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An Avian Survey Conducted At Five Water Sources Within The Northern Chihuahuan Desert On Indio Mountains Research Station, Texas

Geoffrey Hugh Wiseman
University of Texas at El Paso, ghwiseman@miners.utep.edu

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GEOFFREY HUGH WISEMAN

Department of Biological Sciences

APPROVED:

Jerry D. Johnson, Ph.D., Chair

Carl S. Lieb, Ph.D.

Eric A. Hagedorn, Ph.D.

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

Dedication

I would like to dedicate this project and its defense to my late stepfather, Phillip Craven Brown Jr. The day of my defense (July 31, 2014) would have been his 77th birthday.

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by

Geoffrey Hugh Wiseman, B.Sc.

THESIS

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I would like to thank the members of my committee, Dr. Jerry D. Johnson, Dr. Carl S. Lieb, and Dr. Eric A. Hagedorn, for the support given to me and being a part of my graduate education.

I would also like to thank Scott Cutler of the UTEP Centennial Museum for his help early on in the project with bird identifications and for his encouragement.

I would like to acknowledge the Facebook Bird Identification Group of the world. This social media group is a wonderful teaching tool for bird identification for amateurs and professionals alike.

My major advisor, Dr. Jerry D. Johnson, has been lauded many times before and this is no exception. He is all that is important within the University setting; mentor, professor, researcher. Dr. Johnson's door is always open; he is always ready for a question from his students or to dispense advice on what future direction one should take. He spends uncountable hours preparing, traveling and administering the ranch. He spends more hours editing, reviewing and revising journal submissions. Throughout it all he manages to teach classes and grade tests and papers. While at the ranch Dr. Johnson does all the chores so that student researchers can concentrate on research and not wash, cook, etc. For this he does not receive the thanks that he deserves. For this and everything else left unsaid, thank you Dr. J!

Part of my graduate experience was to be a mentor to an undergraduate. Sara Baqla is everything a mentor could want in a mentee; dedicated, motivated, excited to get out into the

field. Best of all, she was low maintenance and needed little to no supervision. Sara will be an outstanding graduate student and I want to thank her for giving me the opportunity to expand in ways that I would not have thought of otherwise. Good luck in your own graduate experience Sara.

Finally, as any married man would (and should), I would like to thank my wife Kelly. She has endured many hardships of separation during my 21 years in the U.S. Army and continued to endure separations while I was doing research away from home. We half-jokingly say that out of 22 years of marriage we have only been together 15 years. Kelly is my sounding board and confessor, personal advisor and editor. Without her patience and dedication I would never have finished my Bachelor degree much less become a graduate student, especially at my age. I would like to express, for these reasons and more too numerous to enumerate; my deepest gratitude to you for putting up with me for all this time.

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Abstract

The objective of this study was to conduct an avian survey of five water sources (four ephemeral former cattle tanks and one perennial spring), determine how many species inhabit or use Indio Mountains Research Station, and show a hierarchal similarity between the survey sites. This survey was conducted in a Chihuahuan Desert scrub landscape on Indio Mountains Research Station (IMRS) in Hudspeth County, Texas. There have been no previous formal studies of the avifauna at IMRS. All species accounts or sightings have been from casual sightings.

Eighty-five avian species were recorded during this project bringing the total of avian species observed on IMRS to 141 species. Rattlesnake Tank recorded the highest number of species with 60 and Squaw Spring the low with 47. Rattlesnake Tank and Mesquite Tank were the highest in similarity sharing 87% of their species. Squaw Spring was hypothesized to have had the highest number of species and be the outlier in similarity. This was rejected as it was grouped with Pirtle Tank in similarity and had the lowest number of species observed.

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Introduction

Indio Mountains Research Station (IMRS) is a University of Texas Land holding located in the northern Chihuahuan Desert of the Trans-Pecos region of Texas. It is used extensively by students and faculty from The University of Texas at El Paso (UTEP) for field based biological, geological, and environmental sciences research and education. Biological research and education has included botany, mammalogy, herpetology, and entomology. However, there have been no organized projects or studies on the avian fauna residing in or temporarily using the IMRS landscape. All 83 bird species listed earlier (2004) in Worthington *et al.* (2004 - 2010) had been from casual sightings only; the expected number of avian species ranged from 160-200 according to unpublished data provided by West (1976). As of 2012, 96 species had been observed (Worthington *et al*. (2011 – 2014)), up from the 83 listed in 2004. By June, 2013 that total had increased to 113 including 17 species added during a preliminary investigation by G. H. Wiseman that was funded by a National Science Foundation (NSF) Undergraduate Research and Mentorship (URM) grant. From these numbers, it was expected that at its completion, the more intensive project described herein would add a number of species totaling closer to the predicted lower end of the range of 160 species. This project, comparing the avian fauna between ephemeral man-made water tanks and one perennial natural spring, was conducted on IMRS from December 2012 through May 2014. It also included preliminary data attained during URM activities that employed the same protocols as the ones used here. Past casual bird sightings, including those listed in both Worthington *et al.* (2004 – 2010) and Worthington et al. (2011 – 2014), was also tallied to produce an up-to-date listing of the species that have been observed on IMRS through May 2014.

There were numerous reasons for this study being conducted around water sources on IMRS. In the 1980s and 1990s, 10 different surveys reviewed by Garcia-Salas *et al*. (1995) for the Chihuahuan Desert (mostly done in Mexico and two sites in Big Bend National Park) produced a high of 76 species recorded at Galeana, Nuevo Leon, Mexico. Most sites reviewed in that paper, including the Big Bend sites recorded less than 30 species. When this survey started there were already a total of 96 species recorded from previous years (Worthington *et al.* 2004 - 2010) and because of the prediction that up to 160 species inhabit or use the region, there was reason to expect many more species as the project progressed. In contrast, however, a project completed in southwest Arizona listed 150 species of birds from two man-made wildlife tanks in a period of one year during 1994 and 1995 (Cutler 1996). According to Naranjo and Raitt (1993) the number and type of bird species that inhabit typical Chihuahuan Desert scrub is more similar to desert grasslands than that of warm deserts of North America (especially in summer), as is evidenced by the aforementioned study conducted by Cutler (1996). The low abundance of species observed in previous studies of the avifauna of the region suggests that the Chihuahuan Desert is depauperate when compared to other, more complex ecosystems in North America (Naranjo and Raitt 1993).

Water availability in the arid southwest has long been a subject of study, debate and contention among biologist and policy makers. In Arizona, over 800 man-made water catchments have been constructed for the purpose of enhancing wildlife abundance and richness. The number of these catchments approaches 6,000 for the entire southwestern region of the United States (O'Brien *et al.* 2006; Rosenstock *et al*. 1999). Some argue that artificial water holes, insofar as avian fauna is concerned, produces higher species richness and abundance (Cutler and Morrison 1998). Others argue that artificial water sources in arid environments can

have adverse impacts and not yield expected benefits (Rosenstock *et al*. 1999, Broyles 1995), although these studies do state more systematic research is necessary in order to evaluate the true consequences/ benefits of artificial waterholes. The Rio Grande, with its subsequent vegetation, corridor was also within close proximity to IMRS (just over 1,800 m at its closest approach to the IMRS border). The river there did not go dry as it was constantly fed by springs and runoff and probably contributed to the number of species that were observed on IMRS proper. While this project included four former man-made cattle tanks, the benefits or adverse impacts of artificial watering sources were not evaluated.

There have been reports of relationships between many bird species and vegetative cover, especially Mesquite (*Prosopis* spp.). Birds, surveyed at two man-made tanks in Cabeza Prieta National Wildlife Refuge, were observed using Mesquite (*Prosopis spp.)* more than expected (Cutler and Morrison 1998). There is a higher density of vegetative cover around water sources and some studies have indicated that a higher vegetative volume (again, especially Mesquite spp.) will lead to greater avian diversity (Mills *et al*. 1991). Avian richness and abundance were shown to be higher when Mesquite, as the main component, was greater than grass (i.e., Black Gramma). A study by St-Louis *et al*. (2009) using vegetation indices (from satellite remote sensing) found that mesa grasslands showed the lowest species richness with a mean of 19 species as compared to 23 for Mesquite; highest value was a mean of 34 in pinyon-juniper. A study conducted on Ft. Bliss, Texas concluded that avian diversity and abundance had increased as a result of the replacement of desert grasslands with desert shrub land (Pidgeon *et al.* 2001). In that study it was also observed that while Mesquite apparently led to increased species richness, White-Thorn Acacia (*Acacia constricta*) resulted in even higher levels of species diversity. Casual observation of the vegetative cover around ephemeral tanks on IMRS seemed

to indicate that they have much thicker stands of shrubs and small trees than the surrounding desert. Riparian habitats of the southwest, such as the microhabitat around Squaw Spring on IMRS, are known to have some of the highest avian densities in North America (Mills et al. 1991). There is also a pronounced edge or boundary around the ephemeral tanks and Squaw Spring. This "edge effect" has the property of increasing bird densities at the interface between habitat types such as those between the "tanks" and the open desert (Mills et al. 1991). Birds may use the edge cover around the tanks because of availability of perching and nesting sites and foraging opportunities that the edge of the water sources provides (Cutler and Morrison 1998).

The avian survey presented herein was conducted to produce a list of all avian species observed on IMRS since UTEP took active control of station lands in 1987. It was also used to conduct a presence/ absence survey of all avian species that reside in or temporarily used five designated water sources on IMRS and to determine which site attracted the most species. The presence/absence survey was used to compare pair-wise similarity (Lomolino et al. 2010; Simpson 1960) of bird species that were found yearly on IMRS between five designated water sources, and to determine how the paired similarity is arranged in a hierarchical manner (Sokal and Michener 1958). Lastly, this data was used to determine from the presence/absence survey if the one perennial water source (Squaw Spring) attracted more avian species than the ephemeral earthen water sources (tanks).

The hypotheses for this project were: 1) more species of birds permanently and seasonally resided on IMRS than was previously known, and the surveys described herein should add a number of different species making the total closer to the 160 forms predicted in the past; 2) Squaw Spring, the permanent water source, would contain the greatest number of bird species

and should be the outlier in the similarity analyses; 3) of the ephemeral tanks, the ones closest in proximity to each other should show the greatest similarity.

Materials and Methods

STUDY AREA: This study was conducted at Indio Mountains Research Station (IMRS) located in extreme southeastern Hudspeth County, Texas. The IMRS headquarters (HQ) is centered on 30.776667°N, 105.015833°W (Worthington *et al*. 2011-2014) and is ca. 40 km southwest of Van Horn, Texas and 240 km southeast of El Paso, Texas. IMRS includes nearly 40,000 acres of Chihuahuan Desert landscapes (Figure 1; Google Earth 2013). The following brief descriptions of IMRS resources was based on Johnson (2000) and Worthington et al. (2011-2014) and are accessible at http://www.utep.edu/indio, the IMRS website.

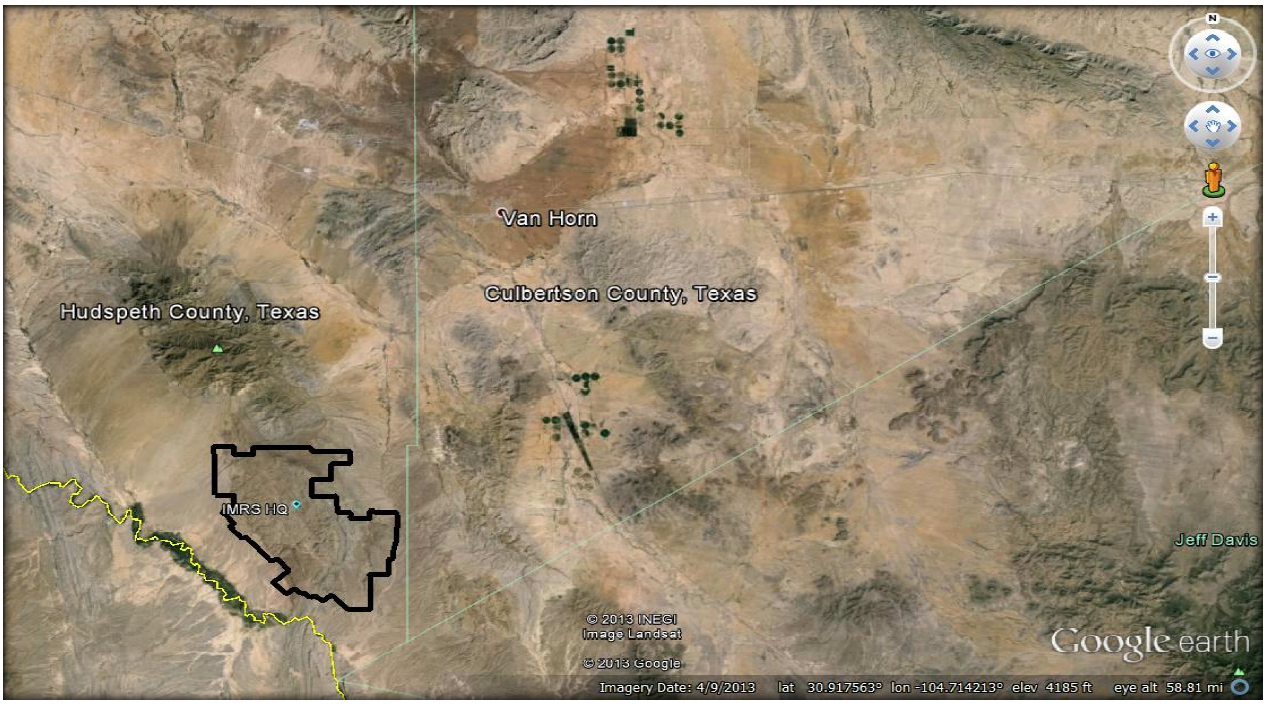


Figure 1: Outline of IMRS in Southeastern Hudspeth County, Texas.

