

BIRDS OF THE U.S. ARMY GARRISON YUMA PROVING GROUND, ARIZONA

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ABSTRACT: Yuma Proving Ground (YPG), a U.S. Army installation, is located in the Sonoran Desert of Yuma County, Arizona. Although several studies of birds have been conducted on YPG, the most recent inventory of the bird community was in 1982-1985. We used point-transect surveys during 3 seasons in 2023-2024 to determine species presence and to compare species diversity and evenness across habitats. We made 2,898 observations of 94 bird species on YPG. Arroyos had the highest species richness and diversity; the lowest richness and diversity were in dunes. Species accumulation curves predict that species totals for each habitat type would increase with additional sampling, and a doubling of survey effort would be expected to yield 17 new species on YPG. Between the present work and previous bird surveys on YPG, 164 bird species have been documented from the installation. The 2 greatest changes to the bird community since the last inventories 4 decades ago were the addition of Eurasian Collared-Dove (*Streptopelia decaocto*) and Great-tailed Grackle (*Quiscalus mexicanus*). We recommend additional surveys specifically targeting nocturnal birds and habitats with high richness such as sewage lagoons and the watered cantonment areas, and a regular monitoring program to detect future changes in the bird community.

The most basic information necessary to manage the biological resources of an area is an inventory of the species present. In many places, especially those that are remote or in harsh environments, species presence information is lacking. The species at any location can also change through time, through the processes of extirpation, extinction, invasion, and recolonization. Natural resource managers rely on species information that is current to determine how best to allocate effort to protect biological resources. This need may be nowhere more pressing than in the deserts of the southwestern United States, where bird communities are collapsing due to the added stressors of climate change on species already living at the limits of physiological tolerance (Iknayan and Beissinger 2018).

Yuma Proving Ground (YPG) is located within Arizona Upland and Lower Colorado subdivisions of the Lower Sonoran Desert in the southwestern corner of Arizona. Approximately 45% of lower Sonoran desertscrub in Arizona is on federal land, including on YPG (AZGFD 2022). There are no perennial or intermittent streams on YPG, only ephemeral washes and catchments, but some parts of YPG approach the Colorado River to the west. From 2000 to 2023, the average total annual precipitation was 7.4 cm. The monthly temperature ranged from a mean minimum of 17 °C to a mean maximum of 32 °C, averaged over the 23-year period (NOAA 2023). This area of the Lower Sonoran Desert is comprised of vegetative communities including desert grassland, creosote-bursage, paloverde-mixed cactus, and ephemeral washes with ironwood and mesquite.

The last installation-wide wildlife inventory on YPG was conducted in 1982-1985 (deVos and Ough 1986, Ough and deVos 1986), but other studies of birds have contributed to the knowledge of bird species on the installation. A survey of wintering bird communities was conducted in 2005-2006 (Leu and Knick 2006). A survey of birds using mesquite bosques was conducted by Rosenstock and Yarborough (2012). Birds using water catchments on YPG were reported by O'Brien et al. (2006). A study of birds around the Laguna Army Airfield was conducted in 2017-2018 (Clark and Ingraldi "2018" [2019]). Other studies on YPG have focused on individual bird species or groups of species. For example, surveys have been conducted for Burrowing Owls (*Athene cunicularia*; Ingraldi and Cobbold 2022), raptors (Don et al. 2023), Golden Eagles (*Aquila chrysaetos*; Diamond et al. 2016), and LeConte's Thrashers (*Toxostoma lecontei*;

Blackman and Diamond 2015, Clark and Ingraldi 2019). Several important additional studies have included birds of YPG but either reported diversity metrics without reporting specific species lists (Esque et al. 2013) or conflated species lists with other adjacent areas (e.g., Rosenberg et al. 1991, Lynn et al. 2006, McCreedy 2011, Fischer et al. 2012, Corman and Wise-Gervais 2005), so they contributed little to informing the total list of birds documented from YPG or assessing changes in that list.

This planning level survey of birds was conducted to inform natural resource management on YPG. We used point-transect surveys of birds to accomplish 4 primary objectives: 1) to provide a list of bird species detected; 2) to describe and compare species diversity and evenness across habitat types; 3) to summarize species detections by unit effort using species accumulation curves, and 4) to provide recommendations that could be implemented to improve the monitoring efforts and natural resource stewardship on YPG.

METHODS

YPG is located in the southwestern corner of Arizona and covers 8,772 km² of land within La Paz and Yuma counties. YPG is bordered by other federal lands including Bureau of Land Management (BLM), the Imperial National Wildlife Refuge, and the Kofa National Wildlife Refuge in the center of the U-shaped property. Arizona State Route 95 splits the property from north to south into 2 sections, with the Cibola Range on the west and the Kofa Range on the east. We stratified our sampling effort into 11 land associations as defined by Kaya Associates, Inc (2010), who adapted the land associations of Malusa (2009). The land associations included 1) *Lycium/Olneya-Parkinsonia-Psorothamnus/Acacia/Hymenoclea* Formation on Intermittently Flooded Extremely Xeromorphic Deciduous Subdesert Shrubland (Wolfberry/Ironwood-Palo Verde-Smocketree/Cat Claw/Cheesebush Formation on Intermittently Flooded Extremely Xeromorphic Deciduous Subdesert Shrubland), 2) *Larrea tridentata/Prosopis velutina-P. glandulosa* Floodplain (Creosote/Mesquite Floodplain), 3) *Larrea tridentata* with less than 10% cover of *Parkinsonia microphylla-Olneya tesota* (Creosote with <10% cover of Palo Verde/Ironwood), 4) *Larrea tridentata-Ambrosia dumosa* Sparse Shrubland Alliance (Creosote and Bursage), 5) *Larrea tridentata* on pavements, with <5% cover of *Parkinsonia microphylla-Olneya tesota* (Creosote on Pavements, with <5% cover of Palo Verde/Ironwood), 6) *Ambrosia dumosa/Pleuraphis rigida/Larrea tridentata* on Dunes (White Bursage/Big Galleta Grass/Creosote), 7) *Prosopis* spp. Bosque (Mesquite Woodland), 8) *Encelia farinosa/Ambrosia/Larrea tridentata/Parkinsonia microphylla* on Mountain Slopes >20% (Brittlebush/Bursage/Creosote/Palo Verde on Mountain Slopes >20%), 9) *Larrea tridentata-Cylindropuntia* spp./*Ambrosia dumosa* Hills >10% and <20% Slope (Creosote-Teddy Bear Cholla/Bursage on Rolling Hills), 10) Disturbed Anthropogenic (Areas Impacted by Human Activity), and 11) North American Warm Desert Badlands. We abbreviated these associations, respectively, 1) arroyos, 2) creosote-mesquite floodplain, 3) creosote-palo verde-ironwood, 4) creosote-white bursage, 5) desert pavement, 6) dunes, 7) mesquite bosque, 8) mountain highlands, 9) rolling hills, 10) disturbed, and 11) badlands. We plotted 2 transects per habitat association, excluding disturbed and badlands associations, which were located in residential areas and active target ranges. The 2 transects in each association were divided equally between the Cibola Range and the Kofa Range, except for dunes. Since no dunes are present within the Kofa Range, dune survey sites were placed within the Cibola Range in the northern Weaver Wash dunes near Ehrenberg and southern dunes south of Imperial Dam Road.

We surveyed for birds using a systematic sampling approach of point transects. Surveys began in May 2023 and concluded in March 2024, and were repeated across seasons to detect resident, migrant, and overwintering species. Each transect consisted of 12 survey points placed every 200 m (Figure 1). When possible, transects were arranged in a U-shaped out-and-back arrangement of 2 lines to keep transects in a single habitat type as much as possible and to maximize travel efficiency. In linear habitat features (e.g. arroyos), transects were constrained by the linear shape of the habitat rather than taking a U-shape. We located each point (± 10 m) using Universal Transverse Mercator coordinates and a handheld Global Positioning System (GPS) receiver. Each survey began no earlier than 30 minutes before sunrise and ended within 3 hours after sunrise to maximize detection probability, and each survey was conducted by one observer. Once each point was reached, the observer remained silent for 1 minute to reduce observer impacts on bird behavior. After this 1-minute period, any birds seen or heard during the next 6 minutes were recorded. The

