ASSESSING HERPETOFAUNAL COMMUNITIES AND SPECIES MONITORING IN THE ROLLING PLAINS OF TEXAS

An Undergraduate Research Scholars Thesis

by

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TABLE OF CONTENTS

ABSTRACT

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Herpetofaunal communities have been monitored intermittently on the Matador Wildlife Management Area for the past 12 years in an attempt to understand and track species' responses to habitat changes. This study analyzed data from all available years (2004, 2013, 2014, and 2016) with the goal of assessing habitat preference, species presence, and population trends. Herp sampling was conducted using standard Y-array drift fences with pitfall traps as well as informal road cruising and documentation of fortuitous encounters. The number of drift fences used each sampling year ranged from 10 to 17 and were opened for varying periods of time (9 to 61 days). Throughout all years combined, a total of 23 species were trapped and 11 additional species were documented through fortuitous encounters, compared to 43 species known from Cottle County. A species accumulation curve indicated trapping effort was insufficient to detect all species in the area. Jaccard's dissimilarity values between trapping arrays were high, indicating little overlap in species assemblages among sites (mean dissimilarity value: 0.71). Trapping data revealed coarse habitat affinities for common species, but sample sizes limited our ability to infer specific habitat preferences or assess population trends. To meet the goal of

monitoring long-term trends in herp communities and species, I recommend implementation of longer, more consistent sampling periods, a stratified sampling protocol with replication, incorporation of time-constrained searches, and improvements to the drift fence design.

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I would like to thank everyone who helped make this project a reality. I am especially grateful for the Matador WMA staff who collected the data from 2004, 2013, and 2014, including Matthew Poole, Celina Nissom, Mariah Box, and Kara Walker. I would also like to thank Derrick Holdstock for providing me with the GIS vegetation data. I greatly appreciate my supervisors at the Matador, Donald Ruthven and Matthew Poole, for providing guidance and assistance with data collection while still allowing me the leeway to take the project in the direction I wanted it to go. I would also like to thank Hannah Gerke for reviewing my thesis draft.

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NOMENCLATURE

TPWD	Texas Parks and Wildlife Department
MWMA	Matador Wildlife Management Area
GIS	Geographic Information System
Herps	Short for herpetofauna (reptiles and amphibians)
Drift fence	Herp trapping array made up of short fences directing animals into buckets
Trap	see “Drift fence” above
GPS	Global Positioning System
NRCS	Natural Resource Conservation Service

CHAPTER I

INTRODUCTION

Many reptile and amphibian species (herpetofauna) are declining worldwide (Gibbons et al. 2000, Bohm et al. 2013). Habitat loss and degradation are important contributors to these declines, and effects of habitat change on herp communities remains an important area of study (Gardner et al. 2007). Studies on habitat preferences and herpetofaunal responses to habitat changes are vital to our understanding of reptile and amphibian conservation (Gardner et al. 2007). It is also important to understand how herpetofauna can be managed and conserved outside of protected areas, particularly in states such as Texas that are primarily composed of private working lands.

This study took place on the Matador Wildlife Management Area (MWMA) in the Rolling Plains ecoregion of Texas. The Matador is state-owned and managed, but more closely resembles a working ranch than a protected park and is thus a good area to study herpetofauna in a working landscape. The Matador is leased for cattle grazing (light stocking rates, rotational grazing) and hosts thousands of public hunters each year. The Texas Parks and Wildlife Department (TPWD) staff working at the MWMA began an extensive habitat management program starting in 2004 that included prescribed burning, herbicide application, mechanical treatments, and prescribed grazing. The goal of the habitat management program is to restore the Matador to its historical prairie state by reducing brush cover and promoting native grasses and forbs. The purpose of restoring the prairie is primarily to increase populations of native game species such as mule deer (*Odocoileus hemionus*), Northern bobwhite (*Colinus virginianus*), and wild turkey (*Meleagris gallopavo intermedia*) in order to benefit public hunting opportunities.

The staff at the Matador have also been interested in how these habitat management activities may be affecting non-game animals such as reptiles, amphibians, small mammals, birds, and invertebrates. In an effort to document these effects, the Matador staff have periodically engaged in sampling and monitoring efforts for these taxa as time and resources have allowed. The result is a long term (12+ years) dataset of non-game species populations on the Matador that is unfortunately patchy and incomplete due to the limited time and resources available to the Matador staff.