IMRS has a complex geological structure. The eastern slopes of the Indio Mountains are composed primarily of limestone from the Cretaceous period while the western slopes contain Permian period conglomerates, sandstones, and shales. Igneous layers containing basalts, pumice and ash can be found in the south-central areas of the property nearest the Rio Grande. Elevation on IMRS ranges from ca. 900 m nearest the river to ca. 1640 m on the highest peaks of the property.

IMRS, being located in an arid environment, typically receives less than 25 cm of precipitation annually. Most of the annual rainfall occurs during the summer monsoon (June-September). Some of the earthen cattle tanks, left over from times when the property was used as a ranch, still collect run-off during the summer monsoon. Squaw Spring is the only permanent water source on the property although recently a new spring has been found 5.5 km northwest of Squaw Spring and only 500 m north of the property boundary.

Vegetation on IMRS reflects typical Chihuahuan Desert scrubland consisting of primarily Creosotebush, acacias, Lechuguilla, Ocotillo, yuccas, and an assortment of cacti. The flora is influenced by the Rio Grande corridor with species that would normally be associated with the Big Bend region moving northwest up the Rio Grande Valley. There are also widespread remnants of desert grasslands that are comprised of Tabosa-Black Gramma associations. Floral inventories have documented 375 species out of an expected 500.

IMRS's animal life is typical of the northern Chihuahuan Desert region. Invertebrates typical of this region are numerous, especially insects and spiders; there are over 400 species of arthropod presently recorded from IMRS. Reptiles (ca. 36 species) are abundant as well, and include 21 species of snakes (including three rattlesnakes) and 15 species of lizards; two species of chelonians (turtles) have also been recorded, albeit not recently. Amphibians are not

encountered as often because of the dry environment, but during the monsoon season up to five species (all anurans) have been found on IMRS. Birds are less well known than the herpetofauna; however casual observations prior to the present study listed ca. 83 species out of a maximum expected 200. A total of 25 species of mammals have been recorded so far at IMRS. Larger mammals include Mountain Lion, Mule Deer, Collared Peccary, Coyotes, Ringtails, and Gray Foxes. Smaller mammals include rabbits, pocket gophers, ground squirrels, bats, and several species of small rodents.

PROCEDURES: Birds were surveyed from four different ephemeral water sources and one permanent water source. Only species that were actually observed and verified were included in the study. Birds were detected and when necessary photographed in order to ensure correct identification. Five survey sites were selected for this study (Figure 2; Google Earth 2013). Four of the sites were selected randomly from numerous ephemeral water sources that were accessible within the boundaries of IMRS. Only one site, Squaw Spring, was not selected randomly, because it was the only permanent water source within the boundaries of IMRS. These sites are:

Squaw Spring (Figure 3): A small permanent water source that was located at 30.79718°N, 105.01125°W; 1263 m elev. It was situated at the end of a narrow canyon with steep limestone cliffs. It was the only permanent water source located on IMRS and contained numerous stands of *Baccharis* spp. and *Typha* spp. During flooding events the spring channel had been cleared of the *Typha* and *Baccharis* and the main pool usually changes shape during those events. One large Desert Willow (*Chilopsis linearis*) was the largest tree in the area surrounding the spring. Mesquite Tank (Figure 4), a large former earthen cattle tank, located at

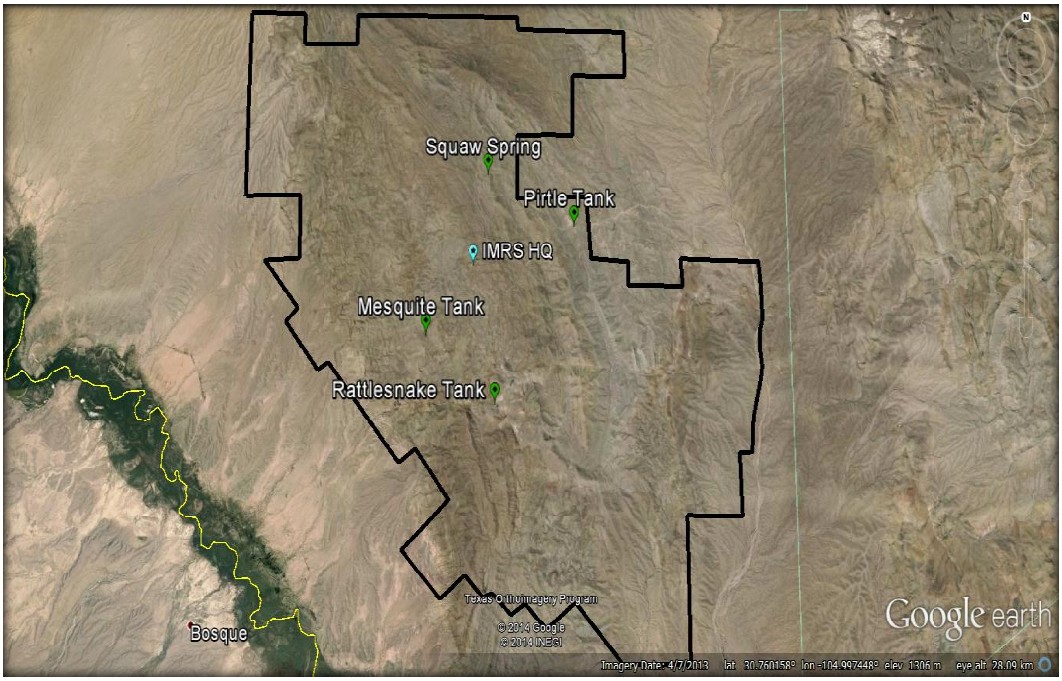


Figure 2: Outline of IMRS showing the five survey sites and IMRS Headquarters (HQ).

Figure 3: Landscape of Squaw Spring.

Figure 4: Landscape of Mesquite Tank as seen from the hill north of the tank.

Figure 5: Landscape of Rattlesnake Tank.

Figure 6: Landscape of Peccary Tank as seen from the dike southeast of the tank.

Figure 7: Photograph of Pirtle Tank from the slope southeast of the tank.

30.76127°N, 105.03051°W; 1167 m elev., was situated alongside a large arroyo complex surrounded by Honey Mesquite and Catclaw. It did not usually hold water at the surface; however water may be held by soil close to the surface as demonstrated by the pervasive lush vegetation.

Rattlesnake Tank (Figure 5): Another large, former cattle watering tank, was located at the base of Flattop Mountain (30.74637°N, 105.00893°W; 1198 m elev.). Rattlesnake Tank is aptly named because of the abundance of Western Diamondback Rattlesnakes (*Crotalus atrox*) that resided there. The actual water catchment was choked with Rough Cocklebur (*Xanthium strumarium*) (virtually 100% coverage) and surrounded primarily by mesquite and acacias with many other desert scrub species intermixed.

Peccary Tank (Figure 6): A small bowl-shaped former cattle tank that is located ca. 1.6 km north of Flattop Mountain, (30.75599°N, 105.00433°W; 1213 m elev). Vegetation was sparser there than at the two previous tanks, although it did attract larger flocks of Mourning Dove (*Zenaida macroura*) than seen at the other tanks or Squaw Spring. The tank had a narrow band of primarily mesquite/acacia that surrounded the tank and was fed by a narrow arroyo that was connected to its northeastern end. Peccary Tank does not hold water for very long, as it quickly drained after the pool filled up.

Pirtle Tank (Figure 7): This cattle tank was located east of the ridge that sits above Echo Canyon (30.78486°N, 104.98424°W; 1339 m elev). It was located near Corral Tank and both together are sometimes referred to as Double Tank Corral. Pirtle Tank was the highest tank in elevation of those surveyed (1,339 m). It was surrounded by numerous species of desert scrub, yucca, Honey Mesquite and acacias. It was the only location surveyed that contains Western Hackberry and in its center was a dense stand of *Baccharis* spp.

Birds were detected and when necessary photographed in order to ensure correct identification. The type of survey used for all five sites was a modified point survey (Gibbons and Gregory 2006). The study sites were accessed by all-terrain vehicles (ATV). The surveys of these sites were set up in a matrix like the one shown in Table 1 to insure an equal number of assessments were made at each site. The sites were assigned the following numbers in the matrix: Squaw Spring; SP (1), Mesquite Tank; MT (2), Rattlesnake Tank; RT (3), Peccary Tank; PT (4), Pirtle Tank; PiT (5).

Table 1: Example of the matrix of AM/PM surveys to ensure equal assessments of all sites. Surveys already conducted have numbers with dates; those to be conducted have numbers without dates. Site numbers are: 1=SP, 2= MT, 3= RT, 4= PT, 5= PiT.

	2012 Survey Matrix							
AM	**1**- 7 Jul	**2**- 7 Jul	**3**- 8 Jul	**4**- 8 Jul	**5**- 14 Jul	**1**- 14 Jul	**2**	**3**
PM	**3**- 7 Jul	**4**- 7 Jul	**5**- 8 Jul	**1**- 8 Jul	**2**- 14 Jul	**3**- 14 Jul	**4**	**5**
AM	**5**	**1**	**2**	**3**	**4**	**5**	**1**	**2**
PM	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**
AM	**4**	**5**	**1**	**2**	**3**	**4**	**5**	**1**
PM	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**

The numbers are then placed into the matrix created with groups of two rows (AM and PM) and multiple columns. As a site was surveyed, the date was written into the cell that the number occupies. Surveys started at site 1 and two surveys were conducted per morning and per evening. If, for instance, a morning survey was done at site "1", the next morning survey was at

site “2”. The following morning, site “3” was surveyed followed by site “4” that same morning. The next time a morning survey was done it began with site “5” followed by site “1” and so on. The same was done with the evening surveys.

Surveys were conducted as close to the same time of day for each sample; i.e. first survey site in the morning was reached at approximate 0700 h. However due to the locations, weather, and road conditions not every site was surveyed at exactly the same time. Also because of factors associated with seasons and day length, the surveys were adjusted throughout the year as the days grew longer and then shorter. The survey time was 20 minutes for all sites during each visit. The allocated 20 minute period was to ensure that enough time was spent at a site to record as many different species as possible, while not staying too long at one site and spending too little time at another. The actual 20 minute time period did not start until five minutes after arriving at the site to allow birds startled by the arrival of a motorized vehicle (usually an ATV) to settle down and return to the area at a later time. Even though this five minute period is not an official segment of the allocated 20 minute survey, any bird that was observed during that interval was identified and recorded. This was done because a species observed outside the survey period does not mean it was not there. All species observed at each site from the time of arrival to the time of departure were recorded as long as positive identification was made. Data recorded from each site included species name, site name, date, time, general weather conditions, and temperature. Also recorded on the data sheet was a general portrayal of the particular bird in question (i.e., warbler like species on mesquite branch). If confirmed identification of a species could not be made in the field, a photograph of that species was taken with a digital single lens reflex camera (Nikon D7000) with a super zoom telephoto lens (Sigma 150-500 mm F3.5-F6.0). The photo was then be used back at IMRS headquarters along with Field Reference guides (e.g.,

Stokes and Stokes 2010; Brinkley 2007) to make a positive identification of the bird. In the case of a nondescript bird, such as a sparrow that is difficult to identify, the photos were sent by e-mail to experts in the field for identification assistance. Another tool that was used for identifying questionable birds was the Cornell Lab of Ornithology website (Cornell Lab of Ornithology: All About Birds 2011), which contains photos, descriptions, and calls of virtually all species found in North America. If identification could not be made, then the bird in question was not included in the data set, especially if the bird in question was by itself and aberrantly colored. However, in most cases abnormal individuals were found together with other more typically patterned members of its species, making it easier to identify.