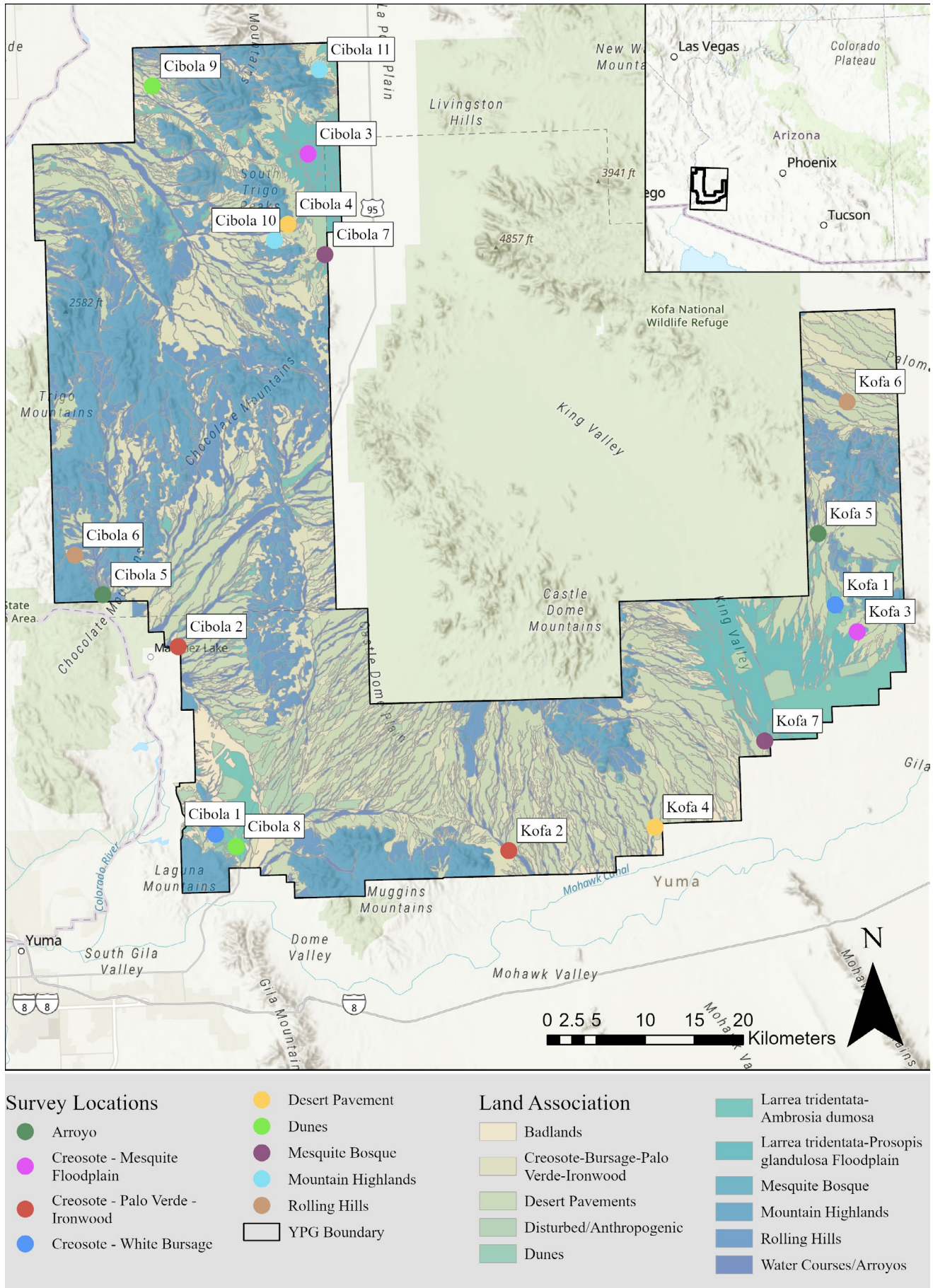


Figure 1. Bird transect locations (2023-2024), symbolized by land association, at Yuma Proving Ground.

species, the number of birds in the flock, and the distance to the birds (categorically indicated as greater or less than 100 m) were recorded. Distances to birds that were not obviously greater, or less than 100 m were confirmed with a laser rangefinder. We also recorded birds that were detected between points while we walked along the transect, with the goal of increasing our probability of detecting cryptic nonbreeding birds such as overwintering sparrows. Birds were recorded at any distance, including flyovers, but to reduce the potential impact of habitat differences in detection probability, comparisons of diversity were conducted on a truncated dataset including only birds observed less than 100 m distant. This truncation removed 45.7% of bird observations. We compiled lists of species and counts at each point on each transect. From these species lists we calculated 3 diversity metrics, each of which describes something subtly different about diversity: Simpson's index (Simpson 1949), Shannon-Wiener index (Shannon and Weaver 1963), and Margalef's richness index (Margalef 1958). Simpson's index and the Shannon-Wiener index are 2 different methods, which both incorporate richness and evenness. Simpson's index corrects for sample size to allow the comparison of communities that have many individuals and those that have few, and it equals the probability that 2 individuals selected at random from the community would be 2 different species. The Shannon-Weiner index also corrects for sample size and although it incorporates evenness, it is less strongly influenced by evenness than Simpson's index. Margalef's richness index is a measure of species richness that is corrected for sample size.

We generated species accumulation curves by resampling our data using iNEXT Online (Chao et al. 2014; Chao et al. 2016). Data were extrapolated from our 6 sampling events per habitat (2 transects per habitat in each of 3 seasons) to 12 sampling events, which is double the current number of transects surveyed for each habitat, to predict how much increased sampling would increase the number of species recorded in each habitat. Counts of each species in each transect were compiled as incidence frequency data, and results were calculated at diversity order $q = 0$ (species richness). Incidence-based confidence intervals were calculated with 100 bootstraps and a 95% confidence interval. In addition to considering each of the 9 habitat types separately, we performed a similar analysis with all data collapsed across habitat types to assess whether increased sampling would be expected to increase the total number of species documented from YPG.

RESULTS

Point Counts

A total of 6,889 individuals of 94 bird species was observed during this study (Table 1). Thirty-five of the species documented are Species of Greatest Conservation Need (SGCN) (AZGFD 2022, Table 1). We did not detect any species that are listed under the federal Endangered Species Act. Two Department of Defense Mission Sensitive species were detected, Bendire's Thrasher (*Toxostoma bendirei*) and Burrowing Owl (DDPF 2021). In addition, 5 Department of Defense Tier 2 species were detected: Gilded Flicker (*Colaptes chrysoides*), Olive-sided Flycatcher (*Contopus cooperi*), Gray Vireo (*Vireo vicinior*), Loggerhead Shrike (*Lanius ludovicianus*), and Black-chinned Sparrow (*Spizella atrogularis*). We detected 6 species that are listed by the U.S. Fish and Wildlife Service as Birds of Conservation Concern at the continental level: Western Grebe (*Aechmophorus occidentalis*), Gilded Flicker, Olive-sided Flycatcher, Bendire's Thrasher, LeConte's Thrasher, and Black-chinned Sparrow (USFWS 2021).

Comparisons of Diversity and Evenness

Across all measures of species diversity and evenness, arroyos had the highest diversity, followed by mesquite bosques. The lowest diversity was in dunes. Simpson's Diversity Index, which is negatively related to diversity, was greatest in dunes, where any individual bird had a 49% chance of being the same species as the next bird, and lowest in arroyos, with only a 9.1% chance (Figure 2). Similar patterns of species diversity across habitats were evident in Shannon-Wiener diversity indices, which are positively related to richness and evenness (Figure 3). Species diversity was highest in arroyos, and lowest in dunes. Margalef's Index is an effort-corrected measurement of species richness, which does not account for evenness, but it showed similar patterns, with the highest species richness in arroyos, and lowest in dunes (Figure 4).

Table 1: List of bird species we detected on Yuma Proving Ground in these surveys, in taxonomic order. "SGCN Tier" indicates Arizona Species of Greatest Conservation Need (Arizona Game and Fish Department 2022). Asterisks (*) indicate species that we observed breeding or we consider likely to breed on YPG. †White-crowned Sparrow (*Zonotrichia leucophrys*), includes some subspecies that are SGCN and some that are not: the "Mountain West White-crowned Sparrow" (*Z. l. oriantha*) is a Tier 2 SGCN, but other subspecies are not SGCN. Both "Gambel's White-crowned Sparrow" (*Z. l. gambelii*) and "Mountain West White-crowned Sparrow" were observed.