I worked at the Matador as an intern during the summer of 2016, during which time new herpetofauna monitoring data was collected and the long-term herpetofauna dataset was analyzed for the first time since the program's inception in 2004. There were two primary goals for this study. The first was to examine the habitat preferences of the herpetofauna species on the Matador and how those species may be responding to the habitat management program. The second goal was to evaluate the monitoring program and offer recommendations to TPWD to improve their program to provide a better understanding of the species' responses to habitat change. A more complete record of habitat preference and responses to habitat change could then be used to inform future management decisions.

CHAPTER II

METHODS

Study Site

The Matador Wildlife Management Area is a 28,183-acre property owned by the Texas Parks and Wildlife Department (TPWD) in Cottle County, Texas. The Matador consists of a diverse array of habitat types ranging from flat tallgrass prairie to rolling gravely hills and rugged red dirt canyons. The property is bisected by the Middle Pease River, and the river's associated flood plain and bluffs make up a significant portion of the property. Past management (or lack thereof) led to woody encroachment across much of the native prairie. This woody encroachment is the target of current restoration efforts.

Drift Fences

The majority of the reptile and amphibian data was collected using Y-array drift fences. Drift fences were constructed out of three 25ft (7.62m) long x 1ft (0.3m) tall sections of aluminum flashing. The three sections of flashing were arranged in a "Y" shape with one 5 gallon (18.9L) bucket sunk flush with the surface of the ground at the end of each arm of the Y-array and one bucket in the center of the array. Holes drilled in each bucket allowed draining of water during rain events. A few of the drift fences constructed in 2004 had large diameter PVC pipes with wire mesh bottoms in place of 5 gallon buckets, but with similar dimensions. Approximately 1in (2.54cm) of soil was placed in each bucket for the comfort of trapped animals. Additionally, small 4in x 4in (10.16cm x 10.16cm) coverboards were placed in each bucket to provide shade structures for captured animals. In 2016, small commercially available ant baits (RAID ©) were placed in traps to control mortality of small herps from fire ants

(*Solenopsis* sp.) that invaded the bucket traps. Data were collected on all trapped organisms (herps, mammals, and invertebrates) but only the herp data was analyzed for this paper.

Over the years, trapping was conducted as time and resources allowed. The only years that trapping was possible were 2004, 2013, 2014, and 2016. The number of trap-days and number of Y-arrays opened varied among years, from 9 to 61 days and 10 to 17 traps. See Appendix A for full details on which traps were open each year and for how many days. See Appendix B for a map of trap locations. Traps were placed selectively (i.e. non-randomly) in an attempt to represent as many habitat types as possible. Traps were placed no greater than 50m from roads to allow staff to check all traps in a timely manner.

When drift fences were open they were checked on a daily basis. A TPWD staff member would begin at roughly 0700 and finish checking traps by 1400. Species and sex were documented for all vertebrates captured. Where appropriate, biometric measurements such as total length, snout-vent length, tail length, and hindfoot length were taken. Recaptures were delineated by clipping the fifth toe of the right-rear foot on lizards and amphibians. Small mammals were marked by shaving small patches of fur. In 2016, all invertebrates collected from the arrays were preserved for later identification. After measurements were completed, all vertebrates were released near the trap location. Biometric data and invertebrate data were not used in this study, but will likely be used in a future study.

I plotted two species accumulation curves, one with the number of species plotted against study days (any day with at least one trap open) and one with number of species plotted against the cumulative number of trap days. These were based on combined captures from all four years the traps were open. A logarithmic trend line was fitted to the points. A total species list of every herp species documented through both the drift fences and fortuitous encounters was compiled, along with a comparison list of all known Cottle County records (Dixon 2013).