Throughout the study period, casual observations not part of the water source surveys were made opportunistically as they became available. Most casual observations were made around IMRS HQ where bird feeding stations have been set up and where research personnel spend a good portion of their visits. Photographs of birds taken during casual observations will become part of the Photographic Atlas depicting species found on IMRS.

Vegetation was surveyed and quantified at each site using a modified belt transect adapted from Sutherland (2006). This analysis was used to determine differences in the plant communities contained within the visible perimete3r of each tank and Squaw Spring. Vegetation was quantified as a percent value of all plants surveyed per site. To determine the percent occurrence out of total vegetation, a base was selected from the longest side perimeter (Figure 8). That base was then divided into 5 equal segments. A 1 m^2 quadrat was then dropped at the beginning of each segment with one side parallel to the line of the "belt" (Figure 8). All individual plants were counted that fell within or touched the quadrat edges. Once the belt transect quadrats were counted, a total perimeter count was conducted. Only perennial trees,

shrubs, and cacti were counted in the perimeter survey, which excluded grasses, forbs, weeds mosses and lichens.

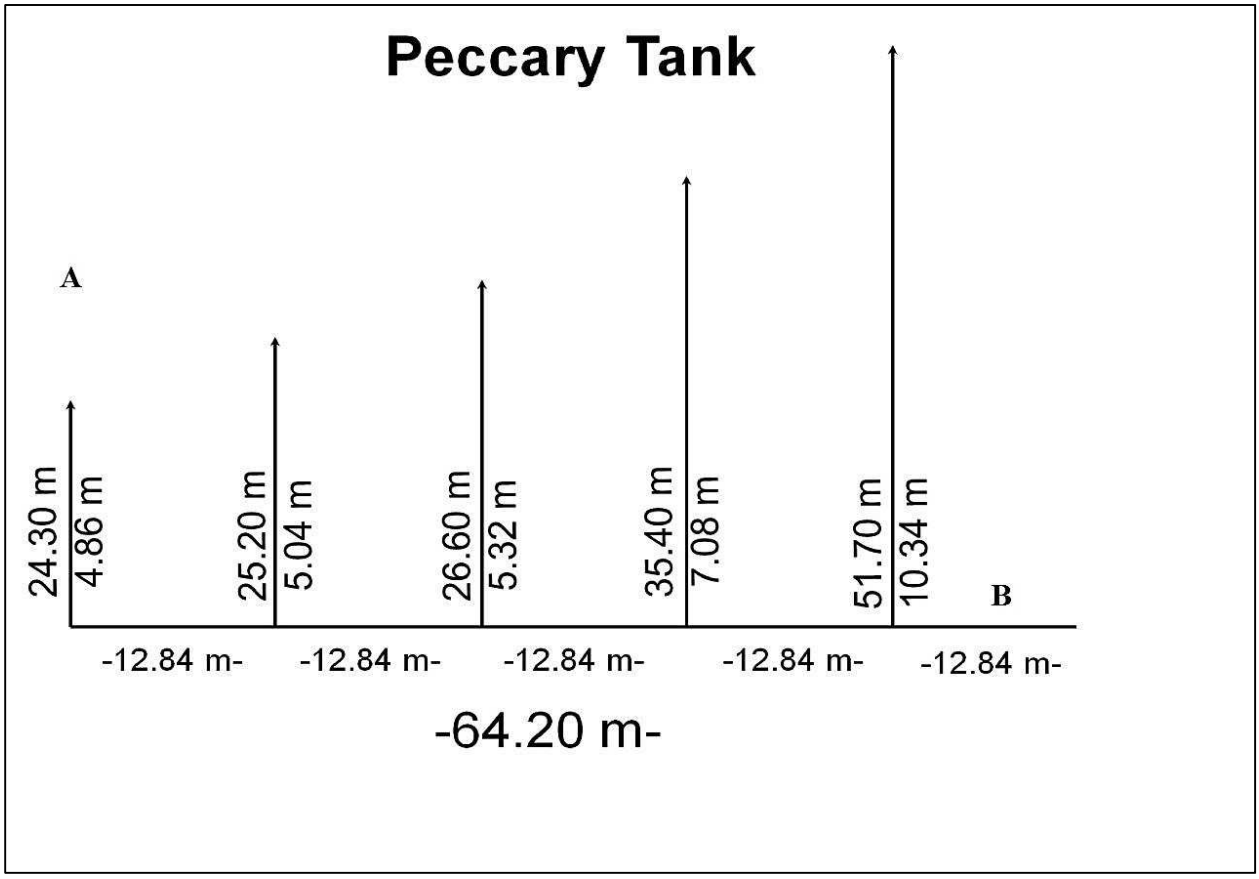


Figure 8: Graphic representation of the modified belt transects as it was laid out at Peccary Tank. The 64.2 m "base" was oriented NNE to SSW as seen in Figure 9. It was divided into sections equaling 12.4 m each. Each of the "belts" started at the end of every 12.84 m interval and was oriented 90 degrees from the base. Each "belt" ran across the tank until reaching the next perimeter. They were then divided into 5 equal sections with a quadrat being dropped at the beginning of each equal section. This would result in 5 quadrats per "belt", 25 quadrats total.

Figure 9: Satellite view of Peccary Tank showing super-imposed view of a modified belt transects. The top "belt" has red crosses in the locations where a 1 by 1 m quadrat was dropped. Each of the other "belts" was also divided into 5 sections with quadrats dropped in the same manner as the top "belt". *Note: A and B correspond to A and B in Figure 8.

Results

VEGETATION COMMUNITIES OF SURVEY SITES: Each site's vegetation community was surveyed and quantified to show the most abundant plant species. Table 2 shows quantified totals of the quadrats and Table 3 shows quantified vegetative totals of perimeters. Total plant count was 1,941, with 924 individual plants counted within quadrats and 1,017 from the perimeters. Squaw Spring had the most species (33) followed in order by Peccary (24), Pirtle (21), Rattlesnake (18) and Mesquite (16). Various grasses (family Poaceae) comprised approximately 25 % of the plants counted in quadrats at Squaw Spring, Mesquite and Rattlesnake Tanks. Grasses composed approximately 50 % of the plant quadrats at Peccary and Pirtle Tanks. Rough Cocklebur (*Xanthium strumarium*) composed the majority of plant species within Rattlesnake and Mesquite Tank quadrats (52.8 % and 35.6, % respectively) and was the fourth highest at Pirtle Tank (15.8 % percent). Interestingly, Willow Baccharis (*Baccharis salicifolia*) was the only tree/shrub that ranked in the top five species counts of the sites surveyed (18.82% at Squaw Spring); it was also the most abundant in the perimeter count of Squaw Spring (89.2 %). Squaw Spring, as the only permanent water source on IMRS, also contained 22 species of plants that were not counted at the other locations. Some of these were wetland adapted forbs/herbs such as Southern Cattail (*Typha domingensis*) and Prairie Gentian (*Eustoma exaltatum*), although others were like the species of cacti that, by chance, were not included in the counts at other sites. In a previous survey conducted by Couvillon (2011), Squaw Spring was described as having six species not found in eight other locations. This discrepancy with our findings can be explained by the type of survey done by Couvillon as opposed to Baqla and Wiseman (Baqla *et al*., 2013). In the Couvillon Survey, eight points were selected at random from pitfall traps (above the spring); transects were 30 m long oriented in random directions.

The Baqla *et al.* (2013) survey was comprised of the aforementioned grid that was placed inside the perceived perimeter vegetation and was therefore much narrower than the Couvillon survey. Obviously, some plant species were stochastically missing from other sites where they feasibly could occur.

AVIAN FAUNA: Over the period from June 2011 to May 2014, 362 surveys were conducted for a total of 120.6 h of actual survey time. Each site received approximately the same amount of survey time during this study. The surveys produced 1,601sightings of various species and 2,699 individual birds recorded. The birds comprised 85 species (Table 4) from 27 different families. The species from these surveys were compared to the year 2010 of Worthington *et al.* (2010 - 2014) and resulted in 135 total species accounted for in the 2014 edition. Thirty-nine first records were documented on IMRS during this study in addition to the 96 in the 2010 edition. With the addition of six species added from casual sightings by students, faculty, and researchers, the total number of species now recorded in Worthington *et al.* (2011-2014) is 141 species. This end-of-survey count is 19 bird species short of the lower end of the predicted number of 160 for IMRS.

Total sightings of avian species were similar at the ephemeral tanks, with Mesquite at 333, Rattlesnake (336), Peccary (322), and Pirtle (332). Squaw Spring number was considerably less, however, with 278 sightings. Species counts for these sites were Mesquite (55), Rattlesnake (60), Peccary (48), Pirtle (55), and Squaw Spring (47). Figure 11 shows the 10 most observed families, with the most being Emberizidae with 376 sightings; the next closest family was Columbidae (176 observations), which is less than half the sightings of Emberizidae. Sixty-four of the 85 species observed were accounted for by the top 10 families.

Table 2: Percentage of vegetation species in quadrats at each of the survey sites. The five highest values are in bold numbers. Classification of vegetation species follows Worthington *et al.* (2014), Powell and Weedin (2004), Powell and Manning (1994), and Southwest Environmental Information Network (SEINet 2012). * Indicates exotic species.

Species	Percent Occurrence at Survey Sites				
	Squaw Spring	Mesquite Tank	Rattlesnake Tank	Peccary Tank	Pirtle Tank
Astrolepis cochisensis (Cochise Scaly Cloakfern)					**5.26**
Acacia constricta (Western White-thorn Acacia)				1.11	
Acacia greggii (Catclaw)	1.18				
Amaranthus palmeri (Palmer's Amaranth)		1.79	**10.67**		
Aristida purpurea (Nealley's Threeawn)	0.59				
Atriplex canescens (Four-wing Saltbush)	2.35				
Baccharis salicifolia (Willow Baccharis)	**18.82**				3.51
Baileya multiradiata (Desert Marigold)				1.11	
Berberis trifololiata (Laredo Oregon-grape)	1.18	0.30			
Bouteloua eriopoda (Black Grama)	1.18				
Chilopsis linearis (Desert Willow)	1.18				
Chloris virgate (Showy Windmillgrass)*		**11.94**			
Condalia ericoides (Javelina Bush)	0.59				
Chrysactina mexicana (Damianita)		**4.48**	0.89	**37.78**	
Cynodon dactylon (Bermudagrass)*	**9.41**				**28.07**
Digitaria spp.(Crabgrasses)*	**16.47**				
Echinocereus enneacanthus (Pitaya)	0.59				
Echinocerus coccineus (Scarlet Hedgehog Cactus)	0.59				
Eragrostis cilianensis (Stinkgrass)*		0.60			
Erioneuron pilosum (Hairy Tridens)				**27.78**	
Escobaria tuberculosa (White Foxtail Cactus)	3.53				
Eustoma exaltatum (Prairie Gentian)	**6.47**				
Forestiera angustifolia (Texas Swampprivet)	0.59				
Heteropogon contortus (Tanglehead)		**13.13**		**11.11**	
Muhlenbergia arenacea (Ear Muhly)				1.11	
Muhlenbergia fragilis (Delicate Muhly)	0.59				
Oenothera brachycarpa (Desert Evening-primrose)	1.18				
Opuntia engelmannii (Engelmann's Prickly-pear)	0.59				
Panicum hallii (Hall's Panicum)	0.59			**11.11**	
Parthenium incanum (Mariola)	1.18				
Prosopis glandulosa (Honey Mesquite)	0.59			1.11	
Prosopis pubescens (Screwbean Mesquite)	1.18				

Table 2: Continued

Species	Percent Occurrence at Survey Sites				
	Squaw Spring	Mesquite Tank	Rattlesnake Tank	Peccary Tank	Pirtle Tank
Rhus microphylla (Littleleaf Sumac)	0.59				
Ruellia parryi (Parry's Wild-petunia)	0.59				
Setaria leucopila (Plains Bristlegrass)		0.90	**24.00**	2.22	**19.30**
Solanum elaeagnifolium (Silverleaf Nightshade)	2.94	**13.73**	**28.00**	1.11	**21.05**
Sphaeralcea angustifolia (Copper Globemallow)		0.30	0.89	1.11	
Tiquilia greggii (Plumed Crinklemat)				**3.33**	
Typha domingensis (Southern Cattail)	5.88				
Unidentified 1	0.59				
Unidentified 2	1.18				
Unidentified 3	0.59				
Unidentified 4	3.53				
Unidentified 5	0.59				
Unidentified 6					1.75
Unidentified 7					**5.26**
Xanthium strumarium (Rough Cocklebur)		**52.84**	**35.56**		**15.79**
Weissia ligulaefolia (Liguleleaf Weissia Moss)	**11.18**				
Ziziphus obtusifolia (Lotebush)	1.77				
Total Species	33	10	6	12	8
Sum of Plants (Quadrats)	170	335	225	90	57

Table 3: Percentage of vegetation species at perimeter of each of the survey sites. The three highest values are in bold numbers. Classification of vegetation species follows Worthington et al. (2014), Powell and Weedin (2004), Powell and Manning (1994), and Southwest Environmental Information Network (SEINet 2012).