Common Name	Scientific Name	SGCN Tier	Common Name	Scientific Name	SGCN Tier
Gambel's Quail*	<i>Callipepla gambelii</i>		Gray Flycatcher	<i>Empidonax wrightii</i>	2
Western Grebe	<i>Aechmophorus occidentalis</i>	2	Western Flycatcher	<i>Empidonax difficilis</i>	
Eurasian Collared-Dove*	<i>Streptopelia decaocto</i>		Say's Phoebe*	<i>Sayornis saya</i>	
Common Ground Dove*	<i>Columbina passerina</i>	3	Ash-throated Flycatcher*	<i>Myiarchus cinerascens</i>	
White-winged Dove*	<i>Zenaida asiatica</i>		Western Kingbird*	<i>Tyrannus verticalis</i>	
Mourning Dove*	<i>Zenaida macroura</i>		Bell's Vireo*	<i>Vireo bellii</i>	
Greater Roadrunner*	<i>Geococcyx californicus</i>		Gray Vireo	<i>Vireo vicinior</i>	2
Lesser Nighthawk*	<i>Chordeiles acutipennis</i>		Plumbeous Vireo	<i>Vireo plumbeus</i>	
Vaux's Swift	<i>Chaetura vauxi</i>		Warbling Vireo	<i>Vireo gilvus</i>	
White-throated Swift	<i>Aeronautes saxatalis</i>	3	Loggerhead Shrike*	<i>Lanius ludovicianus</i>	2
Black-chinned Hummingbird*	<i>Archilochus alexandri</i>		Common Raven*	<i>Corvus corax</i>	
Anna's Hummingbird*	<i>Calypte anna</i>		Verdin*	<i>Auriparus flaviceps</i>	2
Costa's Hummingbird*	<i>Calypte costae</i>	2	Horned Lark*	<i>Eremophila alpestris</i>	2
Turkey Vulture*	<i>Cathartes aura</i>		Tree Swallow	<i>Tachycineta bicolor</i>	
Sharp-shinned Hawk	<i>Accipiter striatus</i>		Violet-green Swallow	<i>Tachycineta thalassina</i>	
Cooper's Hawk	<i>Astur cooperii</i>		Northern Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>	
Red-tailed Hawk*	<i>Buteo jamaicensis</i>		Barn Swallow	<i>Hirundo rustica</i>	
Great Horned Owl*	<i>Bubo virginianus</i>		Cliff Swallow	<i>Petrochelidon pyrrhonota</i>	
Burrowing Owl*	<i>Athene cunicularia</i>	2	Ruby-crowned Kinglet	<i>Corthylio calendula</i>	
Gila Woodpecker*	<i>Melanerpes uropygialis</i>	2	Blue-gray Gnatcatcher	<i>Polioptila caerulea</i>	
Ladder-backed Woodpecker*	<i>Dryobates scalaris</i>		Black-tailed Gnatcatcher*	<i>Polioptila melanura</i>	
Northern Flicker	<i>Colaptes auratus</i>	3	Rock Wren*	<i>Salpinctes obsoletus</i>	3
Gilded Flicker*	<i>Colaptes chrysoides</i>	2	Canyon Wren*	<i>Catherpes mexicanus</i>	
American Kestrel*	<i>Falco sparverius</i>	2	House Wren	<i>Troglodytes aedon</i>	
Olive-sided Flycatcher	<i>Contopus cooperi</i>	2	Bewick's Wren	<i>Thryomanes bewickii</i>	
Western Wood-Pewee	<i>Contopus sordidulus</i>	2			

Common Name	Scientific Name	SGCN Tier
Cactus Wren*	<i>Campylorhynchus brunneicapillus</i>	2
European Starling*	<i>Sturnus vulgaris</i>	
Curve-billed Thrasher	<i>Toxostoma curvirostre</i>	
Bendire's Thrasher*	<i>Toxostoma bendirei</i>	2
LeConte's Thrasher*	<i>Toxostoma lecontei</i>	2
Crissal Thrasher*	<i>Toxostoma crissale</i>	
Northern Mockingbird*	<i>Mimus polyglottos</i>	
Phainopepla*	<i>Phainopepla nitens</i>	
American Pipit	<i>Anthus rubescens</i>	2
House Finch*	<i>Haemorhous mexicanus</i>	
Pine Siskin	<i>Spinus pinus</i>	3
Lesser Goldfinch*	<i>Spinus psaltria</i>	
Chipping Sparrow	<i>Spizella passerina</i>	3
Black-chinned Sparrow	<i>Spizella atrogularis</i>	2
Brewer's Sparrow	<i>Spizella breweri</i>	2
Black-throated Sparrow*	<i>Amphispiza bilineata</i>	
Lark Sparrow	<i>Chondestes grammacus</i>	
Dark-eyed Junco	<i>Junco hyemalis</i>	
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>	2 ⁺
Sagebrush Sparrow	<i>Artemisiospiza nevadensis</i>	3
Vesper Sparrow	<i>Pooecetes gramineus</i>	2
Lincoln's Sparrow	<i>Melospiza lincolnii</i>	2
Abert's Towhee*	<i>Melospiza aberti</i>	2
Green-tailed Towhee	<i>Pipilo chlorurus</i>	
Yellow-headed Blackbird	<i>Xanthocephalus xanthocephalus</i>	
Western Meadowlark	<i>Sturnella neglecta</i>	3
Bullock's Oriole	<i>Icterus bullockii</i>	2
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	2
Brown-headed Cowbird*	<i>Molothrus ater</i>	

Common Name	Scientific Name	SGCN Tier
Great-tailed Grackle*	<i>Quiscalus mexicanus</i>	
Orange-crowned Warbler	<i>Leiothlypis celata</i>	
Lucy's Warbler*	<i>Leiothlypis luciae</i>	
Common Yellowthroat	<i>Geothlypis trichas</i>	
Yellow Warbler	<i>Setophaga petechia</i>	
Yellow-rumped Warbler	<i>Setophaga coronata</i>	
Black-throated Gray Warbler	<i>Setophaga nigrescens</i>	2
Townsend's Warbler	<i>Setophaga townsendi</i>	
Hermit Warbler	<i>Setophaga occidentalis</i>	
Wilson's Warbler	<i>Cardellina pusilla</i>	
Summer Tanager	<i>Piranga rubra</i>	
Western Tanager	<i>Piranga ludoviciana</i>	
Black-headed Grosbeak	<i>Pheucticus melanocephalus</i>	
Lazuli Bunting	<i>Passerina amoena</i>	3

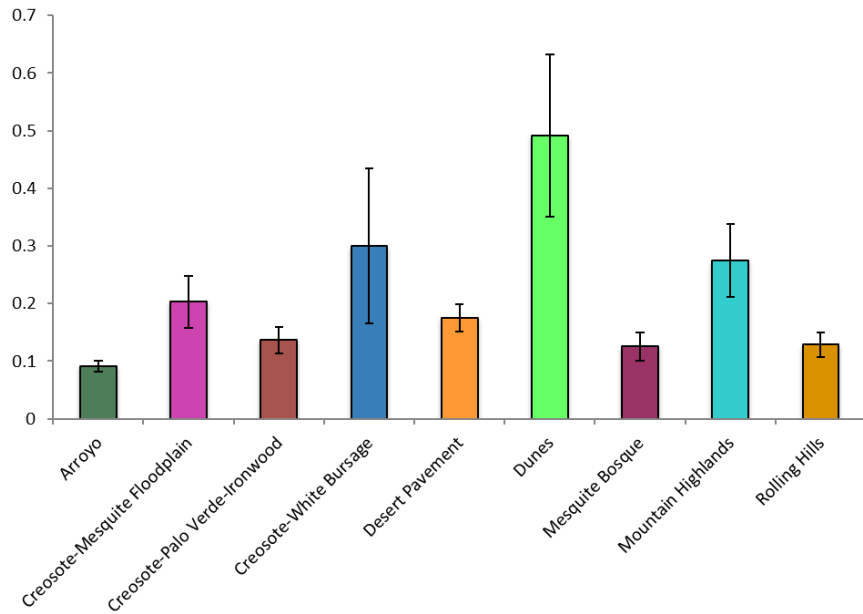


Figure 2. Mean Simpson's Diversity Index compared between the 9 habitat types. Error bars represent 1 standard error.

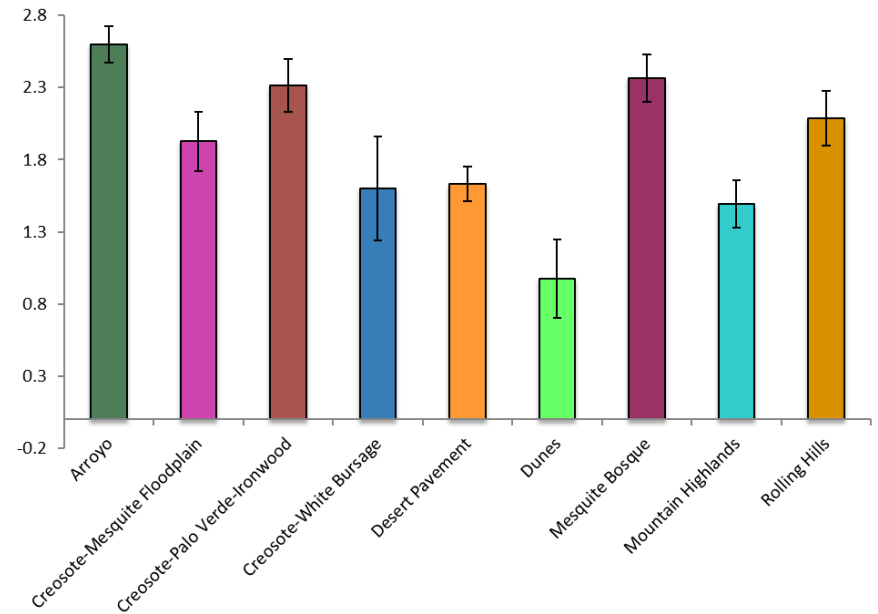


Figure 3. Mean Shannon-Wiener Diversity Index compared between the 9 habitat types. Error bars represent 1 standard error.

