

2018-01-01

Birds and Vegetation Structure of Isolated Juniper and Oak Communities in the Trans-Pecos Chihuahuan Desert.

Kayla Garza

University of Texas at El Paso, kaylagarza517@gmail.com

Follow this and additional works at: https://digitalcommons.utep.edu/open_etd



Part of the [Biology Commons](#), [Botany Commons](#), and the [Zoology Commons](#)

Recommended Citation

Garza, Kayla, "Birds and Vegetation Structure of Isolated Juniper and Oak Communities in the Trans-Pecos Chihuahuan Desert."
(2018). *Open Access Theses & Dissertations*. 1437.
https://digitalcommons.utep.edu/open_etd/1437

This is brought to you for free and open access by DigitalCommons@UTEP. It has been accepted for inclusion in Open Access Theses & Dissertations by an authorized administrator of DigitalCommons@UTEP. For more information, please contact lweber@utep.edu.

BIRDS AND VEGETATION STRUCTURE OF ISOLATED JUNIPER AND
OAK COMMUNITIES IN THE TRANS-PECOS
CHIHUAHUAN DESERT.

KAYLA ROCHELLE GARZA
Master's Program in Biological Sciences

APPROVED:

Jerry D. Johnson, Ph.D., Chair

Carl S. Lieb, Ph.D.

Hugo A. Gutierrez, Ph.D.

Charles Ambler, Ph.D.
Dean of the Graduate School

Copyright ©

by

Kayla R. Garza

2018

Dedication

I dedicate this thesis to my brother, John A. Perrotto Jr. and my grandfather, Anthony J. Perrotto, who both taught me discipline and personal responsibility. I'd especially like to dedicate it to my husband, Nathan T. Garza, and all of our animals, for being loving and supportive in this existence.

BIRDS AND VEGETATION STRUCTURE OF ISOLATED JUNIPER AND
OAK COMMUNITIES IN THE TRANS-PECOS
CHIHUAHUAN DESERT.

By

KAYLA ROCHELLE GARZA, B.Sc.

THESIS

Presented to the Faculty of the Graduate School

The University of Texas at El Paso

in Partial Fulfillment

of the Requirements

for the Degree of

MASTER OF SCIENCE

Department of Biological Sciences

THE UNIVERSITY OF TEXAS AT EL PASO

May 2018

Acknowledgements

I'd like to acknowledge Dr. Jerry D. Johnson for mentoring me from undergraduate to graduate student, and providing nothing but unwavering support throughout the way, both with encouragement and access to his wealth of knowledge as a naturalist. I also acknowledge Dr. Vicente Mata-Silva, who has also been an excellent mentor and inspiration to all of us research students working at Indio Mountains Research Station. Thanks to Dr. Lieb for sitting on my committee, and providing valuable insight in traditional field work, writing skills, and geography. Thanks to Dr. Hugo A. Gutierrez for his willingness to sit on my committee as an outside department member and talk to me about my project ideas and the future work possible. Finally, thanks to Dr. Worthington for his enthusiasm in helping me identify unknown plants and for cataloging the Osler's Oakworm moths found on the research station within my sites.

Abstract

Birds of the Trans-Pecos region are historically understudied, with most literature covering birds of desert grasslands and scrub in New Mexico and Northern Mexico. A multitude of vegetation communities within the Chihuahuan Desert have also been neglected due to this gap in the research, for reasons including lack of access to public or preserve land in West Texas, and rough terrain. Indio Mountains Research Station (IMRS), is located 42-km southwest of Van Horn, Texas and encompasses many different vegetation communities, including juniper-oak habitats of arroyo and canyon systems. The purpose of this study was to document the bird species utilizing these isolated areas, record mating and nesting in the summer, especially if using the oak or juniper as nest plants, get a snapshot of migrating, wintering, and summer breeding bird arrival and departure dates, and better characterize the vegetation communities. We hypothesized that habitats containing both juniper and oak species would contain more bird species richness and diversity than other oak, juniper or thorn-scrub communities. Plant surveys were conducted to calculate shrub and tree percent occurrences, and to document the presence-absence of flower-herbs, cacti, grasses, ferns, spike-mosses, agaves, and vines. Bird surveys were conducted from June 2016 to December 2017 in 4 randomly rotated sites containing these different vegetation communities from 0600-0900 for 30 minutes bi-weekly. Bird species, relative abundance, mating and nesting incidents, nest plants, photographs of nests were collected, and species richness data analyzed for differences in season and bird range category (summer breeding, migrating, wintering, year-round) between each site. Plant surveys indicated that the oak and juniper sites contained large percentages of *Parthenium incanum*, *Viguiera stenoloba*, *Tequiliala greggii* or *Acacia constricta* shrubs, and large percentages of *Quercus pungens*, *Juniperus coahuilensis*, or small *Forestiera pubescens* trees. The data from the juniper

and oak communities, including the flower/herb species found, indicated that these vegetation communities could be classified as Madrean Oriental Chaparral and Apacherian-Chihuahuan Mesquite Upland Scrub of the general shrubland ecosystem. We found 64 bird species total, and analysis indicated there were no significant differences in bird species richness by site overall ($p > 0.50$), in any season ($p = 0.27$), or by bird range category ($p = 0.43$), however, we did document several migrating, wintering, and summer breeding birds using the oak and juniper sites that were not documented using the desert thorn-scrub community. The juniper-oak community contained the most avian diversity and the thorn-scrub community had the least. We also documented *Zenaida macroura* using only *Quercus pungens* as a nest plant, with evidence of use in prior years, and *Archilochus alexandri* using *Juniperus coahuilensis*, both species not documented doing so in the past. Two winter range birds, *Zonotrichia albicollis* and *Pipilo chlorurus*, were found occupying the sites year-round, and *Micrathene whitneyi* was documented in pairs and groups of 3 using the juniper habitat in the summer and fall of 2016 and 2017, an owl that is not shown to have a range in far west Texas, but of which there is growing evidence for across all of the Trans-Pecos region. *Chordeiles minor* was also documented using an oak-juniper arroyo system, and no other habitat, in high relative abundance for one summer, an observation that warrants further research in habitat preference for mating and breeding in the Trans-Pecos region, and the trends in abiotic conditions determining these patterns of use. Comparison to the previous bird study on IMRS of the cattle tanks and permanent spring yielded many similarities in year-round birds, but major differences in species of more riparian oriented birds and rare migrants, as expected. This study provided a better understanding of the life history of several bird species, a clearer understanding of the plant species present in the habitats,

potential updates to the range maps for particular birds, and an even better understanding of how birds use post-grazed ranchlands in the region.

Table of Contents

Acknowledgements	v
Abstract.....	vi
Table of Contents	ix
List of Tables	x
List of Figures	xii
Introduction.....	1
Materials and Methods.....	14
Results.....	26
Discussion.....	54
References.....	71
Appendix 1.....	89
Appendix 2.....	92
Appendix 3.....	103
Appendix 4.....	118
Vita.	120

List of Tables

Table 1: Species of plants found in Oak-Juniper Arroyo, Juniper Grove, Montane Oak Wash, and Thorn-Scrub Arroyo indicating presence-absence.....	34
Table 2: A list of birds found in each site, where S = Species Richness overall and by site, and the Pearson's χ^2 test ($\alpha = 0.05$) for June 2016-December 2017.....	40
Table 3: S per site per season surveyed and contingency table depicting χ^2 test for Independence ($\alpha = 0.05$).....	42
Table 4: S per site per bird category and contingency table depicting χ^2 test for Independence ($\alpha = 0.05$).....	42
Table 5: Shannon's and Simpson's diversity indices by site, including S, total number of organisms, and average population size per site.....	42
Table 6: Nesting occurrences by species, date, location, and other notes in the sites containing juniper and/or oak trees.....	46

Table 7: Species documented mating by date, and location in sites containing juniper and/or oak tree.....	46
Table 8. Migrating birds and their first arrival and departure dates documented during the study for fall 2016-winter 2017.....	48
Table 9: Summer breeding bird arrival and departure dates documented during the study for 2017.....	50
Table 10: Winter non-breeding birds and their first arrival and departure dates documented during the study for 2016-2017 (* indicates birds outside of their seasonal range).....	51

List of Figures

Figure 1: Chihuahuan Desert Map (Schmidt, 1989).....	2
Figure 2: The Rocky Mountain Bird Observatory Map Query for Bird Conservation Regions showing public and government land in a variety of ecoregions with far west Texas lacking access for biotic research (Rocky Mountain Avian Data Center, 2017).....	5
Figure 3: Map depicting avian community studies conducted in the Chihuahuan Desert and published in the scientific literature (Google Earth, 2017a).....	6
Figure 4: Range map (Farjon and Filer, 2013) and photograph (Licher, 2017) of <i>Juniperus arizonica</i>	8
Figure 5: Range map (Farjon and Filer, 2013) and photograph (Gymnosperm Database, 2017a) of <i>Juniperus pinchotii</i>	8
Figure 6: Range map (Farjon and Filer, 2013) and photograph (Gymnosperm Database, 2017b) of <i>Juniperus coahuilensis</i>	9
Figure 7: Range map (Farjon and Filer, 2013) and photograph (Native Plant Society of Texas, 2005) of <i>Juniperus monosperma</i>	9

Figure 8: Range map (Spellenberg et al., 2014) and photograph (Stephen F. Austin State University, 2017) of <i>Quercus pungens</i> populations.....	10
Figure 9: Range map (Spellenberg et al., 2014) and photograph (University of Texas at Austin, 2006) of <i>Quercus vaseyana</i> populations.....	10
Figure 10: Map depicting the location of IMRS in southeastern Hudspeth County, Texas in the northern Chihuahuan Desert. Elevation: 1233 m centered on coordinates: 30°46'37.30"N 105° 0'58.27"W . (Google Earth, 2017b)	15
Figure 11: Landscape photo of IMRS headquarters, mountain-basin topography, and vegetation structure.....	16
Figure 12: Topographic map of IMRS depicting Ranch House location, roads, landmarks, property lines, and study sites (1. Black = Oak-Juniper Arroyo; 2. Blue = Juniper Grove; 3. Red = Montane Oak Wash; 4. Orange = Thorn-scrub Arroyo).....	17
Figure 13: Photograph and map depicting Oak-Juniper Arroyo (Site 1). Elevation: 1332 m. Coordinates: 30°46'59.89"N 104°58'49.73"W (Google Earth, 2017d).....	18
Figure 14: Photo and map depicting Juniper Grove habitat (Site 2) at the intersection of two washes (Google Earth, 2017e). Elevation: 1319 m. Coordinates: 30°47'44.03"N 104°59'37.00"W.....	1F

Figure 15: Photograph and map depicting Montane Oak Wash (Site 3) in a rocky limestone canyon wash (Google Earth, 2017f). Elevation: 1358 m. Coordinates: 30°47'7.86"N 104°59'19.81"W.....19

Figure 16: Photograph and map depicting Thorn-Scrub Arroyo (Site 4) (Google Earth, 2017g). Elevation: 1228 m. Coordinates: 30°46'12.11"N 105° 0'39.96"W.....19

Figure 17. Figure 20. Plant survey transect in Thorn-scrub Arroyo (Begin Coordinates: 30°46'12.96"N, 105°00'33.23"W. End Coordinates: 30°46'12.20"N, 105°00'35.69"W. Distance: 60m).....20

Figure 18. Plant survey transect in Juniper Grove (Begin Coordinates: 30°47'43.93"N, 104°59'37.57"W. End Coordinates: 30°47'45.71"N, 104°59'38.39"W. Distance: 60m).....21

Figure 19. Plant survey transect in Montane Oak Wash (Begin Coordinates: 30°47'06.99"N, 104°59'21.12"W. End Coordinates: 30°47'08.26"N, 104°59'18.97"W. Distance: 60m).....21

Figure 20. Plant survey transect in Thorn-scrub Arroyo (Begin Coordinates: 30°46'12.96"N, 105°00'33.23"W. End Coordinates: 30°46'12.20"N, 105°00'35.69"W. Distance: 60m).....22

Figure 21: Time-Species Curve indicating 30-40 minutes is the point at which the average number of species recorded levels out during avian site survey at the sites on IMRS.....	24
Figure 22: Pie chart depicting percent occurrences of shrub and tree species in Oak-Juniper Arroyo.....	38
Figure 23: Pie chart depicting percent occurrence of shrub and tree species at Juniper Grove.	38
Figure 24: Pie chart depicting percent occurrence of shrub and tree species at Montane Oak Wash.....	39
Figure 25: Pie chart depicting percent occurrence of shrub and tree species at Thorn-Scrub Arroyo.....	39
Figure 26: An abandoned <i>Z. macroura</i> nest in a <i>Q. pungens</i> tree within Oak-Juniper Arroyo during the summer of 2017.....	43
Figure 27: Two <i>Z. macroura</i> eggs in a <i>Q. pungens</i> tree within Oak-Juniper Arroyo during the summer of 2016.....	43
Figure 28: Two <i>Z. macroura</i> nestlings in a <i>Q. pungens</i> tree within Oak-Juniper Arroyo in summer of 2016.....	44

Figure 29: <i>A. alexandri</i> nesting in a <i>J. coahuilensis</i> tree within Oak-Juniper Arroyo during the summer of 2017.....	44
Figure 30: <i>P. caerulea</i> nest in a <i>Q. pungens</i> tree within the Oak Wash during the summer of 2017.....	45
Figure 31: An abandoned <i>A. flavescens</i> nest in a <i>F. pubescens</i> tree found in the Oak-Juniper Arroyo during the winter of 2016.....	45
Figure 32: Migrating birds FADs documented during the study for 2016- 2017 (Macaulay Library, 2018 ¹⁻¹³).....	48
Figure 33: Summer breeding birds and their FADs documented during the study for 2017 (Macaulay Library, 2018 ¹⁻¹²).....	50
Figure 34: Winter non-breeding birds and their FADs documented during the study for 2016-2017 (Macaulay Library, 2018 ¹⁻⁸) (* indicates birds outside of their seasonal range).....	51
Figure 35: Photograph depicting one of the Elf Owls at Juniper Grove perched on a mesquite growing around the juniper stands on 10/2/2017.....	52

Figure 36: Range map depicting the most current breeding, migration, non-breeding, and year-round range of *M. whitneyi* (Birds of North America, 2018; Henry and Gehlbach, 1999). (Red arrow indicates the location of IMRS).....52

Figure 37: Photographs of *C. minor* perching in different juniper trees and other vegetation structures of Oak-Juniper Arroyo during the summer of 2016.....53

Figure 38: Photograph of *S. calliope* perching on a juniper tree branch in Oak-Juniper Arroyo during the summer of 2016.....53

Introduction

The Chihuahuan Desert spans from north central Mexico northward into western Texas, southern New Mexico, and a small portion in southeastern Arizona (Figure 1), has a basin and range topography situated between the Sierra Madre Occidental and Sierra Madre Oriental mountain ranges, and contains the southern portion of the Rocky Mountains (Schmidt, 1986). Elevations of 1800 m and above are classified as Desert Mountains (18% of the region), its temperatures range from 14°–23°C (18.6°C average), 80-95% of all drops in temperature are a result of synoptic cold fronts, and rain is scarce due to the region's orographic barriers, distance from the nearest moisture sources (Gulf of Mexico and Pacific Ocean) and frequent subtropical high cells (Schmidt, 1986). The Chihuahuan Desert receives less winter precipitation than other deserts on the continent and summer monsoon thunderstorms (most of rainfall events), some snowfall during the cooler half of the year in the northern sectors, and late summer and fall tropical storms (including those reaching hurricane intensity) are its main sources of rainfall (Schmidt, 1986). The annual rainfall is 235 mm on average, it ranges from 150 to 400 mm, and the northern areas of the Chihuahuan Desert are primarily drained by the Rio Grande and Rio Conchos systems (Schmidt, 1986).

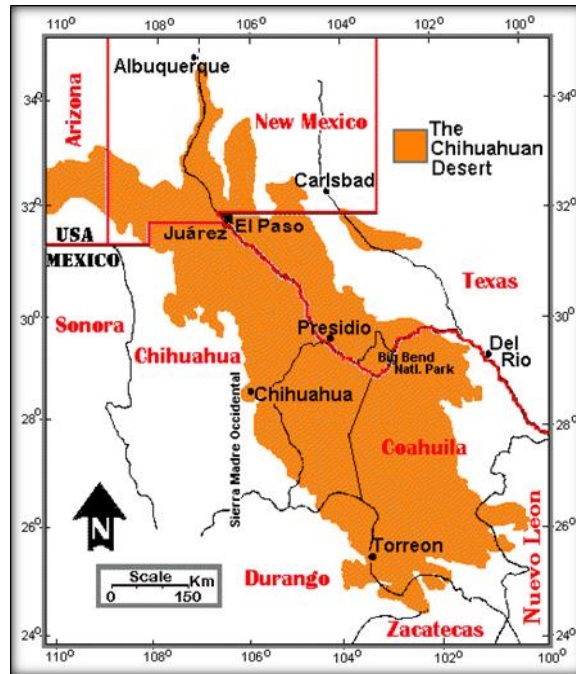


Figure 1: Chihuahuan Desert map (from Schmidt, 1989).

The Chihuahuan Desert's unique climate conditions contribute to its assortment of vegetation communities, which include forests and woodlands at higher elevations (sky island mountains), shrublands, steppes, savannas, herbaceous and woody or mixed wetlands, and barren desert (Nature Serve, 2009). Common names and scientific names used herein follow Worthington et al. (2018). Today, the Chihuahuan Desert is largely characterized by large expanses of Creosotebush (*Larrea tridentata*), Tarbush (*Flourensia cernua*), and Western White-thorn Acacia (*Acacia constricta*) shrublands at lower elevations (Brown, 1982). The shrublands most commonly observed today invaded lower elevations of the Chihuahuan Desert after the subsequent decrease of grassland caused by a variety of anthropogenic stressors, such as combination of overgrazing, drought, climate change, increased CO₂ in the atmosphere, weather events, and fire suppression (Grover and Musick, 1990; Escamilla, 2012). The shrubby vegetation of the Trans-Pecos region of the Chihuahuan Desert are further classified as

Apacherian-Chihuahuan mesquite upland scrub, mixed thorn-scrub, Madrean Oriental chaparral, and Creosotebush or Honey Mesquite (*Prosopis glandulosa*) dominant shrub-land (Nature Serve, 2009). The Trans-Pecos region mountainous vegetation is further classified as Madrean encinal, Madrean montane pine-oak forest and woodland, Madrean pinyon-juniper woodland, and Rocky Mountain bighorn maple ravine woodland (Nature Serve, 2009).

Grasses of the Chihuahuan Desert, which are found in many of the diverse habitats described above, include Sideoats Gramma (*Bouteloua curtipendula*), Fluff Grass (*Dasyochloa pulchella*), Blue Gramma (*Bouteloua gracilis*), Hairy Gramma (*Bouteloua hirsuta*), Burrograss (*Scleropogon brevifolius*), and Bush Muhly (*Muhlenbergia porteri*). Shrubs associated with the mentioned vegetation communities include Javelina Bush (*Condalia ericoides*), Desert Sumac (*Rhus microphylla*), Butterfly Bush (*Buddleia* spp.), Mormon Tea (*Ephedra* spp.), Green Sotol (*Dasyilirion leiophyllum*), various yuccas (*Yucca* spp.), Fourwing Saltbush (*Atriplex canescens*), Lechuguilla (*Agave lechuguilla*), Althorn (*Koeberlinia* spp.), and Beargrass (*Nolina erupens*). The cacti associated with those communities include varied species of prickly pear (*Opuntia* spp.), cholla (*Cylindropuntia* spp.), and Pitaya (*Mammillaria* spp.). Other Herbaceous plants include Grassland Croton (*Croton dioicus*), Mariola (*Parthenium incanum*), and Mesa Dropseed (*Sporobolus flexuosus*). (McMahan et al., 1984)

Birds have responded to the historic habitat changes in a variety of ways, such as increased bird species richness in shrublands, or grassland specialists declining in population size; some to threatened or endangered levels (Pidgeon et al., 2001). Studies on bird communities of the Chihuahuan Desert focus on scarce grassland habitats in North America because of the need to conserve these ecosystems (Coffman et al., 2014). A few shrubland bird studies were conducted on several types of government lands in New Mexico during the summer

breeding season (Kozma and Mathews, 1997; Pidgeon et al., 2003; Naranjo and Rait, 1993), and one study analyzed birds throughout various times of the year on Jornada del Muerto (Rait and Pimm, 1976). A multi-year bird collection study conducted in southeastern Coahuila, Mexico throughout the year produced a substantial species list, but there was no indication as to which birds were found in differing elevations and plant communities (Ely, 1962). Big Bend National Park has traditionally been the location of choice for studying Chihuahuan Desert birds in Trans-Pecos region of Texas, with a few breeding and habitat association studies conducted during the summer breeding season (Gutzwiller, 2001, 2003; Wauer, 1971; Dixon, 1959). Wiseman (2014) conducted a year-round study of avian occupants of abandoned ephemeral cattle tanks and a natural spring on Indio Mountains Research Station (IMRS), Hudspeth County, Texas. IMRS is the University of Texas at El Paso's 40, 000-acre field station (Worthington et al., 2018) and estimated them to contain 160 avian species, with 137 reported from casual sightings and Wiseman's (2014) investigation. IMRS will be the study site for the Chihuahuan Desert bird study proposed herein, given its location in an isolated area of the Trans-Pecos region of Texas containing pristine and secluded juniper and oak communities, my areas of interest.

Yearly literature studies investigating avian inhabitants of the Chihuahuan Desert are lacking, with most focusing in the summer breeding season. Such studies are essential to properly characterize how birds use habitats during winter and fall and spring migration seasons. A summary map of studies conducted on birds of the Chihuahuan Desert expresses the fact that the Trans-Pecos region has been neglected by the ornithological literature (Figure 2). That neglect is probably due to difficulty accessing land for research, since ownership is largely private. This leaves only a few small state parks, some U.S. National Park lands, and sites like IMRS readily available for field research activities (Figure 3). It is imperative that we use these

areas more for research, due to the anthropogenic threats birds face, such as urban expansion, agricultural land use, increased shrubification and desertification caused by overgrazing and climate change, logging, and pollutants (U.S. Fish and Wildlife Service, 2016). Recently, Mayor et al. (2017) determined a mismatch between migration time and seasonal vegetation green-up in North American migrant birds associated with changing climate, which is particularly important due to associated insect population booms. Population declines have also been detected in eastern North American migratory birds (Askins, 1993). Another recent study utilizing year-round eBird data, highlighted the importance of wintering habitats to the overall survival rates of migratory birds in Central America, which are currently under pressure by logging and agricultural expansion in the region (Sorte, 2017).

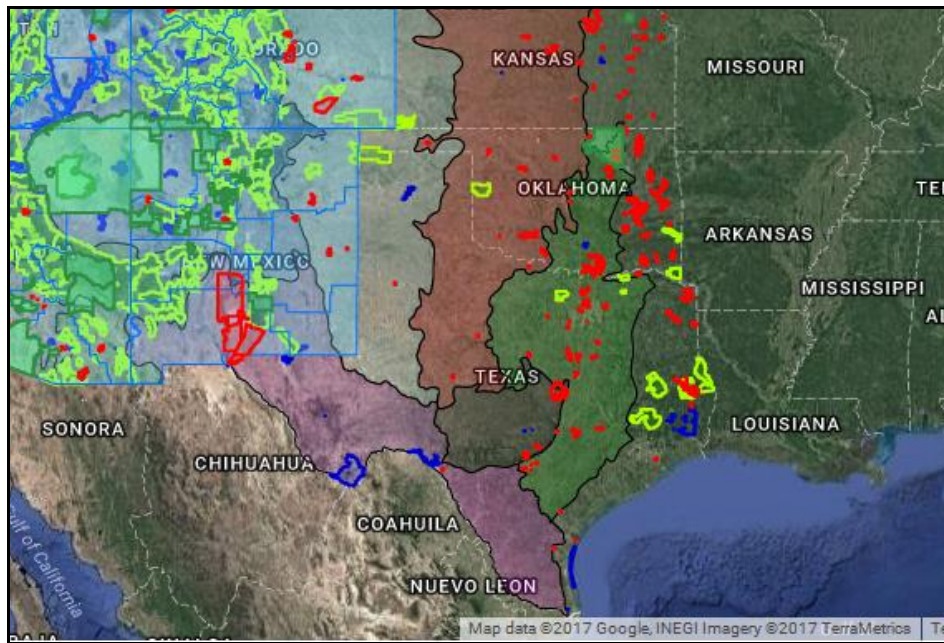


Figure 2: The Rocky Mountain Bird Observatory Map Query for Bird Conservation Regions (light purple = Chihuahuan Desert) showing public and government land, and Texas Chihuahuan Desert lacking this type of access (Rocky Mountain Avian Data Center, 2017).

Figure 5), Mexican Redberry Juniper (*J. coahuilensis*; Figure 6), and One-seed Juniper (*J. monosperma*; Figure 7). *Juniperus monosperma* is found in semi-arid areas on rocky soils (Spellenberg et al., 2014) and birds reported to eat its berries include Northern Flickers (*Colaptes auratus*), Steller's Jays (*Cyanocitta stelleri*), Mountain Chickadees (*Poecile gambeli*), titmouses (*Baeolophus* sp.), Sage Thrashers (*Oreoscoptes montanus*), American Robins (*Turdus migratorius*), Townsend's Solitaires (*Myadestes townsendi*), Western Bluebirds (*Sialia mexicana*), Evening Grosbeaks (*Coccothraustes vespertinus*), and Cassin's Finches (*Haemorhous cassinii*) (Johnson, 2002).

Juniperus coahuilensis occurs with several other juniper species overlapping in their ranges in woodland and savanna ecosystems; it dominates oaks and pines on dry sites that are found in chaparral, mountain shrubland, woodland, and grassland ecosystems. Its berries are eaten by a variety of wildlife that includes Gambel's Quail (*Callipepla gambelii*) and several species of mammals (Sullivan, 1993).

Juniperus pinchotii occupies more than 4.7 million ha of rangeland in the western half of Texas and has become a troublesome native species (Mirik et al., 2013). Its natural environment is rocky outcrops, dry hills, arroyos, canyons, caprocks, and shallow limestone or gypsum soils where they avoided destruction from grassland fires (Ansley et al., 1982). Its berries are eaten by a variety of birds and mammals (Hauser, 2007). *Juniperus arizonica*, a species that was first described in 2006, is found on rocky slopes in central and southern Arizona at 980–1600 m elevations near *Bouteloua* grasslands (Sullivan, 1993). Hybrids also exist between *J. coahuilensis* and *J. arizonica* across west Texas from El Paso to Big Bend, including land to the northwest and southeast of IMRS (Adams, 2017).

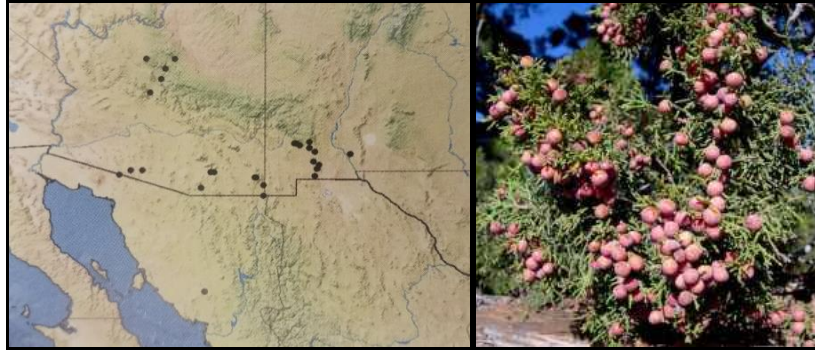


Figure 4: Range map (Farjon and Filer, 2013) and photograph (Licher, 2017) of *Juniperus arizonica*.

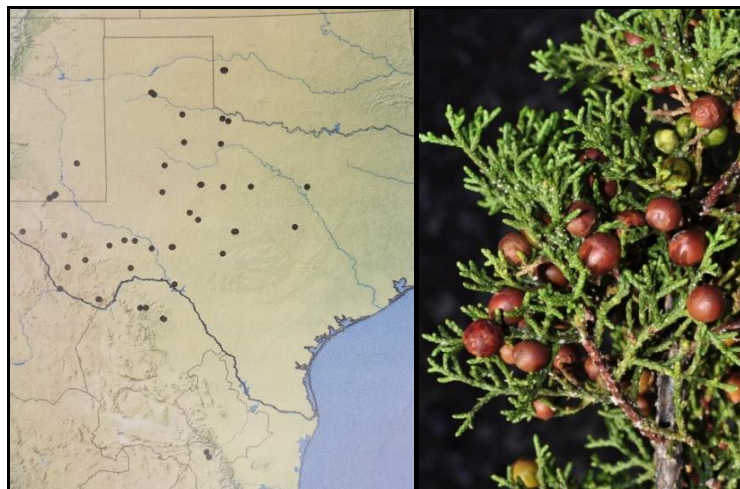


Figure 5: Range map (Farjon and Filer, 2013) and photograph (Gymnosperm Database, 2017a) of *Juniperus pinchotii*.

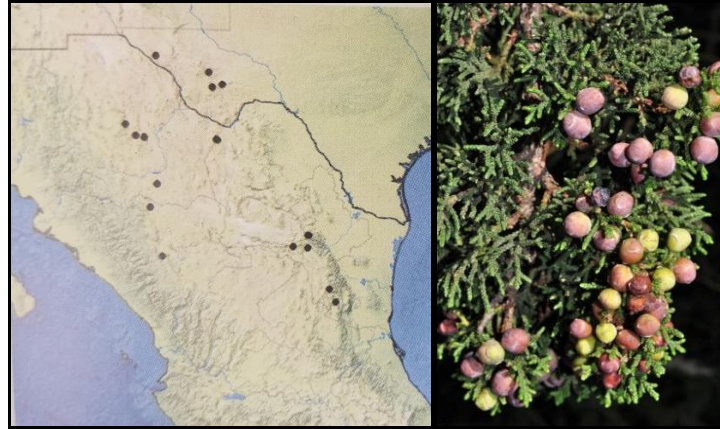


Figure 6: Range map (Farjon and Filer, 2013) and photograph (Gymnosperm Database, 2017b) of *Juniperus coahuilensis*.