Fortuitous Encounters

Throughout 2016, I recorded fortuitous encounters with herps on roads and elsewhere. Fortuitous encounters mainly occurred while carrying out unrelated WMA duties during the day. Some informal road-cruising was done during the evening. Species, time, and GPS location were recorded for each encounter. Additionally, most Texas horned lizards (*Phrynosoma cornutum*), ornate box turtles (*Terrapene ornata*), western diamond-backed rattlesnakes (*Crotalus atrox*), and western massasaguas (*Sistrurus tergeminus*) were captured and brought back to the office for data collection related to other monitoring projects. These individuals were later released at their original capture location.

Fortuitous encounters were not analyzed using statistical methods because they were not based on any standard sampling protocol. They were not random (greater effort was placed on the main road near headquarters because that had to be driven through to reach anywhere else) and there was no control or documentation of effort spent. Thus, the data from these encounters is presented in a simple summary in the Results section. These data are simply meant to show which additional species found through fortuitous encounters were not documented using the drift fences.

Habitat Data

Vegetation data was provided by TPWD employee Derrick Holdstock. In 2011, Holdstock created a vegetation classification scheme for the MWMA that integrated information from national vegetation and ecological site databases, infrared satellite imagery, vegetation management records, and knowledge of vegetation successional processes. This culminated in a GIS map of the MWMA that allowed classification of ecological site type and vegetation description for any location on the property. The ecological site descriptions are from the National Resource Conservation Service (NRCS) database and include coarse scale information on the dominant vegetative community and physical attributes of a site (USDA NRCS 2012). Holdstock created a finer scale classification system by analyzing infrared satellite imagery in 2011. He used a 1:5000 scale resolution to create and classify polygons based on vegetation class and percent canopy cover. Using a standardized system of predicting successional changes from management activities (fire, herbicide, mechanical), the vegetation of a particular site could be predicted for years after 2011 based on the management activities that had been conducted there. In the GIS map of the MWMA vegetation, the vegetation description is the type of vegetation that is predicted to be at a site based on how the vegetation that was present in 2011 was expected to respond to whatever management actions were carried out there (i.e. mature juniper, post-disturbance juniper, etc.). It also includes information on the structure of the vegetation (i.e. post-disturbance juniper w/ standing dead). Due to resource constraints, these predictions were the best data available to us for this project. The predictions were ground-truthed at each Y-array using visual observation and were found to be adequate for this application.

The GPS location for each Y-array was added to the MWMA vegetation GIS map in QGIS (QGIS Development Team 2016). Each location was buffered 25m and clipped from the main MWMA shapefile. These circles represent immediate habitat that was likely utilized by the individuals that were caught in the traps located in the center of the circle. A merged shapefile was created for each drift fence habitat buffer for ecological site and vegetation description, and then the dominant class for each of these (visual estimation) was recorded.

Dissimilarity Matrices and AHC Dendrograms

First, I measured the beta diversity between sites with the goal of identifying sites with similar species assemblages. Beta diversity is the turnover in species occurrences between sites. The goal of this approach was to identify patterns of species assemblages that could be correlated to habitat types and then use those patterns to inform a future stratified sampling program. Dissimilarity matrices were based on Jaccard's Coefficient $(1 - \frac{C}{\mathrm{C+N_1+N_2}})$ were C= overlap in species assemblages, N_1= species unique to site 1 and N_2= species unique to site 2 (Laurencio and Fitzgerald 2010). Jaccard's Coefficient only considers presence/absence data and measures overlap in species assemblages from each location, i.e. the beta diversity (Laurencio and Fitzgerald 2010). In the matrix, a "0" indicates 100% overlap (drift fences have the exact same species assemblage) whereas a "1" indicates zero overlap (not a single species is shared between arrays). I used XLSTAT- Ecology to conduct these analyses (Version 18.06, Addinsoft, USA). Two matrices were created; one for all combined years and one for 2016 alone. 2016 was given its own matrix was because it was the only year with reliable, ground-truthed vegetation descriptions. The combined years matrix only compared ecological sites.

The dissimilarity matrices were plugged back into XLSTAT to generate an Agglomerative Hierarchical Clustering (AHC) dendrogram using an unweighted pairwise function. The AHC dendrogram clustered occurrences from trapping locations into pairs and groups with the goal of minimizing the dissimilarity between the two branches of a cluster. The dendrograms allowed us to visualize which drift fences had similar species assemblages. These groupings were then compared to the habitat data to identify patterns resulting in similar species assemblages. A dissimilarity matrix was also created to compare the total species assemblage from each of the four years to each other. Throughout our analysis we did not standardize the data based on which Y-arrays were open each year and for how long, because doing so would have meant throwing away the majority of our data. For example, drift fences only open for one or two of the four sampling years were included in the dissimilarity and AHC analysis in the same manner as those with greater sampling effort.