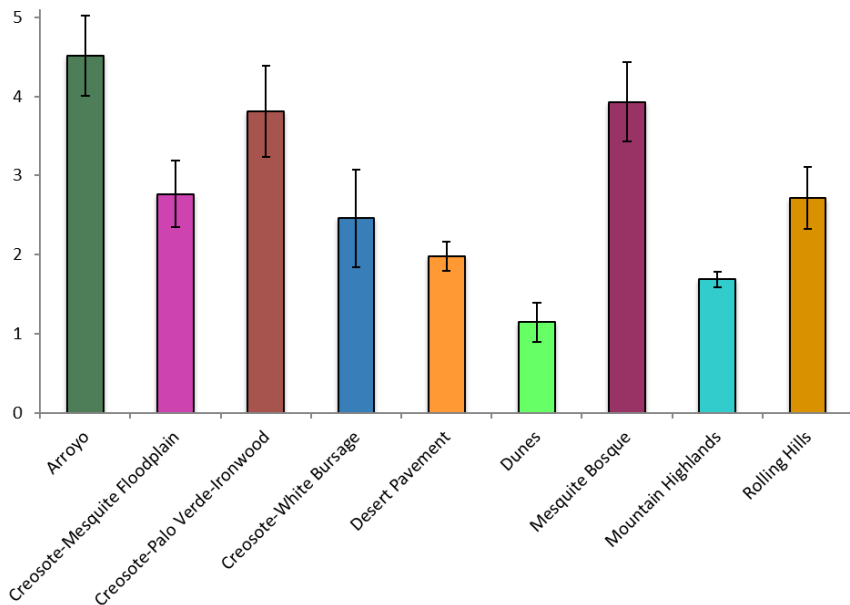


Figure 4. Mean Margalef's Richness Index compared between the 9 habitat types. Error bars represent 1 standard error.

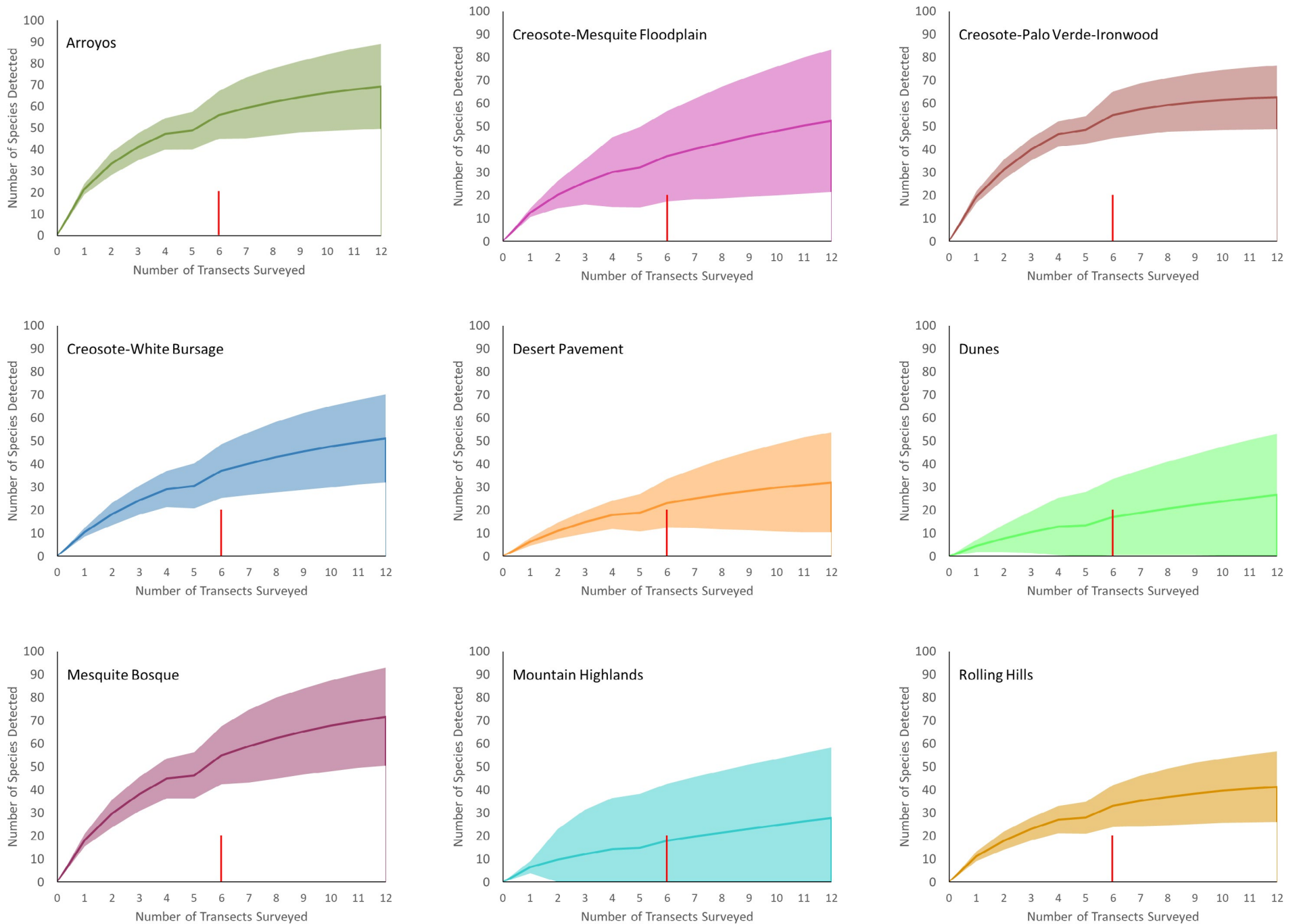


Figure 5: Species accumulation curves for birds on Yuma Proving Ground, for each of 9 habitats. Shaded area indicates 95% confidence interval. Red line indicates total number of sampling events; data to the right of the red line is extrapolated.

Species Accumulation Curves

Species accumulation curves showed that species detections were expected to increase with additional survey effort for each habitat type (Figure 5). Extrapolation predicted that a doubling of the sampling effort would yield an average of 7 (creosote-palo verde-ironwood) to 17 (mesquite bosque) new bird species in each habitat. Some of these new species in each habitat would likely be species already detected in other habitats and would thus not represent new species for YPG. When all data were combined, species accumulation curves predicted that a doubling of the survey effort would produce 17 new bird species for the installation (Figure 6).

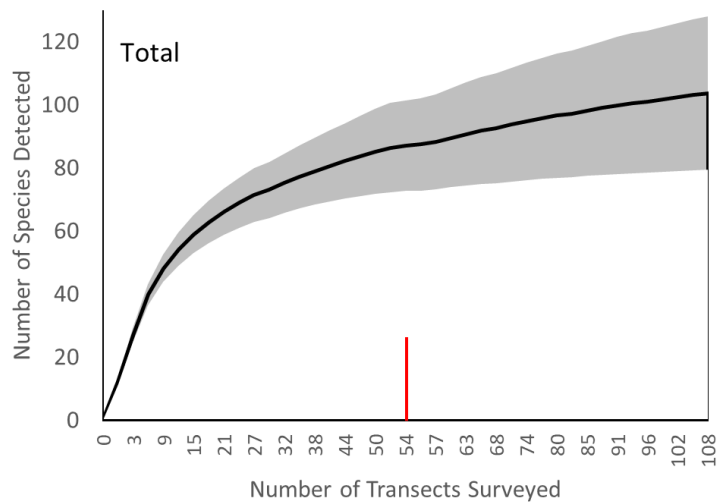


Figure 6: Species accumulation curves for birds on Yuma Proving Ground, combined across all habitats. Shaded area indicates 95% confidence interval. Red line indicates total number of sampling events; data to the right of the red line are extrapolated.