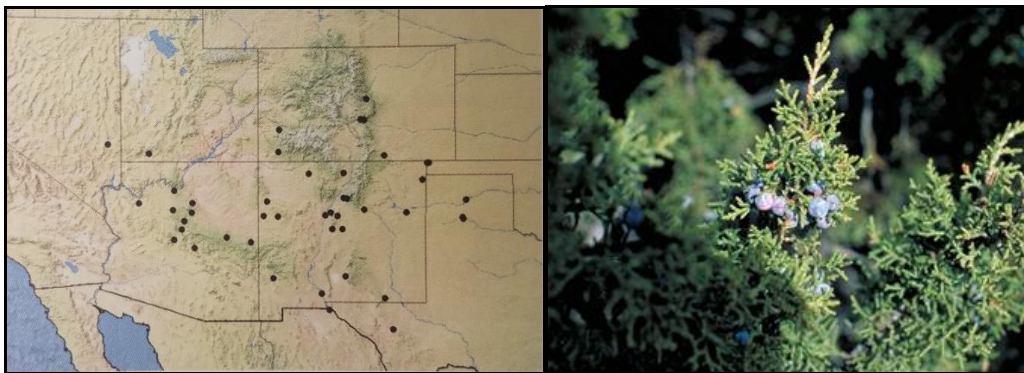


Figure 7: Range map (Farjon and Filer, 2013) and photograph (Native Plant Society of Texas, 2005) of *Juniperus monosperma*.

The oak trees present on IMRS are characterized by toothed margin leaves, have ranges in west Texas, and can occupy lower elevations (Spellenberg et al., 2014). These include Sandpaper Oak (*Quercus pungens*) (Figure 8) and Vasey Oak (*Quercus vaseyana*) (Figure 9). *Quercus pungens* was first described in El Paso, Texas as an evergreen shrub-like tree that occurs on open and rocky slopes at lower elevations (Muller, 1940). It is found in many

ecosystems on the Edward's Plateau and Trans-Pecos region, is often associated with shrub savannah and montane chaparral of the Chihuahuan Desert, and is especially associated with the juniper-oak communities mixed with desert scrub in canyons (Pavek, 1993). The literature contains no information on its importance to wildlife. *Quercus vaseyana*, an oak *Q. pungens* is found overlapping in range and hybridizes with, is found in some small areas of west Texas and Big Bend on dry limestone slopes in grasslands at 300–600 m in elevation (Spellenberg et al., 2014). The literature contains no information on *Q. vaseyana* plant associations or its importance to wildlife.

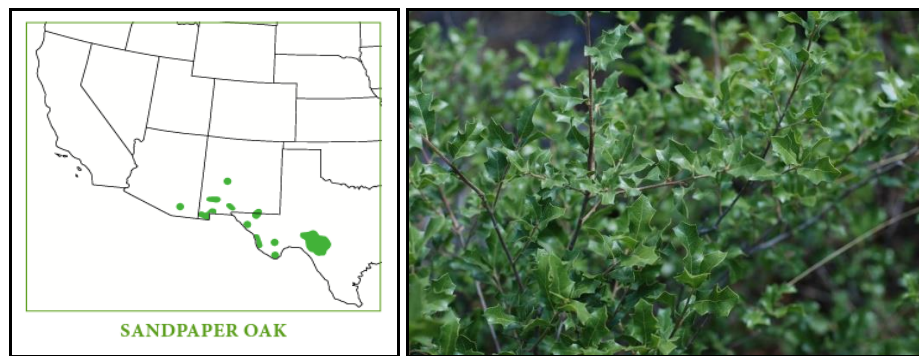


Figure 8: Range map (Spellenberg et al., 2014) and photograph (Stephen F. Austin State University, 2017) of *Quercus pungens* populations.



Figure 9: Range map (Spellenberg et al., 2014) and photograph (University of Texas at Austin, 2006) of *Quercus vaseyana* populations.

Numerous dense tree habitats containing juniper are viewable on private land near the Eagle Mountains and on IMRS using satellite imagery programs. Juniper communities in these areas have not been well investigated in the literature, nor are their bird occupants. Similarly, total vegetation structure and bird occupants of oak communities in these habitats are not known. In deserts of the southwest, junipers are commonly associated with oaks, as well as other trees and shrubs (Sullivan, 1993). *Juniperus pinchotii* and *Q. pungens* have been documented on IMRS on the higher eastern portions of the property (Worthington et al., 2018), and *Juniperus coahuilensis* in a recent genetics study (Adams, 2017), also provided an opportunity to study the vegetation and birds of the arroyos, rocky slopes, and canyon containing them.

Isolated juniper and oak communities of the Chihuahuan Desert may disappear in the future due to the previously discussed stressors on desert ecosystems. This study will help characterize the biota in these communities on IMRS and fill in bird data gaps for the Trans-Pecos Chihuahuan Desert. Reporting migration arrival and departure dates on IMRS will make it easier to form a baseline for the movement patterns of birds using the location, and track changes in movements in the future, such as species migrating earlier or later than previously documented. Similarly, exploring these areas will allow us to update the natural history information of the birds using juniper and oak habitats within desert scrublands. Birds using certain species of oak or juniper for nesting in the region, that haven't been previously documented, are noteworthy to both bird and vegetation conservationists. Inventorying birds present outside of their reported range or staying over in these habitats during migration, wintering, or for summer breeding, are also important updates to their known life history information and valuable to conservationists. Finally, updating the total number of bird species utilizing IMRS habitats can provide a window into how birds use recovering overgrazed desert

habitats of the southwest, and provides a resource for bird conservationists to utilize when designing regional recovery programs.

To the best of my knowledge, there has been no bird community or life history studies conducted in the juniper and oak habitats of the Chihuahuan Desert that are present in the arroyo, canyon and chaparral sites of mountains within the Trans-Pecos region.

The objectives of this study were to:

- 1.) Survey the plant community of each site to more accurately define them and help update the catalog of plant species on IMRS.
- 2.) Determine which bird species use various habitats of Trans-Pecos Chihuahuan Desert on IMRS containing juniper and oak tree communities, and determine if there are significant differences in species richness between sites, season, and range type.
- 3.) Report diversity differences between habitat types.
- 4.) Compile estimated arrival and departure dates of fall and spring migrants, wintering birds, and summer breeding species using juniper and oak tree communities.
- 5.) Determine which birds use the juniper and/or oak trees as sites for mating and nesting.
- 6.) Document any birds using the juniper and oak tree communities outside of their currently recorded range.
- 7.) Determine how many total bird species are now known to occur on IMRS, including those newly added since Wiseman (2014), and create a bird atlas for IMRS researchers, visitors, and students.

The working hypotheses are that: 1) X_0 : Habitats on IMRS that contain juniper and /or oak and thorn-scrub vegetation will not support significantly different bird species richness. X_1 : Habitats on IMRS that contain both junipers and oaks will support significantly higher bird species richness. 2) X_0 : Habitats on IMRS that contain juniper and/or oak and thorn-scrub vegetation will not hold significantly different migrant bird species richness. X_1 : Habitats on IMRS that contain both junipers and oaks will hold significantly more migrant bird species. 3) X_0 : Habitats on IMRS that contain juniper and/or oak and thorn-scrub vegetation will not hold different bird species richness in any astronomical season. X_1 : Habitats on IMRS that contain both junipers and oaks will contain significantly more bird species in the fall than in any other season.

Materials and Methods

STUDY SITE - Bird and vegetation surveys will be conducted on IMRS (Figure 10), centered about 42 km southwest of Van Horn, Texas in southeastern Hudspeth County in the northern Chihuahuan Desert of Trans-Pecos (Worthington et al., 2018). It is located just southeast of the Eagle Mountains and northwest of the Rio Grande (Figure 11). The field station is present on both sides of the main Indio Mountains range and surrounding foothills, smaller isolated peaks, arroyos, and canyons (Figure 12) that contain mostly desert thorn-scrub vegetation. Water sources from the mountain range drain on the east into Green River and on the south and west into the Rio Grande. Oak and juniper sites are located on the eastern portion of the property and a comparison thorn-scrub site is more interior (Figure 13). Sites include a juniper-oak community in an arroyo system (Figure 14), a juniper community between the montane foothills and within two intersecting arroyo systems (Figure 15), an oak community in a canyon-like wash (Figure 16), and a comparison site probably consisting of mainly acacia thorn-scrub vegetation in an arroyo (Figure 17). Common sites, especially sites used in this study, are available in the IMRS natural resource manual (Worthington et al., 2018) and Appendix 4.

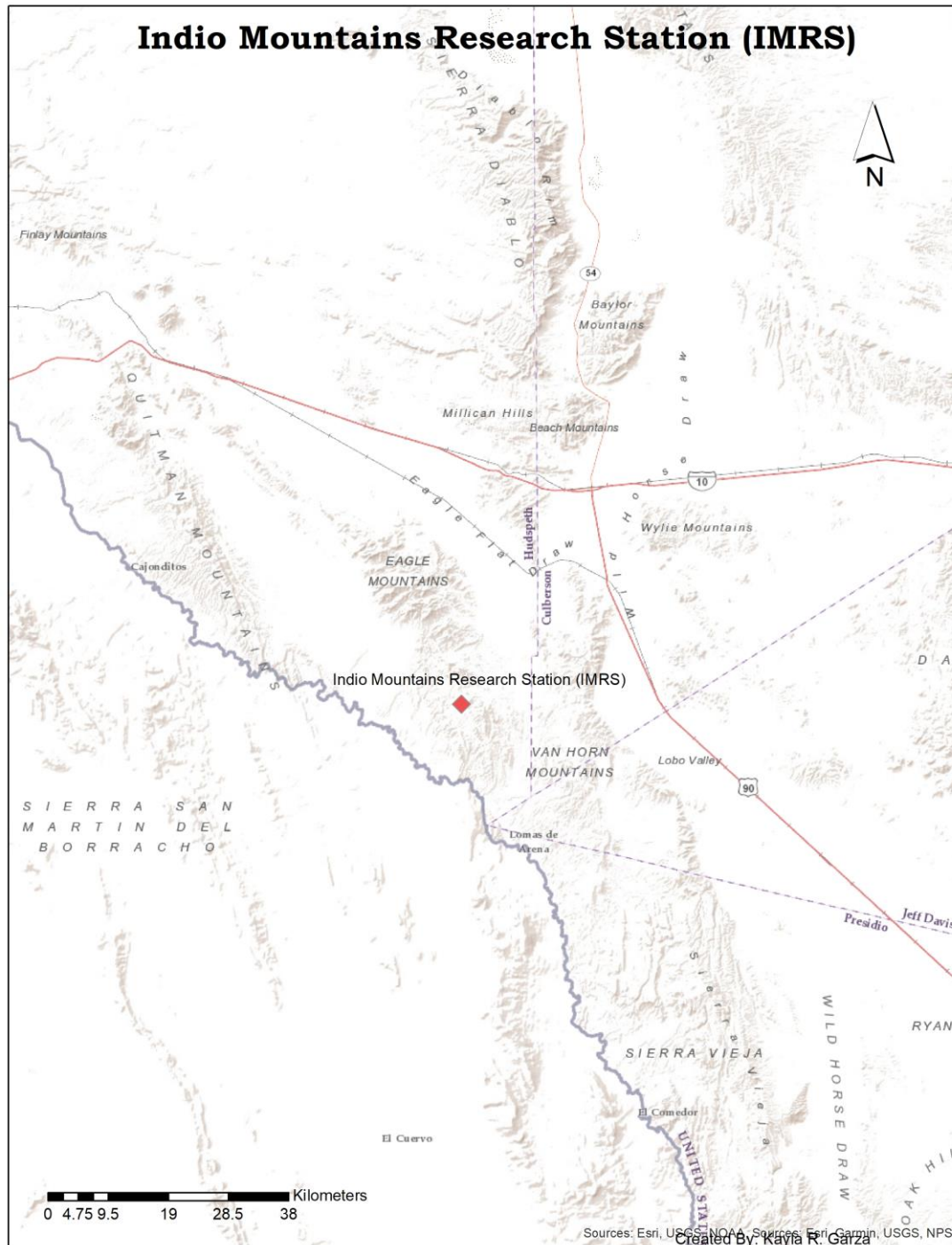


Figure 10: Map depicting the location of IMRS in southeastern Hudspeth County, Texas in the northern Chihuahuan Desert, specifically, on the southeastern spur of the Eagle Mountains and north-northeast of the Rio Grande. Elevation: 1233 m centered on coordinates: 30°46'37.30"N 105° 0'58.27"W.



Figure 11: Landscape photo of IMRS headquarters, mountain-basin topography, and vegetation structure.

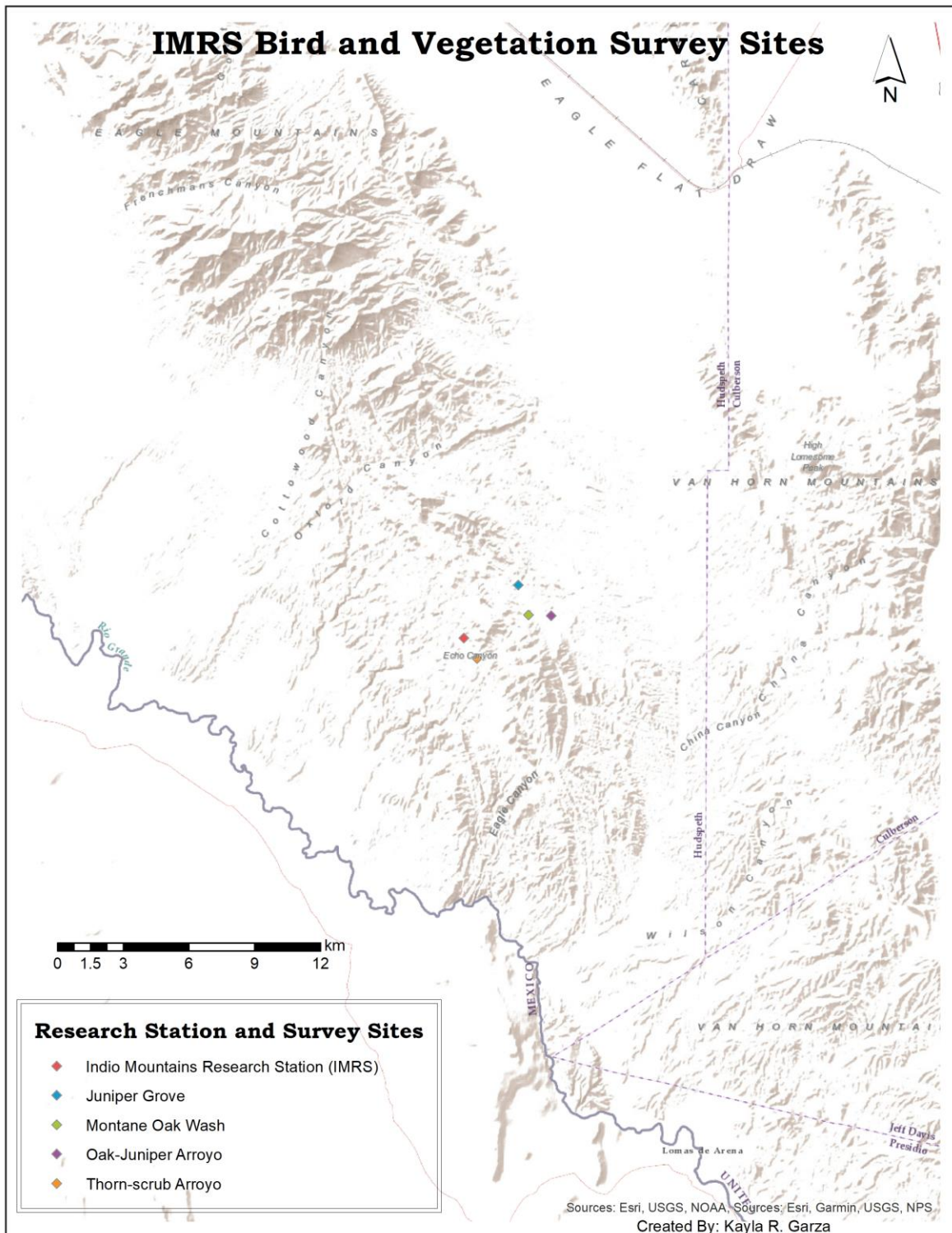


Figure 12: Topographic map of IMRS location and study sites.



Figure 13: Photograph and map depicting Oak-Juniper Arroyo (Site 1). Elevation: 1332 m.

Coordinates: 30°46'59.89"N 104°58'49.73"W (Google Earth, 2017d).



Figure 14: Photo and map depicting Juniper Grove habitat (Site 2) at the intersection of two washes (Google Earth, 2017e). Elevation: 1319 m. Coordinates: 30°47'44.03"N 104°59'37.00"W.



Figure 15: Photograph and map depicting Montane Oak Wash (Site 3) in a rocky limestone canyon wash (Google Earth, 2017f). Elevation: 1358 m. Coordinates: 30°47'7.86"N 104°59'19.81"W.



Figure 16: Photograph and map depicting Thorn-Scrub Arroyo (Site 4) (Google Earth, 2017g). Elevation: 1228 m. Coordinates: 30°46'12.11"N 105° 0'39.96"W.

VEGETATION SURVEYS - Plant identification was confirmed from photographs and specimens not previously collected on the property, or from a unique site, and were mounted by the manager of UTEP's herbarium when necessary. Vegetation structure was determined at each site

by dividing the habitats into 60 m transects in Google Earth Pro (approx. 3-4 possibilities), assigning them a number, and randomly selecting one transect for surveying (randomnumber.org) (Figures 17, 18, 29, 20). We identified all species occurring from the transect center to the tree (juniper and/or oak) boundary, conducted simple counts of all trees and shrubs (Appendix 1). Then, we designated whether wildflower, forbs, herbs, ferns, and grasses were present or absent. Finally, we calculated percent cover for tree and shrub species (Sutherland, 2006b). Vegetation data was written on hard copy self-made data sheets in the field and then transferred to a Microsoft Access database after each survey was conducted. Photographs were taken of unknown plants, which were counted, and identified later to update the plant survey database. Juniper, oak, and other plant species not previously documented on IMRS property were properly pressed and submitted to the herbarium, if not already accomplished by previous researchers, to voucher the record and for proper identification. Juniper and oak species identification required microscopic analysis, and future DNA analysis is recommended for juniper samples.



Figure 17. Plant survey transect in Oak-Juniper Arroyo (Begin Coordinates: 30°47'08.61"N, 104°58'49.90"W. End Coordinates: 30°47'07.11"N, 104°58'48.52"W. Distance: 60m).



Figure 18. Plant survey transect in Juniper Grove (Begin Coordinates: 30°47'43.93"N, 104°59'37.57"W. End Coordinates: 30°47'45.71"N, 104°59'38.39"W. Distance: 60m).

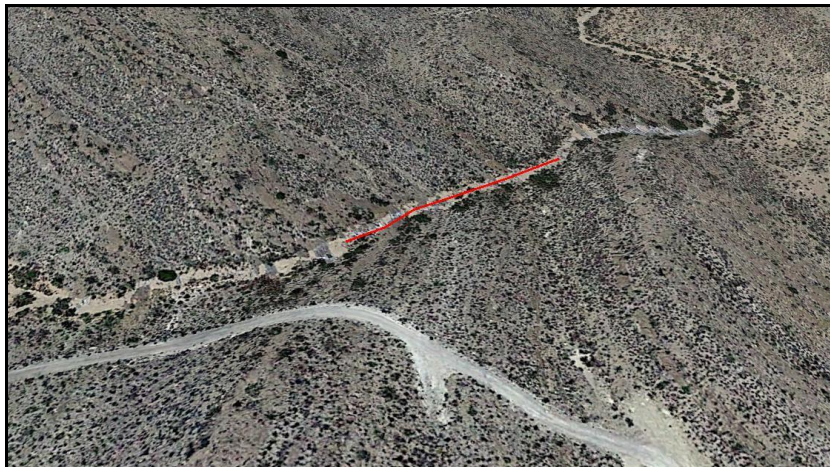


Figure 19. Plant survey transect in Montane Oak Wash (Begin Coordinates: 30°47'06.99"N, 104°59'21.12"W. End Coordinates: 30°47'08.26"N, 104°59'18.97"W. Distance: 60m).



Figure 20. Plant survey transect in Thorn-scrub Arroyo (Begin Coordinates: 30°46'12.96"N, 105°00'33.23"W. End Coordinates: 30°46'12.20"N, 105°00'35.69"W. Distance: 60m).

AVIAN SURVEYS - Bird surveys were normally conducted twice a month (Fridays-Sundays) from June 2016 through December 2017 on IMRS from 0600–0900 h, with two sites surveyed per morning. Sites were randomly rotated per survey trip (randomnumber.org) to evenly cover all sites throughout the study. First, timed species counts (TSCs) (Sutherland, 2006a) were conducted by assigning a 1-6 value to each 10 minutes that passed (1 = 50-60 minutes, 6 = 0-10 minutes, etc.) alongside basic area search surveys (Loyn, 1986; Nur et al., 1999) for one hour and all birds seen or heard were recorded (n = 40 randomly rotated surveys in four different plant communities). TSCs were conducted to determine the time-species curve of the sites while we collected data that was useful for analysis by simply filtering out 30 min worth of data in Microsoft Access by selecting TSCs values of 4-6 (1-3 indicated the second half of the 60 minute survey). After TSCs were completed, basic area search surveys of all birds seen or heard for 30 min were conducted from there forward as modified by the TSCs recommended survey time frame (Figure 21). Survey boundaries were designated beforehand and were simply defined by the presence of dense vegetation surrounding the arroyo and canyon wash systems, especially

where oak and juniper boundaries ceased. No birds were counted outside of this vegetation boundary. Similarly, flyovers were noted for general reporting on the station, but not included in the species richness analysis. When recording relative abundance, no individual bird of the same species was counted more than once, unless more than one individual was seen or heard simultaneously. Bird survey sites were considered independent if they were 250 m apart or more, they took place in different seasons ($n = 7$ total per site in this case), and any type of randomness was incorporated, even when difficult, as recommended by Nur et al. (1999). Repeated observations were taken from each site during each season to capture the estimated first arrival dates (FADs) and estimated departure dates of fall and spring migrants, summer breeding birds, and wintering birds. Field data was written in memo notebooks with permanent black archive quality acid-free ink and then transcribed to Microsoft Access for storage, with multiple backups created on flash drive and cloud drive. The data sheet design in the memo book included date, time, conditions, and site, with columns for bird species name, abundance, TSC score (June-October 2016 only), and other life history information (e. g. nest plants, mating pairs, fledglings, egg numbers, food sources). The total counts of each bird species per site, and the mean and standard deviations, were reported for supplementary reasons and to help explain any patterns seen in diversity (Appendix 2). Photographs of each bird found, and other recorded observations were taken at each site throughout the study, with focus on photographing uncommon birds for the record. Feathers were deposited into UTEP's Biodiversity Collections when possible.

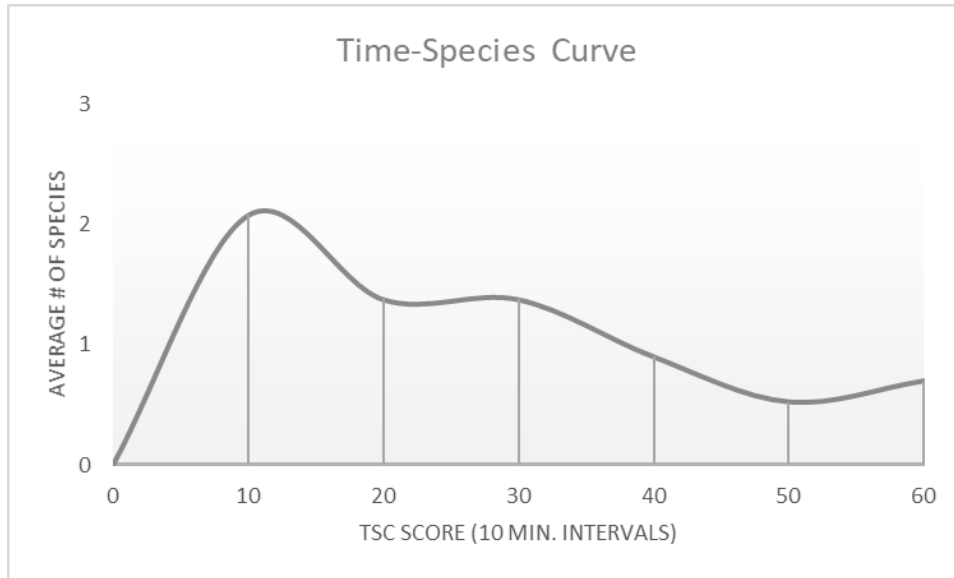


Figure 21: Time-Species Curve indicating 30-40 minutes is the point at which the average number of species recorded levels out during avian site survey at the sites on IMRS.

DATA ANALYSIS - Presence and absence of each bird species using each habitat was depicted by study site in a table format. Total species richness was calculated for each site, by site and bird seasonal activities (migrating, winter non-breeding, summer breeding, year-round), and by site and astronomical season (i.e. spring, summer, fall, winter). Bird species richness (S) by site, season, and bird seasonal activity was analyzed in R-Studio and R-Commander for significant differences in S between sites and seasons, and sites. S of bird range category was analyzed using a χ^2 Test of Independence ($\alpha = 0.05$), and overall S was analyzed by site using Pearson's

Chi-square Test of Independence, $\chi^2 = \sum \frac{(obs - exp)^2}{exp}$ (Ambrose et al., 2007), to determine if any site was significantly different from the others. Bird data from each site was filtered in Microsoft Access to isolate site, common name, species name, and relative abundance. Filtered data was transferred to Excel, the mean was taken of the relative abundance for each species, the standard deviation was calculated, and the data was depicted in graph and table format. Similarly, the total

count of each bird species was calculated per site and depicted in the same way. Bird species, their mean relative abundances, standard deviations, and total counts were reported for general information and any future projects that may require this data (Appendix 2). Diversity was calculated using Shannon's Index $-\sum_i \left(\frac{n_i}{N} \cdot \ln \left(\frac{n_i}{N} \right) \right)$ and Simpson's Index $\frac{\sum_i n_i(n_i - 1)}{N(N - 1)}$ (Stiling, 2012) for each site using S calculated from June 2016-December 2017 and the total counts determined of each species in each survey site (Appendix 1). Documented bird species, dates, and their activity type (migrant, breeding, summer, and wintering) were used to design graphical displays and tables of estimated bird FADs and departure dates. Life history data, including nest plants, birds present outside their reported range for migration, and other useful observations, were summarized and are in progress to be submitted for publication as natural history notes or larger publications. All new species accounts for the property were updated in the IMRS natural resource manual (Worthington et al., 2018; Appendix 3). Total number of birds documented at IMRS were calculated after the survey was completed and species that were newly added by this study were reported. Resulting avian occupants of these vegetation communities were compared to the previous cattle tank and perennial spring study conducted on the property (Wiseman, 2014). As a courtesy to the research station, we compiled a bird atlas of those found during this study for any visitors to use, including researchers and field biology students. In text, common names and species names are cited when they first appear. Then, when cited beyond the initial appearance, the species name with abbreviated genera are used.