Species	Percent Occurrence at Survey Sites				
	Squaw Spring	Mesquite Tank	Rattlesnake Tank	Peccary Tank	Pirtle Tank
Acacia constricta (Western White-thorn Acacia)		5.81	**13.38**	**7.52**	5.33
Acacia greggii (Catclaw)	**2.16**	**36.63**		5.01	**38.67**
Atriplex canescens (Four-wing Saltbush)			5.10	1.00	
Baccharis salicifolia (Willow Baccharis; Mule's Fat)	**89.21**				
Berberis trifololiata (Laredo Oregon-grape)		3.49	3.82	0.25	**8.67**
Celtis reticulata (Western Hackberry)					**12.67**
Chilopsis linearis (Desert-willow)	1.44				
Condalia ericoides (Javelina-bush)	1.44	0.58	1.27	0.75	
Cylindropuntia imbricata (Tree Cholla)				0.25	
Dasylirion leiophyllum (Green Sotol)				0.75	
Flourensia cernua (Tarbush)					6.00
Forestiera angustifolia (Texas Swampprivet)		5.81	0.64	0.75	8.00
Juniperus pinchotii (Red Berry Juniper)					0.67
Koeberlinia spinosa (Crucifixion-thorn)			8.28		
Larrea tridentata (Creosotebush)		**17.44**	**11.46**	**56.14**	**8.67**
Prosopis glandulosa (Honey Mesquite)	1.44	**30.23**	**42.68**	**22.56**	
Prosopis pubescens (Screwbean Mesquite; Tornillo)	0.72				
Rhus microphylla (Littleleaf Sumac)			6.37	0.25	5.33
Viguiera stenoloba (Skeleton Goldeneye; Resinbush)					0.67
Yucca faxoniana (Eve's Needle)			0.64	0.75	2.67
Yucca spp.			0.64		
Yucca treculiana (Torrey's Yucca)					1.33
Ziziphus obtusifolia (Lotebush)	**3.60**		5.73	4.01	1.33
Total Species	**7**	7	12	13	13
Sum of Perimeter Plants	139	172	157	399	150

Table 4: Avian species records for the five survey sites used in this study. * Denotes species that fell/or fall under different genera during this study or most field guides prior to 2012. Classification schema is based on AOU's Checklist of North American Birds (2014).

			Survey Sites				
Family	**Common Name**	***Species***	**Squaw Spring**	**Mesquite Tank**	**Rattlesnake Tank**	**Peccary Tank**	**Pirtle Tank**
Anatidae	Blue-winged Teal	*Anas discors*					X
Cathartidae	Turkey Vulture	*Cathartes aura*	X	X	X	X	X
Accipitridae	Red-tailed Hawk	*Buteo jamaicensis*	X		X		
Odontophoridae	Scaled Quail	*Callipepla squamata*	X	X	X	X	X
Columbidae	White-winged Dove	*Zenaida asiatica*	X	X	X	X	X
	Mourning Dove	*Zenaida macroura*	X	X	X	X	X
Cuculidae	Greater Roadrunner	*Geococcyx californianus*	X		X	X	X
Strigidae	Great Horned Owl	*Bubo vriginianus*		X			
Caprimulgidae	Common Nighthawk	*Chordeiles minor*	X	X	X	X	X
Trochilidae	Black-chinned Hummingbird	*Archilochus alexandri*		X	X		
	Rufous Hummingbird	*Selasphorus rufus*		X			
Picidae	Ladder-backed Woodpecker	*Picoides scalaris*	X	X	X	X	X
	Northern Flicker	*Colaptes auratus*		X	X		X
Falconidae	American Kestrel	*Falco sparverius*			X		
Tyrannidae	Western Wood Pewee	*Contopus sordidulus*	X	X	X	X	X
	Least Flycatcher	*Empidonax minimus*		X	X	X	X
	Dusky Flycatcher	*Empidonax oberholseri*		X	X		
	Cordilleran Flycatcher	*Empidonax occidentalis*					X
	Black Phoebe	*Sayornis nigricans*	X		X	X	X
	Eastern Phoebe	*Sayornis phoebe*			X		
	Say's Phoebe	*Sayornis saya*	X	X	X		
	Ash-throated Flycatcher	*Myiarchus cinerascens*	X	X	X	X	X
	Western Kingbird	*Tyrannus verticalis*	X	X	X	X	X
Laniidae	Loggerhead Shrike	*Lanius ludovicianus*	X	X	X	X	X

Table 4 (continued):

Family	Common Name	*Species*	Survey Sites: Squaw Spring	Mesquite Tank	Rattlesnake Tank	Peccary Tank	Pirtle Tank
Vireonidae	White-eyed Vireo	*Vireo griseus*					X
	Warbling Vireo	*Vireo gilvus*	X		X		X
Remizidae	Verdin	*Auriparus flaviceps*	X	X	X	X	X
Troglodytidae	Rock Wren	*Salpinctes obsoletus*	X	X	X	X	
	Canyon Wren	*Catherpes mexicanus*	X			X	
	Bewick's Wren	*Thryomanes bewickii*	X	X	X	X	X
	Cactus Wren	*Campylorhynchus brunneicapillus*	X	X	X	X	X
Polioptilidae	Blue-gray Gnatcatcher	*Polioptila caerulea*		X	X		
	Black-tailed Gnatcatcher	*Polioptila melanura*				X	
Regulidae	Ruby-crowned Kinglet	*Regulus calendula*	X	X			X
Turdidae	Townsend's Solitaire	*Myadestes towsendi*	X				X
Mimidae	Curve-billed Thrasher	*Toxostoma curvirostra*		X			X
	Crissal Thrasher	*Toxostoma crissale*	X	X	X	X	
	Sage Thrasher	*Oreoscoptes montanus*			X	X	X
	Northern Mockingbird	*Mimus polyglottos*	X	X	X	X	X
Ptiliogonatidae	Phainopepla	*Phainopepla nitens*		X	X		
Parulidae	Northern Waterthrush	**Seirurus (Parkesia) noveboracensis*	X				X
	Nashville Warbler	*Oreothlypis ruficapilla*			X		
	Virginia's Warbler	*Oreothlypis virginiae*	X		X		X
	MacGillivray's Warbler	*Oporornis tolmiei*		X		X	X
	Northern Parula	*Septophaga americana*					X
	Yellow Warbler	**Dendroica (Setophaga) petechia*			X		
	Yellow-rumped Warbler	*Setophaga coronata*	X	X	X	X	X
	Townsend's Warbler	*Setophaga townsendi*	X	X	X	X	X
	Wilson's Warbler	*Cardellina (Wilsonia) pusilla*	X	X	X	X	X
Emberizidae	Green-tailed Towhee	*Pipilo chlorurus*	X	X	X	X	X
	Spotted Towhee	*Pipilo maculatus*				X	X
	Rufous-crowned Sparrow	*Aimophila ruficeps*		X			X

Table 4 (continued):

Family	Common Name	*Species*	Survey Sites: Squaw Spring	Mesquite Tank	Rattlesnake Tank	Peccary Tank	Pirtle Tank
Emberizidae (continued)	Canyon Towhee	*Melozone fusca*	X	X	X	X	X
	Chipping Sparrow	*Spizella passerina*	X	X	X	X	X
	Clay-colored Sparrow	*Spizella pallida*	X	X	X	X	X
	Brewer's Sparrow	*Spizella breweri*		X	X	X	X
	Field Sparrow	*Spizella pusilla*	X				
	Vesper Sparrow	*Pooecetes gramineus*		X	X	X	X
	Lark Sparrow	*Chondestes grammacus*		X	X	X	
	Black-throated Sparrow	*Amphispiza bilineata*	X	X	X	X	X
	Lark Bunting	*Calamospiza melanocorys*		X	X	X	
	Savannah Sparrow	*Passerculus sandwichensis*		X	X	X	X
	Song Sparrow	*Melospiza melodia*			X		
	Lincoln's Sparrow	*Melospiza lincolnii*	X				
	White-crowned Sparrow	*Zonotrichia leucophrys*	X	X	X	X	X
	Dark-eyed Junco	*Junco hyemalis*					X
Cardinalidae	Summer Tanager	*Piranga rubra*	X				X
	Western Tanager	*Piranga ludoviciana*	X	X	X		X
	Pyrrhuloxia	*Cardinalus sinuatus*		X	X	X	X
	Blue Grosbeak	*Passerina caerulea*	X	X	X	X	X
	Varied Bunting	*Passerina versicolor*	X	X	X	X	
	Painted Bunting	*Passerina ciris*				X	
	Dickcissel	*Spiza americana*		X	X		
Icteridae	Red-winged Blackbird	*Agelaius phoneiceus*			X		
	Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	X	X	X	X	X
	Bronzed Cowbird	*Molothrus aeneus*	X	X	X	X	
	Brown-Headed Cowbird	*Molothrus ater*	X	X	X		X
	Orchard Oriole	*Icterus spurius*				X	
	Bullock's Oriole	*Icterus bullockii*		X			
	Scott's Oriole	*Icterus parisorum*	X	X	X	X	X

Table 4 (continued):

Family	Common Name	*Species*	Survey Sites: Squaw Spring	Mesquite Tank	Rattlesnake Tank	Peccary Tank	Pirtle Tank
Fringillidae	House Finch	**Haemorhous (Carpodacus)mexicanus*	X	X	X	X	X
	Pine Siskin	*Spinus pinus*		X	X		
	Lesser Goldfinch	**Spinus (Carduelis) psaltria*	X				X
	American Goldfinch	*Spinus tristis*					X
Total spp/Location			**47**	**55**	**60**	**48**	**55**

COMPARISON OF SURVEY SITES: Survey sites were compared pair-wise using Simpson's Similarity Coefficient (SSC) (Simpson 1960). The SSC is used to compare sites based on the number of species they have in common (see Table 5). Site comparisons were based on the total avian fauna observed. No sites shared all avian species. The SSC values were used to construct a UPGMA Dendrogram (Figure 10) that shows the relationships between survey sites. The highest similarity was between Rattlesnake and Mesquite Tanks which in turn clustered with Peccary Tank. Pirtle Tank and Squaw Spring clustered at a slightly lower index value than the Rattlesnake-Mesquite/Peccary cluster.

The number of singletons; species that were only observed once is shown in Table 6. Rattlesnake Tank had the highest number of singletons at five, while Squaw Spring had the lowest occurrence of singletons at two. There were a total of 17 singleton species observed during this project.

Table 5: SSC values and the number of avian species that are common between the five survey sites. Underlined bold numbers indicate the number of total species observed at each site. The numbers above underlined bold numbers represent the number of shared species between two sites. The decimal numbers below underlined bold numbers are the similarity values; SSC= $\frac{C}{N_1}$ where C= the number of species shared between two sites and N_1 represents the site with the lesser number of total species between the two sites.