DISCUSSION

As expected, arroyos supported the highest diversity and richness of bird species by each of the 3 diversity metrics. In desert ecosystems, arroyos typically harbor greater species diversity because they gather more precipitation and thus can support a larger diversity of plant species than the surrounding desert (Kaya Associates, Inc 2010). Conversely, dunes harbor relatively few plant species, and this was reflected in bird communities with the lowest diversity of the 9 habitats we studied. This pattern of diversity across habitats largely coincides with previous work on the installation. For small mammals, richness was highest in arroyos, creosote-palo verde-ironwood, desert pavement, and mesquite bosque habitats (Rozanski et al. 2024). Reptile species richness also peaked in arroyo habitats (Arnett-Romero et al. 2021).

The species accumulation curves indicated that we detected the majority of species on the installation, but also that additional survey effort would be likely to yield more species. Our methods targeted a diversity of habitats, but they did not include all habitats on YPG, and some of the most diverse habitats available on the installation were excluded. For example, most of the migration through the lower Colorado River area happens along riparian systems (Fischer et al. 2012), which are rare on YPG, but analogs such as sewage treatment lagoons and watered residential areas likely contribute most of the migratory bird diversity and were not included here. These additional species from the lagoons and cantonment area contributed most of the 36 additional species that we observed on YPG but did not detect during our transect surveys (Appendix 1). Many of the species reported earlier by deVos and Ough (1986) and Ough and deVos (1986) but missed by us also reflect the absence of wetland habitats in our survey, such as Song Sparrow (*Melospiza melodia*) and Black Phoebe (*Sayornis nigricans*). Finally, because birds wander, no species list for any location will ever be complete. Vagrants are especially likely in the watered cantonment areas, where irruptive species and vagrants such as Lawrence's Goldfinch (*Spinus lawrencei*), Red-breasted Nuthatch (*Sitta canadensis*), and Golden-crowned Kinglet (*Regulus satrapa*) have been previously reported (Spitler 1976).

Our list of species observed was similar to previous reports from YPG. deVos and Ough (1986) reported detecting 84 bird species from the Kofa Range of YPG (but their list included only 79 species, not counting repeating Black-headed Grosbeak (*Pheucticus melanocephalus*) twice and Yellow-rumped Warbler (*Setophaga coronata*) 3 times). Their species list included 11 species that we did not observe (Appendix 2). Ough and deVos (1986) reported 54 species from the Cibola Range of YPG, including 1 species not reported by deVos and Ough (1986) or by us, Bushtit (*Psaltirparus minimus*). The Bushtit record is suspicious because, although Bushtits do sometimes wander from their typical habitats, there are very few occurrences of the species from La Paz or Yuma counties, and these movements are typically in the fall or winter (Rosenberg et al. 1991). The observation of 3 Bushtits was made in March, when juvenile Verdins

(*Auriparus flaviceps*) are fledging and presenting identification challenges. Otherwise, the absence of these species on our survey routes is neither surprising nor a cause for concern and is more likely to indicate sampling noise than significant changes in local populations.

Conversely, we detected 23 species in our surveys that were not detected by Ough and deVos (1986) or deVos and Ough (1986). Most of these were infrequent but regular migrants that would be easy to miss with limited survey effort, such as Olive-sided Flycatcher, Hermit Warbler (*Setophaga occidentalis*), Pine Siskin (*Spinus pinus*), and American Pipit (*Anthus rubescens*). A few of these represent known population changes. For example, Eurasian Collared-Dove (*Streptopelia decaocto*) was first documented in Arizona in 2000 and has rapidly expanded in the state (Corman 2005). Great-tailed Grackles (*Quiscalus mexicanus*) have undergone rapid range expansion in historical times, reaching Arizona from Mexico only in 1935 and reaching the lower Colorado River Valley in 1964, and were still expanding as of 2005 (Wise-Gervais 2005). These 2 species are likely legitimate additions to the YPG fauna since the 1980s.

A final category of birds we found but Ough and deVos (1986) did not is more difficult to explain. There are a few species, such as Blue-gray Gnatcatcher (*Polioptila caerulea*), Black-chinned Hummingbird (*Archilochus alexandri*), Anna's Hummingbird (*Calypte anna*), and Gilded Flicker, whose absence in the earlier reports might be best explained by misidentifications. Blue-gray Gnatcatchers are common in the region and were common on our surveys, observed more than 30 times, mostly in winter, and seen on almost as many surveys as Black-tailed Gnatcatchers (*Polioptila melanura*). These 2 gnatcatcher species are very similar, and best distinguished by voice or undertail pattern, so their absence from earlier reports seems more likely due to misidentification of some Blue-gray Gnatcatchers as Black-tailed Gnatcatchers than to a change in the species' distribution.

Hummingbirds are notoriously difficult to identify, especially females and immature birds. The vast majority of hummingbirds we observed were Costa's (*Calypte costae*), and the occasional Anna's or Black-chinned would be easy to miss among the more common species. Similarly, we consider the absence of Anna's and Black-chinned hummingbirds from previous reports to be more likely due to the misidentification of those species as Costa's Hummingbirds than to a change in the distribution of these species.

Leu and Knick (2006) reported 28 wintering bird species from YPG. Their list included no unique species, only species that were also reported by other sources (deVos and Ough 1986; Ough and deVos 1986; Rosenstock and Yarborough 2012; present study).

Rosenstock and Yarborough (2012) used camera trap data to detect 39 bird species from mesquite bosques on YPG. This added 2 species to the list that were not previously reported from the range, Golden Eagle and Nashville Warbler (*Leiothlypis ruficapilla*). Additionally, Rosenstock and Yarborough (2012) reported 1 species not documented by us or the Ough and deVos (1986) reports which we consider suspect. Rosenstock and Yarborough (2012) reported 1 observation of Boat-tailed Grackle (*Quiscalus major*) from YPG, but Boat-tailed is nearly identical to Great-tailed Grackle, and Boat-tailed Grackle has never been documented in Arizona, or anywhere west of the coastal plain of Texas. One additional species was noted by Rosenberg et al. (1991): 2 Elf Owls were reported from YPG in 1980.

Although most of YPG is not accessible to the public, some important records have been submitted to eBird, including a few additional species for the installation. Again, many of these were from the watered cantonment areas. Species that have been reported to eBird (Sullivan et al. 2009) from YPG, but were not detected in the previously cited bird survey efforts, include Inca Dove (*Columbina inca*; Steward and Packard 2019), Long-billed Curlew (*Numenius americanus*, multiple records), Western Cattle-Egret (*Ardea ibis*; Walchak 2006), and Varied Thrush (*Ixoreus naevius*; Vander Pluym and Harter 2010). In some additional cases, potential new species for YPG were reported to eBird, but long checklist distances combined with proximity to YPG boundaries made it unclear whether all of the species reported were actually observed within the installation. In total, 164 bird species have been documented from YPG (Appendix 2).

The bird inventory presented here, when combined with insight from previous inventories, can inform the conservation and management of birds on YPG. Globally, invasive species are the leading cause of extinction in birds (Clavero and García-Berthou 2005). Fortunately, few invasive bird species were detected on YPG, only Eurasian Collared-Doves, House Sparrows (*Passer domesticus*), and European Starlings (*Sturnus vulgaris*). Although European Starlings and House Sparrows may provide some competition for nest cavities to native secondary cavity-nesting species such as Brown-crested Flycatchers (*Myiarchus tyrannulus*), Elf Owls (*Micrathene whitneyi*), and House Finches (*Haemorrhous mexicanus*), they are rare on much of YPG and mostly limited to cantonment areas, where they are abundant. Eurasian Collared-Dove is a new invasive species in Arizona that has rapidly spread throughout the state (Corman 2005). However, in the Sonoran Desert the species is mostly limited to urban or agricultural areas, and thus it is not likely to negatively impact the bird community in most of YPG. Invasive bird species are unlikely to be a current significant threat to native species on YPG, especially away from the watered and developed residential areas.

Recommendations

Point count surveys can result in detections of nocturnal birds but are not designed to do so. Nocturnal birds such as owls and nightjars would be more thoroughly inventoried with specific nocturnal surveys. These surveys might result in detections of new breeding species for the installation or new scarce nocturnal migrants like Common Nighthawk (*Chordeiles minor*).

Bird inventories conducted on a regular interval, e.g. every 5 years, using standardized methods, would provide the opportunity to monitor for future changes in the bird community such as the decline of sensitive species or the addition of new invasive species.

Bird surveys targeting habitats that attract migrants and that are more amenable to less desert-adapted breeding species, such as the watered cantonment areas and the sewage treatment lagoons, would likely reveal many new species that use YPG but have not yet been documented in the inventories.