Results

VEGETATION SURVEY - Surveys of the plants growing in each bird study site yielded a complete species list with presence and absence data (Table 1), and percent occurrences of shrubs and trees for Oak-Juniper Arroyo (Figure 22), Juniper Grove (Figure 23), Montane Oak Wash (Figure 24), and Thorn-scrub Arroyo (Figure 25). Oak-Juniper Arroyo's numerically dominant shrub types are Mariola, *Parthenium incanum* (30%) and Skeleton-leaf Goldeneye, *Viguiera stenoloba* (20%) (Figure 22). Trees present in this site included, *Q. pungens* (5%), Desert Olive, *Forestiera pubescens* (2%), Western Hackberry, *Celtis occidentalis* (>1%), and *J. coahuilensis* (>1%) (Figure 22). Juniper Grove's numerically dominant shrub types are *P. incanum* (37%) and *V. constricta* (35%) (Figure 23). Trees present in this site included, *J. coahuilensis* (3%) and *F. pubescens* (>1%) (Figure 23). Montane Oak Wash's numerically dominant shrub types are *P. incanum* (26%) and *V. stenoloba* (19%) (Figure 24). Trees present in this site included, *Q. pungens* (16%) and *F. pubescens* (1%) (Figure 24). The Thorn-scrub Arroyo's numerically dominant shrub types are *V. stenoloba* (19%) and Plumed Crinklemat, *Tiquilia greggii* (16%) (Figure 25). Trees present in this site included, *F. pubescens* (2%) and Desert Willow, *Chilopsis linearis* (>1%) (Figure 25). Fern-like plants found from all of the sites included the Resurrection Fern, *Selaginella lepidophylla*, and Cochise Scaley Cloakfern, *Astrolepia cochisensis*. Shrubs found from all of the sites included Grassland Croton, *Croton dioicus*, Bear Grass, *Nolina erumpens*, Desert Mimosa, *Mimosa aculeaticarpa*, Rabbitbrush, *Ericameria* sp., Desert Holly, *Mahonia trifoliolata*, Creosotebush, *Larrea tridentata*, Boundary Ephedra, *Ephedra aspera*, Mariola, *Parthenium incanum*, Desert Bernardia, *Bernardia myricifolia*, Feathery Dalea, *Dalea formosa*, Catclaw Acacia, *Acacia greggii*, Ocotillo, *Fouquieria splendens*, White-thorn Acacia, *Acacia constricta*, Plumed Crinklemat, *Tiquilia*

greggii, Skeleton-leaf Goldeneye, *Viguiera stenoloba*, Warnock's Condalia, *Condalia warnockii*, Broom Snakeweed, *Gutierrezia sarothrae*, Little-leaf Sumac, *Rhus microphylla*, Sotol, *Dasyilirion leiophyllum*, Barometer Bush, *Leucophyllum minus*, Evergreen Sumac, *Rhus virens*, and Desert Myrtlecroton, *Bernardia obovate*. Trees found from all of the sites included *C. linearis*, *F. pubescens*, *Q. pungens*, *J. coahuilensis*, and Western Hackberry, *Celtis occidentalis*. Grasses found from all of the sites included Fluff Grass, *Dasyochloa pulchella*, Tanglehead Grass, *Heteropogon contortus*, Plains Bristlegrass, *Setaria vulpiseta*, Black Grama Grass, *Bouteloua eriopoda*, Side-oats Grama Grass, *B. curtipendula*, Silver Beard Grass, *Bothriochloa laguroides*, Blue Grama Grass, *B. gracilis*, Threeawn grass, *Aristida* sp., and Alkali Sacaton Grass, *Sporobolus airoides*. Flowers-Herbs found from all of the sites included Plateau Rock Trumpets, *Mandevilla macrosiphon*, Desert Tragia, *Tragia ramosa*, American Threefold, *Trixis californica*, Durango Senna, *Senna durangensis*, Dwarf Indian Mallow, *Abutilon parvulum*, Small-head Sneezeweed, *Helenium microcephallum*, Diamond Flower, *Stenaria nigricans*, Shortleaf Jefe, *Jefe brevifolia*, Desert Marigold, *Baileya multiradiata*, Shortfruit Evening Primrose, *Oenothera brachycarpa*, Blue Milkwort, *Polygala barbeyana*, Parry's Wild Petunia, *Ruellia parryi*, Dudweed, *Psilostrophe gnaphalioides*, Dogweed, *Thymophylla pentachaeta*, Smartweed-leaf Flower, *Phyllanthus polygonoides*, Silverleaf Nighshade, *Solanum elaeagnifolium*, and Glandleaf Milkwort, *Polygala macradenia*, Palm-leaf Mistleflower, *Conoclinium greggii*, Yellow Spiny Daisy, *Machaeranthera pinnatifida*, Croton, *Croton pottsii*, Fendler's Spurge, *Chamaesyce fendleri*, and Wholeleaf Indian Paintbrush, *Castilleja integra*. Cacti found from all of the sites included Christmas Cactus, *Cylindropuntia leptocaulis*, Engelmann's Prickly Pear, *Opuntia engelmannii*, Brown-spined Prickly Pear, *Opuntia phaeacantha*, Texas Rainbow Hedgehog, *Echinocereus dasyacanthus*, Pitaya, *Echinocereus*

enneacanthus, and the Cob Beehive Cactus, *Escobaria tuberculosa*. Yuccas and agaves included Lechuguilla, *Agave lechuguilla*, Banana Yucca, *Yucca baccata*, and Eve's Needle Yucca, *Yucca faxoniana*. Vines found from all of the sites included Climbing Milkweed, *Sarcostemma crispum* and Texas Snoutbean, *Rynchosia texana*. The types of species that were present or absent in the individual sites can be seen in the plant data table. (Table 1)

AVIAN BIODIVERSITY - Presence and absence data for bird species and the sites indicated that the following birds were found in all 4 study sites: Rufous-crowned Sparrow, *Aimophila ruficeps*, Black-throated Sparrow, *Amphispiza bilineata*, Black-chinned Hummingbird, *Archilochus alexandri*, Verdin, *Auriparus flaviceps*, Scaled Quail, *Callipepla squamata*, Cactus Wren, *Campylorhynchus brunneicapillus*, Greater Roadrunner, *Geococcyx californianus*, House Finch, *Haemorhous mexicanus*, Scott's Oriole, *Icterus parisorum*, Northern Mockingbird, *Mimus polyglottos*, Ash-throated Flycatcher, *Myiarchus cinerascens*, Blue Grosbeak, *Passerina caerulea*, Ladder-backed Woodpecker, *Picoides scalaris*, Blue-Gray Gnatcatcher, *Polioptila caerulea*, Ruby-crowned Kinglet, *Regulus calendula*, Rock Wren, *Salpinctes obsoletus*, Lesser Goldfinch, *Spinus psaltria*, Bewick's Wren, *Thryomanes bewickii*, Mourning Dove, *Zenaida macroura*, and White-winged Dove, *Zenaida asiatica* (Table 2). Data also indicated that the following birds were only found in one study site: Golden Eagle, *Aquila chrysaetos*, Red-tailed Hawk, *Buteo jamaicensis*, Lesser Nighthawk, *Chordeiles acutipennis*, Western Wood-Pewee, *Contopus sordidulus*, Chihuahuan Raven, *Corvus cryptoleucus*, Least Flycatcher, *Empidonax minimus*, Hooded Oriole, *Icterus cucullatus*, Elf Owl, *Micrathene whitneyi*, Lazuli Bunting, *Passerina amoena*, Painted Bunting, *Passerina ciris*, Varied Bunting, *Passerina versicolor*, Cassin's Sparrow, *Peucaea cassinii*, Calliope Hummingbird, *Selasphorus calliope*, Rufous

Hummingbird, *Selasphorus rufus*, Brewer's Sparrow, *Spizella breweri*, Curve-billed Thrasher, *Toxostoma curvirostre*, Western Kingbird, *Tyrannus verticalis*, and White-crowned Sparrow, *Zonotrichia leucophrys* (Table 2). Birds found in 2 or more study sites included: Pyrrhuloxia, *Cardinalis sinuatus*, Turkey Vulture, *Cathartes aura*, Canyon Wren, *Catherpes mexicanus*, Common Nighthawk, *Chordeiles minor*, Northern Flicker, *Colaptes auratus*, Gray Flycatcher, *Empidonax wrightii*, American Kestrel, *Falco sparverius*, MacGillivray's Warbler, *Geothlypis tolmiei*, Dark-eyed Junco, *Junco hyemalis*, Loggerhead Shrike, *Lanius ludovicianus*, Canyon Towhee, *Melospiza fusca*, Bronzed Cowbird, *Molothrus aeneus*, Brown-headed Cowbird, *Molothrus ater*, Green-tailed Towhee, *Pipilo chlorurus*, Spotted Towhee, *Pipilo maculatus*, Western Tanager, *Piranga ludoviciana*, Black-tailed Gnatcatcher, *Poliophtila melanura*, Broad-tailed Hummingbird, *Selasphorus platycercus*, Yellow-rumped Warbler, *Setophaga coronata*, Townsend's Warbler, *Setophaga townsendii*, Clay-colored Sparrow, *Spizella pallida*, Chipping Sparrow, *Spizella passerina*, Crissal Thrasher, *Toxostoma crissale*, House Wren, *Troglodytes aedon*, and Wilson's Warbler, *Cardellina pusilla* (Table 2). *A. chrysaetos*, *C. sordidulus*, *C. cryptoleucus*, *E. minimus*, *I. cucullatus*, *M. whitneyi*, *P. amoena*, and *P. versicolor* were found in sites that contained only juniper trees (Table 2). *S. breweri* was the only species found in the Montane Oak Wash and was not found in any of the other vegetation sites (Table 2). *T. verticalis* was the only species that was found in only in the thorn-scrub arroyo site (Table 2). *W. pusilla*, *C. acutipennis*, *P. ciris*, *P. cassinii*, *S. calliope*, *T. curvirostre*, and *Z. leucophrys* were only found in the site containing both oak and juniper. (Table 2). The total number of species found throughout the study was 64. Species richness (S) for Oak-Juniper Arroyo was S = 43, S = 50 for Juniper Grove, S = 36 for Montane Oak Wash, and S = 32 for Thorn-scrub Arroyo. χ^2 Goodness-of-fit test indicated that $\chi^2 = 2.365$, with $df = 3$ and $p > 0.50$.

S for each site by season is as follows: S = 24 in Oak-Juniper Arroyo, S = 28 in Juniper Grove, S = 15 in Montane Oak Wash, and S = 16 in Thorn-scrub Arroyo all during the spring. S = 28 in Oak-Juniper Arroyo, S = 37 in Juniper Grove, S = 24 in Montane Oak Wash, and S = 22 in Thorn-scrub Arroyo all in the summer. S = 17 in Oak-Juniper Arroyo, S = 24 in Juniper Grove, S = 24 in Montane Oak Wash, and S = 17 in Thorn-scrub Arroyo all in the fall. S = 8 in Oak-Juniper Arroyo, S = 3 in Juniper Grove, S = 1 in Montane Oak Wash, and S = 2 in Thorn-scrub Arroyo all in winter. χ^2 test for Independence indicated that $\chi^2 = 11.141$ and $p = 0.27$. (Table 3)

S for each site by bird range category is as follows: S = 24 in Oak-Juniper Arroyo, S = 24 in Juniper Grove, S = 21 in Montane Oak Wash, and S = 19 in Thorn-scrub Arroyo for Year-Round birds. S = 8 in Oak-Juniper Arroyo, S = 9 in Juniper Grove, S = 6 in Montane Oak Wash, and S = 8 in Thorn-scrub Arroyo for Summer Breeding birds. S = 6 in Oak-Juniper Arroyo, S = 11 in Juniper Grove, S = 2 in Montane Oak Wash, and S = 4 in Thorn-scrub Arroyo for Migrants. S = 6 in Oak-Juniper Arroyo, S = 7 in Juniper Grove, S = 8 in Montane Oak Wash, and S = 1 in Thorn-scrub Arroyo for Winter Non-Breeding birds. χ^2 test for Independence indicated that $\chi^2 = 9.1132$ and $p = 0.43$. (Table 4)

Diversity index calculations resulted in the following: Oak-Juniper Arroyo had a Shannon's diversity index of 4.576 and a Simpson's diversity index of 0.05965, with a total of 354 organisms, and an average population size of 8.233. Juniper Grove had a Shannon's diversity index of 3.38 and a Simpson's diversity index of 0.04785, with a total of 342 organisms, and an average population size of 6.84. Montane Oak Wash had a Shannon's Diversity index of 3.074 and a Simpson's diversity index of 0.05789, with a total of 228 organisms, and an average population size of 6.333. Thorn-scrub Arroyo had a Shannon's

diversity index of 2.61 and a Simpson's diversity index of 0.1584, with a total of 207 organisms, and an average population size of 6.469. (Table 5)

NESTING AND MATING OCCURRENCES - An adult *Z. macroura* was documented nesting in *Q. pungens* (Table 6), and photos provide evidence of previous *Z. macroura* nesting throughout Oak-Juniper Arroyo in *Q. pungens* (Figure 26), such as a nest with 2 eggs (Figure 27) and 2 surviving nestlings (Figure 28) during the summer of 2016. No photo or noted documentation was available past their nestling stage. An adult female *A. alexandri* was documented nesting and sitting on her eggs in *J. coahuilensis* in Oak-Juniper Arroyo (Figure 29). No photo or noted documentation was available for number of eggs or success of the offspring. An adult *M. fusca* was documented nest building *Q. pungens* in Oak-Juniper Arroyo. No other photo or noted documentation was available on whether the nest was built successfully. A *P. caerulea* nest with 2 eggs was found in *Q. pungens* in the Montane Oak Wash, and the parents were not present (Figure 30). An abandoned *A. flavescens* nest was photographed in the Oak-Juniper Arroyo site in a *F. pubescens* tree during the winter of 2016 (Figure 31). There were no incidences of nesting in the juniper trees of Juniper Grove during the length of this survey, although, as with the other sites, nesting was occurring in trees and shrubs other than juniper and oak. Bird documented nest building, sitting in nests, guarding nests, or nests with eggs in them in each of the sites included: *Z. macroura* in *Q. pungens* (8/18-8/26/2016), *M. fusca* in *Q. pungens* in Oak-Juniper Arroyo (8/28/2016) and in *R. virens* in Montane Oak Wash (7/30/2017), *A. alexandri* in *J. coahuilensis* in Juniper Grove (5/7-6/6/2017), *C. brunneicapillus* in *Y. faxoniana* (7/8/2017) and *P. caerulea* in *Q. pungens* (7/8/2017) at Oak-Juniper Arroyo, and *A. bilineata* in *L. tridentata* in Juniper Grove (7/30/2017) (Table 5). Birds documented displaying mating behavior, such as male female

pairs participating in courtship, or copulating included: Pairs of *P. ludoviciana*, *P. caerulea*, *L. ludovicianus*, and *P. caerulea* (7/21/2016-8/20/2016) in Oak-Juniper Arroyo. Pairs of *C. sinuatus* and *P. caerulea* (8/27/2016) in Montane Oak Wash. A pair of *I. parisorum* (8/28/2016) in Oak-Juniper Arroyo. *M. whitneyi* and *C. mexicanus* (10/2-10/29/2016) in Juniper Grove. A pair of *P. maculatus* in Oak-Juniper Arroyo (10/29/2016). A pair of *G. californianus* in Montane Oak Wash (3/26/2017). A pair of *E. wrightii* in Oak-Juniper Arroyo (5/6/2017). A pair of *P. caerulea* in Juniper Grove (5/7/2017) and in Oak-Juniper Arroyo (5/19/2017). A pair of *I. parisorum* in Juniper Grove (5/19/2017). A pair of *A. ruficeps* in Oak-Juniper Arroyo (5/19/2017). A pair of *M. polyglottos* in Juniper Grove (5/21/2017). A pair of *A. ruficeps* (6/6/2017) and *Z. asiatica* (7/8/2017) in Oak-Juniper Arroyo. A pair of *T. bewickii* in Montane Oak Wash (7/8/2017). Pairs of *C. brunneicapillus*, *H. mexicanus*, *I. parisorum*, *C. squamata*, and *M. cinerascens* (7/8-7/22/2017) in Oak-Juniper Arroyo. A pair of *H. mexicanus* in Montane Oak Wash (7/22/2017). A pair of *A. bilineata* in Juniper Grove (7/29/2017). A pairs of *M. fusca* in Montane Oak Wash (7/30/2017). Pairs of *W. pusilla*, *R. calendula*, *A. bilineata*, and *P. caerulea* in Juniper Grove (9/8-9/23/2017). (Table 7).

MIGRANT, SUMMER BREEDING, AND WINTER BIRD ARRIVAL-DEPARTURE DATES -

Bird surveys included date documentation for each individual tallied and yielded estimated arrival and departure dates for spring and fall migrants, summer breeding, and wintering birds. Migrants documented were generally seen using the study sites from late July to late September (fall migrants) and majorly during May (spring migrants) (Figure 32, Table 8). *M. whitneyi*, however, was documented through early October of 2016 and *S. pallida* was documented through late December 2016 (Figure 32, Table 8). Summer breeding birds documented generally

used the study sites from May through July of 2017, however, *C. aura*, *P. caerulea*, and *I. parisorum* were documented in the sites through September 2017 (Figure 33, Table 9). Winter non-breeding birds documented generally used the study sites from August through late January; however, the winter range birds *Z. leucophrys* and *P. chlorurus* were documented using the sites in May of 2017 (Figure 34, Table 10).

BIRDS DOCUMENTED OUTSIDE OF THEIR TYPICAL RANGES AND INTERESTING SIGHTINGS - *M. whitneyi* was documented on several occasions perching in the vegetation of Juniper Grove, including in younger *J. coahuilensis* trees and *P. glandulosa* (Figure 35) outside of its documented range (Figure 36). The most *M. whitneyi* individuals we saw at one time were 3 perching in a young *J. coahuilensis* tree within Juniper Grove and the latest they were documented stopping over in this location was 10/2/2016 (Table 8). On a few occasions, we noted a pair of *M. whitneyi* using this vegetation site in the summer of 2017 (Table 8). *Chordeiles minor* was documented in high relative abundance, especially perching on juniper tree branches and other vegetation structures in the AM hours (Figure 37), compared to other breeding birds during the summer of 2016 (Appendix 1; Table 9; Figure 33). *Selasphorus calliope* was sighted once in the summer of 2016 (Table 8; Figure 32) in Oak-Juniper Arroyo perched on a *J. coahuilensis* branch (Figure 38). The winter birds, *Z. leucophrys* and *P. chlorurus* (Table 10; Figure 34), were also present during the warm months on IMRS.

UPDATES TO THE IMRS NATURAL RESOURCE MANUAL (Worthington et al., 2018) - A total of 64 bird species were documented by this study alone, bringing the total number of bird species documented to date on IMRS to 143 (Appendix 3). A total of 6 bird species were newly added

by this survey and from casual documentation. They are as follows: *C. acutipennis* (casual and study area) *S. calliope*, *S. platycercus*, *P. amoena*, Barn Owl, *Tyto alba* (casual), and *T. aedon*. These were singleton sightings, except in the case of *C. acutipennis* and *T. aedon*.

Table 1: Species of plants found in Oak-Juniper Arroyo, Juniper Grove, Montane Oak Wash, and Thorn-Scrub Arroyo indicating presence-absence.

<i>Family</i>	<i>Common Name</i>	<i>Scientific Name</i>	Oak-Juniper Arroyo	Juniper Grove	Oak Wash	Thorn-scrub Arroyo
<i>Trees</i>						
<u><i>Bignoniaceae</i></u>	Desert Willow	<i>Chilopsis linearis</i>				X
<u><i>Cannabaceae</i></u>	Western Hackberry	<i>Celtis occidentalis</i>	X			
<u><i>Cupressaceae</i></u>	Coahuila Redberry Juniper	<i>Juniperus coahuilensis</i>	X	X		
<u><i>Fagaceae</i></u>	Pungent Oak	<i>Quercus pungens</i>	X		X	
<u><i>Oleaceae</i></u>	Desert Olive	<i>Forestiera pubescens</i>	X	X	X	X
<i>Shrubs</i>						
<u><i>Anacardiaceae</i></u>	Evergreen Sumac	<i>Rhus virens</i>	X		X	
	Littleleaf Sumac	<i>Rhus microphylla</i>	X	X	X	X
<u><i>Asparagaceae</i></u>	Beargrass	<i>Nolina erumpens</i>	X	X	X	X
	Sotol	<i>Dasylirion leiophyllum</i>	X	X	X	X
<u><i>Asteraceae</i></u>	Broom Snakeweed	<i>Gutierrezia sarothrae</i>	X		X	X
	Mariola	<i>Parthenium incanum</i>	X	X	X	X
	Rabbitbrush	<i>Ericameria sp.</i>				X
	Skeleton-leaf Goldeneye	<i>Viguiera stenoloba</i>	X	X	X	X
<u><i>Berberidaceae</i></u>	Desert Holly	<i>Mahonia trifoliolata</i>	X	X		X
<u><i>Boraginaceae</i></u>	Plumed Crinklemat	<i>Tiquilia greggii</i>	X		X	X
<u><i>Ephedraceae</i></u>	Boundary Ephedra	<i>Ephedra aspera</i>	X	X	X	X
<u><i>Euphorbiaceae</i></u>	Desert Bernardia	<i>Bernardia myricifolia</i>		X	X	X
	Desert myrtlecroton	<i>Bernardia obovata</i>	X			
<u><i>Fabaceae</i></u>	Catclaw Acacia	<i>Acacia greggii</i>		X	X	X

	Desert Mimosa	<i>Mimosa aculeaticarpa</i>		X		X
	Feathery Dalea	<i>Dalea formosa</i>	X			X
	Honey Mesquite	<i>Prosopis glandulosa</i>		X		
	White-thorn Acacia	<i>Acacia constricta</i>	X	X	X	X
<u>Fouquieriaceae</u>	Ocotillo	<i>Fouquieria splendens</i>	X	X	X	X
<u>Rhamnaceae</u>	Warnock's Condalia	<i>Condalia warnockii</i>		X		X
<u>Scrophulariaceae</u>	Barometer Bush	<i>Leucophyllum minus</i>	X		X	
<u>Zygophyllaceae</u>	Creosote Bush	<i>Larrea tridentata</i>	X	X	X	X
	Agaves					
<u>Asparagaceae</u>	Shin Dagger	<i>Agave lechuguilla</i>	X		X	X
	Cacti					
<u>Cactaceae</u>	Brown-spined Prickley Pear	<i>Opuntia phaeacantha</i>	X		X	X
	Christmas Cactus	<i>Cylindropuntia leptocaulis</i>				X
	Cob Beehive Cactus	<i>Escobaria tuberculosa</i>			X	
	Engelmann's Prickley Pear	<i>Opuntia engelmannii</i>				X
	Pitaya	<i>Echinocereus enneacanthus</i>	X		X	
	Texas Rainbow Cactus	<i>Echinocereus dasyacanthus</i>			X	
	Yuccas					
<u>Asparagaceae</u>	Banana Yucca	<i>Yucca baccata</i>	X	X	X	X
	Eve's Needle Yucca	<i>Yucca faxoniana</i>	X	X	X	X
	Flower/Herb					
<u>Acanthaceae</u>	Parry's Wild Petunia	<i>Ruellia parryi</i>	X	X		X
<u>Apocynaceae</u>	Plateau Rock Trumpets	<i>Mandevilla macrosiphon</i>			X	X
<u>Asteraceae</u>	American Threefold	<i>Trixis californica</i>		X		X
	Desert Marigold	<i>Baileya multiradiata</i>	X			
	Dogweed	<i>Thymophylla pentachaeta</i>	X			

	Dudweed	<i>Psilostrophe gnaphalioides</i>	X	X		
	Palm-leaf	<i>Conoclinium</i>		X		
	Mistflower	<i>greggii</i>				
	Poreleaf	<i>Porophyllum scoparium</i>		X		
	Shortleaf Jefe	<i>Jefea brevifolia</i>	X	X	X	
	Small-head Sneezeweed	<i>Helenium microcephallum</i>	X	X	X	
	Yellow Spiny Daisy	<i>Machaeranthera pinnatifida</i>		X		
<u>Brassicaceae</u>	Fendler's Bladderpod	<i>Physaria fendleri</i>		X		
<u>Euphorbiaceae</u>	Croton	<i>Croton pottsii</i>				X
	Desert Tragacanth	<i>Tragacantha ramosa</i>	X	X		
<u>Euphorbiaceae</u>	Fendler's Spurge	<i>Chamaesyce fendleri</i>		X		
	Smartweed-leaf Flower	<i>Phyllanthus polygonoides</i>	X			
<u>Fabaceae</u>	Durango Senna	<i>Senna durangensis</i>	X		X	
<u>Malvaceae</u>	Dwarf Indian Mallow	<i>Abutilon parvulum</i>			X	
<u>Onagraceae</u>	Short-fruit Evening Primrose	<i>Oenothera brachycarpa</i>	X		X	
<u>Orobanchaceae</u>	Wholeleaf Indian Paintbrush	<i>Castilleja integra</i>	X	X	X	
<u>Polygalaceae</u>	Blue Milkwort	<i>Polygala barbeyana</i>	X			
	Glandleaf Milkwort	<i>Polygala macradenia</i>	X	X	X	X
<u>Rubiaceae</u>	Diamond Flower	<i>Stenaria nigricans</i>			X	
<u>Solanaceae</u>	Silverleaf Nightshade	<i>Solanum elaeagnifolium</i>	X			X
Ferns						
<u>Pteridaceae</u>	Cochise Scaley Cloakfern	<i>Astrolepis cochisensis</i>	X	X	X	
Spikemosses						
<u>Selaginellaceae</u>	Resurrection Fern	<i>Selaginella lepidophylla</i>	X		X	X
Vines						
<u>Apocynaceae</u>	Climbing Milkweed	<i>Sarcostemma crispum</i>	X	X		
<u>Fabaceae</u>	Texas Snoutbean	<i>Rhynchosia texana</i>	X		X	X

<u>Poaceae</u>	Grasses				
	Alkali Sacaton Grass	<i>Sporobolus airoides</i>			X
	Black Grama Grass	<i>Bouteloua eriopoda</i>	X	X	X
	Blue Grama Grass	<i>Bouteloua gracilis</i>	X		
	Fluff Grass	<i>Dasyochloa pulchella</i>			X
	Plains Bristlegrass	<i>Setaria vulpiseta</i>			X
	Sideoats Grama Grass	<i>Bouteloua curtipendula</i>	X	X	X
	Silverbeard Grass	<i>Bothriochloa laguroides</i>	X	X	X
	Tanglehead Grass	<i>Heteropogon contortus</i>			X
	Threeawn Grass	<i>Aristida sp.</i>			X

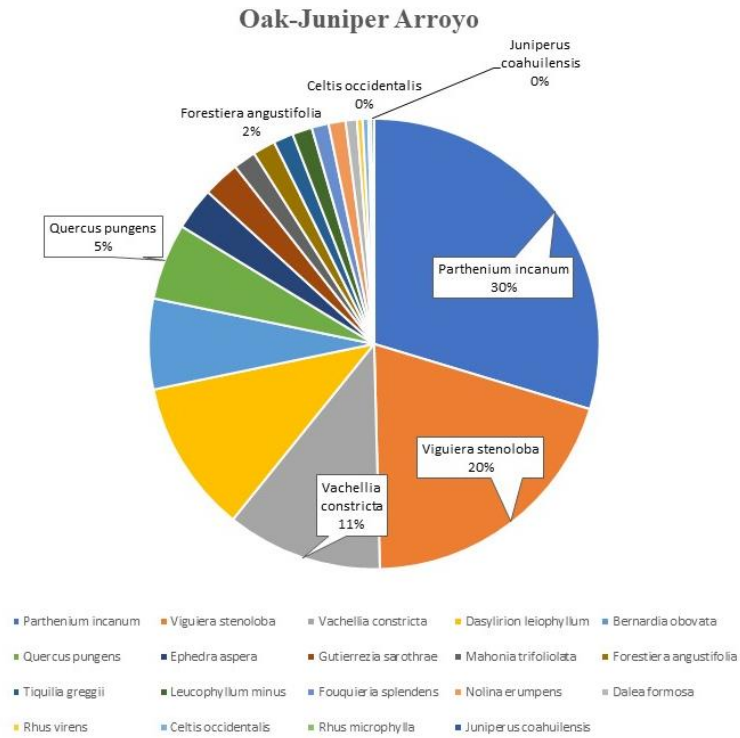


Figure 22: Pie chart depicting percent occurrences of shrub and tree species in Oak-Juniper Arroyo.

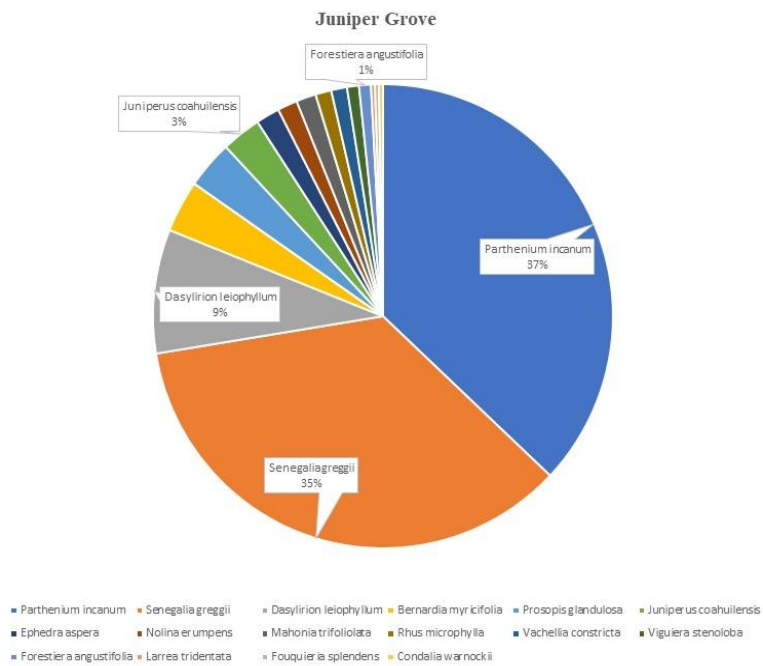


Figure 23: Pie chart depicting percent occurrence of shrub and tree species at Juniper Grove.

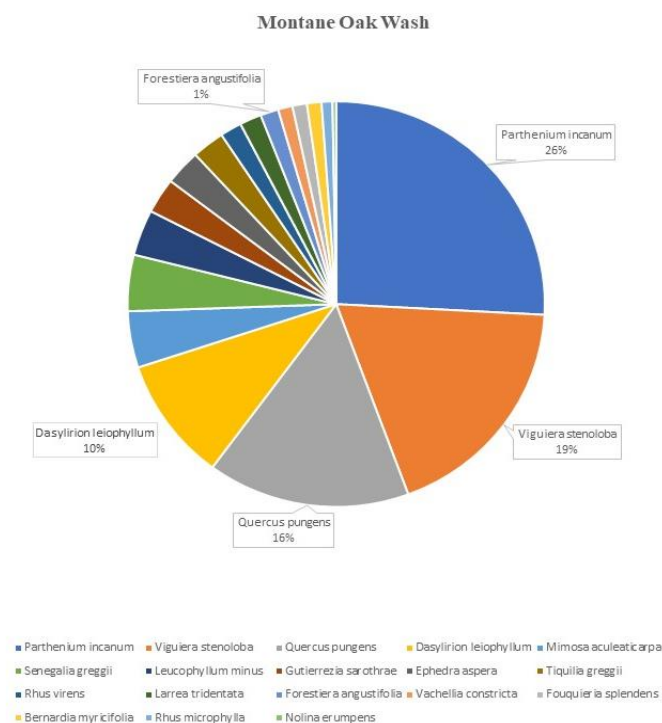


Figure 24: Pie chart depicting percent occurrence of shrub and tree species at Montane Oak Wash.

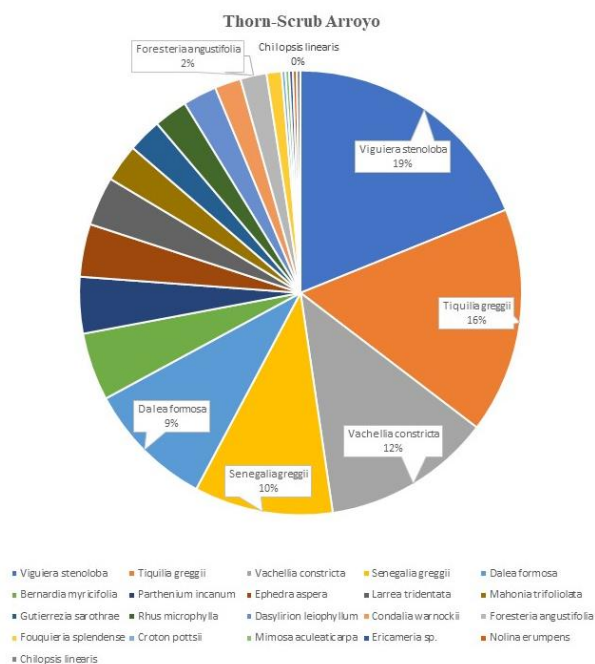


Figure 25: Pie chart depicting percent occurrence of shrub and tree species at Thorn-Scrub Arroyo.