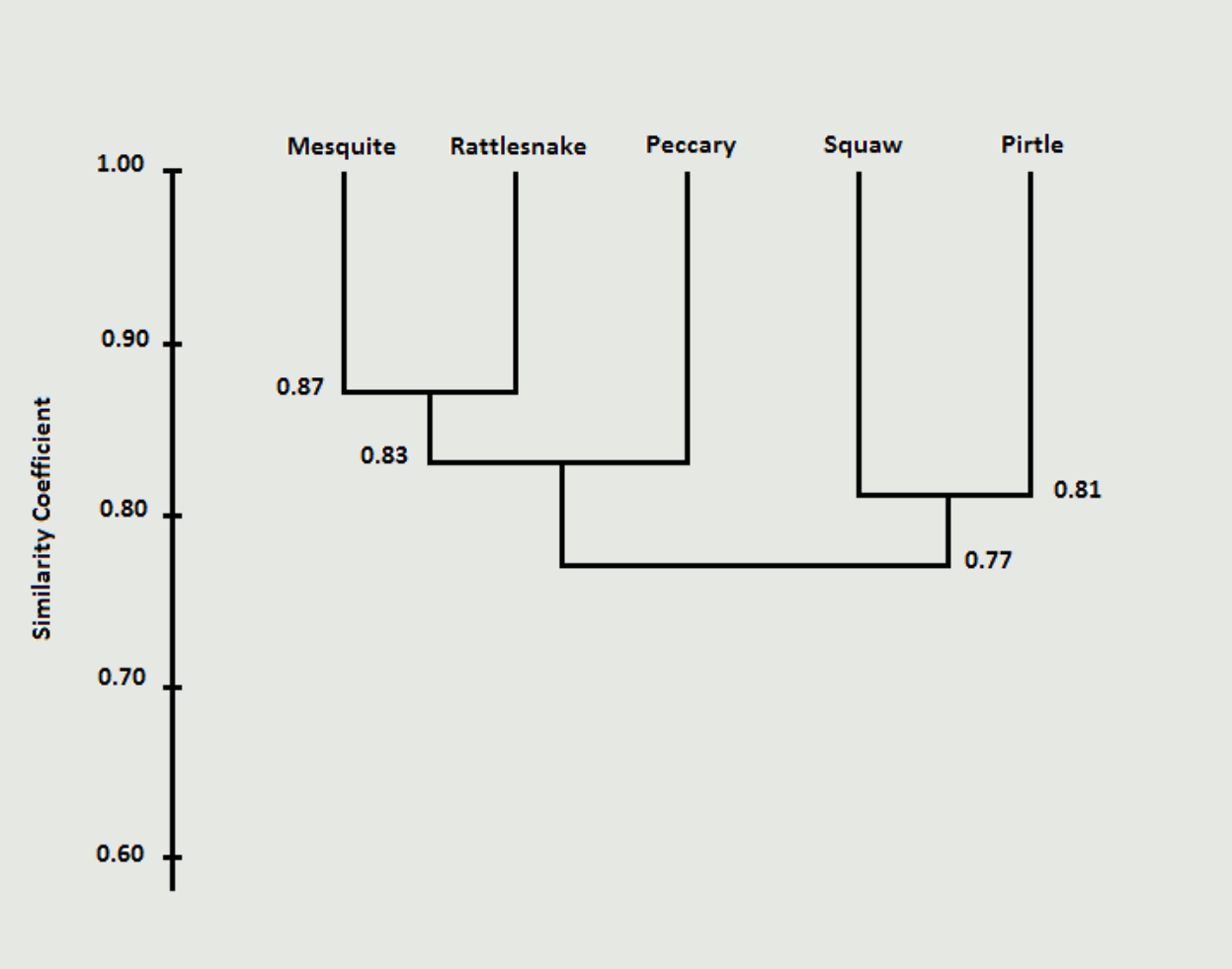
	Squaw Springs	Mesquite Tank	Rattlesnake Tank	Peccary Tank	Pirtle Tank
Squaw Springs	**47**	35	39	34	38
Mesquite Tank	0.745	**55**	48	39	39
Rattlesnake Tank	0.830	0.873	**60**	41	40
Peccary Tank	0.723	0.813	0.854	**48**	37
Pirtle Tank	0.809	0.709	0.727	0.771	**55**

Table 6: The number of singletons recorded by site. Total singletons recorded were 17 (20% of total species).

Singletons Recorded

Species	Squaw Springs	Mesquite Tank	Rattlesnake Tank	Peccary Tank	Pirtle Tank
American Goldfinch					X
American Kestrel			X		
Black-tailed Gnatcatcher				X	
Blue-winged Teal					X
Bullock's Oriole		X			
Chihuahuan Raven				X	
Cordilleran Flycatcher					X
Eastern Phoebe			X		
Field Sparrow	X				
Great Horned Owl		X			
Lincoln's Sparrow	X				
Northern Parula					X
Orchard Oriole				X	
Red-winged Blackbird			X		
Rufous Hummingbird		X			
Song Sparrow			X		
White-eyed Vireo					X
Total singletons by location	2	3	4	3	5
Percent by location	11.8%	17.6%	23.5%	17.6%	29.4%

Figure 10: UPGMA Dendrogram for all species observed during this study. Values depict the similarity coefficient.



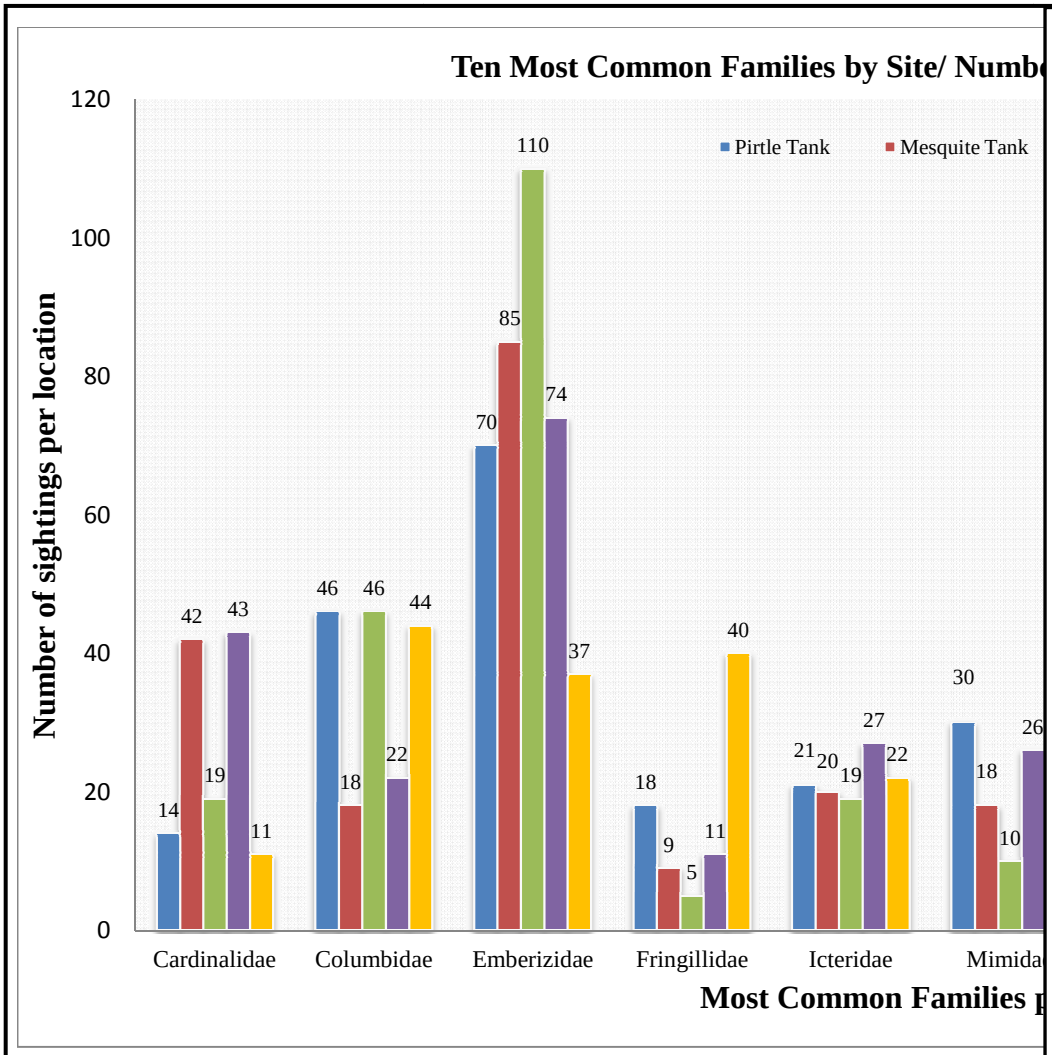


Figure 11: Bar graph of the ten (10) families with the most sighting by location at IMRS. The family Emberizidae had the most observations with 376. This was more than double the next closest family, Columbidae at 176. Emberizidae was comprised of 17 species, Columbidae- 2 spp., Tyrannidae- 9 spp., Cardinalidae- 7 spp., Troglodytidae- 4 spp., Icteridae- 7 spp., Parulidae- 9 spp., Mimidae- 4 spp., Fringillidae- 4 spp., and Odontophoridae- 1 spp.

Discussion

VEGETATION OF SURVEY SITES: The vegetation of IMRS has been generally categorized as typical Chihuahuan Desert scrub according to Worthington *et al.* (2014) with several sub-classifications also associated in the arrangement. According to Henrickson and Johnson (1983) some of the associations that appeared to be present were *Larrea*, *Lechuguilla*, and *Prosopis-Atriplex* scrub. The Texas Natural Heritage Program series (1993) (Schulz 2013) has indicated that several other classifications should occur on IMRS, including Apache Plume series in Arroyos, Lechuguilla-Sotol series in thin soils situated on limestone, Mesquite-saltbush series in areas of deep soil, and thick Acacia series occurring on gravel benches. The Association for Biodiversity Information[1] (2001) (Schulz 2013) also described the previous associations (as alliances) along with *Fallugia paradoxa* shrubland alliance and *Chilopsis linearis* shrubland alliance (Worthington *et al*. 2014).

Vegetation at the survey sites many times resembled the aforementioned associations, although grasses seemed to play a greater role in the assemblages of all sites, especially around Pirtle and Peccary Tanks, than the above mentioned non-grass associations and alliances. The Pirtle Tank and Squaw Spring cluster appeared to contain the highest rate of exotic grass species with Peccary Tank having no quantified exotic grasses in quadrats. Grasses made up approximately 50% and 47% of the quadrat surveyed plants at Peccary and Pirtle Tanks (Table 2). It is assumed that the high occurrence of *Baccharis salicifolia* may have resulted in the lowest total number of avian species at Squaw Spring. Along with quadrat counts and 89.2% of the perimeter counts (Table 3), this species was overwhelmingly the most dominant plant species at

[1] Association of Biodiversity Information has become part of NatureServe.org. Alliances are now under review and no longer available to users. The National Heritage Program has also been merged with NatureServe.org (Schulz 2013).

Squaw Spring. However, Squaw Spring did contain more plant species than at any other site with 22 species not recorded in the other locations. Mesquite and Rattlesnake Tanks clustered together with the highest similarity of avian species. These tanks had the highest recorded frequencies of Rough Cocklebur (*Xanthium strumarium*) in its quadrats. In the perimeter counts these tanks had the highest recorded frequency of Honey Mesquite. Rattlesnake Tank had no frequencies of exotic grasses while Mesquite Tank had 47% of its total grasses as exotic. While Rattlesnake Tank did not contain Catclaw Acacia in the perimeter counts, it did have White Thorn Acacia (*A. constricta*) as the third highest perimeter frequency. Peccary Tank and Rattlesnake Tank quadrats were similar with shared species; however the highest occurring frequencies for particular species differed for Peccary Tank. Quadrat surveys of Peccary Tank produced a shrub, Damianita (*Chrysactina mexicana*), at 37.8% rounded out with various grasses (family *Poaceae*) comprising the top frequencies. While Rough Cocklebur was observed at Peccary Tank it was nowhere near as abundant and, by random chance, not collected in quadrat counts. Peccary perimeter counts were led by Creosotebush (*Larrea tridentata*) at 56.1%, followed by Honey Mesquite (22.6%) and Western White-thorn Acacia (7.5%). Pirtle Tank quadrat counts produced Bermudagrass and Plains Bristlegrass in the highest frequencies (28.1% and 19.3% respectively) along with Silverleaf Nightshade and Rough Cocklebur (21.1% and 15.8% respectively). Perimeter counts produced Catclaw Acacia and Western Hackberry (*Celtis reticulata*) at the highest frequencies and is the only site where Western Hackberry was observed. During an earlier project related to this study (Baqla *et al.* 2013), a similarity analysis yielded a UPGMA Dendrogram with clusters similar to Figure 9.

AVIFAUNA AT SURVEY SITES: Overall bird numbers appeared to follow trends set by vegetation. The most observed avian family was *Emberizidae* (Figure 11). This family also

contained the most species at 17 overall. The second most observed family was *Columbidae* with 176 observations (but only 2 species). There were several families that had only one species observed (*e.g.,* Cathartidae, Odontophoridae, and Caprimulgidae), however, they were observed on a regular basis (Table 4, Appendix 2).

The tanks that had the highest overall number of species were Rattlesnake Tank (60), Mesquite Tank (55), and Pirtle Tank (55). These sites shared plant species that had some of the highest frequencies observed (*e.g.*, Rough Cocklebur, *Acacia* spp. and Creosotebush). Rough Cocklebur had the highest quadrat frequencies in both Rattlesnake and Mesquite Tanks and was fourth highest at Pirtle Tank. The Cocklebur that grows in these tanks grows 1 m plus in height and has virtually 100% coverage in the areas where it grows, usually in the bowls of the tanks where water ultimately collects. Creosotebush was in the top three plants of perimeter counts for these tanks as well. A couple of examples of this similarity associated with birds are: Black-throated sparrows have been noted to use Creosotebush in their range (Cutler and Morrison 1998; Raitt and Maze 1968) and were the overwhelmingly dominant avian species at IMRS with 181 total observations. Black-throated Sparrows outnumbered all other family observations (Figure 11) and can be considered ubiquitous on IMRS. Black-throated Sparrows were the most observed bird at Peccary Tank (58 observations) (see Appendix 2), which was more than any single species observed at any location. Peccary Tank had the highest perimeter frequency of Creosotebush than any other location at 56.14%. While this does not constitute strong evidence that Black-throated Sparrows are primarily associated with Creosotebush, because other studies have indicated preference for Mesquite (Naranjo and Raitt 1993; Mills *et al.* 1991); it bears more observation using more controlled methods.