Surveys targeting sensitive breeding species specifically, such as Gilded Flicker, Loggerhead Shrike, and Bendire's Thrasher, could provide more information about the precise distribution of these species on the installation and help reduce the risk of conflict between training exercises or infrastructure development and species that might become federally listed in the future.

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Appendix 1: Additional species observed incidentally on Yuma Proving Ground by the first author but not as part of these point-transect surveys. Most of the waterfowl and shorebirds were observed at the sewage treatment lagoons in or near the cantonment areas. "SGCN Tier" indicates Arizona Species of Greatest Conservation Need (Arizona Game and Fish Department 2022). Asterisks indicate species we observed breeding or consider likely to breed on YPG.

Common Name	Scientific Name	SGCN Tier
Blue-winged Teal	<i>Spatula discors</i>	
Cinnamon Teal	<i>Spatula cyanoptera</i>	
Northern Shoveler	<i>Spatula clypeata</i>	
Gadwall	<i>Mareca strepera</i>	
Mallard	<i>Anas platyrhynchos</i>	
Mexican Duck	<i>Anas diazi</i>	
Northern Pintail	<i>Anas acuta</i>	
Green-winged Teal	<i>Anas crecca</i>	
Redhead	<i>Aythya americana</i>	
Ring-necked Duck	<i>Aythya collaris</i>	
Lesser Scaup	<i>Aythya affinis</i>	
Bufflehead	<i>Bucephala albeola</i>	
Common Goldeneye	<i>Bucephala clangula</i>	
Ruddy Duck	<i>Oxyura jamaicensis</i>	
Common Poorwill*	<i>Phalaenoptilus nuttallii</i>	
Rufous Hummingbird	<i>Selasphorus rufus</i>	
American Coot	<i>Fulica americana</i>	
Black-necked Stilt	<i>Himantopus mexicanus</i>	
American Avocet	<i>Recurvirostra americana</i>	
Killdeer*	<i>Charadrius vociferus</i>	2
Snowy Plover	<i>Anarhynchus nivosus</i>	2
Long-billed Dowitcher	<i>Limnodromus scolopaceus</i>	
Wilson's Snipe	<i>Gallinago delicata</i>	
Red-necked Phalarope	<i>Phalaropus lobatus</i>	
Spotted Sandpiper	<i>Actitis macularius</i>	3
Greater Yellowlegs	<i>Tringa melanoleuca</i>	
Dunlin	<i>Calidris alpina</i>	

Common Name	Scientific Name	SGCN Tier
Least Sandpiper	<i>Calidris minutilla</i>	
Eared Grebe	<i>Podiceps nigricollis</i>	3
Osprey	<i>Pandion haliaetus</i>	
Northern Harrier	<i>Circus hudsonius</i>	2
Ferruginous Hawk	<i>Buteo regalis</i>	2
Western Screech-Owl*	<i>Megascops kennicottii</i>	2
Peregrine Falcon	<i>Falco peregrinus</i>	1
Vermilion Flycatcher*	<i>Pyrocephalus rubinus</i>	
Marsh Wren	<i>Cistothorus palustris</i>	
Mountain Bluebird	<i>Sialia currucoides</i>	3

Appendix 2: Cumulative list of bird species detected on Yuma Proving Ground, in taxonomic order. Names have been updated to current taxonomy. List excludes three species that have been reported from Yuma Proving Ground, but which we consider to have been misidentifications: Bushtit (*Psaltriparus minimus*), Rufous-winged Sparrow (*Peucaea carpalis*), and Boat-tailed Grackle (*Quiscalus major*). Asterisk indicates a species added to the list based on unpublished data shared with the authors by Tracy McCarthey and Chris McCreedy. Birds that are listed but without a cited source in the table were added to the cumulative list on the basis of data submitted to eBird.org, except for Elf Owl, which is based on Rosenberg et al. (1991), and Lawrence's Goldfinch, Golden-crowned Kinglet, and Red-breasted Nuthatch, based on Spitler (1976).

Common Name	Scientific Name	This report	Ough and deVos 1986	deVos and Ough 1986	Rosenstock and Yarborough 2012	Clark and Ingraldi "2018" (2019)
Blue-winged Teal	<i>Spatula discors</i>	X				X
Cinnamon Teal	<i>Spatula cyanoptera</i>	X				
Northern Shoveler	<i>Spatula clypeata</i>	X				X
Gadwall	<i>Mareca strepera</i>	X				X
American Wigeon	<i>Mareca americana</i>					X
Mallard	<i>Anas platyrhynchos</i>	X				
Mexican Duck	<i>Anas diazi</i>	X				
Northern Pintail	<i>Anas acuta</i>	X				
Green-winged Teal	<i>Anas crecca</i>	X				X
Redhead	<i>Aythya americana</i>	X				X
Ring-necked Duck	<i>Aythya collaris</i>	X				X
Lesser Scaup	<i>Aythya affinis</i>	X				
Bufflehead	<i>Bucephala albeola</i>	X				
Common Goldeneye	<i>Bucephala clangula</i>	X				
Ruddy Duck	<i>Oxyura jamaicensis</i>	X				X
Gambel's Quail	<i>Callipepla gambelii</i>	X	X	X	X	
Eurasian Collared-Dove	<i>Streptopelia decaocto</i>	X				X
Inca Dove	<i>Columbina inca</i>					
Common Ground Dove	<i>Columbina passerina</i>	X				
White-winged Dove	<i>Zenaida asiatica</i>	X	X	X	X	
Mourning Dove	<i>Zenaida macroura</i>	X	X	X	X	X
Greater Roadrunner	<i>Geococcyx californicus</i>	X	X		X	
Lesser Nighthawk	<i>Chordeiles acutipennis</i>	X	X	X		X
Common Poorwill	<i>Phalaenoptilus nuttallii</i>	X	X		X	X
Vaux's Swift	<i>Chaetura vauxi</i>	X				
White-throated Swift	<i>Aeronautes saxatalis</i>	X		X		
Black-chinned Hummingbird	<i>Archilochus alexandri</i>	X			X	
Anna's Hummingbird	<i>Calypte anna</i>	X				X
Costa's Hummingbird	<i>Calypte costae</i>	X	X	X		
Rufous Hummingbird	<i>Selasphorus rufus</i>	X				
Common Gallinule	<i>Gallinula galeata</i>					

Common Name	Scientific Name	This report	Ough and deVos 1986	deVos and Ough 1986	Rosenstock and Yarborough 2012	Clark and Ingraldi "2018" (2019)
American Coot	<i>Fulica americana</i>	X				X
Black-necked Stilt	<i>Himantopus mexicanus</i>	X				X
American Avocet	<i>Recurvirostra americana</i>	X				X
Killdeer	<i>Charadrius vociferus</i>	X		X		X
Snowy Plover	<i>Anarhynchus nivosus</i>	X				
Long-billed Curlew	<i>Numenius americanus</i>					
Long-billed Dowitcher	<i>Limnodromus scolopaceus</i>	X				X
Wilson's Snipe	<i>Gallinago delicata</i>	X				
Wilson's Phalarope	<i>Phalaropus tricolor</i>					X
Red-necked Phalarope	<i>Phalaropus lobatus</i>	X				
Spotted Sandpiper	<i>Actitis macularius</i>	X				X
Greater Yellowlegs	<i>Tringa melanoleuca</i>	X				X
Dunlin	<i>Calidris alpina</i>	X				
Least Sandpiper	<i>Calidris minutilla</i>	X				
Heermann's Gull	<i>Larus heermanni</i>					X
Eared Grebe	<i>Podiceps nigricollis</i>	X				X
Western Grebe	<i>Aechmophorus occidentalis</i>	X				
White-faced Ibis	<i>Plegadis chihi</i>					X
Least Bittern	<i>Botaurus exilis</i>					X
Western Cattle-Egret	<i>Ardea ibis</i>					
Turkey Vulture	<i>Cathartes aura</i>	X	X		X	X
Osprey	<i>Pandion haliaetus</i>	X	X			
Golden Eagle	<i>Aquila chrysaetos</i>				X	
Sharp-shinned Hawk	<i>Accipiter striatus</i>	X	X	X		
Cooper's Hawk	<i>Astur cooperii</i>	X				
Northern Harrier	<i>Circus hudsonius</i>	X				
Red-tailed Hawk	<i>Buteo jamaicensis</i>	X	X	X	X	X
Ferruginous Hawk	<i>Buteo regalis</i>	X				
Western Screech-Owl	<i>Megascops kennicottii</i>	X	X			
Great Horned Owl	<i>Bubo virginianus</i>	X	X	X	X	
Elf Owl	<i>Micrathene whitneyi</i>					
Burrowing Owl	<i>Athene cunicularia</i>	X				
Long-eared Owl	<i>Asio otus</i>	*				
Gila Woodpecker	<i>Melanerpes uropygialis</i>	X	X	X	X	X
Ladder-backed Woodpecker	<i>Dryobates scalaris</i>	X	X	X		
Northern Flicker	<i>Colaptes auratus</i>	X	X	X		
Gilded Flicker	<i>Colaptes chrysoides</i>	X				
American Kestrel	<i>Falco sparverius</i>	X	X	X	X	X