Table 2: A list of birds found in each site, where S = species richness overall and by site, and the χ^2 Test of Independence ($\alpha = 0.05$) for June 2016-December 2017.

Family	Scientific Name	Common Name	Oak-Juniper Arroyo	Juniper Grove	Montane Oak Wash	Thorn-Scrub Arroyo
<u>Accipitridae</u>	<i>Aquila chrysaetos</i>	Golden Eagle		X		
	<i>Buteo jamaicensis</i>	Red-tailed Hawk	X			
<u>Cathartidae</u>	<i>Cathartes aura</i>	Turkey Vulture	X	X	X	
<u>Odontophoridae</u>	<i>Callipepla squamata</i>	Scaled Quail	X	X	X	X
<u>Columbidae</u>	<i>Zenaida asiatica</i>	White-winged Dove	X	X	X	X
	<i>Zenaida macroura</i>	Mourning Dove	X	X	X	X
<u>Cuculidae</u>	<i>Geococcyx californianus</i>	Greater Roadrunner	X	X	X	X
<u>Strigidae</u>	<i>Micrathene whitneyi</i>	Elf Owl		X		
<u>Caprimulgidae</u>	<i>Chordeiles acutipennis</i>	Lesser Nighthawk	X			
	<i>Chordeiles minor</i>	Common Nighthawk	X	X		X
<u>Trochilidae</u>	<i>Archilochus alexandri</i>	Black-chinned Hummingbird	X	X	X	X
	<i>Selasphorus platycercus</i>	Broad-tailed Hummingbird		X		X
	<i>Selasphorus calliope</i>	Calliope Hummingbird	X			
	<i>Selasphorus rufus</i>	Rufous Hummingbird		X		
<u>Picidae</u>	<i>Colaptes auratus</i>	Northern Flicker	X	X	X	
	<i>Picoides scalaris</i>	Ladder-backed Woodpecker	X	X	X	X
<u>Falconidae</u>	<i>Falco sparverius</i>	American Kestrel		X	X	
<u>Tyrannidae</u>	<i>Contopus sordidulus</i>	Western Wood-Pewee		X		
	<i>Empidonax minimus</i>	Least Flycatcher		X		
	<i>Empidonax wrightii</i>	Gray Flycatcher	X	X		X
	<i>Myiarchus cinerascens</i>	Ash-throated Flycatcher	X	X	X	X
	<i>Tyrannus verticalis</i>	Western Kingbird				X
<u>Laniidae</u>	<i>Lanius ludovicianus</i>	Loggerhead Shrike	X		X	
<u>Corvidae</u>	<i>Corvus cryptoleucus</i>	Chihuahuan Raven		X		
<u>Remizidae</u>	<i>Auriparus flaviceps</i>	Verdin	X	X	X	X
<u>Troglodytidae</u>	<i>Campylorhynchus brunneicapillus</i>	Cactus Wren	X	X	X	X
	<i>Catherpes mexicanus</i>	Canyon Wren		X	X	X
	<i>Salpinctes obsoletus</i>	Rock Wren	X	X	X	X
	<i>Thryomanes bewickii</i>	Bewick's Wren	X	X	X	X
	<i>Troglodytes aedon</i>	House Wren	X		X	

<u>Poliophtidae</u>	<i>Poliophtila caerulea</i>	Blue-Gray Gnatcatcher	X	X	X	X
	<i>Poliophtila melanura</i>	Black-tailed Gnatcatcher	X	X		X
<u>Regulidae</u>	<i>Regulus calendula</i>	Ruby-crowned Kinglet	X	X	X	X
<u>Mimidae</u>	<i>Mimus polyglottos</i>	Northern Mockingbird	X	X	X	X
	<i>Toxostoma crissale</i>	Crissal Thrasher	X	X		X
	<i>Toxostoma curvirostre</i>	Curve-billed Thrasher	X			
<u>Parulidae</u>	<i>Cardellina pusilla</i>	Wilson's Warbler	X			
	<i>Geothlypis tolmiei</i>	MacGillivray's Warbler		X		X
	<i>Setophaga coronata</i>	Yellow-rumped Warbler		X	X	
	<i>Setophaga townsendi</i>	Townsend's Warbler		X	X	
<u>Passerellidae</u>	<i>Aimophila ruficeps</i>	Rufous-crowned Sparrow	X	X	X	X
	<i>Amphispiza bilineata</i>	Black-throated Sparrow	X	X	X	X
	<i>Junco hyemalis</i>	Dark-eyed Junco	X	X	X	
	<i>Melospiza fusca</i>	Canyon Towhee	X	X	X	
	<i>Peucaea cassinii</i>	Cassin's Sparrow	X			
	<i>Pipilo chlorurus</i>	Green-tailed Towhee		X	X	
	<i>Pipilo maculatus</i>	Spotted Towhee	X	X		
	<i>Spizella breweri</i>	Brewer's Sparrow			X	
	<i>Spizella pallida</i>	Clay-colored Sparrow	X		X	X
	<i>Spizella passerina</i>	Chipping Sparrow	X	X	X	
	<i>Zonotrichia leucophrys</i>	White-crowned Sparrow	X			
<u>Cardinalidae</u>	<i>Cardinalis sinuatus</i>	Pyrrhuloxia		X	X	X
	<i>Passerina amoena</i>	Lazuli Bunting		X		
	<i>Passerina caerulea</i>	Blue Grosbeak	X	X	X	X
	<i>Passerina ciris</i>	Painted Bunting	X			
	<i>Passerina versicolor</i>	Varied Bunting		X		
	<i>Piranga ludoviciana</i>	Western Tanager	X	X		
	<i>Icterus cucullatus</i>	Hooded Oriole		X		
<u>Icteridae</u>	<i>Icterus parisorum</i>	Scott's Oriole	X	X	X	X
	<i>Molothrus aeneus</i>	Bronzed Cowbird		X		X
	<i>Molothrus ater</i>	Brown-headed Cowbird	X		X	
	<i>Haemorrhous mexicanus</i>	House Finch	X	X	X	X
<u>Fringillidae</u>	<i>Spinus psaltria</i>	Lesser Goldfinch	X	X	X	X
S overall: 64		S by Site:	43	50	36	32

$$\chi^2 = 2.365 \text{ df} = 3$$

$$p\text{-value} > 0.50$$

Table 3: S per site per season surveyed and contingency table depicting χ^2 Test of Independence ($\alpha = 0.05$).

Species Richness by Site				
Season	Oak-Juniper Arroyo	Juniper Grove	Montane Oak Wash	Thorn-scrub Arroyo
Spring	24	28	15	16
Summer	28	37	24	22
Fall	17	24	24	17
Winter	8	3	1	2
$\chi^2 = 11.141$ p-value = 0.27				

Table 4: S per site per bird category and contingency table depicting χ^2 Test of Independence ($\alpha = 0.05$).

Species Richness by Site				
Range Classification	Oak-Juniper Arroyo	Juniper Grove	Montane Oak Wash	Thorn-scrub Arroyo
Year-round	24	24	21	19
Summer Breeding	8	9	6	8
Migration	6	11	2	4
Winter Non-Breeding	6	7	8	1
$\chi^2 = 9.1132$ p-value = 0.43				

Table 5: Shannon's and Simpson's diversity indices by site, including S, total number of organisms, and average population size per site.

	<i>S</i>	<i># of organisms</i>	<i>Avg. Pop. Size</i>	<i>Diversity</i>	<i>Indexes</i>
<i>Sites</i>				Shannon's	Simpson's
<i>Oak-Juniper Arroyo</i>	43	354	8.233	4.576	0.05965
<i>Juniper Grove</i>	50	342	6.84	3.38	0.04785
<i>Montane Oak Wash</i>	36	228	6.333	3.074	0.05789
<i>Thorn-scrub Arroyo</i>	32	207	6.469	2.61	0.1584



Figure 26: An abandoned *Z. macroura* nest in a *Q. pungens* tree within Oak-Juniper Arroyo during the summer of 2017.



Figure 27: Two *Z. macroura* eggs in a *Q. pungens* tree within Oak-Juniper Arroyo during the summer of 2016.



Figure 28: Two *Z. macroura* nestlings in a *Q. pungens* tree within Oak-Juniper Arroyo in summer of 2016.



Figure 29: *A. alexandri* nesting in a *J. coahuilensis* tree within Oak-Juniper Arroyo during the summer of 2017.



Figure 30: *P. caerulea* nest in a *Q. pungens* tree within the Oak Wash during the summer of 2017.



Figure 31: An abandoned *A. flavescens* nest in a *F. pubescens* tree found in the Oak-Juniper Arroyo during the winter of 2016.

Table 6: Nesting occurrences by species, date, location, and other notes in the sites containing juniper and/or oak trees.

Date	Common Name	Species Name	Nest Plant	Location
8/19/2016- 8/26/2016	Mourning Dove	<i>Zenaida macroura</i>	<i>Quercus pungens</i>	Oak-Juniper Arroyo
8/28/2016	Canyon Towhee	<i>Melospiza fusca</i>	<i>Quercus pungens</i>	Oak-Juniper Arroyo
5/7/2017- 6/6/2017	Black-chinned Hummingbird	<i>Archilochus alexandri</i>	<i>Juniperus coahuilensis</i>	Oak-Juniper Arroyo
7/8/2017	Cactus Wren	<i>Campylorhynchus brunneicapillus</i>	<i>Yucca faxoniana</i>	Oak-Juniper Arroyo
7/8/2017	Blue Grosbeak	<i>Passerina caerulea</i>	<i>Quercus pungens</i>	Oak-Juniper Arroyo
7/23/2017	Black-chinned Hummingbird	<i>Archilochus alexandri</i>	<i>Juniperus coahuilensis</i>	Juniper Grove
7/29/2017	Black-throated Sparrow	<i>Amphispiza bilineata</i>	<i>Larrea tridentata</i>	Juniper Grove
7/30/2017	Canyon Towhee	<i>Melospiza fusca</i>	<i>Rhus virens</i>	Montane Oak Wash

Table 7: Species documented mating by date, and location in sites containing juniper and/or oak tree.

Date	Common Name	Species Name	Location
7/21/2016	Western Tanager	<i>Piranga ludoviciana</i>	Oak-Juniper Arroyo
7/21/2016	Blue Grosbeak	<i>Passerina caerulea</i>	Oak-Juniper Arroyo
7/23/2016	Loggerhead Shrike	<i>Lanius ludovicianus</i>	Oak-Juniper Arroyo
8/20/2016	Blue-Gray Gnatcatcher	<i>Polioptila caerulea</i>	Oak-Juniper Arroyo
8/27/2016	Pyrrhuloxia	<i>Cardinalis sinuatus</i>	Montane Oak Wash
8/27/2016	Blue Grosbeak	<i>Passerina caerulea</i>	Montane Oak Wash
8/28/2016	Scott's Oriole	<i>Icterus parisorum</i>	Oak-Juniper Arroyo
10/2/2016	Elf Owl	<i>Micrathene whitneyi</i>	Juniper Grove
10/29/2016	Canyon Wren	<i>Catherpes mexicanus</i>	Juniper Grove

10/29/2016	Spotted Towhee	<i>Pipilo maculatus</i>	Oak-Juniper Arroyo
3/26/2017	Greater Roadrunner	<i>Geococcyx californianus</i>	Montane Oak Wash
5/6/2017	Gray Flycatcher	<i>Empidonax wrightii</i>	Oak-Juniper Arroyo
5/7/2017	Blue Grosbeak	<i>Passerina caerulea</i>	Juniper Grove
5/19/2017	Blue Grosbeak	<i>Passerina caerulea</i>	Oak-Juniper Arroyo
5/19/2017	Scott's Oriole	<i>Icterus parisorum</i>	Juniper Grove
5/19/2017	Rufous-crowned Sparrow	<i>Aimophila ruficeps</i>	Oak-Juniper Arroyo
5/21/2017	Northern Mockingbird	<i>Mimus polyglottos</i>	Juniper Grove
6/6/2017	Rufous-crowned Sparrow	<i>Aimophila ruficeps</i>	Oak-Juniper Arroyo
7/8/2017	White-winged Dove	<i>Zenaida asiatica</i>	Oak-Juniper Arroyo
7/8/2017	Bewick's Wren	<i>Thryomanes bewickii</i>	Montane Oak Wash
7/8/2017	Cactus Wren	<i>Campylorhynchus brunneicapillus</i>	Oak-Juniper Arroyo
7/8/2017	House Finch	<i>Haemorhous mexicanus</i>	Oak-Juniper Arroyo
7/8/2017	Scott's Oriole	<i>Icterus parisorum</i>	Oak-Juniper Arroyo
7/22/2017	Scaled Quail	<i>Callipepla squamata</i>	Oak-Juniper Arroyo
7/22/2017	Scott's Oriole	<i>Icterus parisorum</i>	Oak-Juniper Arroyo
7/22/2017	Ash-throated Flycatcher	<i>Myiarchus cinerascens</i>	Oak-Juniper Arroyo
7/22/2017	House Finch	<i>Haemorhous mexicanus</i>	Montane Oak Wash
7/29/2017	Black-throated Sparrow	<i>Amphispiza bilineata</i>	Juniper Grove
7/30/2017	Canyon Towhee	<i>Melospiza fusca</i>	Montane Oak Wash
9/8/2017	Wilson's Warbler	<i>Wilsonia pusilla</i>	Juniper Grove
9/8/2017	Ruby-crowned Kinglet	<i>Regulus calendula</i>	Juniper Grove
9/23/2017	Black-throated Sparrow	<i>Amphispiza bilineata</i>	Juniper Grove
9/23/2017	Blue-gray Gnatcatcher	<i>Poliophtila caerulea</i>	Juniper Grove

Spring & Fall Migrant Arrivals: 2016-2017

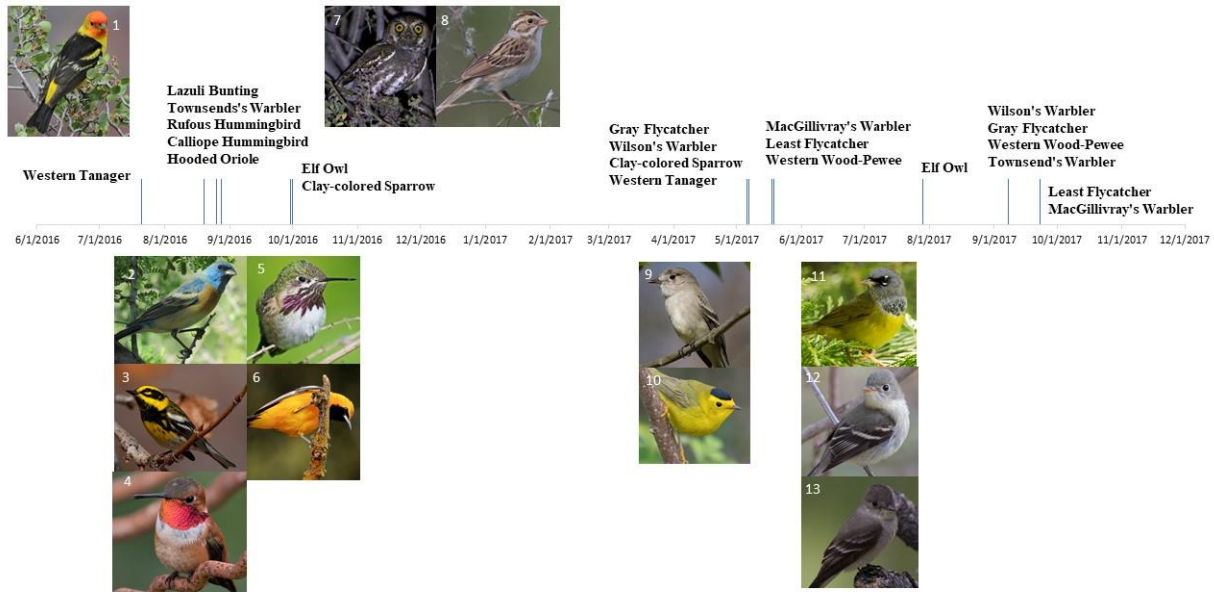


Figure 32: Migrating birds FADs documented during the study for 2016- 2017 (Macaulay Library, 2018¹⁻¹³).

Table 8. Migrating birds and their first arrival and departure dates documented during the study for fall 2016-winter 2017.

<i>Date</i>	<i>Common Name</i>	<i>Species Name</i>
7/21/2016	Western Tanager	<i>Piranga ludoviciana</i>
8/20/2016	Lazuli Bunting	<i>Passerina amoena</i>
8/26/2016-8/27/2016	Townsend's Warbler	<i>Setophaga townsendi</i>
8/26/2016	Rufous Hummingbird	<i>Selasphorus rufus</i>
8/26/2016	Calliope Hummingbird	<i>Selasphorus calliope</i>
8/28/2016	Hooded Oriole	<i>Icterus cucullatus</i>
8/28/2016	Western Wood-Pewee	<i>Contopus sordidulus</i>
9/30/2016-10/2/2016	Elf Owl	<i>Micrathene whitneyi</i>
10/1/2016-12/15/2016	Clay-colored Sparrow	<i>Spizella pallida</i>
5/6/2017-5/7/2017	Gray Flycatcher	<i>Empidonax wrightii</i>
5/6/2017	Wilson's Warbler	<i>Cardellina pusilla</i>
5/7/2017	Clay-colored Sparrow	<i>Spizella pallida</i>

5/7/2017	Western Tanager	<i>Piranga ludoviciana</i>
5/18/2017	MacGillivray's Warbler	<i>Geothlypis tolmiei</i>
5/19/2017	Least Flycatcher	<i>Empidonax minimus</i>
5/19/2017	Western Wood-Pewee	<i>Contopus sordidulus</i>
7/29/2017	Elf Owl	<i>Micrathene whitneyi</i>
9/8/2017	Wilson's Warbler	<i>Wilsonia pusilla</i>
9/8/2017	Gray Flycatcher	<i>Empidonax wrightii</i>
9/8/2017	Western Wood-Pewee	<i>Contopus sordidulus</i>
9/8/2017	Townsend's Warbler	<i>Setophaga townsendi</i>
9/23/2017	Least Flycatcher	<i>Empidonax minimus</i>
9/23/2017	MacGillivray's Warbler	<i>Geothlypis tolmiei</i>

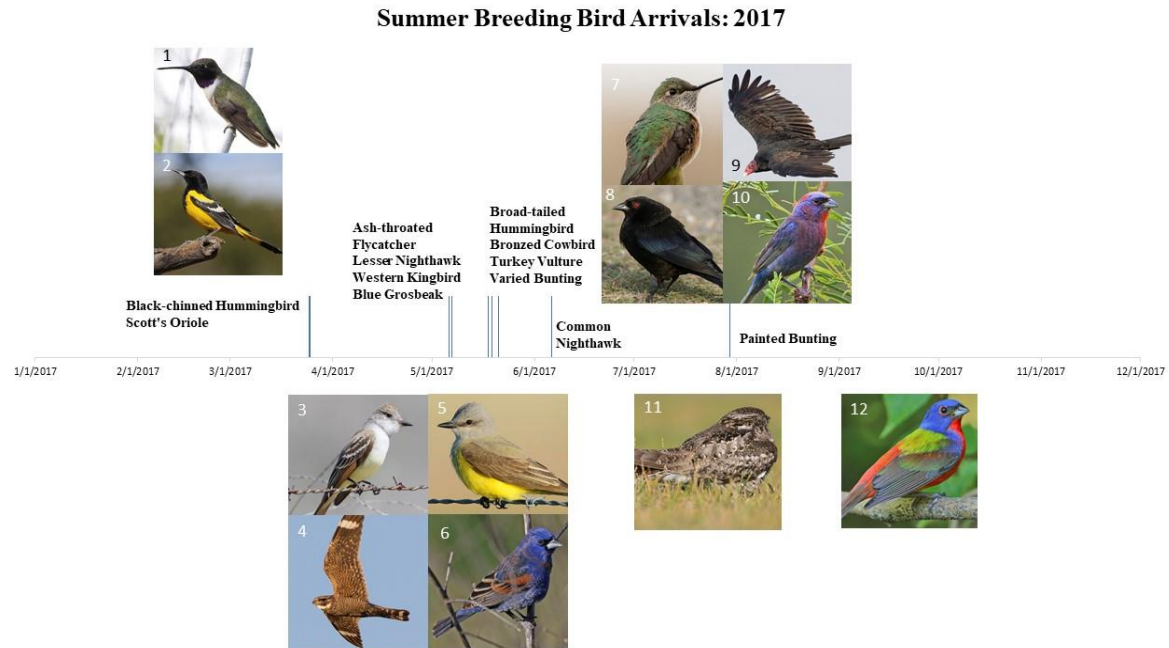


Figure 33: Summer breeding birds and their FADs documented during the study for 2017
(Macaulay Library, 2018¹⁻¹²)

Table 9: Summer breeding bird arrival and departure dates documented during the study for 2017.

<i>Date</i>	<i>Common Name</i>	<i>Scientific Name</i>
3/25/2017-7/23/2017	Black-chinned Hummingbird	<i>Archilochus alexandri</i>
3/25/2017-9/8/2017	Scott's Oriole	<i>Icterus parisorum</i>
5/6/2017-7/23/2017	Ash-throated Flycatcher	<i>Myiarchus cinerascens</i>
5/6/2017-7/30/2017	Lesser Nighthawk	<i>Chordeiles acutipennis</i>
5/6/2017	Western Kingbird	<i>Tyrannus verticalis</i>
5/7/2017-9/23/2017	Blue Grosbeak	<i>Passerina caerulea</i>
5/7/2017	Broad-tailed Hummingbird	<i>Selasphorus platycercus</i>
5/19/2017-6/6/2017	Bronzed Cowbird	<i>Molothrus aeneus</i>
5/21/2017-9/8/2017	Turkey Vulture	<i>Cathartes aura</i>
5/21/2017	Varied Bunting	<i>Passerina versicolor</i>
6/6/2017-7/30/2017	Common Nighthawk	<i>Chordeiles minor</i>
7/30/2017	Painted Bunting	<i>Passerina ciris</i>

Winter Non-Breeding Bird Arrival Dates: 2016-2017

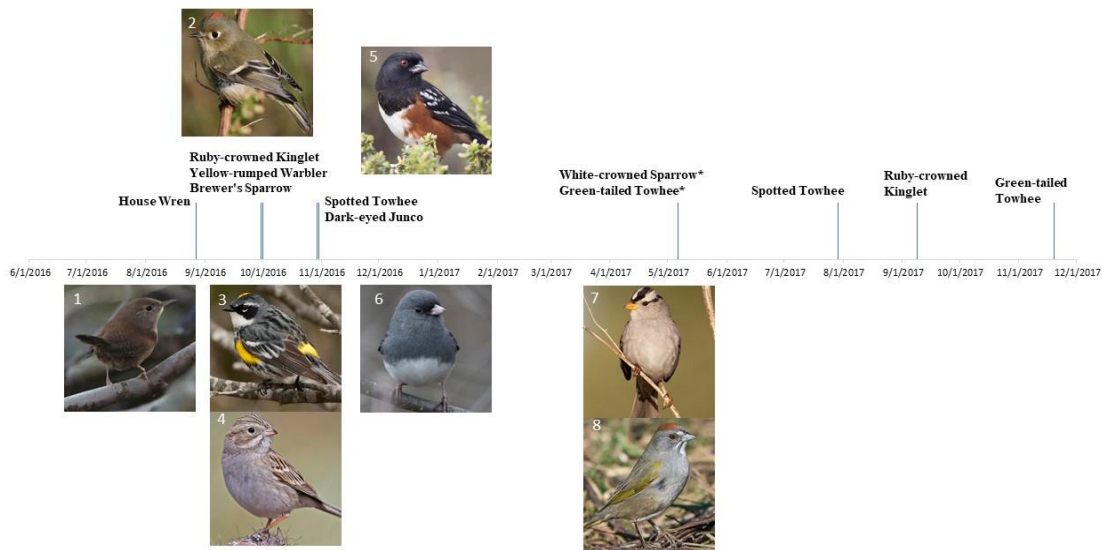


Figure 34: Winter non-breeding birds and their FADs documented during the study for 2016-2017 (Macaulay Library, 2018¹⁻⁸) (* indicates birds outside of their seasonal range).

Table 10: Winter non-breeding birds and their first arrival and departure dates documented during the study for 2016-2017 (* indicates birds outside of their seasonal range).

<i>Common Name</i>	<i>Species Name</i>	<i>Date</i>
<i>House Wren</i>	<i>Troglodytes aedon</i>	8/27/2016
<i>Ruby-crowned Kinglet</i>	<i>Regulus calendula</i>	9/30/2016-3/26/2017
<i>Yellow-rumped Warbler (Audubon's)</i>	<i>Setophaga coronata</i>	10/1/2016-10/2/2016
<i>Brewer's Sparrow</i>	<i>Spizella breweri</i>	10/1/2016
<i>Spotted Towhee</i>	<i>Pipilo maculatus</i>	10/29/2016-3/26/2017
<i>Dark-eyed Junco</i>	<i>Junco hyemalis</i>	10/30/2016-1/28/2017
<i>White-crowned Sparrow*</i>	<i>Zonotrichia leucophrys</i>	5/6/2017
<i>Green-tailed Towhee*</i>	<i>Pipilo chlorurus</i>	5/6/2017
<i>Spotted Towhee</i>	<i>Pipilo maculatus</i>	7/29/2017
<i>Ruby-crowned Kinglet</i>	<i>Regulus calendula</i>	9/8/2017
<i>Green-tailed Towhee</i>	<i>Pipilo chlorurus</i>	11/19/2017



Figure 35: Photograph depicting one of the Elf Owls at Juniper Grove perched on a mesquite growing around the juniper stands on 10/2/2017.

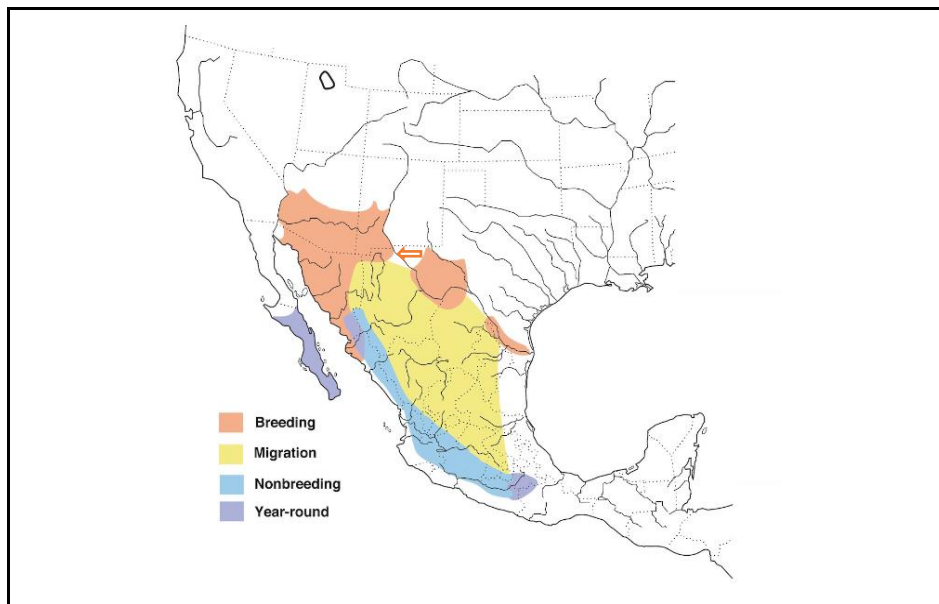


Figure 36: Range map depicting the most current breeding, migration, non-breeding, and year-round range of *M. whitneyi* (Birds of North America, 2018; Henry and Gehlbach, 1999). (Red arrow indicates the location of IMRS)



Figure 37: Photographs of *C. minor* perching in different juniper trees and other vegetation structures of Oak-Juniper Arroyo during the summer of 2016.



Figure 38: Photograph of *S. calliope* perching on a juniper tree branch in Oak-Juniper Arroyo during the summer of 2016.