Habitat Preferences

The first step in identifying potential habitat preferences was determining catch per unit effort (CPUE) for drift fences. The CPUE for each species at each drift fence was calculated by dividing the number of captured individuals of a species by the number of days the drift fence was open. This standardized the data and removed some bias imparted by the unequal trapping effort between locations and years. Only reptiles were considered for this analysis because it was assumed that the amphibian captures were more closely tied to water availability than vegetation structure. 2016 was analyzed separately because it was the only year that reliable vegetation description data was available. The combined years data (which included 2016) were only analyzed in reference to ecological site. Only six-lined racerunners (*Aspidoscelis sexlineata*), common spotted whiptails (*A. gularis*), and Great Plains skinks (*Plestiodon obsoletus*) were examined for habitat preferences because those were the only species with large enough sample sizes to glean any meaningful information. For each of the focus species a ranked list of their CPUE at each drift fence was created. The assumption is that the higher a species' CPUE ranked at a specific location, the greater that species' preference for that habitat type.

Habitat Change Correlations

The last analysis I conducted aimed to identify patterns in species abundance (using CPUE as a proxy) that were influenced by habitat management activities. To do this, changes in individual species' CPUEs at each drift fence were compared between years. Amphibians were excluded from this comparison because their CPUE was likely closely associated with rain events, which may have affected potential correlations to changes in vegetation (Mceachern 2008). The three species with the highest number of captures were the focus of this analysis (*A. sexlineata*, *A. gularis*, and *P. obsoletus*). A table was created that contained a summary of the species' CPUE response at trap locations with and without habitat management activities.

CHAPTER III

RESULTS

Species Recorded

Over the entire history of the monitoring program, 23 species were captured in the Y-arrays (640 captures). An additional 11 species were recorded through fortuitous encounters, plus five species that had already been recorded in the traps. There were 98 fortuitous encounter records for 2016. Overall, 34 species were detected at the WMA between 2004 and 2016, whereas 43 species are known from Cottle County. Appendix C contains a list of each species recorded on the Matador (with observation counts) alongside a list of all Cottle County records (Dixon 2013). Appendix D contains the raw data for the drift fence captures, displayed as both observations and CPUE.

Figures 1 and 2 show the species accumulation curve for the drift fences. Figure 1 plots the number of new species against the "study days," which is any day when at least one trap is open. Figure 2 plots the number of new species against the cumulative number of trap days. The curves are very similar. Both begin to flatten out near the end and the new records become less frequent, but the curves does not reach an asymptote, indicating that more sampling would likely turn up additional species not previously encountered on the WMA.