Common Name	Scientific Name	This report	Ough and deVos 1986	deVos and Ough 1986	Rosenstock and Yarborough 2012	Clark and Ingraldi "2018" (2019)
Peregrine Falcon	<i>Falco peregrinus</i>	X				
Prairie Falcon	<i>Falco mexicanus</i>		X	X	X	
Olive-sided Flycatcher	<i>Contopus cooperi</i>	X				
Western Wood-Pewee	<i>Contopus sordidulus</i>	X		X		
Hammond's Flycatcher	<i>Empidonax hammondii</i>		X	X		
Gray Flycatcher	<i>Empidonax wrightii</i>	X			X	
Dusky Flycatcher	<i>Empidonax oberholseri</i>			X		
Western Flycatcher	<i>Empidonax difficilis</i>	X			X	
Black Phoebe	<i>Sayornis nigricans</i>			X		
Say's Phoebe	<i>Sayornis saya</i>	X	X	X		X
Vermilion Flycatcher	<i>Pyrocephalus rubinus</i>	X				
Ash-throated Flycatcher	<i>Myiarchus cinerascens</i>	X	X	X	X	
Western Kingbird	<i>Tyrannus verticalis</i>	X		X		X
Bell's Vireo	<i>Vireo bellii</i>	X	X	X		
Gray Vireo	<i>Vireo vicinior</i>	X				
Plumbeous Vireo	<i>Vireo plumbeus</i>	X				
Warbling Vireo	<i>Vireo gilvus</i>	X				
Loggerhead Shrike	<i>Lanius ludovicianus</i>	X	X	X		X
Common Raven	<i>Corvus corax</i>	X	X		X	X
Verdin	<i>Auriparus flaviceps</i>	X	X	X	X	X
Horned Lark	<i>Eremophila alpestris</i>	X	X	X	X	
Tree Swallow	<i>Tachycineta bicolor</i>	X	X	X		X
Violet-green Swallow	<i>Tachycineta thalassina</i>	X		X	X	X
Purple Martin	<i>Progne subis</i>			X		
Northern Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>	X		X	X	
Barn Swallow	<i>Hirundo rustica</i>	X		X		X
Cliff Swallow	<i>Petrochelidon pyrrhonota</i>	X				
Ruby-crowned Kinglet	<i>Corthylio calendula</i>	X	X	X	X	
Golden-crowned Kinglet	<i>Regulus satrapa</i>					
Red-breasted Nuthatch	<i>Sitta canadensis</i>					
Blue-gray Gnatcatcher	<i>Polioptila caerulea</i>	X				
Black-tailed Gnatcatcher	<i>Polioptila melanura</i>	X	X	X	X	X
Rock Wren	<i>Salpinctes obsoletus</i>	X	X	X		X
Canyon Wren	<i>Catherpes mexicanus</i>	X	X	X		
House Wren	<i>Troglodytes aedon</i>	X		X		
Marsh Wren	<i>Cistothorus palustris</i>	X				
Bewick's Wren	<i>Thryomanes bewickii</i>	X		X		

Common Name	Scientific Name	This report	Ough and deVos 1986	deVos and Ough 1986	Rosenstock and Yarborough 2012	Clark and Ingraldi "2018" (2019)
Cactus Wren	<i>Campylorhynchus brunneicapillus</i>	X	X	X	X	
European Starling	<i>Sturnus vulgaris</i>	X	X	X		X
Curve-billed Thrasher	<i>Toxostoma curvirostre</i>	X		X		
Bendire's Thrasher	<i>Toxostoma bendirei</i>	X	X	X	X	
LeConte's Thrasher	<i>Toxostoma lecontei</i>	X	X	X		
Crissal Thrasher	<i>Toxostoma crissale</i>	X	X	X	X	
Sage Thrasher	<i>Oreoscoptes montanus</i>		X	X		X
Northern Mockingbird	<i>Mimus polyglottos</i>	X	X	X	X	
Western Bluebird	<i>Sialia mexicana</i>					X
Mountain Bluebird	<i>Sialia currucoides</i>	X				
Varied Thrush	<i>Ixoreus naevius</i>					
American Robin	<i>Turdus migratorius</i>			X		
Phainopepla	<i>Phainopepla nitens</i>	X	X	X	X	X
House Sparrow	<i>Passer domesticus</i>					X
American Pipit	<i>Anthus rubescens</i>	X				X
House Finch	<i>Haemorhous mexicanus</i>	X	X	X	X	X
Pine Siskin	<i>Spinus pinus</i>	X				
Lesser Goldfinch	<i>Spinus psaltria</i>	X	X	X	X	X
Lawrence's Goldfinch	<i>Spinus lawrencei</i>					
Chipping Sparrow	<i>Spizella passerina</i>	X		X		
Black-chinned Sparrow	<i>Spizella atrogularis</i>	X	X			
Brewer's Sparrow	<i>Spizella breweri</i>	X	X	X	X	
Black-throated Sparrow	<i>Amphispiza bilineata</i>	X	X	X	X	
Lark Sparrow	<i>Chondestes grammacus</i>	X		X		
Lark Bunting	<i>Calamospiza melanocorys</i>					
Dark-eyed Junco	<i>Junco hyemalis</i>	X	X	X		
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>	X	X	X	X	
Sagebrush Sparrow	<i>Artemisiospiza nevadensis</i>	X	X	X		
Vesper Sparrow	<i>Poocetes gramineus</i>	X		X		
Song Sparrow	<i>Melospiza melodia</i>			X		
Lincoln's Sparrow	<i>Melospiza lincolni</i>	X		X		
Abert's Towhee	<i>Melozona aberti</i>	X		X	X	
Green-tailed Towhee	<i>Pipilo chlorurus</i>	X		X	X	
Spotted Towhee	<i>Pipilo maculatus</i>			X		
Yellow-headed Blackbird	<i>Xanthocephalus xanthocephalus</i>	X		X		
Western Meadowlark	<i>Sturnella neglecta</i>	X	X	X		
Hooded Oriole	<i>Icterus cucullatus</i>		X	X		

Common Name	Scientific Name	This report	Ough and deVos 1986	deVos and Ough 1986	Rosenstock and Yarborough 2012	Clark and Ingraldi "2018" (2019)
Bullock's Oriole	<i>Icterus bullockii</i>	X		X		
Scott's Oriole	<i>Icterus parisorum</i>			X		
Red-winged Blackbird	<i>Agelaius phoeniceus</i>	X		X		
Bronzed Cowbird	<i>Molothrus aeneus</i>			X		
Brown-headed Cowbird	<i>Molothrus ater</i>	X	X			
Great-tailed Grackle	<i>Quiscalus mexicanus</i>	X			X	X
Orange-crowned Warbler	<i>Leiothlypis celata</i>	X			X	
Lucy's Warbler	<i>Leiothlypis luciae</i>	X				
Nashville Warbler	<i>Leiothlypis ruficapilla</i>				X	
MacGillivray's Warbler	<i>Geothlypis tolmiei</i>			X		
Common Yellowthroat	<i>Geothlypis trichas</i>	X		X		
Yellow Warbler	<i>Setophaga petechia</i>	X		X		
Yellow-rumped Warbler	<i>Setophaga coronata</i>	X	X	X	X	
Black-throated Gray Warbler	<i>Setophaga nigrescens</i>	X		X		
Townsend's Warbler	<i>Setophaga townsendi</i>	X		X		
Hermit Warbler	<i>Setophaga occidentalis</i>	X				
Wilson's Warbler	<i>Cardellina pusilla</i>	X	X	X	X	
Summer Tanager	<i>Piranga rubra</i>	X				
Western Tanager	<i>Piranga ludoviciana</i>	X	X	X	X	
Black-headed Grosbeak	<i>Pheucticus melanocephalus</i>	X		X		
Lazuli Bunting	<i>Passerina amoena</i>	X		X		