Discussion

PLANT COMMUNITIES - The Chihuahuan Desert of Trans-Pecos contains southern vegetation groups within the Madrean Region, called the Chihuahuan and Apachian groups; the Chihuahuan having endemic vegetation from the Chihuahuan Plateau, southern New Mexico, and Trans-Pecos region of Texas, and the Apachian having vegetation confined to the northwestern Chihuahuan Plateau into southwestern New Mexico and southeastern Arizona, both containing Madrean species (McLaughlin, 1992). Based on the plant survey data (Table 1; Figures 18, 19, 20, 21), sites containing oak or both oak and juniper tree associations within arroyos and canyons (Oak-Juniper Arroyo at an elevation of 1332-m and Montane Oak Wash at an elevation of 1358-m) are most similar to a Montane Chaparral System; they could even be a gradient between this system and a Montane Woodlands system (Hendrickson and Johnston, 1986). Based on the plant species present, the sites could be designated as Madrean Oriental Chaparral (NatureServe, 2009). These plant communities are found on Permian limestone mountains of West Texas, on rocky and gravelly slopes with no real soil development, are considered above the desert shrublands, and typically occur on more xeric sites with moderate to dense vegetation (Texas Parks and Wildlife Department). Plant species of note were, the Cochise Scaley Cloakfern (*Astrolepis cochisensis*), the Indian Paintbrush (*Castilleja integra*), and the Short-fruit Evening Primrose (*Oenothera brachycarpa*) present in Oak-Juniper Arroyo, Montane Oak Wash, and Juniper Grove. Also, of note in Montane Oak Wash, we found False Earth Star fungi (*Astraeus hygrometricus*) growing atop *Q. pungens* leaf litter in areas where the previously mentioned plants were growing, and where moisture was maintained by the limestone providing ample shade throughout the day. Juniper trees noted within and near Oak-Juniper Arroyo, but not tallied in the random plant survey, were *J. pinchotii* (Worthington et al., 2018). *Juniperus*

pinchotii can occupy these elevations if the geological conditions are favorable (Hendrickson and Johnston, 1986). Similarly, *J. pinchotii* is found in Arizona chaparral woodlands with shrub live oak (*Q. turbinella*), since they form associations in shrublands and woodlands (Sullivan, 1993). In Juniper Grove (Table 1; Figure 19), the elevation was 1319-m, and the types of flower/herbs found, the species of juniper found canvassing the area (*J. coahuilensis*), and the habitat being situated completely surrounded by hills, rather than large limestone slabs, led us recommend it be designated as Apacherian-Chihuahuan Mesquite Upland Scrub (NatureServe, 2009). The Bureau of Land Management (BLM) defines this as a Rocky Mountain Piedmont, located a bit above the Lower Basin and Range physiographic region (Sullivan, 1993). The Thorn-scrub Arroyo plant composition (Table 1; Figure 21, at an elevation of 1228-m, was typical of the Chihuahuan Desert Thorn-scrub classification (NatureServe, 2009), which was expected, due to the presence of plant species such as *F. pubescens*, *C. linearis*, *Yucca* sp., *T. greggi*, and *A. constricta* (Table 1), as well as the surrounding conglomerate substrate with sandy soils identified in the area (Worthington et al., 2018). Madrean Oriental Chaparral and the Apacherian-Chihuahuan Mesquite Upland Scrub vegetation communities do not dominate this landscape, but the Chihuahuan Desert Thorn-scrub is common. It is important to note, that all of these vegetation community sub-classifications are part of the broader shrubland classification (NatureServe, 2009).

Junipers, especially of the southwestern U.S., are very difficult to identify (Adams and Zanoni, 1979), and the most recent study using DNA analysis conducted with samples from the property indicated that *J. coahuilensis* is present (Adams, 2017) which we can corroborate with photographic evidence of the light pink-orange cones from the juniper trees that don't exhibit shrub-like characteristics. Worthington et al. (2018), also noted *J. pinchotii* near the main road,

which we can also corroborate with photographic evidence of the darker red-brown cones and shrub-like tree characteristics. It is recommended that a more focused DNA project be conducted on the property. This is also the case for *Q. pungens*, which has also been historically difficult to identify (Muller, 1940). Without microscopic and DNA analysis of the trees, it is not possible at this time to know if hybridization is occurring with Wavyleaf Oak (*Q. undulata*), found overlapping in range with *Q. pungens*, and sharing evergreen to deciduous characteristics (Spellenberg et al., 2014) like what was seen in the sites with some of the trees.

AVIAN BIODIVERSITY - Bird species richness results indicated that Oak-Juniper Arroyo held many species during the survey (2016-2017), including many bird species in each season and bird range category, but it did not hold significantly more bird species than any of the other sites, where $p > 0.50$ (Table 2), $p = 0.2662$ by season (Table 3), and $p = 0.4269$ by bird range category (Table 4). Juniper Grove held numerically more bird species in any site (Table 2), season (Table 3), or bird range category (Table 4), but did not hold significantly more species than any of the other surveyed sites. We failed to reject our null hypotheses, and rejected our alternative hypotheses, which stated that 1) habitats on IMRS that contain juniper and/or oak and thorn-scrub vegetation will support significantly different bird species richness, 2) juniper and oak habitats (Oak-Juniper Arroyo) will hold significantly more migrant bird species, and 3) juniper and oak habitats (Oak-Juniper Arroyo) will hold significantly more bird species in the fall than in any other season. As shown in Table 2, bird species occupying the sites varied, with some species only being found in one site, a few sites, or all sites. Birds found in all sites during the survey were largely year-round species that utilize the typical Chihuahuan Desert landscape and have been well documented by several studies (Dixon, 1959; Ely, 1962; Gutzwiller and Barrow Jr., 2003; Kozma and Mathews, 1997; Kozma et al., 2012; Naranjo and Rait, 1993; Nelson et al.,

1997; Nelson et al., 1999; Pidgeon et al., 2003; Rait and Pimm, 1976; Wiseman, 2014). One year-round species we did not document in this study that historically occurred in the region, and has not been documented on IMRS to date, was the highly understudied *Columbina inca* (Inca Dove). It now occurs mainly in urban areas, but used to occur in natural arid habitats across the desert southwest (Mueller, 2004). Birds found in all study sites, that were not year-round species, were *I. parisorum*, *M. cinerascens* and *P. caerulea*, well documented summer breeding birds in the desert southwest (Naranjo and Rait, 1993; Gutzwiller and Barrow, 2003), and *R. calendula*, a well-documented wintering bird of the entire southern USA (Swanson et al., 2008), including IMRS (Worthington et al, 2018).

Birds found utilizing only the Oak-Juniper Arroyo (Table 2), were *C. pusilla*, *C. acutipennis*, *P. ciris*, *P. cassinii*, *S. calliope*, *T. curvirostre*, and *Z. leucophrys*, which are a variety of migrants and summer breeding birds, with the exception of *T. curvirostre* and *Z. leucophrys*, which are year-round and wintering species, respectively. The warbler, *C. pusilla*, prefers riparian zones and its populations have declined recently, due to loss of preferred habitat (Ammon and Gilbert, 1999). Oak-Juniper Arroyo contains very dense vegetation and limestone structures that hold water very well in the rainy season, so *C. pusilla* may be stopping over in this type of site, because it has the preferred resources for migration. Also, a probable cause is the use of two ephemeral cattle tanks nearby, which have riparian vegetation, so *C. pusilla* may have been exploring Oak-Juniper Arroyo for resources since it was already nearby. A *P. ciris* male was documented singing in Oak-Juniper Arroyo, and since they prefer woodland edge habitat and IMRS is within their breeding range, albeit their scarce breeding range, this sighting was expected (Lowther et al., 2015). The sparrow, *P. cassinii*, is considered unpredictable in its habitat preference, since it is highly understudied and might be nomadic depending on the

environmental conditions (Dunning et al., 1999). The sighting of a *P. cassinii* flock in this study reveals little about its life history, other than males of its species showed up for one morning only in the Oak-Juniper Arroyo grassy and shrub-filled edging and performed its “skylarking.” To the best of my knowledge, *P. cassinii* has not been documented performing this mating display on IMRS in the past, further lending evidence that they may indeed be nomadic, looking for random breeding sites. Further study is needed, especially using the weather stations on IMRS to test if there is a link between rainfall or other abiotic conditions for this species on IMRS. The nighthawk, *C. acutipennis*, was present in lower relative abundance in Oak-Juniper Arroyo compared to its relative, *C. minor*, which was in higher in relative abundance, especially during the summer of 2016 (Appendix 1). This species was documented perching on some vegetation structures, but *C. minor* was documented perching on many juniper branches and yucca stumps in the morning hours (Figure 35) and was observed searching for insects in multiple study sites (Table 2). IMRS is also within both species’ summer breeding range, but *C. minor* actually prefers woody and coniferous habitats, whereas *C. acutipennis* prefers arid and semi-arid scrub habitats; both lay their eggs on the ground in substantial leaf-litter (Brigham, 2011; Latta and Baltz, 2012), which is well provided by the oak trees, but no eggs were found during this study (they are very difficult to spot due to camouflage). The hummingbird, *S. calliope*, is the smallest long distance migrating hummingbird, but not much is known about its life history or biology (Calder and Calder, 1994). It had never been documented on IMRS before and was simply photographed perching in a juniper tree in Oak-Juniper Arroyo (Figure 36). It is possible this hummingbird prefers stopping over in these unique arroyo habitats containing scrub oaks and juniper trees in search of resources, and since these areas have never been surveyed in the Trans-Pecos region, this data can help fill in some life history information for the species. It

was, however, a singleton sighting and we never documented one thereafter. The sparrow, *Z. leucophrys*, a wintering bird of the region, shows range pattern diversity, meaning populations are present year-round and others migrate short or long distances depending on where in the U.S. they are (Chilton et al., 1995). This sparrow was documented utilizing only Oak-Juniper Arroyo, but was also present 5/6/2017 (Figure 32, Table 10), providing evidence that the species' year-round range may extend farther south in the U.S. than the currently documented southerly range in northern New Mexico. It is possible that more populations of this species are adapting to using these areas year-round, rather than just during the winter. It is also possible, that due to the lack of access to land for wildlife surveys in the Trans-Pecos region, the species has historically used this region year-round, similar to other spotty year-round ranges across the western USA. These sightings show that these unstudied habitats may be uniquely important to birds other than year-round residents.

The thrasher, *T. curvirostre*, is a common year-round bird of the desert southwest, with a general habitat preference for shrubby landscapes, but also brushy woodlands and anthropogenically altered habitats (Tweit, 1996). Oak-Juniper Arroyo has plenty of brush habitat with woodland species intertwined in the vegetation structure with surrounding desert scrub in all directions, so this may have been preferred habitat for the species. Its closest relative, *T. crissale*, was also documented using Oak-Juniper Arroyo (along with Juniper Grove and Thornscrub Arroyo), consistent with its preference for dense vegetation patches in the southwest; large desert washes, mesquite stands, and more specifically, pine-oak-juniper habitats containing dense shrubs in the region (Cody, 1999).

Birds found utilizing only Juniper Grove (Table 2) were *A. chrysaetos*, *C. sordidulus*, *C. cryptoleucus*, *E. minimus*, *I. cucullatus*, *M. whitneyi*, *P. amoena*, and *P. versicolor*. *A.*

chrysaetos, the more commonly spotted eagle, is present year-round in the western U.S. and occupies mountain canyon habitats of deserts and grasslands in the region (Kochert, 2002), so spotting one by Juniper Grove was to be expected, and the species has been well documented in the area (Worthington et al. 2018). Finding this species in only Juniper Grove, and not when surveying other habitats may have been due to chance, since they soar frequently over the landscape during all times of the year. The migrating flycatcher, *C. sordidulus*, enjoys forest edges and riparian zones (Bemis and Rising, 1999), so Juniper Grove provides the type of vegetation it prefers for hunting insects, having cover, and plenty of perching sites during migration. The raven, *C. cryptoleucus*, occupies desert grasslands with scattered shrubs, chooses nesting sites in places that have mesquite, acacia, and yuccas, and ventures into the lower edge of pinon-juniper habitats (Dwyer et al, 2013). Although *C. cryptoleucus* was seen only at Juniper Grove during this study, the species has been well documented around IMRS flying over the mountain ranges and interacting with other individuals in flight (Worthington et al., 2018). The migrant flycatcher, *E. minimus*, stops over in the region, prefers wooded habitats, or sometimes isolated patches of trees (Tarof and Briskie, 2008), so spotting one at Juniper Grove was expected. *Icterus cucullatus*, a less common oriole spotted on IMRS compared to *I. parisorum*, has a migration range that included IMRS, and although research on their migration habitat selection is lacking in the literature, it is known that they like to breed in habitats with scattered trees and lush vegetation, most commonly choosing mesquite thickets, willows, or cottonwood stands near the Rio Grande (Pleasants and Albano, 2001). *Icterus. cucullatus* may have been stopping over in Juniper Grove in search of breeding habitat or resources on the way to its breeding range, since it contains oasis-like features within the desert scrub, like large juniper trees, shade, and wildflowers. *Micrathene whitneyi*, the smallest owl in the world, does not have

a clear range in the Trans-Pecos region, but occupies all kinds of vegetation communities, like evergreen woodland, subtropical vegetation, desert habitats, and habitats semi-altered by humans (Henry and Gehlbach, 1999). It is likely, due to a lack of land available for research, that they occupy preferred habitats in the Trans-Pecos region for breeding, as has been documented previously on IMRS (Worthington et al., 2018). *Passerina. versicolor*, a bunting with a breeding range mainly in Mexico, has a life history that is neglected in the literature, but is known to occupy areas that have woodland or thorn scrub vegetation like our sites on IMRS (Groschupf and Thompson, 1998). As with other birds previously mentioned, *P. versicolor* may have historically occupied disjoint patches of preferred vegetation communities for breeding in the Trans-Pecos region, but lack of available land for surveying has contributed to the gaps in its life history literature, including more accurate range maps.

Spizella breweri, an emberizid that largely occupies sagebrush lands of the western U.S., is a winter occupant of the desert scrub of the southwest and was found utilizing just the Montane Oak Wash. Literature indicates that *S. breweri* inhabits areas away from humans, even if they occupy large landscapes, making it difficult to understand reported declines in its breeding populations. (Rotenberry et al., 1999) It is not clear why we found *S. breweri* in just this site, but more research on their wintering habitats in these landscapes and the resource they depend on to survive into the warm months may help determine why breeding populations are declining.

Only one bird, *T. verticalis*, was found using Thorn-scrub Arroyo, probably due to its preference for vegetation and structures closer to human disturbance, like trees outside of buildings and powerlines for nesting and perching (Ohlendorf, 1974). The Ranch House is not

far down the road from the site, and *T. verticalis* has been well documented in that area near the solar panels and other human structures (Worthington et al., 2018).

Diversity analysis indicated that Oak-Juniper Arroyo was more diverse than the other sites when species richness and evenness were measured (Shannon's Diversity Index) and Thorn-scrub Arroyo was the least diverse. When the Simpson's Diversity Index was used, Juniper Grove was more diverse, and Thorn-scrub Arroyo was still the least diverse. Given the plant community composition in Oak-Juniper Arroyo and Juniper Grove (Table 1), the habitats could provide ample cover, a unique mix of plant types, abundant resources, such as insects and seeds, and possible mates and nesting sites, all of which may look preferable when traveling across the landscape. Thorn-scrub Arroyo presented typical plant species of the Chihuahuan Desert scrub (Table 1; Figure 22), the cover wasn't as extensive, and it contained a high relative abundance of the endemic *A. bilineata* (Appendix 1) in comparison to other bird species, which caused the diversity to be lower in comparison to the other sites, which had more evenly distributed individuals across each species tallied.

NESTING AND MATING OCCURENCES - Most of the birds documented nesting and mating in the study sites are well documented in the literature, since most Chihuahuan Desert bird studies took place during the summer breeding season. Chihuahuan Desert year-round and summer breeding birds, like the species I documented (Table 6, Table 7), have been shown to prefer nesting in arroyo scrub vegetation in particular (Dixon, 1959; Kozma and Mathews, 1997) and in the surrounding scrub vegetation (Naranjo and Rait, 1993). *Amphispiza bilineata*, an endemic sparrow, has been well documented nesting in *L. tridentata* shrubs (Pidgeon et al., 2003) as I corroborated in this study. I also documented bird species nesting in plant species that were not recorded in the literature. *Passerina caerulea* was documented nesting in *Q. pungens*, but

photographic evidence was not as substantial, since I did not actively see the parents using the nest and could not get photographs of the eggs (Figure 27; Table 6). The hummingbird, *A. alexandri*, was documented nesting in *J. coahuilensis* in Oak-Juniper Arroyo (Figure 26; Table 6). To the best of my knowledge, this hummingbird has not been documented nesting in this species of juniper in particular, but has been documented nesting in *J. monosperma*, Alligator Juniper (*Juniperus deppeana*), a variety of *Quercus* species, and prefers habitats in semi-arid regions like the Chihuahuan Desert that have open woodland vegetation (Baltosser and Russell, 2000). *Zenaida macroura*, to the best of our knowledge, has not been documented nesting in *Q. pungens*. The study shows that not only in 2016, but in previous years, this dove had extensively used *Q. pungens* as a nest plant (Figures 23, 24, 25; Table 6). This could be due to its tall, dense, and intricate branching structure, as well as its rough spiny leaves providing support and protection for the nest and nestlings throughout incubation and fledging. In 2017, however, we did not document any new use of *Q. pungens* by *Z. macroura*, despite evidence that the site and trees were being used in the past. This is possibly due to abiotic conditions that need to be explored using data from the weather stations on IMRS, plant surveys, and exploration of other sites *Z. macroura* possibly nests in. This observation is consistent with observations of *C. minor* being present during its summer breeding season (Figure 34) in high relative abundance in Oak-Juniper Arroyo during the summer of 2016 (Appendix 1), but not using the habitat nearly as much during the summer of 2017. A multi-year study should be conducted to find out how *C. minor* uses these oak-juniper arroyos, confirm if eggs are present in leaf litter (no eggs were found), how many males are using these corridors, and why only certain years are preferable. *C. minor* breeds in such a variety of habitats (Brigham et al., 2011), it is not clear why so many were documented congregated in this area, especially males calling in flight, when they have

never been seen on the property in any vegetation community in that capacity. This documentation of nesting and mating further adds to the life history literature on the species utilizing the Trans-Pecos region. Most of the birds found mating or demonstrating mating behaviors were expected, since IMRS is within their summer breeding range, but *C. pusilla*, *E. wrightii*, *P. maculatus*, *M. whitneyi*, and *P. ludoviciana* were not expected to be present in mating pairs or displaying mating behavior, because IMRS is only within their migrating or wintering range according to the literature (Ammon and Gilbert, 1999; Schlossberg and Sterling, 2013; Bartos Smith and Greenlaw, 2015; Henry and Gehlbach, 1999; Hudon, 1999). As previously mentioned, due to land in the Trans-Pecos region being difficult to access for wildlife monitoring, so it is possible IMRS is within these species' historic range for breeding and/or year-round occupancy, but it is also possible they have adapted to using this region and these habitats in particular for year-round use or breeding.

MIGRANTS, SUMMER BREEDING, AND WINTERING BIRDS - We documented several bird species during our survey that are not present year-round and developed a snapshot of their arrival and departure times from 2016-2017. As indicated in Table 2 and 4, several migrant, summer breeding, and wintering species stopped over in Oak-Juniper Arroyo, Juniper Grove, Montane Oak Wash, and even the Thorn-scrub Arroyo. Table 8, 9, and 10 and Figures 29, 30, and 31 show each of their arrival times during the study. Migration forecasts have been compiled and are easily viewed online through various sources, including BirdCast (Bird Migration Forecasts in Real-Time, <http://birdcast.info/>). We found that migrating birds arrived during their expected times, although it was hard to measure when exactly they arrived or departed, since we traveled to survey bi-weekly, and had more time in between surveying on some occasions, due to weather or vehicle issues. There were obvious abnormalities in arrivals, though, such as winter

birds that arrived outside of winter. The towhee *P. chlorurus* and the sparrow *Z. leucophrys*, according to the literature, use this region for wintering and have a year-round range farther north (Dobbs et al, 2012; Chilton et al., 1995), but were found utilizing the sites in the summer (Figure 31, Table 10). As previously mentioned, these range maps may not be accurate. These species may have historically used higher elevation habitats in the Trans-Pecos region year-round, and survey data from areas like this can help update them. It is also possible their year-round range is expanding or changing, but without historical data, it is not possible to know. *M. whitneyi* was also found arriving during the summer and departing in the fall (Figure 29; Table 8). According to the literature, its range does not usually include the Trans-Pecos region (Henry and Gehlbach, 1999) and will be discussed in detail in our significant bird range updates.

SIGNIFICANT BIRD RANGE UPDATES - IMRS does not fall in any part of the published *M. whitneyi* migration or summer breeding range (Henry and Gehlbach, 1999). The most recent range map (Figure 34) indicates that their migration range is farther south in northern Mexico, and their breeding range is farther east and west in Arizona, New Mexico, and Texas. The most probable cause of these range maps not including the rest of west Texas, is simply a problem of access to land, since most of it is private ranch land, so wildlife data cannot be collected to update the literature. Previous documentation over several years of *M. whitneyi* breeding on IMRS (Worthington et al. 2018; G. H. Wiseman, pers. comm.) along with sightings of a pair and a group of 3 during this study, indicate they most likely use the region similar to how they use southeastern Arizona and Big Bend. The eBird data indicate that *M. whitneyi* sightings in the Trans-Pecos region were geo-referenced incorrectly, belonged in the Davis Mountain range or from students using eBird on IMRS, but were never photographed (sighting in Quitman Mountains; eBird, 2018). Further north, one sighting was reported without audio or photograph

documentation in the Organ Mountains in 1996 (eBird, 2018). The El Paso/Trans-Pecos Audubon Society indicates their surveys of private (permission accessed) land in Sierra Blanca did include *M. whitneyi* (J. Paton, pers. comm.), but there is no audio or photographic evidence available. Checklists published for the Davis Mountains State Park (Bryan et al., 2015) and Guadalupe Mountains National Park (Chambers, 2016) in combination with this study and citizen science data, indicate they are probably widespread across the region in preferred habitat during migration or summer breeding.

COMPARISON TO THE WISEMAN STUDY - A previous bird survey of five abandoned cattle tanks and a natural spring (Squaw Spring) on IMRS (Wiseman, 2014) showed similarities to the oak-juniper habitat study, but there were also major differences. For instance, we found many of the same birds utilizing our sites that utilized the cattle tanks and Squaw Spring, however, there were many more species of flycatchers found using the cattle tanks and the permanent, such as the Dusky Flycatcher, *Empidonax oberholseri*, Cordilleran Flycatcher, *Empidonax occidentalis*, Black Phoebe, *Sayornis phoebe*, Eastern Phoebe, *Sayornis nigricans*, and the Say's Phoebe, *Sayornis saya*. These flycatchers prefer stopping over in the desert during migration where there are oases (Lowther et al., 2016), shade and trees with broad-leaves (Pereyra and Sedgwick, 2015), cattle tanks and ephemeral ponds (Wolf, 1997), or in the case of the year-round *S. saya*, who choose a variety of habitats, including desert scrub, canyon openings, borders of deserts, open country, and more (Schukman and Wolf, 1998). I expected to document *S. saya*, since it is a year-round species. It may prefer the nearby cattle tanks and open desert scrub that is readily available nearby for nesting and perching for insect predation, rather than the arroyo systems we studied.

A variety of waterfowl Wiseman documented were not expected in our study. Vireos we did not document were the White-eyed Vireo, *Vireo griseus* and the Warbling Vireo, *Vireo gilvus*. The vireo, *V. griseus*, is a rare migrant for the region, given its range is much farther east (Hopp et al, 1995), however, *V. gilvus* prefers Five-stamen Tamarisk, *Tamarix* sp. habitats (the spring on IMRS contains tamarisk) during migration, but has also been documented preferring desert scrub and oak dominated habitats where the Chihuahuan Desert and Sonoran Desert gradient is in southeastern Arizona (Gardali and Ballard, 2000). It is possible that *V. gilvus* does use the habitats I surveyed, but not frequently enough to document it during our bi-weekly visits.

Other species we did not find included: The Sage Thrasher, *Oreoscoptes montanus*, which prefers semi-open habitat, like country or scattered scrub (Reynolds et al., 1999). Townsend's Solitaire, *Myadestes townsendi*, which was not expected, since it prefers juniper woodland habitats, however, they are attracted to them for their abundance of berries (cones) (Bowen, 1997) and the junipers in our sites don't produce many. The cattle tank it was found in (Pyrtle Tank) and the permanent spring may have some other preferable food source in abundance that attracted it to those sites. The Phainopepla, *Phainopepla nitens*, did not turn up during our surveys either, probably due to its preference for habitats containing mistletoe and the plant species it parasitizes (many of the tanks have this) in riparian and wash areas, however, in its summer breeding range it is found in chaparral habitats farther west with similar plant compositions to our sites (Chu and Walsberg, 1999). In the Trans-Pecos region, the riparian and mistletoe habitat may be more important for *P. nitens*.

Warbler species documented using the cattle tanks and the natural spring that we didn't document are as follows: Northern Waterthrush, *Parkesia noveboracensis*, a species that prefers dense vegetation near water (Whitaker and Eaton, 2014). Nashville Warbler, *Oreothlypis*

ruficapilla, a more rarely sighted migrating species whose range does not usually include the Trans-Pecos region, but prefers desert washes, bottoms of creeks, and desert flats in southeastern Arizona (Lowther and Williams, 2011). Virginia's Warbler, *O. virginiae*, a breeding and migrating warbler in the area that prefers riparian areas with willow and cottonwood, but also pine and juniper woodlands above 1500-m elevation (Olson and Martin, 1999). Northern Parula, *Setophaga americana*, is a rare migrant species whose range is much farther east (Moldenhauer and Regelski, 2012).

Warblers we found in common included: *G. tolmiei*, which prefers dense desert shrub habitats in riparian or mountainous regions, as well as pine or juniper habitats (Pitocchelli, 2013). *S. townsendi*, which uses many different habitats, those of which include orchards, juniper, pinon, and oak habitats, and mountain habitat in Mexico above 1500-m elevation. (Wright et al, 1998). The warbler, *S. coronate*, a wintering species that prefers a variety of habitats to include desert scrub, disjunct deciduous forests, agriculture groves, and marshes (Hunt and Flaspohler, 1998). Lastly, *C. pusilla*, which is found in deciduous shrub habitats of in desert and suburban areas, woodlands, and mountain forests (Ammon and Gilbert, 1999).

Cardinalids not found included: The Summer Tanager, *Piranga rubra*, which was expected, since IMRS is within its summer breeding range, but was not documented. This could be due to *P. rubra* preferring riparian woodlands with willows and cottonwoods (Robinson, 2012) that are more similar in vegetation to the permanent spring and some of the cattle tanks. Dickcissel, *Spiza americana*, were also documented using some of the cattle tanks, but has a scarce breeding range much farther east, and strictly prefers dense grassland habitat (Temple, 2002).

Blackbirds documented by the Wiseman study that we didn't find were the Red-winged Blackbird, *Agelaius phoeniceus*, the Yellow-Headed Blackbird, *Xanthocephalus xanthocephalus*, the Orchard Oriole, *Icterus spurius*, and Bullock's Oriole, *I. bullockii*, species that prefer riparian areas in the case of *A. phoeniceus*, *I. spurius*, and *I. bullockii* (Yasukawa and Searcy, 1995; Scharf and Kren, 2010; Flood et al. 2016) or in the case of *X. xanthocephalus*, riparian wetlands during the warm months and flocking in disturbed sites, like agriculture fields, in the winter (Twedt and Crawford, 1995).

Finches Wiseman documented that we did not find were the Pine Siskin, *Spinus pinus*, which we did expect in our sites during the winter. It prefers a variety of habitats to include chaparral and woodlands (Dawson, 2014). We did not find the American Goldfinch, *S. tristis*, which was not expected, since its movements are nomadic in the winter and they prefer feeders, weedy areas, and fields when this occurs (McGraw and Middleton, 2017).

Overall, Wiseman found 85 species total and we found 64 species total. The cattle tanks, the permanent spring, and oak-juniper canyon and arroyo sites are probably important stop over sites for various migrants compared to the surrounding desert scrub, important foraging sites for wintering birds, and breeding or mating sites for summer birds. The combination of Wiseman's study and this study provides a clearer understanding of how birds use different habitats on IMRS and the Trans-Pecos region throughout the year, especially on post-grazed ranchland.

CONCLUSIONS - There are a few studies on the variety of habitats birds use in the Trans-Pecos region of the Chihuahuan Desert, especially those containing oak and juniper vegetation near mountains and within the desert scrub. There may not be significantly more species richness in sites that contain both oak and juniper in these isolated habitats, but they do attract a wide variety of migrating, wintering, and summer breeding birds compared to the surrounding desert scrub.

This study also provided a better understanding of the life history of several bird species, a clearer understanding of the plant species present in the habitats, potential updates to the range maps for particular birds, and an even better understanding of how birds use post-grazed ranchlands in the region. For this reason, IMRS is an important site for researchers wishing to explore these questions with all kinds of wildlife. It can serve as an important example of desert ecology post-grazing, to test interventionist recovery plans, and to study how land management practices and conservation initiatives fair in the region. Just as a basic site for updating the natural history or wildlife, or exploring neglected aspects of life history for species, IMRS is valuable. As mentioned previously, most studies of bird inhabitants have taken place on preserved and recovering Chihuahuan Desert grasslands in New Mexico, but IMRS and other retiring ranch lands in the Trans-Pecos region may be opportunity for study and conservation in the future.

References

2018. Macaulay Library. The Cornell Lab of Ornithology. Retrieved February 15, 2018 from <https://www.macaulaylibrary.org/>
- Adams, R. P. and T. A. Zaroni. 1979. The Distribution, Synonymy, and Taxonomy of Three Junipers of Southwestern United States and Northern Mexico. *The Southwestern Naturalist*. 24(2): 323-329.
- ADAMS, R. P. 2017. Multiple evidences of past evolution are hidden in nrDNA of *Juniperus arizonica* and *J. coahuilensis* populations in the Trans-Pecos, Texas region. *Phytologia* 99: 38–47.
- AMBROSE III H. W., K. P. AMBROSE, D. J. EMLLEN, K. L. BRIGHT. 2007. A Handbook of Biological Investigation. χ^2 Test of Independence Between Two or More Samples. Hunter Textbooks, Inc. Winston-Salem, NC. pp. 96.
- AMMON, E. M. AND W. M. GILBERT. 1999. *Wilson's Warbler* (*Cardellina pusilla*), version 2.0. In *The Birds of North America* (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.478>
- ANSLEY R.J., PINCHAK W.E., UECKERT D.N. Changes in redberry Juniper distribution in northwest Texas (1948 to 1982). *Journal of Rangeland Management*. 17(2): 49-53.