Pyrrhuloxia has been documented to prefer Honey Mesquite as its prevailing habitat (Pidgeon *et al. 2*001). While Honey Mesquite was in the top three perimeter species for three of the tanks, it was not recorded on the perimeter or in quadrats at Pirtle Tank. Rattlesnake and Mesquite Tanks recorded 18 and 27 of Pyrrhuloxia observations, respectively, and had the highest perimeter recordings for Honey Mesquite (see Appendix 2), while Pirtle Tank only had four Pyrrhuloxia observations. There is Honey Mesquite in the area outside the perimeter, however; this may account for the four observations. Squaw Spring had no Pyrrhuloxia observations with a frequency of only 1.44% frequency of Honey Mesquite. Again, like Pirtle Tank, Squaw Spring had an abundance of Honey Mesquite (some in heavy concentrations) just outside of its perimeter area. A possible explanation for the apparent lack of Pyrrhuloxia is that Squaw Spring sits at the end of a small canyon that leads into a deep arroyo; possibly this "narrow" space represents habitat not suited to Pyrrhuloxia.

The family *Emberizidae* is primarily granivorous (AOU 1998). Peccary Tank had the highest frequency of emberizids (29.3%) and the highest frequency of grasses at 50%. Peccary Tank plant surveys did not record any exotic grasses. The other three tanks had similar frequencies to each other (18.6-22.6%) of emberizids and had grass frequencies ranging from 24 to 47.4%. Squaw Spring, which had the fewest observations of emberizids (frequency of 9.8%) and a grass frequency of 25.9% (99.92% of which are exotic), still had more emberizid observations than any other family except *Columbidae* (44) and *Fringillidae* (40) (Table 4 and Figure 11). Another granivore, the Mourning Dove (*Zenaida macroura*), was the second most observed species at 123 observations. Observations of Mourning Dove at Peccary Tank numbered 44, which was the second highest frequency of species observations behind the Black-throated Sparrow.

TOTAL SPECIES: Table 4 shows the 85 species that have been recorded from all observations during this project period. These, along with casual observations since 2004, bring the total to 141 species listed in Worthington *et al.* (2014). All species are listed in Appendix 1. Thirty-nine of those species came from surveys while six were added from casual sightings (mostly near HQ). This total falls 19 species short of West's (1976) predicted lower end of 160 total numbers of species. Singletons (Table 6) made up 20% of all species observed during surveys. With such a high frequency of singletons, there is little doubt that at least a few species have been missed. Ongoing casual observations and future projects should add to the total number of IMRS bird species.

SIMILARITY OF SITES: Similarity was highest at Rattlesnake and Mesquite Tanks at 87% (Figure 10). Peccary Tank was paired with the Rattlesnake/Mesquite Tank cluster at 83%. Total species were also higher at these sites with Rattlesnake Tank having 60 species observed and Mesquite with 55 (along with Pirtle Tank). The Squaw Spring/Pirtle Tank cluster paired with the Rattlesnake Tank/Mesquite Tank/ Peccary Tank cluster at 77%. IMRS, which contains a varied topography dominated by low mountains and high hills, contains most of its tanks inside or at the end of arroyos. Bird diversity and arroyo vegetation have been linked in the past (Kozma *et al.* 2012). There may be an association with a cattle tank and the arroyo that feeds it, along with the increased vegetation and the intermittent presence of water. It was hypothesized that Squaw Spring would be the outlier with the most species of all sites surveyed. This was rejected as Squaw Spring had the lowest number of species observed (47) and was clustered with Pirtle Tank at 81%. This also went contrary to studies that recorded or predicted higher diversity in riparian and perennial water habitats (Mills *et al.* 1991; Cutler and Morrison 1998). It was thought that the occurrence of singletons would also be higher at Squaw Spring. This area, with

its permanent water, was similar to a site in southwestern Arizona that was dominated by migrant birds. These migrants, presumably, were not desert adapted and described as needing the water and vegetative cover at the stopover site (Cutler and Morrison 1998). Again, the evidence on IMRS does not support the finding of the Arizona study. Of the 17 singletons recorded on IMRS (14 of which were migrants), only two (both were migrants) were observed at Squaw Spring (Table 6). Pirtle Tank had the highest number of singletons (5 species, of which 4 were migrants). It is possible that the terrain around Squaw Spring was not preferred habitat for the species observed. The narrow canyon which ended at Squaw Spring may not have attracted species that do not use bare rock faces, even though there was plentiful vegetation in the bottom of the canyon/arroyo that surrounded Squaw Spring. Baqla *et al.* (2013) compared vegetation between the sites that were used for this study. Her UPGMA dendrogram was similar to the one found in this study, with Rattlesnake Tank and Peccary Tank having the highest similarity, and Mesquite Tank clustering with them. The major difference in her UPGMA vegetation dendrogram is that Squaw Spring had a unique set of plant species.

DISTANCE BETWEEN SITES AND SIMILARITY: Survey sites were hypothesized to have more similarity in relation to distance between them. This was generally supported except for Peccary and Rattlesnake Tanks. These tanks were only 1.1 km apart, yet they did not share the highest diversity with a similarity index of 85%. Rattlesnake and Mesquite Tanks had the highest at 87% and were 2.7 km apart. Peccary Tank was clustered with those tanks with a similarity index of 83%. Insofar as the clusters are concerned those tanks were much closer to each other than to either Squaw Spring or Pirtle Tank. The closest approach from the Squaw Spring/ Pirtle Tank cluster was 3.8 km to any of the other tanks; the average was 4.7 km. Squaw Spring and Pirtle

Tank were 2.9 km from each other; however, they are connected by a series of arroyos and canyons that intersect and run between them.

OBSERVATIONS ON TWO SPECIES: There were two observations of special note during the project reported herein. The first one of interest concerns the diet of the Elf Owl, *Micrathene whitneyi*. This species was described as feeding exclusively (or almost exclusively) on arthropod prey (Ligon 1968; Dickerman *et al.* 2010; Henry and Gehlbach 1999). This owl was first observed in a Honey Mesquite at IMRS HQ during the summer of 2011. Beginning in the spring of 2013, motion triggered photographs were taken at an Elf Owl's nesting site in a Ladder-backed Woodpecker (*Picoides scalaris*) hole in one of the HQ water tank's wooden legs. During that nesting season there were 3237 photographs taken of which 243 showed prey items. Approximately 30% showed vertebrate prey such as lizards and snakes (Wiseman 2014). This raises more questions about the biology of this species and the impact of changing environments on their ecogeographic distribution. This species warrants further study at IMRS.

The second observation of note was on the Mourning Dove (*Zenaida macroura*). These birds have been observed in the greatest numbers of individual birds of any species per sighting at Peccary Tank (30 in one sighting). This species normally flushes and flies up and away from human disturbance. However, after the hunting season, Mourning Doves observed at Peccary Tank did not fly up and away as they usually do. They flush, skim the shrubs around the perimeter of the tank and then land. A study conducted by two universities (Stankowich and Blumstein 2005) produced a summary (in the form of a flow chart) that shows experiences with predators and distance to refuge are the two most important factors in flight initiation distance in animals. Do Mourning Doves learn during hunting season that predator avoidance patterns normally used outside of hunting season mean certain capture (being shot) by predators during

hunting season? They make short, low flights when they flush presumably to avoid bird shot from shotguns. This observation is anecdotal; therefore a structured study of flush behavior could benefit our understanding of this species after the annual hunting season.

FUTURE DIRECTIONS: This is the first formal study of avifauna of IMRS, whether at the species or higher taxonomic level. The bird surveys conducted during this study can be used as a baseline for future projects on IMRS. Frequencies of avifauna at the survey sites can help determine what species, genera, or families could be studied and where. Similarity of the survey sites between avifauna and vegetation can help determine not only locations of future projects, but which sites to compare and contrast. Cattle are grazed in all areas surrounding IMRS, so comparisons of the usage by birds in both systems could be evaluated. Species not observed, but are noted to occur within the region, could be assessed as to why they do not inhabit or use IMRS habitats. There is also the Rio Grande to the south and west of IMRS, so birds that use this river corridor could be identified for determining migration paths, stopover durations, and avian disease dispersal. It is hoped that the study presented herein will develop interest in avian ecology of the Chihuahuan Desert.

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Appendix

Appendix 1: Avifauna reported from IMRS by Worthington *et al*. (2011-2014). The order of the families and nomenclature follows the Texas Parks and Wildlife "A Checklist of Texas Birds" 6th ed. (2003).

Class: Aves (Birds)

Contributed by Scott Cutler, Carl Lieb, Jerry D. Johnson, and Geoffrey Wiseman.

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 classes and observations by Terry Hibbits and Jerry D. Johnson. Geoffrey Wiseman completed a project on avian diversity in August, 2014. The order of the families and nomenclature follows the Texas Parks and Wildlife "A Checklist of Texas Birds" 6th ed. (2003). The avifauna of the area between Indian Hot Springs and Presidio was reported to consist of 160 species; 30 were residents (West, 1976); others used the area seasonally or were migratory.

ARDEIDAE (Bittern, Heron and Egret Family)

Ardea herodias — Great Blue Heron
Egretta thula — Snowy Egret
Nycticorax nycticorax — Black-crowned Night-heron

CATHARTIDAE (Vulture Family)

Cathartes aura — Turkey Vulture
Observations: Squaw Spring, May 1995. Common throughout IMRS, J. D. Johnson.
Note: Turkey Vultures usually arrive on IMRS early in April and leave in October.

ANATIDAE (Duck and Geese Family)

Bucephala albeola — Bufflehead
Observation: 14 Janurary 2012, Road Tank, G. Wiseman.

Anas crecca — Green-winged Teal
Observations: IMRS, 16 March 1991, Field Biology Class. 14 January 2012; Road Tank, G. Wiseman.

Anas discors — Bue-winged Teal
Observasions: Pirtle Tank, 8 September 2012. G. Wiseman.

Anas platyrhyncos — Mallard
Obserations: 14 January 2012, Road Tank, G. Wiseman.

Anas strepera — Gadwall
Observations: IMRS, 5 April 1991, Field Biology Class.

Appendix 1 (Continued):

ACCIPITRIDAE (Hawk, Kite, and Eagle Family)

Aquila chrysaetos Golden Eagle
Observations: A pair was observed S of IMRS near the Box Canyon, May 2009 by G. W. Johnson. Occasionally observed near Echo Canyon, J. D. Johnson.

Buteo jamaicensis Red-tailed Hawk
Observations: 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. J. D. Johnson.

Buteo regalis Ferruginous Hawk
Observations: IMRS HQ, 3 May 2008, S. Dash.

Buteo swainsoni Swainson's Hawk

Circus cyaneus Northern Harrier
Observations: IMRS, March-April 1991, Field Biology Class.

Elanus leucurus White-tailed Kite
Observations: IMRS HQ, May 2008, J. D. Johnson; verified from photograph by Cutler.

Pandion haliaetus Osprey
Observations: IMRS HQ area, April 2006 and May 2008, J. D. Johnson.

FALCONIDAE (Falcon and Kestrel Family)

Falco sparverius American Kestrel
Observations: IMRS, 2-3 May 1992, Hibbits.

ODONTOPHORIDAE (Quail Family)

Callipepla gambelii Gambel's Quail
Note: The presence of this species on IMRS needs to be confirmed.

Callipepla squamata Scaled Quail
Observations: IMRS HQ area, July 2000, Cutler; IMRS, 2-3 May 1992, Hibbits; IMRS, Apr. 1995, Field Biology Class; common around IMRS HQ.

RALLIDAE (Coot and Rail Family)

Fulica americana American Coot

Rallus limicola Virginia Rail
Observations: IMRS Squaw Creek, 27 April 2013, Field Biology Class; Verified by G. Wiseman

RECURVIROSTRIDAE (Avocet Family)

Recurvirostra americana American Avocet
Observations: IMRS Road Tank, 13 April 2013, G. Wiseman. J. Johnson, IMRS HQ.

CHARADRIIDAE (Plover and Killdeer Family)

Charadrius vociferous Killdeer
Observations: IMRS, 2-3 May 1992, Hibbits, 9 August 2013, G. Wiseman

SCOLOPACIDAE (Sandpipers, Snipes, Phalaropes et al.)

Gallinago gallinago Common Snipe
Observations: IMRS, 2-3 May 1992, Hibbits.