LITERATURE CITED

- [AZGFD] Arizona Game and Fish Department. 2022. Arizona wildlife conservation strategy: 2022-2032. Arizona Game and Fish Department, Phoenix, AZ. 378 pp.
- Arnett-Romero, S. L., R. P. O'Donnell, and M. F. Ingraldi. 2021. Long term wildlife trends on the Yuma Proving Ground, Arizona: 2020 annual report. Arizona Game and Fish Department, Phoenix, AZ. 82 pp.
- Blackman, S. T., and J. Diamond. 2015. Meta-population dynamics of Le Conte's Thrasher (*Toxostoma lecontei*): A species at risk on three southwestern military installations. Year 3. Arizona Game and Fish Department, Phoenix, AZ. 28 pp.
- Chao, A., N. J. Gotelli, T. C. Hsieh, E. L. Sander, K. H. Ma, R. K. Colwell, and A. M. Ellison. 2014. Rarefaction and extrapolation with Hill numbers: a framework for sampling and estimation in species diversity studies. *Ecological Monographs* 84:45-67.
- Chao, A., K. H. Ma, and T. C. Hsieh. 2016. iNEXT Online: Software for interpolation and extrapolation of species diversity. Available: <https://chao.shinyapps.io/iNEXTOnline/>.
- Clark, N. D., and M. F. Ingraldi. "2018" (2019). Wildlife Aircraft Strike Hazard (WASH) Assessment 2017-2018 for Yuma Proving Ground Laguna Army Airfield in Yuma, Arizona. Arizona Game and Fish Department, Phoenix, AZ. 70 pp.
- Clark, N. D., and M. F. Ingraldi. 2019. LeConte's Thrasher Surveys during 2019 at Yuma Proving Ground in Yuma, Arizona. Arizona Game and Fish Department, Phoenix, AZ. 17 pp.
- Clavero, M., and E. García-Berthou. 2005. Invasive species are a leading cause of animal extinctions. *Trends in Ecology and Evolution* 20:110.
- Corman, T. E. 2005. Eurasian Collared-Dove. Pp 188-189 in Corman, T. E., and C. Wise-Gervais, eds. 2005. Arizona breeding bird atlas. Univ. of New Mexico Press, Albuquerque, NM.
- Corman, T. E., and C. Wise-Gervais, eds. 2005. Arizona breeding bird atlas. Univ. of New Mexico Press, Albuquerque.
- Diamond, J. M., E. Scobie, M. D. Piorkowski, D. P. Sturla, and M. F. Ingraldi. 2016. Status and distribution modeling of Golden Eagles on southwestern military installations and overflight areas: Assessing "take" for this sensitive species at risk - year 3. Final report, Legacy 15-631. Arizona Game and Fish Department, Phoenix, AZ. 28 pp.
- [DDPF] Department of Defense Partners in Flight. 2021. Mission-sensitive species: Those with the highest potential to impact DoD missions if federally listed under ESA. 2 pp.
- deVos, J. C., and W. D. Ough. 1986. Yuma Proving Grounds East wildlife inventory. Special Services Division, Arizona Game and Fish Department, Phoenix, AZ. 192 pp.
- Don, R., M. Ingraldi, N. Clark, and H. Nelson. 2023. Raptor inventory surveys during 2021-2022 at Yuma Proving Ground in Yuma, Arizona. Arizona Game and Fish Department, Phoenix, AZ. 19 pp.
- Esque, T. C., R. H. Webb, C. S. A. Wallace, C. Van Riper, C. McCreedy, and L. Smythe. 2013. Desert fires fueled by native annual forbs: Effects of fire on communities of plants and birds in the Lower Sonoran Desert of Arizona. *The Southwestern Naturalist* 58:223-233.
- Fischer, R. A., M. P. Guilfoyle, J. Valente, S. A. Gauthreaux Jr., C. G. Belser, D. V. Blaricom, J. W. Livingston, E. Cohen, and F. R. Moore. 2012. The identification of military installations as important migratory bird stopover sites and the development of bird migration forecast models: A radar ornithology approach. US Army Corps of Engineers, Engineer Research and Development Center. 151 pp.
- Iknayan, K. J., and S. R. Beissinger. 2018. Collapse of a desert bird community over the past century driven by climate change. *Proceedings of the National Academy of Sciences* 115:8597-8602.
- Ingraldi, M. F., and S. M. Cobbold. 2022. Assessment of vertebrate Tier 1A and 1B species presence and vegetation classification of the requested Highway 95 BLM withdrawal for the U.S. Army, Yuma Proving Ground, Yuma and La Paz counties, Arizona: Final report. Arizona Game and Fish Department, Phoenix, AZ. 59 pp.
- Kaya Associates, Inc. 2010. Yuma Proving Ground Vegetation Classification Geographic Information System (GIS): Draft Report. Kaya Associates, Inc, Huntsville, AL. 48 pp.
- Leu, M. and S. Knick. 2006. Wintering ecology of shrubland birds: Linking landscape and habitat: Annual progress report. US Geological Survey, Biological Resources Division. 34 pp.
- Lynn, J. C., C. C. Chambers, and S. S. Rosenstock. 2006. Use of wildlife water developments by birds in southwest Arizona during migration. *Wildlife Society Bulletin* 34:592-601.

- Margalef, R. 1958. Information theory in ecology. *General Systems* 3:36-71.
- Malusa, J. 2009. Vegetation mapping at the Barry M. Goldwater Range, Marine Corps Air Station, Arizona. School of Natural Resources, University of Arizona. Unpublished report.
- McCreedy, C. 2011. Birds of Sonoran desert xeric thorn woodlands: Patterns of bird species composition, richness, abundance, and nest survivorship 2003-2010. PRBO Contribution No. 1861, PRBO Conservation Science, Petaluma, CA. 112 pp.
- [NOAA] National Oceanic and Atmospheric Administration. 2023. National Weather Service website, <https://www.weather.gov/wrh/Climate?wfo=psr>, accessed Nov 10, 2023.
- O'Brien, C. S., R. B. Waddell, S. S. Rosenstock, and M. J. Rabe. 2006. Wildlife use of water catchments in southwestern Arizona. *Wildlife Society Bulletin* 34:582-591.
- Ough, W. D., and J. C. deVos. 1986. North Cibola Range wildlife inventory. Funds Coordination Branch, Arizona Game and Fish Department, Phoenix, AZ. 355 pp.
- Rosenberg, K. V., R. D. Ohmart, W. C. Hunter, and B. W. Anderson. 1991. *Birds of the Lower Colorado River Valley*. Univ. of Arizona Press, Tucson, AZ.
- Rosenstock, S. S., and R. F. Yarborough. 2012. Yuma Proving Ground wildlife studies: Final report. Arizona Game and Fish Department, Phoenix, AZ. 28 pp.
- Rozanski, C. A., S. Arnett-Romero, R. P. O'Donnell, and M. Ingraldi. 2024. Long-term wildlife trends: Small mammal and mammalian predator inventory at the U.S. Army Garrison Yuma Proving Grounds. Arizona Game and Fish Department, Wildlife Contracts Branch, Phoenix, AZ, USA. 24 pp.
- Shannon, C. E., and W. Weaver. 1963. *The mathematical theory of communication*. University of Illinois Press, IL.
- Simpson, E. H. 1949. Measurement of diversity. *Nature* 163:688.
- Spitler, S. S. 1976. Four "unusuals." *North American Bird Bander* 1:176.
- Steward, D. and R. Packard. 2019. eBird Checklist: <https://ebird.org/ebird/view/checklist/S62372941>. eBird: An online database of bird distribution and abundance [web application]. eBird, Ithaca, NY. Available: <http://www.ebird.org>. Accessed 11 Apr 2025.
- Sullivan, B. L., C. L. Wood, M. J. Iliff, R. E. Bonney, D. Fink, and S. Kelling. 2009. eBird: A citizen-based bird observation network in the biological sciences. *Biological Conservation* 142: 2282-2292.
- U.S. Fish and Wildlife Service. 2021. *Birds of conservation concern 2021*. United States Department of the Interior, U.S. Fish and Wildlife Service, Migratory Birds, Falls Church, VA. 47 pp.
- Vander Pluym, D., and L. Harter. 2010. eBird Checklist: <https://ebird.org/ebird/view/checklist/S7352575>. eBird: An online database of bird distribution and abundance [web application]. eBird, Ithaca, NY. Available: <http://www.ebird.org>. Accessed 11 Apr 2025.
- Walchak, F. 2006. eBird Checklist: <https://ebird.org/ebird/view/checklist/S2094319>. eBird: An online database of bird distribution and abundance [web application]. eBird, Ithaca, NY. Available: <http://www.ebird.org>. Accessed 11 Apr 2025.
- Wise-Gervais, C. 2005. Great-tailed Grackle. Pp 562-563 in Corman, T. E., and C. Wise-Gervais, eds. 2005. *Arizona Breeding Bird Atlas*. Univ. of New Mexico Press, Albuquerque, NM.