- ASKINS, R. A. 1993. Population trends in grassland, shrubland, and forest birds in eastern North America. *Current Ornithology*, Springer US. pp. 1-34.
- BARTOS SMITH, S. AND J. S. GREENLAW. 2015. Spotted Towhee (*Pipilo maculatus*), version 2.0. In *The Birds of North America* (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.263>
- BALTOSSER, W. H. AND S. M. RUSSELL. 2000. *Black-chinned Hummingbird* (*Archilochus alexandri*), version 2.0. In *The Birds of North America* (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.495>
- BEMIS, C. AND J. D. RISING. 1999. Western Wood-Pewee (*Contopus sordidulus*), version 2.0. In *The Birds of North America* (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.451>
- BOWEN, R. V.. 1997. Townsend's Solitaire (*Myadestes townsendi*), version 2.0. In *The Birds of North America* (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.269>
- BRIGHAM, R. M., J. NG, R. G. POULIN AND S. D. GRINDAL. 2011. *Common Nighthawk* (*Chordeiles minor*), version 2.0. In *The Birds of North America* (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.213>

BROWN, D. E. (Ed.). 1982. Biotic Communities: Southwestern United States and Northwestern Mexico. University of Utah Press, Salt Lake City.

BRYAN, K., P. ESPY AND J. MILLER. 2015. Birds of Jeff Davis County, Texas, including Davis Mountains State Park: a seasonal checklist. Natural Resource Program, Texas Parks and Wildlife.

CALDER, W. A. AND L. L. CALDER. 1994. Calliope Hummingbird (*Selasphorus calliope*), version 2.0. In The Birds of North America (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.135>

CHAMBERS, N.. 2016 .Guadalupe Mountains National Park. Bird Checklist. U.S. Department of the Interior. National Park Service. Retrieved from https://www.nps.gov/gumo/learn/nature/upload/GUMO_Birdlist_5x7.pdf

CHILTON, G., M. C. BAKER, C. D. BARRENTINE AND M. A. CUNNINGHAM. 1995. White-crowned Sparrow (*Zonotrichia leucophrys*), version 2.0. In The Birds of North America (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.183>

CHU, M. AND G. WALSBERG. 1999. Phainopepla (*Phainopepla nitens*), version 2.0. In The Birds of North America (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.415>

CODY, M. L.. 1999. *Crissal Thrasher* (*Toxostoma crissale*), version 2.0. In *The Birds of North America* (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

<https://doi.org/10.2173/bna.419>

COFFMAN, J. M., B. T. BESTELMEYER, J. F. KELLY, T. F. WRIGHT, R. L. SCHOOLEY. 2014. Restoration practices have positive effects on breeding bird species of concern in the Chihuahuan Desert. *Restoration Ecology* 22: 336-344.

DAWSON, W. R.. 2014. Pine Siskin (*Spinus pinus*), version 2.0. In *The Birds of North America* (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.280>

DIXON, K. L. 1959. Ecological and distributional relations of desert scrub birds of western Texas. *The Condor* 61: 397–409.

DUNNING JR., J. B., R. K. BOWERS JR., S. J. SUTER AND C. E. BOCK. 1999. *Cassin's Sparrow* (*Peucaea cassinii*), version 2.0. In *The Birds of North America* (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.471>

DOBBS, R. C., P. R. MARTIN AND T. E. MARTIN. 2012. Green-tailed Towhee (*Pipilo chlorurus*), version 2.0. In *The Birds of North America* (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.368>

- DWYER, J. F., J. C. BEDNARZ AND R. J. RAITT. 2013. Chihuahuan Raven (*Corvus cryptoleucus*), version 2.0. In The Birds of North America (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.606>
- EBIRD. 2018. [Map indicating the georeferenced sightings of the Elf Owl, *Micrathene whitneyi* as of March 26, 2018]. *Species Maps*. Retrieved from <https://ebird.org/map/elfowl?neg=true&env.minX=&env.minY=&env.maxX=&env.maxY=&zh=false&gp=false&ev=Z&mr=1-12&bmo=1&emo=12&yr=all&byr=1900&eyr=2018>
- ELY, C. A. 1962. The birds of southeastern Coahuila. *The Condor* 62: 34–39.
- ESCAMILLA, R. E. 2012. An Assessment of Land Cover Change at The Indio Mountains Research Station. PhD Dissertation, The University of Texas at El Paso, El Paso, Texas.
- FARJON, A., AND D. FILER. 2013. An Atlas of the World's Conifer: An Analysis of their Distribution, Biogeography, Diversity, and Conservation Status". Koninklijke Brill NV. Leiden, The Netherlands.
- FLOOD, N. J., C. L. SCHLUETER, M. W. REUDINK, P. PYLE, M. A. PATTEN, J. D. RISING AND P. L. WILLIAMS. 2016. Bullock's Oriole (*Icterus bullockii*), version 3.0. In The Birds of North America (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.bulori.03>

GARDALI, T. AND G. BALLARD. 2000. Warbling Vireo (*Vireo gilvus*), version 2.0. In *The Birds of North America* (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.551>

GOOGLE EARTH. 2017a. Map of Chihuahuan Desert Bird Studies. Google Earth Pro. Created August 15, 2017.

GOOGLE EARTH. 2017b. Map depicting the location of IMRS in southeastern Hudspeth County, Texas in the Northern Chihuahuan Desert. Google Earth Pro. Created August 15, 2017.

GOOGLE EARTH. 2017c. IMRS located on the Indio Mountains, the southern spur of the Eagle Mountains, and northwest of the Rio Grande River. Google Earth Pro. Created July 12, 2017.

GOOGLE EARTH. 2017d. Map depicting oak-juniper arroyo. Google Earth Pro. Created May 31, 2016.

GOOGLE EARTH. 2017e. Map depicting a juniper habitat at the intersection of two washes. Google Earth Pro. Created May 31, 2016.

GOOGLE EARTH. 2017f. Map depicting an oak habitat in a rocky limestone canyon wash. Google Earth Pro. Created November 30, 2016.

GOOGLE EARTH. 2017g. Map depicting a desert thorn-scrub arroyo. Google Earth Pro. Created January 6, 2017.

- GROSCHUPF, K. D. AND C. W. THOMPSON. 1998. Varied Bunting (*Passerina versicolor*), version 2.0. In The Birds of North America (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.351>
- GROVER, H. D., AND H. B. MUSICK. 1990. Shrubland encroachment in southern New Mexico, U.S.A.: An analysis of desertification processes in the American southwest. *Climatic Change* 17: 305–330.
- GUTZWILLER, K. J., AND W. C. BARROW. 2001. Bird–landscape relations in the Chihuahuan Desert: coping with uncertainties about predictive models. *Ecological Applications*, 11: 1517–1532.
- GUTZWILLER, K. J. AND W.C. BARROW JR. 2003. Influence of roads and development on bird communities in protected Chihuahuan Desert Landscapes. *Biological Conservation*. 113: 225–237.
- HAUSER, A. S. 2007. *Juniperus pinchotii*. In: *Fire Effects Information System*, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: <http://www.fs.fed.us/database/feis/> [2017, August 10].
- HENDRICKSON, J. AND M. C. JOHNSTON. 1986. *Vegetation and Community Types of the Chihuahuan Desert*. Jornada LTER Publication. Chihuahuan Desert – U.S. and Mexico II. pp. 20-39.

- HENRY, SUSANNA G. AND FREDERICK R. GEHLBACH. 1999. *Elf Owl (Micrathene whitneyi)*, version 2.0. In *The Birds of North America* (P. G. Rodewald, editor). Cornell Lab of Ornithology, Ithaca, New York, USA. Available: <https://birdsna.org/Species-Account/bna/species/elfowl/introduction> [January 23, 2017]
- HOPP, S. L., A. KIRBY AND C. A. BOONE. 1995. White-eyed Vireo (*Vireo griseus*), version 2.0. In *The Birds of North America* (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.168>
- HUDON, J. 1999. Western Tanager (*Piranga ludoviciana*), version 2.0. In *The Birds of North America* (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.432>
- HUNT, P. D. AND D. J. FLASPOHLER. 1998. Yellow-rumped Warbler (*Setophaga coronata*), version 2.0. In *The Birds of North America* (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.376>
- JOHNSON, K. A. 2002. *Juniperus monosperma*. In: *Fire Effects Information System*, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: <http://www.fs.fed.us/database/feis/> [August 10, 2017].

- KOCHERT, M. N., K. STEENHOF, C. L. MCINTYRE AND E. H. CRAIG. 2002. Golden Eagle (*Aquila chrysaetos*), version 2.0. In The Birds of North America (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.684>
- KOZMA, J. M. AND N. E. MATHEWS. 1997. Breeding bird communities and nest plant selection in Chihuahuan Desert habitats in South-Central New Mexico. *Wilson Bulletin*. 109(3):424-436.
- KOZMA, J.M., L. M. BURKETT, N. E. MATHEWS. 2012. Associations of small migratory and resident birds with two scrub habitats during late winter and spring in the Northern Chihuahuan Desert, New Mexico. 57(1):31-38.
- LATTA, S. C. AND M. E. BALTZ. 2012. *Lesser Nighthawk* (*Chordeiles acutipennis*), version 2.0. In The Birds of North America (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.314>
- LICHER, MAX. 2017. *J. arizonica* [Online Image]. Retrieved August 2, 2017 from http://hasbrouck.asu.edu/imglib/seinet/Cupressaceae/photos/Juniperus_coahuilensis_020207_7_tn.jpg.
- LOWTHER, P. E., S. M. LANYON AND C. W. THOMPSON. 2015. *Painted Bunting* (*Passerina ciris*), version 2.0. In The Birds of North America (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.398>

- LOYN, RICHARD. H. 1986. The 20 Minute Search – A Simple Method for Counting Forest Birds. *Corella*. 10(2): 58–60.
- LOWTHER, P. E. AND J. M. WILLIAMS. 2011. Nashville Warbler (*Oreothlypis ruficapilla*), version 2.0. In *The Birds of North America* (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.205>
- LOWTHER, P. E., P. PYLE AND M. A. PATTEN. 2016. Cordilleran Flycatcher (*Empidonax occidentalis*), version 3.0. In *The Birds of North America* (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.corfly.03>
- MAYOR, S. J., R. P. GARULNICK, M. W. TINGLEY, J. OTEGUI, J. C. WITHEY, S. C. ELMENDORF, M. E. ANDREW, S LEYK, I. S. PEARSE, AND D. C. SCHNEIDER. 2017. Increasing phenological asynchrony between spring green-up and arrival of migratory birds. *Scientific Reports* 7: 1–10.
- MCGRAW, K. J. AND A. L. MIDDLETON. 2017. American Goldfinch (*Spinus tristis*), version 2.1. In *The Birds of North America* (P. G. Rodewald, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.amegfi.02.1>
- MCLAUGHLIN, S. P. (1992). Are floristic areas hierarchically arranged?. *Journal of Biogeography*, 21-32.
- MCMAHAN C.A., R.G. FRYE, AND K.L. BROWN. 1984. *The Vegetation Types of Texas*. Texas Parks and Wildlife Department, Wildlife Division, Austin, Texas.

- MIRIK, M., S. CHAUDHURI, B. SURBER, S. ALE, R. J. ANSLEY. 2013. Evaluating Biomass of Juniper Trees (*Juniperus pinchotii*) from Imagery-Derived Canopy Area Using the Support Vector Machine Classifier. *Advances in Remote Sensing*. 2: 181-192.
- MOLDENHAUER, R. R. AND D. J. REGELSKI. 2012. Northern Parula (*Setophaga americana*), version 2.0. In *The Birds of North America* (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.215>
- MUELLER, A. J.. 2004. *Inca Dove* (*Columbina inca*), version 2.0. In *The Birds of North America* (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.28>
- MULLER, CORNELIUS H. 1940. Oaks of Trans-Pecos Texas. *The American Midland Naturalist* 24:703–728.
- NARANJO, L.G. AND R.J. RAIT. 1993. Breeding Bird Distribution in Chihuahuan Desert Habitats. *The Southwestern Naturalist* 38: 43–51.
- NATIVE PLANT SOCIETY OF TEXAS. 2017. *Juniperus monosperma* [Online Image]. Retrieved August 8, 2017 from https://www.wildflower.org/image_archive/320x240/PCD3934/PCD3934_IMG0033.JPG

- NATURESERVE. 2009. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A. Data current as of 08 October 2009.
- NELSON, T., J. HOLECHEK, R. VALDEZ. 1999. Wildlife plant community preference in the Chihuahuan Desert. *Rangelands* 21(1): 9-11.
- NUR, N., S.L. JONES, AND G.R. GEUPEL. 1999. A statistical guide to data analysis of avian monitoring programs. U.S. Department of the Interior, Fish and Wildlife Service, BTP-R6001–1999, Washington, D.C.
- OHLENDORF, H. .1974. Competitive Relationships among Kingbirds (*Tyrannus*) in Trans-Pecos Texas. *The Wilson Bulletin*. 86(4): 357-373.
- OLSON, C. R. AND T. E. MARTIN. 1999. Virginia's Warbler (*Oreothlypis virginiae*), version 2.0. In *The Birds of North America* (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.477>
- PAVEK, D. S. 1993. *Quercus pungens*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: <http://www.fs.fed.us/database/feis/> [August 10, 2017].

- PEREYRA, M. E. AND J. A. SEDGWICK. 2015. Dusky Flycatcher (*Empidonax oberholseri*), version 2.0. In The Birds of North America (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.78>
- PIDGEON, A. M., N. E. MATHEWS, R. BENOIT, AND E. V. NORDHEIM. 2001. Response of avian communities to historic habitat change in the northern Chihuahuan Desert. *Conservation Biology* 15: 1772–1788.
- PIDGEON, A. M., V. C. RADELOFF, AND N. E. MATHEWS. 2003. Landscape-scale patterns of Black-throated Sparrow (*Amphispiza bilineata*) abundance and nest success. *Ecological Applications*. 13: 530–542.
- PITOCHELLI, J. 2013. MacGillivray's Warbler (*Geothlypis tolmiei*), version 2.0. In The Birds of North America (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.159>
- PLEASANTS, B. Y. AND D. J. ALBANO. 2001. Hooded Oriole (*Icterus cucullatus*), version 2.0. In The Birds of North America (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.568>
- RAIT, R.J. AND S.L. PIMM. 1976. Dynamics of bird communities in the Chihuahuan Desert, New Mexico. *The Condor* 78: 427–442.

REYNOLDS, T. D., T. D. RICH AND D. A. STEPHENS. 1999. Sage Thrasher (*Oreoscoptes montanus*), version 2.0. In *The Birds of North America* (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.463>

ROBINSON, W. D.. 2012. Summer Tanager (*Piranga rubra*), version 2.0. In *The Birds of North America* (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.248>

ROCKY MOUNTAIN AVIAN DATA CENTER. 2017. Explore the Data [Online Image]. Rocky Mountain Observatory. Retrieved March 24, 2017 from <http://rmbo.org/v3/avian/ExploretheData.aspx>

ROTENBERRY, J. T., M. A. PATTEN AND K. L. PRESTON. 1999. *Brewer's Sparrow* (*Spizella breweri*), version 2.0. In *The Birds of North America* (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.390>

SCHARF, W. C. AND J. KREN. 2010. Orchard Oriole (*Icterus spurius*), version 2.0. In *The Birds of North America* (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.255>

SCHMIDT, R.H. JR 1986. Chihuahuan Climate. Pp. 40–63, in *Second Symposium on Resources of the Chihuahuan Desert Region: United States and Mexico..* Chihuahuan Desert Research Institute, Alpine, Texas.

- SCHMIDT, R.H. 1989. The Chihuahuan Desert [Online Image]. Retrieved June 10, 2016 from <http://museum2.utep.edu/archive/climate/chides6a.gif>
- SCHLOSSBERG, S. AND J. C. STERLING. 2013. Gray Flycatcher (*Empidonax wrightii*), version 2.0. In The Birds of North America (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.458>
- SCHUKMAN, J. M. AND B. O. WOLF. 1998. Say's Phoebe (*Sayornis saya*), version 2.0. In The Birds of North America (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.374>
- SORTE, F. A. LA, D. FINK, P. J. BLANCHER, A. D. RODEWALD, V. RUIZ-GUTIERREZ, K. V. ROSENBERG, AND S. KELLING. 2017. Global change and the distributional dynamics of migratory bird populations wintering in Central America. *Global Change Biology*. <http://doi.org/10.1111/gcb.13794>.
- SPELLENBERG, R., J. E. CHRISTOPHER, AND G. NELSON. 2014. *Trees of Western North America*. Princeton University Press. Princeton, New Jersey.
- STEPHEN F. AUSTIN STATE UNIVERSITY. 2017. *Quercus pungens* [Online Image]. Retrieved August 9, 2017 from http://src.sfasu.edu/~jvk/TransPecosPlants/TransPecosPlants/Fagaceae/IrQuercus_pungens2.jpg

- STILING, P. 2012. Ecology: Global Insights and Investigations. *Species Diversity*. McGraw Hill. New York, NY. pp. 364.
- SULLIVAN, J.. 1993. *Juniperus coahuilensis*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: <http://www.fs.fed.us/database/feis/> [August 10, 2017].
- SUTHERLAND, W. J. 2006a. Ecological Census Techniques: A Handbook. 2nd Edition. Cambridge University Press. Cambridge, UK. pp. 313-314.
- SUTHERLAND, W. J. 2006b. Ecological Census Techniques: A Handbook. 2nd Edition. Cambridge University Press. Cambridge, UK. pp. 188-189.
- SWANSON, D. L., J. L. INGOLD AND G. E. WALLACE. 2008. *Ruby-crowned Kinglet* (*Regulus calendula*), version 2.0. In The Birds of North America (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.119>
- TAROF, S. AND J. V. BRISKIE. 2008. Least Flycatcher (*Empidonax minimus*), version 2.0. In The Birds of North America (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.99>

TEMPLE, S. A.. 2002. Dickcissel (*Spiza americana*), version 2.0. In The Birds of North America (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

<https://doi.org/10.2173/bna.703>

Texas Parks and Wildlife Department. 2017. Ecological Mapping Systems of Texas: Madrean Oriental Chaparral. Texas Parks and Wildlife Department. Retrieved August 10, 2017.

<https://tpwd.texas.gov/landwater/land/programs/landscape-ecology/ems/emst/shrublands/madrean-oriental-chaparral>

THE GYMNOSPERM DATABASE. 2017a. *Juniperus pinchotti* [Online Image]. Retrieved August 2, 2017 from <http://www.conifers.org/cu/ju/pinchotii02.jpg>

THE GYMNOSPERM DATABASE. 2017b. *Juniperus coahuilensis* [Online Image]. Retrieved August 2, 2017 from <http://www.conifers.org/cu/ju/coahuilensis02.jpg>

TWEIT, R. C.. 1996. Curve-billed Thrasher (*Toxostoma curvirostre*), version 2.0. In The Birds of North America (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA.

<https://doi.org/10.2173/bna.235>

TWEDT, D. J. AND R. D. CRAWFORD. 1995. Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*), version 2.0. In The Birds of North America (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.192>

UNIVERSITY OF TEXAS AT AUSTIN. 2006. *Quercus vaseyana* [Online Image]. Retrieved August 9, 2017 from https://www.wildflower.org/image_archive/640x480/SAW/SAW_03038.JPG

U.S. FISH AND WILDLIFE SERVICE. 2016. Threats to Birds. Migratory Bird Program. Retrieved July 2, 2017 from <https://www.fws.gov/birds/bird-enthusiasts/threats-to-birds.php>

WAUER, R. H., 1971. Ecological distribution of birds of the Chisos Mountains, Texas. The Southwestern Naturalist 16:1–29.

WISEMAN, G. H. 2014. An avian survey conducted at five water sources within the northern Chihuahuan Desert on Indio Mountains Research Station, Texas. M.S. Thesis, The University of Texas at El Paso, El Paso, Texas.

WHITAKER, D. M. AND S. W. EATON. 2014. Northern Waterthrush (*Parkesia noveboracensis*), version 2.0. In The Birds of North America (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.182>

WOLF, B. O.. 1997. Black Phoebe (*Sayornis nigricans*), version 2.0. In The Birds of North America (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.268>

WORTHINGTON, R. D., J. D. JOHNSON, C. S. LIEB, AND W. ANDERSON. 2018. Natural Resources and Physical Environment of Indio Mountains Research Station (IMRS) Southeastern Hudspeth

County, Texas. A Handbook for Students and Researchers. The University of Texas at El Paso.
El Paso, Texas. Privately printed.

WRIGHT, A. L., G. D. HAYWARD, S. M. MATSUOKA AND P. H. HAYWARD. 1998. Townsend's Warbler
(*Setophaga townsendi*), version 2.0. In *The Birds of North America* (A. F. Poole and F. B. Gill,
Editors). Cornell Lab of Ornithology, Ithaca, NY, USA. <https://doi.org/10.2173/bna.333>

YASUKAWA, K. AND W. A. SEARCY. 1995. Red-winged Blackbird (*Agelaius phoeniceus*), version 2.0.
In *The Birds of North America* (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology,
Ithaca, NY, USA. <https://doi.org/10.2173/bna.184>

Appendix

APPENDIX 1: Tables of plant species and their abundances at each site.

Oak-Juniper Arroyo Plant Survey Data

<i>Common Name</i>	<i>Scientific Name</i>	<i>Abundance</i>
<i>Mariola</i>	<i>Parthenium incanum</i>	146
<i>Skeleton-leaf Goldeneye</i>	<i>Viguiera stenoloba</i>	98
<i>White-thorn Acacia</i>	<i>Vachellia constricta</i>	55
<i>Sotol</i>	<i>Dasyilirion leiophyllum</i>	54
<i>Desert Myrtlecroton</i>	<i>Bernardia obovata</i>	32
<i>Pungent Oak Tree</i>	<i>Quercus pungens</i>	27
<i>Boundary Ephedra</i>	<i>Ephedra aspera</i>	15
<i>Broom Snakeweed</i>	<i>Gutierrezia sarothrae</i>	13
<i>Desert Holly</i>	<i>Mahonia trifoliolata</i>	8
<i>Desert Olive Tree</i>	<i>Forestiera angustifolia</i>	8
<i>Plumed Crinklemat</i>	<i>Tiquilia greggii</i>	7
<i>Barometer Bush</i>	<i>Leucophyllum minus</i>	7
<i>Ocotillo</i>	<i>Fouquieria splendens</i>	6
<i>Beargrass</i>	<i>Nolina erumpens</i>	6
<i>Feathery Dalea</i>	<i>Dalea formosa</i>	4
<i>Evergreen Sumac</i>	<i>Rhus virens</i>	2
<i>Western Hackberry Tree</i>	<i>Celtis occidentalis</i>	2
<i>Little-leaf Sumac</i>	<i>Rhus microphylla</i>	1
<i>Coahuila Redberry Juniper Tree</i>	<i>Juniperus coahuilensis</i>	1

Juniper Grove Plant Survey Data

<i>Common Name</i>	<i>Scientific Name</i>	<i>Abundance</i>
<i>Mariola</i>	<i>Parthenium incanum</i>	133
<i>Catclaw Acacia</i>	<i>Senegalia greggii</i>	127
<i>Sotol</i>	<i>Dasyilirion leiophyllum</i>	31
<i>Desert Bernardia</i>	<i>Bernardia myricifolia</i>	13
<i>Honey Mesquite</i>	<i>Prosopis glandulosa</i>	12
<i>Coahuila Redberry Juniper Tree</i>	<i>Juniperus coahuilensis</i>	10
<i>Boundary Ephedra</i>	<i>Ephedra aspera</i>	6
<i>Bear Grass</i>	<i>Nolina erumpens</i>	5
<i>Desert Holly</i>	<i>Mahonia trifoliolata</i>	5
<i>Littleleaf Sumac</i>	<i>Rhus microphylla</i>	4
<i>White-thorn Acacia</i>	<i>Vachellia constricta</i>	4

<i>Skeleton-leaf Goldeneye</i>	<i>Viguiera stenoloba</i>	3
<i>Desert Olive Tree</i>	<i>Forestiera angustifolia</i>	3
<i>Creosote Bush</i>	<i>Larrea tridentata</i>	1
<i>Ocotillo</i>	<i>Fouquieria splendens</i>	1
<i>Warnock's Condalia</i>	<i>Condalia warnockii</i>	1

Montane Oak Wash Plant Survey Data

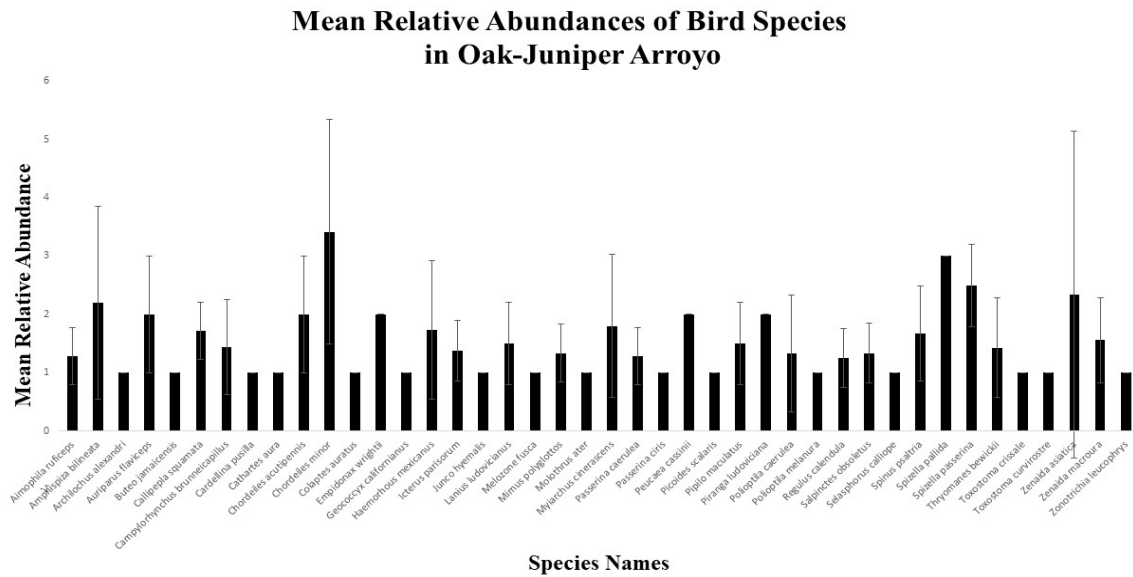
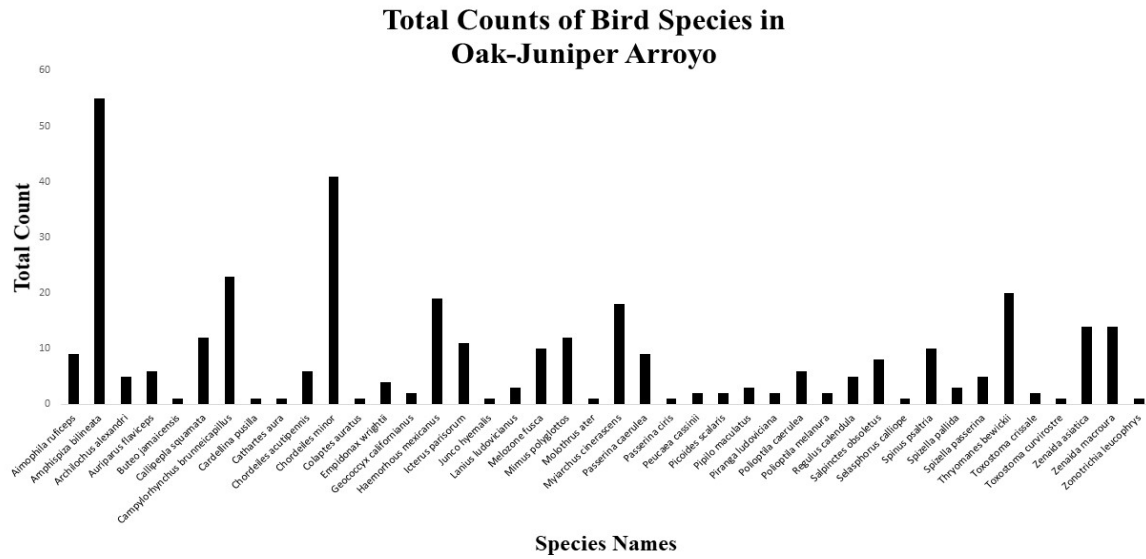
<i>Common Name</i>	<i>Scientific Name</i>	<i>Abundance</i>
<i>Mariola</i>	<i>Parthenium incanum</i>	92
<i>Skeleton-leaf Goldeneye</i>	<i>Viguiera stenoloba</i>	66
<i>Pungent Oak Tree</i>	<i>Quercus pungens</i>	56
<i>Sotol</i>	<i>Dasylirion leiophyllum</i>	35
<i>Desert Mimosa</i>	<i>Mimosa aculeaticarpa</i>	16
<i>Catclaw Acacia</i>	<i>Senegalia greggii</i>	16
<i>Barometer Bush</i>	<i>Leucophyllum minus</i>	13
<i>Broom Snakeweed</i>	<i>Gutierrezia sarothrae</i>	10
<i>Boundary Ephedra</i>	<i>Ephedra aspera</i>	10
<i>Plumed Crinklemat</i>	<i>Tiquilia greggii</i>	9
<i>Evergreen Sumac</i>	<i>Rhus virens</i>	6
<i>Creosote Bush</i>	<i>Larrea tridentata</i>	6
<i>Desert Olive Tree</i>	<i>Forestiera angustifolia</i>	5
<i>White-thorn Acacia</i>	<i>White-thorn Acacia</i>	4
<i>Ocotillo</i>	<i>Fouquieria splendens</i>	4
<i>Desert Bernardia</i>	<i>Bernardia myricifolia</i>	4
<i>Little-leaf Sumac</i>	<i>Rhus microphylla</i>	3
<i>Beargrass</i>	<i>Nolina erumpens</i>	1

Thorn-scrub Arroyo Plant Survey Data

<i>Common Name</i>	<i>Scientific Name</i>	<i>Abundance</i>
<i>Skeleton-leaf Goldeneye</i>	<i>Viguiera stenoloba</i>	69
<i>Plumed Crinklemat</i>	<i>Tiquilia greggii</i>	60
<i>White-thorn Acacia</i>	<i>Vachellia constricta</i>	45
<i>Catclaw Acacia</i>	<i>Senegalia greggii</i>	37
<i>Feathery Dalea</i>	<i>Dalea formosa</i>	34
<i>Desert Bernardia</i>	<i>Bernardia myricifolia</i>	18
<i>Mariola</i>	<i>Parthenium incanum</i>	15
<i>Boundary Ephedra</i>	<i>Ephedra aspera</i>	14

<i>Creosote Bush</i>	<i>Larrea tridentata</i>	13
<i>Desert Holly</i>	<i>Mahonia trifoliolata</i>	10
<i>Broom Snakeweed</i>	<i>Gutierrezia sarothrae</i>	9
<i>Little-leaf Sumac</i>	<i>Rhus microphylla</i>	9
<i>Sotol</i>	<i>Dasylirion leiophyllum</i>	9
<i>Warnock's Condalia</i>	<i>Condalia warnockii</i>	7
<i>Desert Olive Tree</i>	<i>Foresteria angustifolia</i>	7
<i>Ocotillo</i>	<i>Fouquieria splendense</i>	4
<i>Grassland Croton</i>	<i>Croton pottsii</i>	1
<i>Desert Mimosa</i>	<i>Mimosa aculeaticarpa</i>	1
<i>Rabbitbrush</i>	<i>Ericameria sp.</i>	1
<i>Beargrass</i>	<i>Nolina erumpens</i>	1
<i>Desert Willow Tree</i>	<i>Chilopsis linearis</i>	1

APPENDIX 2: Graphs and tables of bird species, and their total counts (N), mean relative abundances (X) and standard deviations (SD) by site.



