Western Bluebird	<i>Sialia mexicana</i>	6	*
Townsend's Solitaire	<i>Myadestes townsendi</i>	2	-
Hermit Thrush	<i>Catharus guttatus</i>	9	1
Rufous-backed Robin	<i>Turdus rufopalliatus</i>	1	-
American Robin	<i>Turdus migratorius</i>	25	*
Bell's Vireo	<i>Vireo bellii</i>	163	19
Cassin's Vireo	<i>Vireo cassinii</i>	2	*
Plumbeous Vireo	<i>Vireo plumbeus</i>	2	*
Western Warbling-Vireo	<i>Vireo gilvus</i>	27	5
Rock Wren	<i>Salpinctes obsoletus</i>	8	-
Cactus Wren	<i>Campylorhynchus brunneicapillus</i>	61	2

Common Name	Species	SW	M
Bewick's Wren	<i>Thryomanes bewickii</i>	2	*
Northern House Wren	<i>Troglodytes aedon</i>	40	2
House Finch	<i>Haemorhous mexicanus</i>	236	16
Pine Siskin	<i>Spinus pinus</i>	1	-
Lesser Goldfinch	<i>Spinus psaltria</i>	28	4
Lawrence's Goldfinch	<i>Spinus lawrencei</i>	74	-
Woodhouse's Scrub-Jay	<i>Aphelocoma woodhouseii</i>	1	-
Common Raven	<i>Corvus corax</i>	223	37
Blue-gray Gnatcatcher	<i>Polioptila caerulea</i>	7	*
Black-tailed Gnatcatcher	<i>Polioptila melanura</i>	273	20
Loggerhead Shrike	<i>Lanius ludovicianus</i>	136	14
Verdin	<i>Auriparus flaviceps</i>	291	44
Horned Lark	<i>Eremophila alpestris</i>	13	61
Ruby-crowned Kinglet	<i>Corthylio calendula</i>	93	7
Cedar Waxwing	<i>Bombycilla cedrorum</i>	73	*
Phainopepla	<i>Phainopepla nitens</i>	991	31
Sum of Individuals		3,362	357
Sum of Appendices 2, 3, and 4		21,615	2,172

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