Appendix 1 (continued):

Phalaropus tricolor Wilson's Phalarope
Observations: IMRS Road Tank, 15 October 2011, G. Wiseman
Tringa solitaria Solitary Sandpiper
Observations: IMRS, 5 Apr. 1991, Field Biology Class.

COLUMBIDAE (Dove and Pigeon Family)

Columbina inca Inca Dove
Note: This species needs to be documented on IMRS.
Zenaida asiatica White-winged Dove
Observations: IMRS HQ area; May 1995, Cutler; Squaw Spring, July 2000, Cutler; IMRS, 2-3 May 1992, Hibbits; common around IMRS HQ and Squaw Spring.

**Steptopelia decaocto* Eurasian Collared-Dove
Observation: A pair at IMRS HQ, 27 August 2011. G. Wisemen and J. D. Johnson.
Note: The records were possibly for the Ringed Turtle-Dove, *S. risoria*.
**Steptopelia orientalis* Oriental Turtle Dove
Observations: IMRS HQ, May 2005, J. D. Johnson, with flock of White-winged Doves.

Zenaida macroura Mourning Dove
Observations: Squaw Spring, May 1995, July 2000, Cutler; IMRS, 2-3 May 1992, Hibbits. Common around IMRS HQ and Squaw Spring..

CUCUILDAE (Roadrunner, Cuckoo Family)

Geococcyx californianus Greater Roadrunner
[Mata-Silva et al., 2012]
Observations: SE of IMRS HQ, July 2000, Cutler; IMRS, 2-3 May 1992, Hibbits; IMRS HQ, May 2009, 12 June 2010, J. D. 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 September 2011 the males brought the nestlings a dead *Sonora semiannulata.*

STRIGIDAE (Owl Family)

Athene cunicularia Burrowing Owl
Note: This species needs to be verified on IMRS.
Bubo virginianus Great Horned Owl
Note: Commonly heard around HQ
Micrathene whitneyi Elf Owl
Observations: IMRS HQ, 25 May 2010; 13, 27 April 2012. J. D. Johnson, G. Wiseman (Photos). Nesting pair in woodpecker Hole in wooden water tower next to Kitchen. Fledged week of 27 June 2012; returned April 2013, 2014.

CAPRIMULGIDAE (Nighthawk, Poor-will Family)

Chordeiles acutipennis Lesser Nighthawk
Note: This species needs to be verified on IMRS.
Chordeiles minor Common Nighthawk
Observations: IMRS HQ, May 1995, Cutler. Common near IMRS HQ.

Appendix 1 (continued):

Phalaenoptilus nuttallii Common Poorwill
Observations: IMRS, 2-3 May 1992, Hibbits; IMRS HQ, 18 March 2011, J. D. Johnson..

APODIDAE (Swift Family)

Aeronautes saxatalis White-throated Swift
Observations: IMRS, 2-3 May 1992, Hibbits.

TROCHILIDAE (Hummingbird Family)

Archilochus alexandri Black-chinned Hummingbird
Observations: 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, J. D. Johnson.

Selasphorus rufus Rufus Hummingbird
Observations: IMRS HQ, 4 August 2011, G. Wiseman, 27 August 2011, G. Wiseman and J. D. Johnson. Road Tank, 4 August 2011, Mata-Silva. Mesquite Tank, 8 October 2011, G. Wiseman.

PICIDAE (Woodpecker Family)

Colaptes cafer Red-shafted Flicker
Observations: Common near IMRS HQ, J. D. Johnson.

Picoides scalaris Ladder-backed Woodpecker
Observations: road from IMRS HQ to Squaw Spring, July 2000, Cutler. IMRS HQ, 7 June 2008, J. D. Johnson.

TYRANNIDAE (Flycatcher, Kingbird and Phoebe Family)

Contopus cooperi [in some books as *C. borealis*] Olive-sided Flycatcher
Observations: Squaw Spring, May 1995, Cutler.

Contopus sordidulus Western Wood Pewee
Observations: Rattlesnake Tank, 20 August 2011, G. Wiseman.

Empidonax minimus Least Flycatcher
Observations: Rattlesnake Tank, 10 September 2011, G. Wiseman.

Empidonax oberholseri Dusky Flycatcher
Obsertvations: Mesquite and Rattlesnake Tanks, 14 May 2012. G. Wiseman.

Empidonax occidentalis Cordilleran Flycatcher
Observations: Pirtle Tank, 17 May 2013. G. Wiseman

Myiarchus cinerascens Ash-throated Flycatcher
Observations: Double Tank Corrals, May 1995, Cutler; Squaw Spring, May 1995, Cutler; IMRS HQ, May 1995, Cutler; May 1992, Hibbits; April 2012, J. D. Johnson.

Pyrocephalus rubinus Vermillion Flycatcher
Observations: IMRS HQ, 18 April 2010, J. D. Johnson.

Sayornis nigricans Black Phoebe
Observations: Pirtle Tank, 24 September 2011, G. Wiseman.

Sayornis saya Say's Phoebe
Observations: Nests annually on buildings at IMRS HQ, J. D. Johnson.

Tyrannus verticalis Western Kingbird
[Gardea and Mena, 1992].
Observations: IMRS HQ, March 1992; May 1992, Hibbits.

LANIIDAE (Shrike Family)

Lanius ludovicianus Loggerhead Shrike
[Gardea and Mena, 1992].
Observations: IMRS HQ, April 1990, March 1992, Field Biology.

VIREONIDAE (Vireo Family)

Vireo gilvus Warbling Vireo
Observations: Squaw Spring, 25 August 2012; Rattlesnake Tank, 2012; PirtleTank, 2013. G. Wiseman.

Vireo griseus White-eyed Vireo
Observations: PirtleTank, 22 May 2013. G. Wiseman.

Vireo solitarius Blue-headed Vireo
Note: This species needs to be documented on IMRS.

Vireo vicinior Gray Vireo
Observations: IMRS, March 1995, Field Biology Class.

CORVIDAE (Jay, Crow, Raven Family)

Aphelocoma californica Western Scrub Jay
Observations: IMRS HQ, 11, 18 April 2010, G. W. Johnson, J. D. Johnson.

Corvus cryptoleucus Chihuahuan Raven
Observations: IMRS, 2-3 May 1992, Hibbits. IMRS HQ, 18 April 2010; 2 May 2014. J. D. Johnson.

ALAUDIDAE (Horned Lark Family)

Eremophila alpestris Horned Lark
Note: Needs to be verified on IMRS.

HIRUNDINIDAE (Martin and Swallow Family)

Hirundo rustica Barn Swallow
Observations: IMRS, May 1995, field trip group.

Petrochelidon pyrrhonota Cliff Swallow
[*Hirundo pyrrhonota*]
Note: Needs to be verified.

REMIZIDAE (Verdin Family)

Auriparus flaviceps Verdin
Observations: IMRS, Apr. 1990, March-April, 1995, Field Biology Class; IMRS HQ, June 2009, J. D. Johnson; August 2011, G. Wiseman.

TROGLODYTIDAE (Wren Family)

Campylorhynchus brunneicapillus Cactus Wren
Observations: Calling at Squaw Spring, May 1995, Cutler; along the road to Squaw Spring, July 2000, Cutler; IMRS, April 1990; IMRS, 2-3 May 1992, Hibbits; IMRS, March 1990, Field Biology Class; IMRS HQ, June 2007, J. D. Johnson.

Catherpes mexicanus Canyon Wren
Observation: Squaw Spring, 16 July 2011, G. Wiseman.

Salpinctus obsoletus Rock Wren
Observations: area of IMRS HQ, March 1992 [Gardea and Mena, 1992]; IMRS, 2-3 May 1992, Hibbits. Squaw Spring, 18 February 2012, G. Wiseman.

Thryomanes bewickii Bewick's Wren
Observations: Squaw Spring, July 2000, Cutler; area of IMRS HQ, March 1992 [Gardea and Mena, 1992]; IMRS, Apr. 1992, Field Biology Class. Mesquite Tank, 24 September 2011, G. Wiseman.

Appendix 1 (continued):

SYLVIIDAE (Gnatcatcher Family)

Polioptila melanura Black-tailed Gnatcatcher
Observations: Squaw Spring, May 1995, Cutler; IMRS HQ area, May 1995, Cutler; March 1992, [Gardea and Mena, 1992]; July 2009, J. D. Johnson.

Polioptila caerulea Blue-Gray Cnatcatcher
Observations: Mesquite Tank, 10 September 2011, G. Wiseman.

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

Catharus guttatus Hermit Thrush
Observations: IMRS, May 1995, Herp Field Trip.

Myadestes townsendi Townsend's Solitaire
Observations: Squaw Spring, 28 September 2013; Pirtle Tank, 19 October 2013. G. Wiseman.

Sialia currucoides Mountain Bluebird
Observations: Red Tank, 5 November 2011; Red Tank, G. Wiseman

Sialia mexicana Western Bluebird
Observations: IMRS HQ, 23 May 2010, G. W. Johnson.

Turdus migratorius American Robin
Observations: IMRS HQ, 12 March 2010, J. D. Johnson.

MIMIDAE (Thrashers and Mockingbird Family)

Mimus polyglottos Northern Mockingbird
Observations: Double Tank Corral, May 1995, Cutler; Squaw Spring, May, 1995, Cutler; IMRS HQ area, May 1995, Cutler. Common around IMRS HQ during breeding season.

Oreoscoptes montanus Sage Thrasher
Observations: Pirtle Tank, 23 September 2011, G. Wiseman

Toxostoma crissale Crissal Thrasher
Observations: Squaw Spring, May 1995, Cutler; Double Tank Corral, May 1995, Cutler; area of IMRS HQ, March 1992 [Gardea and Mena, 1992].

Toxostoma curvirostre Curve-billed Thrasher
Observations: IMRS HQ, 12 March 2010, J. D. Johnson

PTILOGONATIDAE (Phainopepla Family)

Phainopepla nitens Phainopepla
Observations: Squaw Spring, May 1995, Cutler; IMRS HQ, June 2006, J. D. Johnson. Mesquite Tank, March 2013, G. Wiseman.

REGULIDAE (Kinglet Family)

Regulus calendula Ruby-crowned Kinglet
Observations: Squaw Spring, 20 January 2012, G. Wiseman.

MOTACILLIDAE (Pipit Family)

Anthus rubescens American Pipit
Observations: IMRS, 4 April 1991, Field Biology Class.

BOMBYCILLIDAE (Waxwing Family)

Bombycilla cedrorum Cedar Waxwing
Observations: IMRS, May 1995, Herp Field Trip.

Appendix 1 (continued):

PARULIDAE (Warbler Family)

Dendroica coronata Yellow-rumped Warbler
Observations: Squaw Spring, May 1995, Cutler; IMRS HQ, 7 April, 14 May 2011, J. D. Johnson.

Dendroica petechia Yellow Warbler
Observations: Rattlesnake Tank, 27 August 2011, G. Wiseman

Geothlypis trichas Common Yellowthroat
Observations: Needs to be verified.

Oporornis tolmiei MacGillivray's Warbler
Observations: Squaw Spring, May 1995, Cutler.

Oreothlypis ruficapilla Nashville Warbler
Observations: Rattlesnake Tank, 12 April 2014. G. Wiseman.

Seiurus noveboracensis Northern Waterthrush
Observations: Road Tank, 13 August 2011, G. Wiseman (photo).

Setophaga Americana Northern Parula
Observations: PirtleTank, 15 October 2011, G. Wiseman.

Setophaga townsendi Townsend's Warbler
Observations: Mesquite Tank, 8 October 2012. Observed at all ephemeral tanks and Squaw Spring. G. Wiseman.

Vermivora virginiae Virginia's Warbler
Observations: IMRS, May 1995, Herp Field Trip; Red Tank, 7 June 2008 (dead on ground), J. D. Johnson.

Wilsonia pusilla Wilson's Warbler
Observations: IMRS, 2-3 May 1992, Hibbits; August 2011.

EMBERIZIDAE (Sparrow and Towhee Family)

Aimophila ruficeps Rufous-crowned Sparrow

Observations: area of IMRS HQ, March 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
Observations: IMRS HQ area, May 1995, Cutler; Squaw Spring, July 2000, Cutler; area of IMRS HQ, March 1992 [Gardea and Mena, 1992]; IMRS, April 1990, common near IMRS HQ.

Calamospiza melanocorys Lark Bunting
Observations: IMRS, April 1990, Field Biology Class; IMRS HQ, 11 April 2010, 7 August 2010, J. D. Johnson; 4 August 2011, 3 May 2014, G. Wiseman.

Chondestes grammacus Lark Sparrow
Observations: IMRS HQ, Mesquite Tank, 20 August 2011, G. Wiseman and J. D. Johnson.

Junco hyemalis Dark-eyed Junco
Observation: IMRS HQ, 4 November 2012. J.D. Johnson, G. Wiseman.