<i>Common Name</i>	<i>Species Name</i>	<i>N (Total Counts)</i>	<i>X (Mean)</i>	<i>SD</i>
<i>Rufous-crowned Sparrow</i>	<i>Aimophila ruficeps</i>	9	1.285714286	0.48795
<i>Black-throated Sparrow</i>	<i>Amphispiza bilineata</i>	55	2.2	1.658312
<i>Black-chinned Hummingbird</i>	<i>Archilochus alexandri</i>	5	1	0
<i>Verdin</i>	<i>Auriparus flaviceps</i>	6	2	1
<i>Red-tailed Hawk</i>	<i>Buteo jamaicensis</i>	1	1	0
<i>Scaled Quail</i>	<i>Callipepla squamata</i>	12	1.714285714	0.48795
<i>Cactus Wren</i>	<i>Campylorhynchus brunneicapillus</i>	23	1.4375	0.813941
<i>Wilson's Warbler</i>	<i>Cardellina pusilla</i>	1	1	0
<i>Turkey Vulture</i>	<i>Cathartes aura</i>	1	1	0
<i>Lesser Nighthawk</i>	<i>Chordeiles acutipennis</i>	6	2	1
<i>Common Nighthawk</i>	<i>Chordeiles minor</i>	41	3.416666667	1.928652
<i>Northern Flicker</i>	<i>Colaptes auratus</i>	1	1	0
<i>Gray Flycatcher</i>	<i>Empidonax wrightii</i>	4	2	0
<i>Greater Roadrunner</i>	<i>Geococcyx californianus</i>	2	1	0
<i>House Finch</i>	<i>Haemorhous mexicanus</i>	19	1.727272727	1.190874
<i>Scott's Oriole</i>	<i>Icterus parisorum</i>	11	1.375	0.517549
<i>Dark-eyed Junco</i>	<i>Junco hyemalis</i>	1	1	0
<i>Loggerhead Shrike</i>	<i>Lanius ludovicianus</i>	3	1.5	0.707107
<i>Canyon Towhee</i>	<i>Melospiza fusca</i>	10	1	0
<i>Northern Mockingbird</i>	<i>Mimus polyglottos</i>	12	1.333333333	0.5
<i>Brown-headed Cowbird</i>	<i>Molothrus ater</i>	1	1	0
<i>Ash-throated Flycatcher</i>	<i>Myiarchus cinerascens</i>	18	1.8	1.229273
<i>Blue Grosbeak</i>	<i>Passerina caerulea</i>	9	1.285714286	0.48795
<i>Painted Bunting</i>	<i>Passerina ciris</i>	1	1	0
<i>Cassin's Sparrow</i>	<i>Peucaea cassinii</i>	2	2	0
<i>Ladder-backed Woodpecker</i>	<i>Picoides scalaris</i>	2	1	0
<i>Spotted Towhee</i>	<i>Pipilo maculatus</i>	3	1.5	0.707107
<i>Western Tanager</i>	<i>Piranga ludoviciana</i>	2	2	0
<i>Blue-gray Gnatcatcher</i>	<i>Poliophtila caerulea</i>	6	1.333333333	1
<i>Black-tailed Gnatcatcher</i>	<i>Poliophtila melanura</i>	2	1	0
<i>Ruby-crowned Kinglet</i>	<i>Regulus calendula</i>	5	1.25	0.5
<i>Rock Wren</i>	<i>Salpinctes obsoletus</i>	8	1.333333333	0.516398
<i>Calliope Hummingbird</i>	<i>Selasphorus calliope</i>	1	1	0
<i>Lesser Goldfinch</i>	<i>Spinus psaltria</i>	10	1.666666667	0.816497
<i>Clay-colored Sparrow</i>	<i>Spizella pallida</i>	3	3	0
<i>Chipping Sparrow</i>	<i>Spizella passerina</i>	5	2.5	0.707107
<i>Bewick's Wren</i>	<i>Thryomanes bewickii</i>	20	1.428571429	0.851631
<i>Crissal Thrasher</i>	<i>Toxostoma crissale</i>	2	1	0
<i>Curve-billed Thrasher</i>	<i>Toxostoma curvirostre</i>	1	1	0
<i>House Wren</i>	<i>Troglodytes aedon</i>	1	1	0

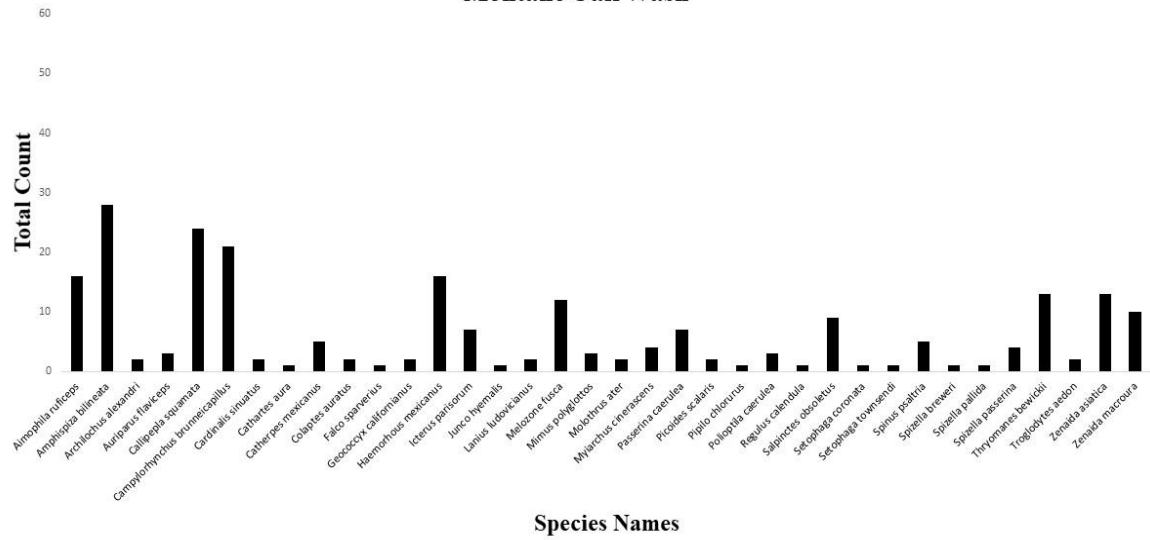
<i>White-winged Dove</i>	<i>Zenaida asiatica</i>	14	2.333333333	2.804758
<i>Mourning Dove</i>	<i>Zenaida macroura</i>	14	1.555555556	0.726483
<i>White-crowned Sparrow</i>	<i>Zonotrichia leucophrys</i>	1	1	0

[illegible][illegible]

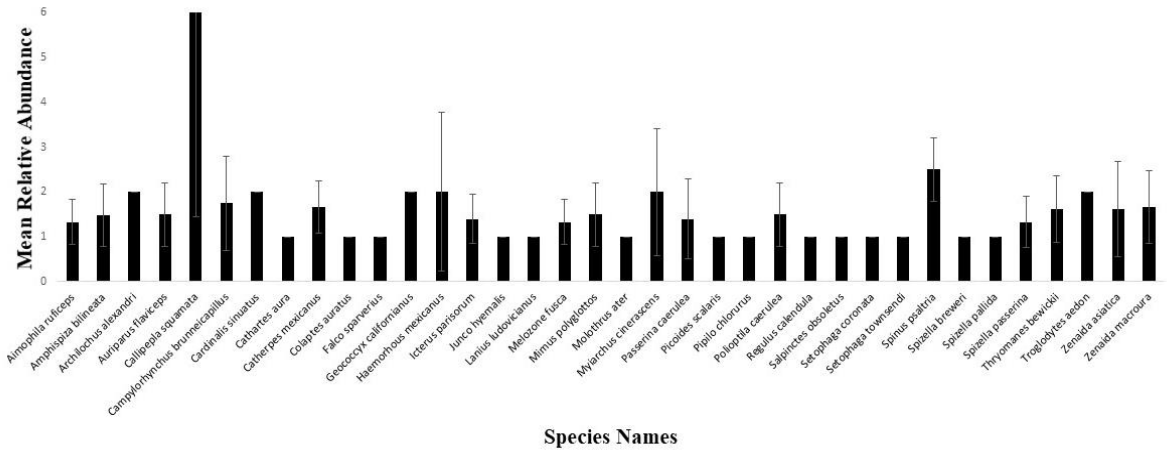
<i>Common Name</i>	<i>Species Name</i>	<i>N (Total Count)</i>	<i>X (Mean)</i>	<i>SD</i>
<i>Rufous-crowned Sparrow</i>	<i>Aimophila ruficeps</i>	8	1.142857143	0.377964
<i>Black-throated Sparrow</i>	<i>Amphispiza bilineata</i>	46	1.916666667	1.17646
<i>Golden Eagle</i>	<i>Aquila chrysaetos</i>	1	1	0
<i>Black-chinned Hummingbird</i>	<i>Archilochus alexandri</i>	2	1	0
<i>Verdin</i>	<i>Auriparus flaviceps</i>	19	1.055555556	0.235702
<i>Scaled Quail</i>	<i>Callipepla squamata</i>	9	1.285714286	0.755929
<i>Cactus Wren</i>	<i>Campylorhynchus brunneicapillus</i>	31	1.409090909	0.666125
<i>Pyrrhuloxia</i>	<i>Cardinalis sinuatus</i>	3	1	0
<i>Turkey Vulture</i>	<i>Cathartes aura</i>	2	1	0
<i>Canyon Wren</i>	<i>Catherpes mexicanus</i>	2	2	0
<i>Common Nighthawk</i>	<i>Chordeiles minor</i>	1	1	0
<i>Northern Flicker</i>	<i>Colaptes auratus</i>	6	1.2	0.447214
<i>Western Wood-Pewee</i>	<i>Contopus sordidulus</i>	3	1	0
<i>Chihuahuan Raven</i>	<i>Corvus cryptoleucus</i>	2	2	0
<i>Least Flycatcher</i>	<i>Empidonax minimus</i>	2	1	0
<i>Gray Flycatcher</i>	<i>Empidonax wrightii</i>	3	1.5	0.707107
<i>American Kestrel</i>	<i>Falco sparverius</i>	3	1.5	0.707107
<i>Greater Roadrunner</i>	<i>Geococcyx californianus</i>	1	1	0
<i>MacGillivray's Warbler</i>	<i>Geothlypis tolmiei</i>	1	1	0
<i>House Finch</i>	<i>Haemorhous mexicanus</i>	25	1.923076923	1.38212
<i>Hooded Oriole</i>	<i>Icterus cucullatus</i>	1	1	0
<i>Scott's Oriole</i>	<i>Icterus parisorum</i>	10	1.25	0.46291
<i>Dark-eyed Junco</i>	<i>Junco hyemalis</i>	3	3	0
<i>Canyon Towhee</i>	<i>Melospiza fusca</i>	7	1.75	0.5
<i>Elf Owl</i>	<i>Micrathene whitneyi</i>	6	2	1
<i>Northern Mockingbird</i>	<i>Mimus polyglottos</i>	11	1.375	0.517549
<i>Bronzed Cowbird</i>	<i>Molothrus aeneus</i>	2	2	0
<i>Ash-throated Flycatcher</i>	<i>Myiarchus cinerascens</i>	7	1.4	0.547723
<i>Lazuli Bunting</i>	<i>Passerina amoena</i>	1	1	0
<i>Blue Grosbeak</i>	<i>Passerina caerulea</i>	8	1.6	0.547723
<i>Varied Bunting</i>	<i>Passerina caerulea</i>	1	1	0
<i>Ladder-backed Woodpecker</i>	<i>Picoides scalaris</i>	8	1.333333333	0.516398
<i>Green-tailed Towhee</i>	<i>Pipilo chlorurus</i>	1	1	0
<i>Spotted Towhee</i>	<i>Pipilo maculatus</i>	3	1	0
<i>Western Tanager</i>	<i>Piranga ludoviciana</i>	2	2	0
<i>Blue-gray Gnatcatcher</i>	<i>Poliophtila caerulea</i>	7	1.166666667	0.408248
<i>Black-tailed Gnatcatcher</i>	<i>Poliophtila melanura</i>	3	1.5	0.707107
<i>Ruby-crowned Kinglet</i>	<i>Regulus calendula</i>	10	1.25	0.46291
<i>Rock Wren</i>	<i>Salpinctes obsoletus</i>	5	1.25	0.5
<i>Broad-tailed Hummingbird</i>	<i>Selasphorus platycercus</i>	1	1	0

<i>Rufous Hummingbird</i>	<i>Selasphorus rufus</i>	1	1	0
<i>Yellow-rumped Warbler</i> (Audubon's)	<i>Setophaga coronata</i>	3	3	0
<i>Townsend's Warbler</i>	<i>Setophaga townsendi</i>	5	1.666666667	1.154701
<i>Lesser Goldfinch</i>	<i>Spinus psaltria</i>	10	1.428571429	1.133893
<i>Chipping Sparrow</i>	<i>Spizella passerina</i>	3	3	0
<i>Bewick's Wren</i>	<i>Thryomanes bewickii</i>	20	1.428571429	0.646206
<i>Crissal Thrasher</i>	<i>Toxostoma crissale</i>	1	1	0
<i>Wilson's Warbler</i>	<i>Wilsonia pusilla</i>	2	2	0
<i>White-winged Dove</i>	<i>Zenaida asiatica</i>	14	1.75	0.886405
<i>Mourning Dove</i>	<i>Zenaida macroura</i>	6	1	0

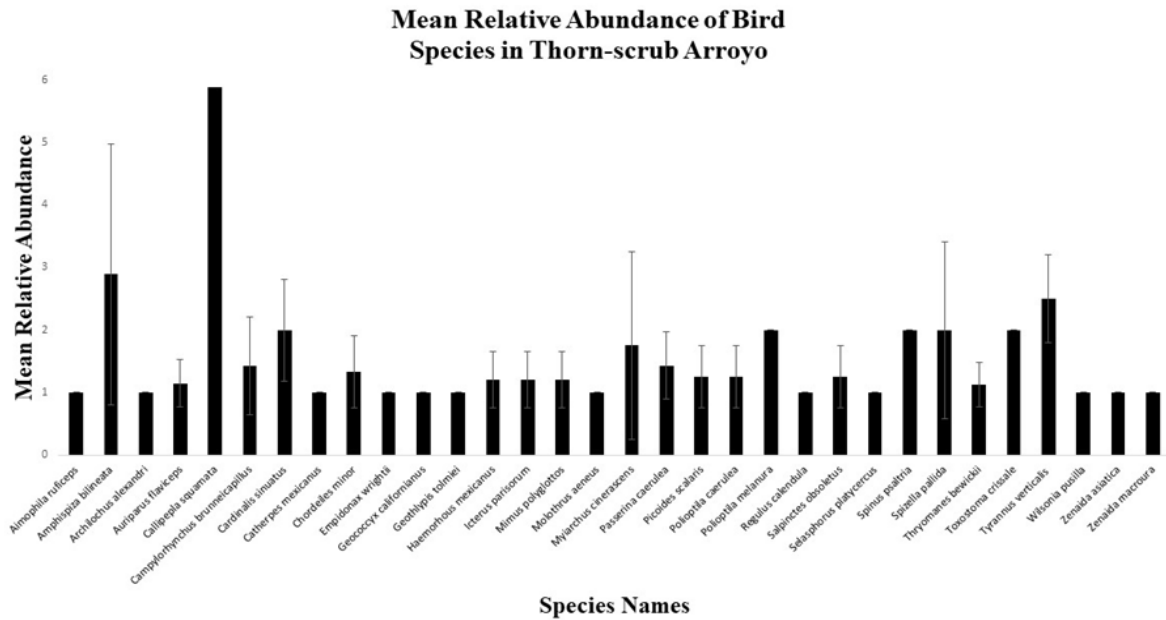
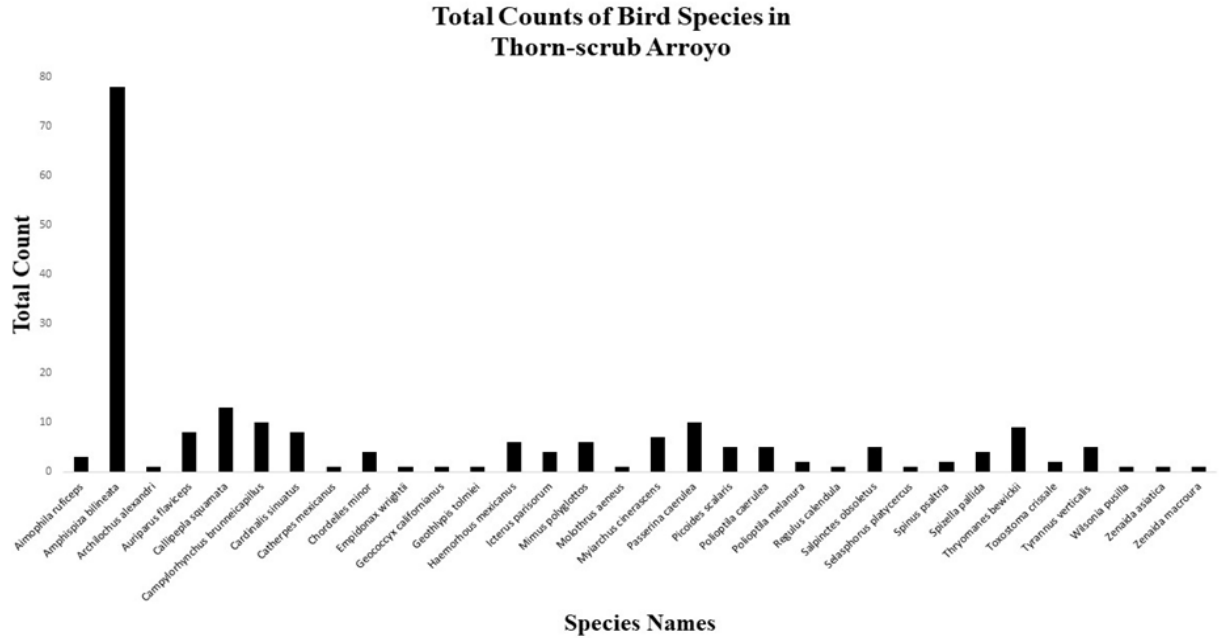
Total Count of Bird Species in Montane Oak Wash



Mean Relative Abundance of Bird Species in Montane Oak Wash



<i>Common Name</i>	<i>Species Name</i>	<i>N (Total Count)</i>	<i>X (Mean)</i>	<i>SD</i>
<i>Rufous-crowned Sparrow</i>	<i>Aimophila ruficeps</i>	16	1.33333333	0.492366
<i>Black-throated Sparrow</i>	<i>Amphispiza bilineata</i>	28	1.47368421	0.696692
<i>Black-chinned Hummingbird</i>	<i>Archilochus alexandri</i>	2	2	0
<i>Verdin</i>	<i>Auriparus flaviceps</i>	3	1.5	0.707107
<i>Scaled Quail</i>	<i>Callipepla squamata</i>	24	8	6.557439
<i>Cactus Wren</i>	<i>Campylorhynchus brunneicapillus</i>	21	1.75	1.05529
<i>Pyrrhuloxia</i>	<i>Cardinalis sinuatus</i>	2	2	0
<i>Turkey Vulture</i>	<i>Cathartes aura</i>	1	1	0
<i>Canyon Wren</i>	<i>Catherpes mexicanus</i>	5	1.66666667	0.57735
<i>Northern Flicker</i>	<i>Colaptes auratus</i>	2	1	0
<i>American Kestrel</i>	<i>Falco sparverius</i>	1	1	0
<i>Greater Roadrunner</i>	<i>Geococcyx californianus</i>	2	2	0
<i>House Finch</i>	<i>Haemorhous mexicanus</i>	16	2	1.772811
<i>Scott's Oriole</i>	<i>Icterus parisorum</i>	7	1.4	0.547723
<i>Dark-eyed Junco</i>	<i>Junco hyemalis</i>	1	1	0
<i>Loggerhead Shrike</i>	<i>Lanius ludovicianus</i>	2	1	0
<i>Canyon Towhee</i>	<i>Melospiza fusca</i>	12	1.33333333	0.5
<i>Northern Mockingbird</i>	<i>Mimus polyglottos</i>	3	1.5	0.707107
<i>Brown-headed Cowbird</i>	<i>Molothrus ater</i>	2	1	0
<i>Ash-throated Flycatcher</i>	<i>Myiarchus cinerascens</i>	4	2	1.414214
<i>Blue Grosbeak</i>	<i>Passerina caerulea</i>	7	1.4	0.894427
<i>Ladder-backed Woodpecker</i>	<i>Picoides scalaris</i>	2	1	0
<i>Green-tailed Towhee</i>	<i>Pipilo chlorurus</i>	1	1	0
<i>Blue-Gray Gnatcatcher</i>	<i>Poliophtila caerulea</i>	3	1.5	0.707107
<i>Ruby-crowned Kinglet</i>	<i>Regulus calendula</i>	1	1	0
<i>Rock Wren</i>	<i>Salpinctes obsoletus</i>	9	1	0
<i>Yellow-rumped Warbler (Audubon's)</i>	<i>Setophaga coronata</i>	1	1	0
<i>Townsend's Warbler</i>	<i>Setophaga townsendi</i>	1	1	0
<i>Lesser Goldfinch</i>	<i>Spinus psaltria</i>	5	2.5	0.707107
<i>Brewer's Sparrow</i>	<i>Spizella breweri</i>	1	1	0
<i>Clay-colored Sparrow</i>	<i>Spizella pallida</i>	1	1	0
<i>Chipping Sparrow</i>	<i>Spizella passerina</i>	4	1.33333333	0.57735
<i>Bewick's Wren</i>	<i>Thryomanes bewickii</i>	13	1.625	0.744024
<i>House Wren</i>	<i>Troglodytes aedon</i>	2	2	0
<i>White-winged Dove</i>	<i>Zenaidura macroura</i>	13	1.625	1.06066



<i>Common Name</i>	<i>Species Name</i>	<i>N (Total Counts)</i>	<i>X (Mean)</i>	<i>SD</i>
<i>Rufous-crowned Sparrow</i>	<i>Aimophila ruficeps</i>	3	1	0
<i>Black-throated Sparrow</i>	<i>Amphispiza bilineata</i>	78	2.888888889	2.081666
<i>Black-chinned Hummingbird</i>	<i>Archilochus alexandri</i>	1	1	0
<i>Verdin</i>	<i>Auriparus flaviceps</i>	8	1.142857143	0.377964
<i>Scaled Quail</i>	<i>Callipepla squamata</i>	13	5.87995564	
<i>Cactus Wren</i>	<i>Campylorhynchus brunneicapillus</i>	10	1.428571429	0.786796
<i>Pyrhuloxia</i>	<i>Cardinalis sinuatus</i>	8	2	0.816497
<i>Canyon Wren</i>	<i>Catherpes mexicanus</i>	1	1	0
<i>Common Nighthawk</i>	<i>Chordeiles minor</i>	4	1.333333333	0.57735
<i>Gray Flycatcher</i>	<i>Empidonax wrightii</i>	1	1	0
<i>Greater Roadrunner</i>	<i>Geococcyx californianus</i>	1	1	0
<i>MacGillivray's Warbler</i>	<i>Geothlypis tolmiei</i>	1	1	0
<i>House Finch</i>	<i>Haemorhous mexicanus</i>	6	1.2	0.447214
<i>Scott's Oriole</i>	<i>Icterus parisorum</i>	4	1.2	0.447214
<i>Northern Mockingbird</i>	<i>Mimus polyglottos</i>	6	1.2	0.447214
<i>Bronzed Cowbird</i>	<i>Molothrus aeneus</i>	1	1	0
<i>Ash-throated Flycatcher</i>	<i>Myiarchus cinerascens</i>	7	1.75	1.5
<i>Blue Grosbeak</i>	<i>Passerina caerulea</i>	10	1.428571429	0.534522
<i>Ladder-backed Woodpecker</i>	<i>Picoides scalaris</i>	5	1.25	0.5
<i>Blue-Gray Gnatcatcher</i>	<i>Polioptila caerulea</i>	5	1.25	0.5
<i>Black-tailed Gnatcatcher</i>	<i>Polioptila melanura</i>	2	2	0
<i>Ruby-crowned Kinglet</i>	<i>Regulus calendula</i>	1	1	0
<i>Rock Wren</i>	<i>Salpinctes obsoletus</i>	5	1.25	0.5
<i>Broad-tailed Hummingbird</i>	<i>Selasphorus platycercus</i>	1	1	0
<i>Lesser Goldfinch</i>	<i>Spinus psaltria</i>	2	2	0
<i>Clay-colored Sparrow</i>	<i>Spizella pallida</i>	4	2	1.414214
<i>Bewick's Wren</i>	<i>Thryomanes bewickii</i>	9	1.125	0.353553
<i>Crissal Thrasher</i>	<i>Toxostoma crissale</i>	2	2	0
<i>Western Kingbird</i>	<i>Tyrannus verticalis</i>	5	2.5	0.707107

<i>Wilson's Warbler</i>	<i>Wilsonia pusilla</i>	1	1	0
<i>White-winged Dove</i>	<i>Zenaida asiatica</i>	1	1	0
<i>Mourning Dove</i>	<i>Zenaida macroura</i>	1	1	0

APPENDIX 3: The updated version of the avian species listed in the Natural Resources and Physical Environment of Indio Mountains Research Station (IMRS) Southeastern Hudspeth County, Texas: A Handbook for Students and Researchers.

Class: Aves (Birds)

Contributed by Geoffrey H. Wiseman, Kayla R. Garza, Jerry D. Johnson, Scott Cutler, and Carl S. Lieb.

Many of the following observations on the avifauna were taken from the field notes of Scott Cutler who visited the ranch 19-21 May 1995 and 15-16 July 2000. Merged in are observations listed on the web site for past Field Biology classes and observations by Terry Hibbits and Jerry D. Johnson. Wiseman (2014) completed a three-year bird survey, especially near five water sources on IMRS and found 83 species. Garza completed an ecogeographic study of IMRS birds in canyon and arroyo habitats and recorded 64 species (2018). The order of the orders, families, and nomenclature used to follow the Texas Parks and Wildlife "A Checklist of Texas Birds" 6th ed. (2003), but now follows American Ornithological Society (AOS) Checklist of North and Middle American Birds 7th Edition 58th Supplement (2017). The avifauna of the area between Indian Hot Springs and Presidio was reported to consist of 160 species, 30 residents (West, 1976); others used the area seasonally or were migratory. A total of 143 species have been documented on IMRS to date.

ANSERIFORMES

ANATIDAE (Duck and Geese Family)

Bucephala albeola

Bufflehead

Records: 14 January 2012, Road Tank, Wiseman.

Anas crecca

Green-winged Teal

Records: IMRS, 16 March 1991, Field Biology Class. 14 January 2012;

Road Tank, Wiseman.

Spatula discors

Blue-winged Teal

Records: Pirtle Tank, 8 September 2012, Wiseman.

Note: Used to be classified as *Anas discors*.

Anas platyrhynchos

Mallard

Records: 14 January 2012, Road Tank, Wiseman.

Mareca strepera

Gadwall

Records: IMRS, 5 April 1991, Field Biology Class.

Note: Used to be classified as *Anas strepera*.

GALLIFORMES

ODONTOPHORIDAE (Quail Family)

Callipepla gambelii

Gambel's Quail

Note: The presence of this species on IMRS was confirmed for areas near prospect

Pits and between HQ and Squaw Spring, Summer of 2015 – Photo by Mata-Silva.

Observed on Green river Road and near Box Canyon of the Rio Grande.

Callipepla squamata

Scaled Quail

Records: IMRS HQ area, July 2000, Cutler; IMRS, 2-3 May 1992, Hibbits;

IMRS, Apr. 1995, Field Biology Class; common around IMRS HQ.

PELICANIFORMES

ARDEIDAE (Bittern, Heron and Egret Family)

Ardea herodias

Great Blue Heron

Egretta thula

Snowy Egret

Records: IMRS Headquarters, 25 September 2016, V. Mata [photo]

Nycticorax nycticorax

Black-crowned Night-heron

CATHARTIFORMES

CATHARTIDAE (Vulture Family)

Cathartes aura

Turkey Vulture

Records: Squaw Spring, May 1995. Common throughout IMRS.

Note: Turkey Vultures usually arrive on IMRS early in April and leave in October.

ACCIPITRIFORMES

PANDIONIDAE (Osprey Family)

Pandion haliaetus

Osprey

Records: IMRS HQ area, April 2006 and May 2008, Johnson.

ACCIPITRIDAE (Hawk, Kite, and Eagle Family)

Aquila chrysaetos

Golden Eagle

Records: A pair was observed S of IMRS near the Box Canyon, May 2009,
G. W. Johnson; Echo Canyon, June 2015. Johnson.