Melospiza melodia Song Sparrow
Observation: Rattlesnake Tank, 7 September 2013. G. Wiseman.

Melospiza lincolnii Lincoln Sparrow
Observations: Squaw Spring, 2 March 2013. G. Wiseman.

Passerculus sandwichensis Savannah Sparrow
Observation: Rattlesnake Tank, 10 September 2011. Seen at all Ephemeral Tanks, but not at Squaw Spring. G. Wiseman.

Appendix 1 (continued):

Pipilo chlorurus Green-tailed Towhee
Observations: IMRS, 2-3 May 1992, Hibbits; IMRS HQ, 8 May 2010, J. D. Johnson.

Pipilo erythrophthalamus Eastern Towhee
Observations: IMRS, April 1990, Field Biology Class.

Pipilo fuscus Canyon Towhee
Observations: Road to Squaw Spring, May 1995, Cutler; IMRS, March 1995, Field Biology Class; IMRS HQ, 7 April 2011, J. D. Johnson.

Pipilio maculates Spotted Towhee
Observations: Pirtle Tank, 15 October 2011, G. Wiseman.

Pooecetes gramineus Vesper Sparrow
Observations: Pirtle Tank, 15 October 2011. Recorded at all ephemeral Tanks, but not Squaw Spring. G. Wiseman.

Spizella atrogularis Black-chinned Sparrow
Observations: IMRS HQ, March 1992 [Gardea and Mena, 1992].

Spizella breweri Brewer's Sparrow
Observations: IMRS HQ, March 1992 [Gardea and Mena, 1992]; IMRS, April 1991, March 1995, Field Biology Class.

Spizella pallida Clay-colored Sparrow
Observations: Rattlesnake Tank, 10 September 2012. Common during summer months. G. Wiseman

Spizella passerine Chipping Sparrow
Observations: IMRS HQ, March 1992 [Gardea and Mena, 1992]; IMRS, 2-3 May 1992, Hibbits; Mesquite Tank, 20 August 2011, G.Wiseman.

Spizella pusilla Field Sparrow
Observation: Squaw Spring, 30 September 2012. G. Wiseman.

Zonotrichia leucophrys White-crowned Sparrow
Observations: Squaw Spring, May 1995, Cutler; IMRS HQ area, March, 1992 [Gardea and Mena, 1992]; IMRS HQ, 7 April 2011, March 2013, J. D. Johnson.

CARDINALIDAE (Grosbeak, Cardinal, and Bunting Family)

Cardianlis cardinalus Cardinal
Observations: Rio Grande River vicintiy the "Box" June, 2013, W. Lukefahr and May 2014, G. Wiseman.

Cardinalis sinuatus Pyrrhuloxia
Observations: IMRS HQ, May 1995; Squaw Spring; 1.5 mi. SE of IMRS HQ, July 2000, Cutler; IMRS, April 1990, Field Biology Class; IMRS HQ and Squaw Spring, summer 2010, J, D. Johnson; IMRS, 7 April 2011, J. D. Johnson.

Passerina caerulea Blue Grosbeak
Observations: IMRS, May 1995, Herp Field Trip. IMRS HQ, 2 May 2010, J. D. Johnson; Squaw Spring, 12 June 2010, J. D. Johnson. Mesquite Tank, 4 August 2011, G. Wiseman.

Passerina ciris Painted Bunting
Observations: Peccary Tank, 16 July 2011, G. Wiseman (mating pair).

Appendix 1 (continued):

Passerina versicolor Varied Bunting
Observations: Squaw Spring, May 1995, Cutler.

Pheucticus melanocephalus Black-headed Grosbeak
Observations: Road to Squaw Spring, July 2000, Cutler; Squaw Spring 10 May 2014, G. Wiseman

Prianga ludoviciana Western Tanager
Observations: Squaw Spring, May 1995, Cutler; The Box, 17 July 2010, J. D. Johnson

Prianga rubra Summer Tanager
Observations: Squaw Spring, May 1995, Cutler.

Spiza americana Dickcissel
Observations: Rattlesnake Tank, 27 August 2011, 10 September 2010, G. Wiseman.

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

Ageliaus phoeniceus Red-winged Blackbird
Obervations: Rattlesnake Tank, 10 September 2011, G. Wiseman.

Euphagus cyanocephalus Brewer's Blackbird
Observations: IMRS HQ area, May 1995, Cutler: IMRS, 2-3 May 1992, Hibbits; IMRS, March 1995, Field Biology Class.

Icterus bullockii Bullock's Oriole
Observations: Mesquite Tank, 10 September 2011, G. Wiseman.

Icterus cucullatus Hooded Oriole
Observations: IMRS HQ, 7 June 2008, S. Dash.

Icterus parisorum Scott's Oriole
Observations: Squaw Spring, May 1995, July 2000, Cutler; IMRS HQ, March-April 1991, March 1995, Field Biology Classes; IMRS, 2-3 May 1992, Hibbits. Common around IMRS HQ.

Icterus spurius Orchard Oriole
Observations: PirtleTank, 28 July 2014. G. Wiseman.

Molothrus ater Brown-headed Cowbird
Observations: HQ area, July 2000, Cutler; IMRS, 2-3 May 1992, Hibbits. Common around IMRS HQ during summer.

Molothrus aeneus Bronzed Cowbird
Observations: IMRS HQ, 6 June 2009, G. W. Johnson, J. D. Johnson. IMRS HQ, summer 2010, 4 August 2011, J. D. Johnson.

Sturnella neglecta Western Meadowlark
Observation: IMRS HQ, October 2010, J. D. Johnson; IMRS HQ, 7 April 2011, J. D. Johnson.

Quiscalus mexicanus Great-tailed Grackle
Observations: IMRS HQ, 18 April 2010, J. D. Johnson; IMRS HQ, 7 April 2011, 16 March 2013. J. D. Johnson.

Xanthocephalus xanthocephalus Yellow-headed Blackbird
Observations: IMRS HQ, summers 2004, 2006, 2008, 2010, 2011, 2013, J. D. Johnson.

Appendix 1 (continued):

FRINGILLIDAE (Finch, Crossbill, Goldfinches Family)

Haemorrhus mexicanus House Finch
Observations: Squaw Spring, May 1995, July 1995, Cutler; area of IMRS HQ, March 1992 [Gardea and Mena. 1992]; IMRS, 2-3 May 1992, Hibbits; IMRS, April 1990, March 1995, Squaw Spring, 12 June 2010, 4 August 2011, G. Wiseman.

Spinus pinus Pine Siskin
Observation: Mesquite Tank, 24 November 2012; Rattlesnake Tank, 12 April 2014.

Spinus psaltria Lesser Goldfinch
Observations: Squaw Spring, 8 July 2011. Pirtle Tank. 28 January 2012 G. Wiseman.

Spinus tristis American Goldfinch
Observations: Pirtle Tank, 31 March 2013, G. Wiseman.

Appendix 2: Total Count of avian species by common name and location.

Common Name	Pirtle Tank	Mesquite Tank	Peccary Tank	Rattlesnake Tank	Squaw Springs	Grand Total
American Goldfinch	1					1
American Kestrel				1		1
Ash-throated Flycatcher	15	16	13	23	12	79
Bewick's Wren	5	7	8	3	3	26
Black Phoebe	2		1	1	1	5
Black-chinned Hummingbird		1		3		4
Black-tailed Gnatcatcher			1			1
Black-throated Sparrow	21	39	58	38	25	181
Blue Grosbeak	5	10	9	17	7	48
Blue-gray Gnatcatcher		2		2		4
Blue-winged Teal	1					1
Brewer's Sparrow	1	5	1	1		8
Bronzed Cowbird		1	1	2	5	9
Brown-Headed Cowbird	6	6		3	3	18
Bullock's Oriole		1				1
Cactus Wren	24	10	9	4	2	49
Canyon Towhee	8	3	4	7	1	23
Canyon Wren			1		14	15
Chihuahuan Raven			1			1
Chipping Sparrow	13	10	13	5	3	44
Clay-colored Sparrow	5	8	10	8	2	33
Common Nighthawk	14	11	8	4	10	47
Cordilleran Flycatcher	1					1
Crissal Thrasher		1	2	2	1	6
Curve-billed Thrasher	2	2				4
Dark-eyed Junco	7					7
Dickcissel		1		4		5
Dusky Flycatcher		2		1		3
Eastern Phoebe				1		1
Field Sparrow					1	1
Great Horned Owl		1				1
Greater Roadrunner	1		1	2	1	5
Green-tailed Towhee	4	7	6	6	2	25
House Finch	16	8	5	10	37	76
Ladder-backed Woodpecker	8	13	9	1	4	35
Lark Bunting		2	4	1		7
Lark Sparrow		2	4	1		7

Appendix 2 Continued:

Common Name	Pirtle Tank	Mesquite Tank	Peccary Tank	Rattlesnake Tank	Squaw Springs	Grand Total
Least Flycatcher	1	1	3	5		10
Lesser Goldfinch	1				3	4
Lincoln's Sparrow					1	1
Loggerhead Shrike	8	5	3	5	3	24
MacGillivray's Warbler	3	2	4			9
Mourning Dove	27	12	44	19	21	123
Nashville Warbler				2		2
Northern Flicker	8	3		2		13
Northern Mockingbird	27	15	6	24	9	81
Northern Parula	1					1
Northern Waterthrush	1				2	3
Orchard Oriole			1			1
Painted Bunting			2			2
Phainopepla		4		1		5
Pine Siskin		1		1		2
Pyrrhuloxia	4	27	7	18		56
Red-tailed Hawk				1	4	5
Red-winged Blackbird				1		1
Rock Wren		3	5	1	17	26
Ruby-crowned Kinglet	2	4			6	12
Rufous Hummingbird		1				1
Rufous-crowned Sparrow	2	1				3
Sage Thrasher	1		2	1		4
Savannah Sparrow	1	4	4	2		11
Say's Phoebe		1		2	1	4
Scaled Quail	6	16	19	13	3	57
Scott's Oriole	13	9	16	18	13	69
Song Sparrow				1		1
Spotted Towhee	1		1			2
Summer Tanager	3				1	4
Townsend's Solitaire	1				1	2
Townsend's Warbler	1	1	1	2	1	6
Turkey Vulture	3	6	2	4	11	26
Varied Bunting		3	1	2	2	8
Verdin	4	13	7	13	1	38
Vesper Sparrow	2	2	4	1		9
Virginia's Warbler	1			1	2	4
Warbling Vireo	1			2	1	4
Western Kingbird	1	1	1	1	1	5

Appendix 2 Continued:

Common Name	Pirtle Tank	Mesquite Tank	Peccary Tank	Rattlesnake Tank	Squaw Springs	Grand Total
Western Tanager	2	1		2	1	6
Western Wood Pewee	6	4	3	7	2	22
White-crowned Sparrow	5	2	1	3	2	13
White-eyed Vireo	1					1
White-winged Dove	19	7	2	3	23	54
Wilson's Warbler	7	10	7	18	6	48
Yellow Warbler				2		2
Yellow-headed Blackbird	2	3	1	2	1	9
Yellow-rumped Warbler	6	2	6	5	5	24
Grand Total	**332**	**333**	**322**	**336**	**278**	**1601**

VITA

Geoffrey Hugh Wiseman was born in Memphis, Tennessee on December 24, 1968. Geoff graduated from Jesse O. Sanderson High School in Raleigh, North Carolina in 1987. He promptly joined the United States Army and after 21 years of moving across the country and the world he retired from the Texas Army National Guard in December 2009. In high school Geoff was a below average student so in August 2012 when he graduated from the University of Texas at El Paso (UTEP) with a 3.81 grade point average, it was a surprise to both him and his family. He continued his education by completing his Master of Science in Biology in 2014. While completing the requirements for his graduate degree, Geoff was a teaching assistant for numerous biological and environmental science classes. During his time at UTEP Geoff took part in the Undergraduate Research and Mentoring (URM) and Students Mentoring to Achieve Retention Triads in Science (SMARTS). These programs allowed him to travel to different regions of the country and present his research to other scientists. His SMARTS mentee became a graduate student and a mentor in the SMARTS program. Geoff plans to follow his interests in Biology and Natural History by becoming a teacher, either in community college or high school. Geoff volunteers with the Franklin Mountains State Park, numerous public school programs, and is a Texas Master Naturalist. Geoff also founded his own not-for-profit, El Paso Native Reptile Rescue (EPNRR).

Geoff is a member of Ecological Society of America (ESA), Southwest Association of Naturalist (SWAN), and L.I.O.N.S. Club International.

Permanent address: 649 Abington Drive
El Paso, TX 79912
geoffwiseman@hotmail.com

This thesis was typed by Geoffrey Hugh Wiseman.