Buteo jamaicensis

Red-tailed Hawk

Records: SE of IMRS HQ, July 2000, Cutler; Squaw Spring, July 2000,
Cutler; IMRS, 2-3 May 1992, Hibbits; IMRS, Field Biology Class, March 1995;
Squaw Spring, 12 June 2001, Johnson.

Buteo regalis

Ferruginous Hawk

Records: IMRS HQ, 3 May 2008, S. Dash.

Buteo swainsoni

Swainson's Hawk

Note: This species needs to be documented on IMRS.

Circus cyaneus

Northern Harrier

Records: IMRS, March-April 1991, Field Biology Class. IMRS Headquarter
21 October 2016, J.D. Johnson.

Elanus leucurus

White-tailed Kite

Records: IMRS HQ, May 2008, Johnson; verified from photograph by Cutler.

GRUIFORMES

RALLIDAE (Coot and Rail Family)

Fulica americana

American Coot

Records: Needs to be confirmed.

Porzana carolina

Sora

Records: 17 July 2016, Rattlesnake Tank (Eaten by *C. atrox*);
6 August 2016 Peccary Tank, D. DeSantis

Rallus limicola

Virginia Rail

Records: Pirtle Tank, 27 April 2013, Wiseman.

CHARADRIIFORMES

CHARADRIIDAE (Plover and Killdeer Family)

Charadrius vociferous

Killdeer

Records: IMRS, 2-3 May 1992, Hibbits; 9 August 2013, Wiseman.

RECURVIROSTRIDAE (Stilts and Avocets)

Recurvirostra americana

Avocet

Records: Road Tank, 13 April 2013, Wiseman; IMRS HQ, June 2014, Johnson.

SCOLOPACIDAE (Sandpipers, Snipes, Phalaropes et al.)

Gallinago gallinago

Common Snipe

Records: IMRS, 2-3 May 1992, Hibbits.

Phalaropus tricolor

Wilson's Phalarope

Records: Road Tank, 15 Oct. 2011, Wiseman.

Tringa solitaria

Solitary Sandpiper

Records: IMRS, 5 Apr. 1991, Field Biology Class; 27 July 2013, Wiseman.

COLUMBIFORMES

COLUMBIDAE (Dove and Pigeon Family)

Columbina inca

Inca Dove

Note: This species needs to be documented on IMRS.

**Streptopelia decaocto*

Eurasian Collared-Dove

Records: A pair at IMRS HQ, 27 August 2011, G. Wiseman, J.D.Johnson.

Note: The records were possibly for the Ringed Turtle-Dove, *S. risoria*.

**Streptopelia orientalis*

Oriental Turtle Dove

Records: IMRS HQ, May 2005, Johnson, with flock of White-winged Doves.

Zenaida asiatica

White-winged Dove

Records: IMRS HQ area; May 1995, Cutler; Squaw Spring, July 2000, Cutler;

IMRS, 2-3 May 1992, Hibbits; common around IMRS HQ and Squaw Spring.

Zenaida macroura

Mourning Dove

Records: Squaw Spring, May 1995, July 2000, Cutler; IMRS, 2-3 May 1992, Hibbits.

Note: Common around IMRS HQ and Squaw Spring.

CUCULIFORMES

CUCULIDAE (Roadrunner, Cuckoo Family)

Geococcyx californianus

Greater Roadrunner

[Mata-Silva et al., 2012]

Records: SE of IMRS HQ, July 2000, Cutler; IMRS, 2-3 May 1992,

Hibbits; IMRS HQ, May 2009, 12 June 2010, July 2016, Johnson.

Note: A nesting pair with nest high in a Catclaw near old ranch house, 14 August

2010; laid four eggs, three of which hatched. On 11 Sept. 2010 males brought the nestlings a dead *Sonora semiannulata*.

STRIGIFORMES

TYTONIDAE (Barn Owl Family)

Tyto alba

Barn Owl

Records: Observed around IMRS HQ, August 2016, K. Garza

STRIGIDAE (Owl Family)

Athene cunicularia

Burrowing Owl

Records: This species needs to be documented on IMRS.

Bubo virginianus

Great Horned Owl

Records: Commonly heard and observed around IMRS HQ.

Micrathene whitneyi

Elf Owl

Record: IMRS HQ, 25 May 2010; 13, 27 Apr. 2012, J.D. Johnson,

Wiseman (Photos). Juniper Grove, 2 October 2016, K. Garza (photo).

Note: Nesting pair in woodpecker hole in wooden water tower legs. Fledged week of 27 June 2012; returned Apr. 2013, 2014, 2015, 2016; gone by October. J.D. Johnson.

Megascops kennicottii

Western Screech-Owl

Records: Near IMRS HQ, 19 June 2015, J. Emerson

Note: Used to be classified as *Otis kennicottii*

CAPRIMULGIFORMES

CAPRIMULGIDAE (Nighthawk, Poor-will Family)

Chordeiles acutipennis

Lesser Nighthawk

Records: IMRS HQ, summer 2016, K. Garza, J.D. Johnson

Chordeiles minor

Common Nighthawk

Records: IMRS HQ, May 1995, Cutler. Common near IMRS HQ.

Phalaenoptilus nuttallii

Common Poorwill

Records: IMRS, 2-3 May 1992, Hibbits; IMRS HQ, 18 March 2011,

J.D. Johnson; 7 March 2014, Wiseman.

APODIDAE (Swift Family)

Aeronautes saxatalis

White-throated Swift

Records: IMRS, 2-3 May 1992, Hibbits. IMRS HQ, 12 Aug. 2016,

J.D. Johnson.

TROCHILIDAE (Hummingbird Family)

Archilochus alexandri

Black-chinned Hummingbird

Records: Squaw Spring, May 1995, Cutler; IMRS, Apr.

1990, Field Biology Class; IMRS, 2-3 May 1992, Hibbits. IMRS HQ, 7 June

2008, 16 June 2009, 27 August 2011, May 2013, 2014, 2015. 2016 J.D.Johnson.

Selasphorus calliope

Calliope Hummingbird

Records: Oak Arroyo, August 2016, K. Garza [photo]

Selasphorus rufus

Rufus Hummingbird

Records: IMRS HQ, 4 Aug. 2011, Wiseman, 27 Aug. 2011, J.D Johnson.

Road Tank, 4 Aug.2011, Mata-Silva; Mesquite Tank, 8 Oct. 2011, Wiseman.

Salasphorus platycercus

Broad-tailed Hummingbird

Records: Juniper Grove, 27 Aug. 2016, K. Garza [photo].

PICIFORMES

PICIDAE (Woodpecker Family)

Colaptes cafer

Northern Flicker

Records: Common near IMRS HQ, Johnson.

Picoides scalaris

Ladder-backed Woodpecker

Records: road from IMRS HQ to Squaw Spring, July 2000,

Cutler; IMRS HQ, 7 June 2008, J.D. Johnson.

FALCONIFORMES

FALCONIDAE (Falcon and Kestrel Family)

Falco sparverius

American Kestrel

Records: IMRS, 2-3 May 1992, Hibbits; IMRS HQ, J.D. Johnson

July & August 2016..

Falco mexicanus

Prairie Falcon

Records: IMRS HQ, 12 June 2015, Johnson

PASSERIFORMES

TYRANNIDAE (Flycatcher, Kingbird and Phoebe Family)

Contopus cooperi

[in some books as *C. borealis*]

Olive-sided Flycatcher

Records: Squaw Spring, May 1995, Cutler.

Contopus sordidulus

Western Wood Pewee

Records: Rattlesnake Tank, 20 August 2011, Wiseman.

Empidonax minimus

Least Flycatcher

Records: Rattlesnake Tank, 10 September 2011, Wiseman.

Empidonax oberholseri

Dusky Flycatcher

Records: Mesquite and Rattlesnake Tanks, 14 May 2012, Wiseman.

Empidonax occidentalis

Cordilleran Flycatcher

Record: Pirtle Tank, 17 May 2013. Wiseman.

Myiarchus cinerascens

Ash-throated Flycatcher

Records: Double Tank Corral, May 1995, Cutler; Squaw Spring, May 1995,

Cutler; IMRS HQ, May 1995, Cutler; May 1992, Hibbits; Apr. 2012, J.D. Johnson.

Note: Common around HQ.

Pyrocephalus rubinus

Vermillion Flycatcher

Records: IMRS HQ, 18 Apr. 2010, J.D. Johnson.

Sayornis nigricans

Black Phoebe

Records: Pirtle Tank, 24 September 2011, Wiseman.

Sayornis saya

Say's Phoebe

Records: Nests annually on buildings at IMRS HQ, Johnson.

Tyrannus verticalis

Western Kingbird

[Gardea and Mena, 1992].

Records: IMRS HQ, Mar. 1992; May 1992, Hibbits.

LANIIDAE (Shrike Family)

Lanius ludovicianus

Loggerhead Shrike

[Gardea and Mena, 1992].

Records: IMRS HQ, Apr. 1990, Mar. 1992, Field Biology.

Note: Commonly observed around IMRS HQ, J.D. Johnson.

VIREONIDAE (Vireo Family)

Vireo gilvus

Warbling Vireo

Records: Squaw Spring, 25 Aug. 2012; Rattlesnake Tank, 2012; Pirtle Tank, 2013, Wiseman.

Vireo griseus

White-eyed Vireo

Records: Pirtle Tank, 22 May 2013, Wiseman.

Vireo solitarius

Blue-headed Vireo

Note: This species needs to be documented on IMRS.

Vireo vicinior

Gray Vireo

Records: IMRS, Mar. 1995, Field Biology Class.

CORVIDAE (Jay, Crow, Raven Family)

Aphelocoma woodhouseii

Woodhouse's Scrub-Jay

Records: IMRS HQ, 11, 18 Apr. 2010, J.D. Johnson.

Note: Used to be classified as *Aphelocoma californica*.

Corvus cryptoleucus

Chihuahuan Raven

Records: IMRS, 2-3 May 1992, Hibbits. IMRS HQ, 18 Apr. 2010; 25 Nov. 2012, Wiseman. 2 May 2014, January 2015, J.D. Johnson.

ALAUDIDAE (Horned Lark Family)

Eremophila alpestris

Horned Lark

Records: Needs to be verified on IMRS.

HIRUNDINIDAE (Martin and Swallow Family)

***Hirundo rustica* [*Hirundo pyrrhonota*]**

Barn Swallow

Records: IMRS, May 1995, field trip group.

Petrochelidon pyrrhonota

Cliff Swallow

Records: Needs to be verified.

REMIZIDAE (Verdin Family)

Auriparus flaviceps

Verdin

Records: IMRS, Apr. 1990, Mar.-April, 1995, Field Biology Class;
IMRS HQ, June 2009, J.D. Johnson; August 2011, Wiseman.

TROGLODYTIDAE (Wren Family)

Campylorhynchus brunneicapillus

Cactus Wren

Records: Calling at Squaw Spring, May 1995, Cutler; along the road
to Squaw Spring, July 2000, Cutler; IMRS, Apr. 1990; IMRS, 2-3 May 1992,
Hibbits; IMRS, Mar. 1990, Field Biology Class; IMRS HQ, June 2007, J.D. Johnson.

Catherpes mexicanus

Canyon Wren

Records: Squaw Spring, 16 July 2011, Wiseman. IMRS HQ, 2013, J.D. Johnson.

Salpinctes obsoletus

Rock Wren

Records: IMRS HQ, Mar. 1992 (Gardea and Mena, 1992); IMRS, 2-3 May
1992, Hibbits. Squaw Spring, 18 Feb. 2012, Wiseman.

Thryomanes bewickii

Bewick's Wren

Records: Squaw Spring, July 2000, Cutler; IMRS HQ, Mar. 1992 (Gardea and Mena, 1992);
IMRS, Apr. 1992, Field Biology Class. Mesquite Tank, 24 Sept. 2011, Wiseman.

Troglodytes aedon

House Wren

Records: Oak Wash, 27 Aug. 2016, K. Garza.

POLIOPTILIDAE (Gnatcatcher Family)

Poliophtila melanura

Black-tailed Gnatcatcher

Records: Squaw Spring, May 1995, Cutler; IMRS HQ area, May 1995,
Cutler; Mar. 1992, [Gardea and Mena, 1992]; July 2009, J.D. Johnson.

Poliophtila caerulea

Blue-Gray Gnatcatcher

Records: Mesquite Tank, 10 Sept. 2011, Wiseman.

REGULIDAE (Kinglet Family)

Regulus calendula

Ruby-crowned Kinglet

Records: Squaw Spring, 20 Jan. 2012, Wiseman.

TURDIDAE (Thrush, Robin, Solitaire, and Bluebird Family)

Catharus guttatus

Hermit Thrush

Records: IMRS, May 1995, Herp Field Trip.

Myadestes townsendi

Townsend's Solitaire

Records: Squaw Spring, 28 Sept. 2013; Pirtle Tank, 19 Oct. 2013. Wiseman.

Sialia currucoides

Mountain Bluebird

Records: Red Tank, 5 Nov. 2011, Wiseman

Sialia mexicana

Western Bluebird

Records: IMRS HQ, 23 May 2010, G.W. Johnson.

Turdus migratorius

American Robin

Records: IMRS HQ, 12 Mar. 2010, J.D. Johnson.

MIMIDAE (Thrashers and Mockingbird Family)

Mimus polyglottos

Northern Mockingbird

Records: Double Tank Corral, May 1995, Cutler; Squaw Spring, May, 1995,
Cutler; IMRS HQ, May 1995, Cutler.

Note: Common around IMRS HQ during breeding season.

Oreoscoptes montanus

Sage Thrasher

Records: Pirtle Tank, 23 Sept. 2011, Wiseman

Toxostoma crissale

Crissal Thrasher

Records: Squaw Spring, May 1995, Cutler; Double Tank Corral,
May 1995, Cutler; IMRS HQ, Mar. 1992 [Gardea and Mena, 1992].

Toxostoma curvirostre

Curve-billed Thrasher

Records: IMRS HQ, 12 Mar. 2010, J.D. Johnson.

MOTACILLIDAE (Pipit Family)

Anthus rubescens

American Pipit

Records: IMRS, 4 Apr. 1991, Field Biology Class; Road Tank,
21 June 2012, Wiseman.

BOMBYCILLIDAE (Waxwing Family)

Bombycilla cedrorum

Cedar Waxwing

Records: IMRS, May 1995, Herp Field Trip.

PTILOGONATIDAE (Phainopepla Family)

Phainopepla nitens

Phainopepla

Records: Squaw Spring, May 1995, Cutler; IMRS HQ, June 2006, 2014,
J.D. Johnson; Mesquite Tank, Mar. 2013, Wiseman.
Note: Now classified in its own family.

PARULIDAE (Warbler Family)

<i>Setophaga coronata</i>	Yellow-rumped Warbler
Records: Squaw Spring, May 1995, Cutler; IMRS HQ, 7 Apr., 14 May 2011, J.D. Johnson. Note: Used to be classified as <i>Dendroica coronata</i> .	
<i>Setophaga petechia</i>	Yellow Warbler
Records: Rattlesnake Tank, 27 August 2011, Wiseman Note: Used to be classified as <i>Setophaga petechia</i> .	
<i>Geothlypis trichas</i>	Common Yellowthroat
Records: Needs to be confirmed.	
<i>Geothlypis tolmiei</i>	MacGillivray's Warbler
Records: Squaw Spring, May 1995, Cutler. Note: Used to be classified as <i>Oporornis tolmiei</i> .	
<i>Oreothlypis ruficapilla</i>	Nashville Warbler
Records: Rattlesnake Tank, 12 Apr. 2014, Wiseman.	
<i>Parkesia noveboracensis</i>	Northern Waterthrush
Records: Road Tank, 13 Aug. 2011, Wiseman (photo). Note: Used to be classified as <i>Seiurus noveboracensis</i> .	
<i>Setophaga americana</i>	Northern Parula
Records: Pirtle Tank, 15 Oct. 2011, Wiseman.	
<i>Setophaga townsendi</i>	Townsend's Warbler
Records: Mesquite Tank, 8 Oct. 2012. Note: Observed at all ephemeral tanks and Squaw Spring, Wiseman.	
<i>Oreothlypis virginiae</i>	Virginia's Warbler
Records: IMRS, May 1995, Herp Field Trip; Red Tank, 7 June 2008 Note: Used to be classified as <i>Vermivora virginiae</i> . (dead on ground), J.D. Johnson.	
<i>Cardellina pusilla</i>	Wilson's Warbler

Records: IMRS HQ, 2-3 May 1992, Hibbits; Aug., Sept. 2011, Wiseman;
Peccary Tank, Pirtle Tank, Rattlesnake Tank, Red Tank 10 Sept. 2011, Wiseman.
Note: Used to be classified as *Wilsonia pusilla*.

PASSERELIDAE (Sparrow and Towhee Family)

Note: Many of these used to be in the Emberizidae family.

Aimophila ruficeps **Rufous-crowned Sparrow**

Records: IMRS HQ, Mar. 1992 [Gardea and Mena, 1992]; IMRS,
Apr. 1990, Field Biology Class; IMRS 2-3 May 1992, Hibbits. Common
around IMRS HQ.

Amphispiza bilineata **Black-throated Sparrow**

Records: IMRS HQ area, May 1995, Cutler; Squaw Spring, July 2000,
Cutler; area of IMRS HQ, Mar. 1992 [Garde and Mena, 1992]; IMRS,
Apr. 1990, common near IMRS HQ.

Calamospiza melanocorys **Lark Bunting**

Records: IMRS, Apr. 1990, Field Biology Class; IMRS HQ, 11 Apr.
2010, 7 Aug. 2010, J.D. Johnson; 4 Aug. 2011, 3 May 2014, Wiseman.

Chondrestes grammacus **Lark Sparrow**

Records: IMRS HQ, 26 Aug 2011, J.D. Johnson; Mesquite Tank, 20 Aug.
2011, Wiseman.

Junco hyemalis **Dark-eyed Junco**

Records: IMRS HQ, 4 Nov. 2012. J.D. Johnson, Wiseman.

Melospiza melodia **Song Sparrow**

Records: Rattlesnake Tank, 7 Sept. 2013. Wiseman.

Melospiza lincolni **Lincoln Sparrow**

Records: Squaw Spring, 2 Mar. 2013. Wiseman.

Passerculus sandwichensis **Savannah Sparrow**

Records: Rattlesnake Tank, 10 Sept. 2011, Wiseman.

Note: Seen at all ephemeral Tanks, but not at Squaw Spring, Wiseman.

Pipilo chlorurus **Green-tailed Towhee**

Records: IMRS, 2-3 May 1992, Hibbits; IMRS HQ, 8 May
2010, J.D. Johnson.

Pipilo erythrophthalmus Eastern Towhee

Records: IMRS, Apr. 1990, Field Biology Class.

Melospiza fusca Canyon Towhee

Records: Road to Squaw Spring, May 1995, Cutler; IMRS, Mar. 1995, Field Biology Class; IMRS HQ, 7 Apr. 2011, J.D. Johnson.

Note: Used to be classified as *Pipilo fuscus*.

Pipilo maculatus Spotted Towhee

Records: Pirtle Tank, 15 Oct. 2011, Wiseman.

Pooecetes gramineus Vesper Sparrow

Records: Pirtle Tank, 15 Oct. 2011. Recorded at all ephemeral Tanks, but not Squaw Spring, Wiseman.

Spizella atrogularis Black-chinned Sparrow

Records: IMRS HQ, Mar. 1992 [Gardea and Mena, 1992].

Spizella breweri Brewer's Sparrow

Records: IMRS HQ, Mar. 1992 [Gardea and Mena, 1992]; IMRS, Apr. 1991, Mar. 1995, Field Biology Class.

Spizella pallida Clay-colored Sparrow

Records: Rattlesnake Tank, 10 Sept. 2011.

Note: Common during summer, Wiseman.

Spizella passerina Chipping Sparrow

Records: IMRS HQ, Mar. 1992 [Gardea and Mena, 1992]; IMRS, 2-3 May 1992, Hibbits; Mesquite Tank, Aug. 2011, Wiseman.

Spizella pusilla Field Sparrow

Records: Squaw Spring, 30 Sept. 2012, Wiseman.

Zonotrichia leucophrys White-crowned Sparrow

Records: Squaw Spring, May 1995, Cutler; IMRS HQ, Mar., 1992 [Gardea and Mena, 1992]; IMRS HQ, 7 Apr. 2011, Mar. 2013, J.D. Johnson.

CARDINALIDAE (Grosbeak, Cardinal, and Bunting Family)

Piranga ludoviciana Western Tanager

Records: Squaw Spring, May 1995, Cutler; the Box, 17 July 2010, Johnson.

Note: Used to be classified in the Thraupidae family.

Prianga rubra

Summer Tanager

Records: Squaw Spring, May 1995, Cutler.

Note: Used to be classified in the Thraupidae family.

Cardinalis sinuatus

Pyrrhuloxia

Records: IMRS HQ, May 1995; Squaw Spring; 1.5 mi. SE of IMRS HQ, July

2000, Cutler; IMRS, Apr. 1990, Field Biology Class; IMRS HQ and Squaw Spring, summer 2010, J.D. Johnson; IMRS HQ, 7 Apr. 2011, Aug. 2014, J.D. Johnson.

Passerina ameona

Lazuli Bunting

Records: Juniper Grove, 27 Aug. 2016, K. Garza [photo]

Passerina caerulea

Blue Grosbeak

Records: IMRS, May 1995, Herp Field Trip. IMRS HQ, 2 May 2010, Johnson;

Squaw Spring, 12 June 2010, Johnson; Mesquite Tank, 4 Aug. 2011, Wiseman.

Passerina ciris

Painted Bunting

Records: Peccary Tank, 16 July 2011, Wiseman (mating pair).

Passerina versicolor

Varied Bunting

Records: Squaw Spring, May 1995, Cutler.

Pheucticus melanocephalus

Black-headed Grosbeak

Records: Road to Squaw Spring, July 2000, Cutler; 10 May 2013, Wiseman.

Spiza americana

Dickcissel

Records: Rattlesnake Tank, 27 Aug. 2011, 10 Sept. 2010, Wiseman.

ICTERIDAE (Blackbird, Meadowlark, Cowbird, and Oriole Family)

Agelaius phoeniceus

Red-winged Blackbird

Records: Rattlesnake Tank, 10 Sept. 2011, Wiseman.

Euphagus cyanocephalus

Brewer's Blackbird

Records: IMRS HQ, May 1995, Cutler: IMRS, 2-3 May 1992, Hibbits;

IMRS, Mar. 1995, Field Biology Class; IMRS HQ, 15 Apr. 2013, Wiseman.

Icterus bullockii

Bullock's Oriole

Records: Mesquite Tank, 10 Sept. 2011, Wiseman.

Icterus cucullatus

Hooded Oriole

Records: IMRS HQ, 7 June 2008, S. Dash.

Icterus parisorum

Scott's Oriole

Records: Squaw Spring, May 1995, July 2000, Cutler; IMRS HQ, March-April 1991, March 1995, Field Biology Classes; IMRS, 2-3 May 1992, Hibbits.
Note: Common around IMRS HQ, J.D. Johnson.

Icterus spurius

Orchard Oriole

Records: PirtleTank, 28 July 2014. Wiseman.

Molothrus ater

Brown-headed Cowbird

Records: IMRS HQ, July 2000, Cutler; IMRS, 2-3 May 1992, Hibbits.
Note: Common around IMRS HQ during summer, J.D.

Molothrus aeneus

Bronzed Cowbird

Records: IMRS HQ, 6 June 2009, G. W. Johnson, Johnson. IMRS HQ, summer 2010, 4 Aug. 2011, J.D. Johnson.
Note: Common around HQ during summer, J.D. Johnson.

Quiscalus mexicanus

Great-tailed Grackle

Records: IMRS HQ, 18 April 2010, 7 April 2011, 16 March 2013, J.D. Johnson

Sturnella neglecta

Western Meadowlark

Records: IMRS HQ, October 2010, 7 April 2011, J.D. Johnson.

Xanthocephalus xanthocephalus

Yellow-headed Blackbird

Records: IMRS HQ, summers 2004, 2006, 2008, 2010, 2011, 2013, 2015, 2016, J.D. Johnson.

FRINGILLIDAE (Finch, Crossbill, Goldfinches Family)

Haemorhous mexicanus

House Finch

Records: Squaw Spring, May 1995, July 1995, Cutler; IMRS HQ, Mar. 1992 [Gardea and Mena. 1992]; IMRS, 2-3 May 1992, Hibbits; IMRS HQ, Apr. July 9, 2016. Squaw Spring, 12 June 2010, 4 Aug. 2011, Wiseman.
Note: Used to be classified as *Carpodacus mexicanus*.

Spinus pinus

Pine Siskin

Records: Mesquite Tank, 24 Nov. 2012; Rattlesnake Tank, 12 Apr. 2014. Wiseman.

Spinus psaltria

Lesser Goldfinch

Records: Squaw Spring, 8 July 201; Pirtle Tank 28 Jan. 2012, Wiseman.

Spinus tristis

American Goldfinch

Records: Pirtle Tank, 31 Mar.2013, Wiseman.

APPENDIX 4: A gazetteer of the common and study sites on IMRS, especially those relevant to this study.

“The Box”: Eastern opening of canyon of the Rio Grande near S end of Indio Mts. On the O’Connor Ranch (30° 39’50”N, 104° 59’25”W), 3150 ft. elev. [1].

Indio Mountains: Southern spur of Eagle Mountains, Hudspeth County, Texas; bounded by Oxford Canyon (N), Rio Grande (S), Red Light Draw (W), and Green River (E) [4].

Indio Ranch House [IMRS Headquarters Complex]: Old Bailey Evans Ranch House and central facilities of IMRS Headquarters, 3.6 rd. mi. W and N of East Gate (30.776667°N, 105.015833°W), ca. 1230 m elev. [1]. Facilities at the Headquarters include two dorms and bathrooms, old Ranch House Lab; New Lab, small sleeping building, an assembly hall that includes a kitchen, and a shed holding ATVs. All buildings and the water sources are powered with solar generated electricity [8]. Has pit-fall trap array.

IMRS: Abbreviation for UTEP’s Indio Mountains Research Station.

Juniper Grove: North of Double Tank Corral on road to Squaw Spring (30°47’40.82”N, 104°59’35.92”W [9].

Main Road: Gravel road from Green River Road, through East Gate, Echo Canyon, to Indio Ranch House, and then NNW toward North Gate, Oxford Canyon, and Squaw Spring.

Mesquite Tank: Tank near Bailey Evens Arroyo located ca. 2.78 km WSW of IMRS Headquarters (30.76167°N, 105.03085°W), 1167 m elev.

Montane Oak Wash: A canyon-like wash system located on the northern side of the Main Road between the big hill and Corral Tank. 30°47’6.39”N, 104°59’22.60”W [9], * m elev.

Oak-Juniper Arroyo: 1st arroyo inside east gate, 30.78636°N, 104.98044°W, 1327 m. elev.) [9]. Pit-fall trap array.

Peccary Tank: Seasonally dry impoundment along River Road, ca. 1.8 rd. mi. S of IMRS Headquarters (30°45’20”N, 105° 00’15”W), 1213 m elev. [3].

Pirtle Tank: Southeasternmost of the two seasonally dry impoundments in the Double Tank Corral area adjacent to the Main Road near the jct. with Eagle Canyon Road (30° 47'05"N, 104° 59'00"W), 4380 ft. elev. [6]; also called **Bull Tank** [8].

Prospect Pits Arroyo (Thorn-scrub Arroyo): Large Arroyo draining Echo Canyon and Ranch House Draw at the bottom of the hill past the Y on the main road to IMRS Headquarters (30°46'11.70"N, 105°0'36.65"W) [8].

Rattlesnake Tank: Seasonally dry impoundment at head of small east draining canyon ca. 1 km (air) ENE of summit of Red Mountain and 0.25 km W of River Road (30° 44'47"N, 105° 00'30"W), 1198 m elev. Also called Trap Tank [6] and Oh S*** Tank [9].

Red Tank: Large seasonally dry impoundment along River Road just W of Eagle Canyon (30° 43'48"N, 104° 59'18"W), 3920 ft. elev. [1]. Pit-fall trap array.

Squaw Spring: Permanent spring in Squaw Creek Canyon ca. 2.5 km (air) N of IMRS HQ (30.796944°N, 105.010556°W), 1263 m elev. [1]. Has pit-fall trap array.

Vita

Kayla Rochelle Garza was born in Riverside, California on June 25, 1988, and grew up in El Paso, TX, forming a deep connection to the Chihuahuan Desert. She earned her G.E.D. from El Paso Community College (EPCC) at 16 after leaving Edison Hope Christian Academy. In 2009, she completed an Associates of Science in Biology at EPCC and transferred to the University of Texas at El Paso (UTEP). Upon completing Dr. Jerry D. Johnson's field biology course, she concentrated her focus in ecology and evolutionary biology. She was recruited to apply for the CDB-REU (Chihuahuan Desert Biodiversity-Research Experience for Undergraduates) and worked on life history studies of the Texas Banded Gecko. Mentored by her lab senior members, she presented her research at various symposiums and conferences, and remained a field assistant in the lab until graduation in 2015. She was accepted into UTEP's Graduate School for a Master of Science in Biological Sciences, and completed an 18-month bird study of migrants, wintering, year-round, and summer breeding birds using isolated oak and juniper habitats in the Trans-Pecos Chihuahuan Desert. Kayla published a very interesting natural history note in the Herpetological Review on *Urosaurus ornatus* (Ornate Tree Lizard). She loved being a teaching assistant and mentor for Dr. Johnson's field biology course, freshman biology labs and vertebrate zoology. Incoming publications include, a paper on the smallest owl in North America, the Elf Owl, and the Osler's Oakworm Moth. She plans on pursuing a biological specialist-GIS position with Texas Parks and Wildlife, and loves teaching biology to students and the public.

Contact Information: kaylagarza517@gmail.com

This thesis was typed by Kayla Rochelle Garza.