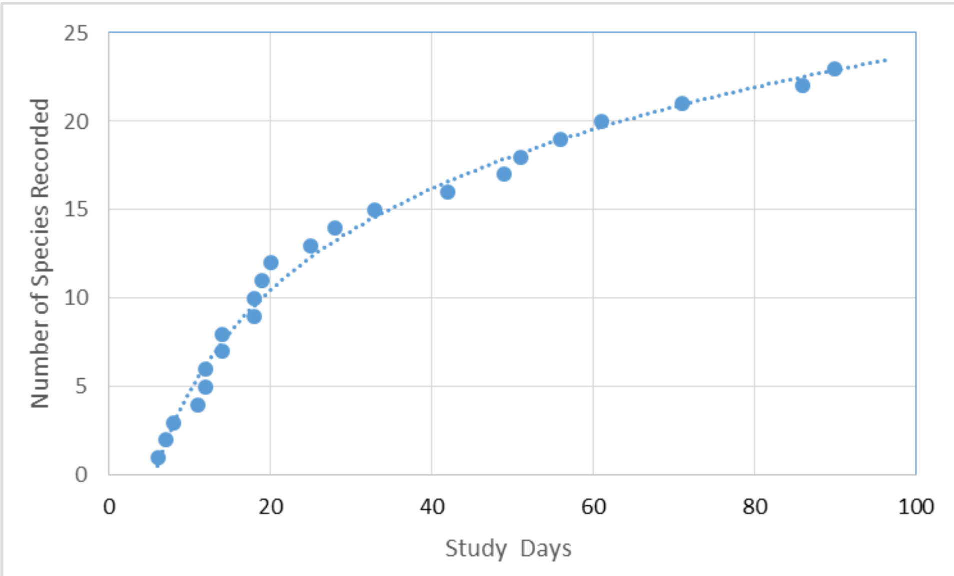


Figure 1. Species Accumulation Curve: The species accumulation curve did not show a clear asymptote with all study days included. During the study 24 species were documented in the drift fences. Forty-three species of reptiles and amphibians are known to occur in Cottle County (Dixon 2013).

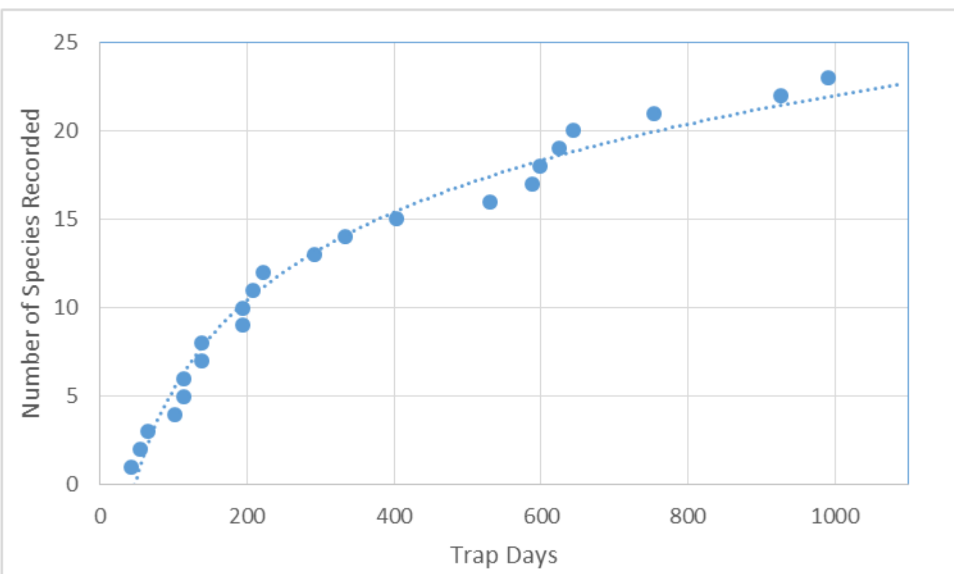


Figure 2. Species Accumulation Curve: The species accumulation curve did not show a clear asymptote with all trap days included.

Habitat Data

A map of the NRCS Ecological Sites present on the MWMA can be found in Appendix E. Appendix F contains a map of the vegetation descriptions for the MWMA. Table 1 provides the ecological site and vegetation description for each drift fence. The most common NRCS ecological site represented by the drift fences was "Gravelly" and the most common vegetation description represented by the drift fences was "Tight Soil Shortgrasses w/ Slash." Overall, there are 11 ecological site types and 72 vegetation description classes present on the MWMA. The drift fences represented seven ecological sites and 12 vegetation description classes.

Table 1. Drift Fence Ecological Sites and Vegetation Description

Drift Fence	Abreviation	NRCS Ecological Site Description	Vegetation Description
East Aermotor	EA	Gravelly	Post-Disturbance Redberry Juniper w/ Slash
Sisk	Sisk	Gravelly	Post-Disturbance Redberry Juniper
South Middle	SM	Gravelly	Mature Redberry Juniper
Dogleg	DL	Gravelly	Mature Mesquite
Samson	Sam	Loamy Bottomland	Young Mesquite
Shorty	Short	Loamy Bottomland	Mature Mesquite
North North Middle	NNM	Loamy Prairie	Tight Soil Shortgrasses w/ Slash
Stonewall	SW	Loamy Prairie	Tight Soil Shortgrasses w/ Slash
West East Aermotor	WEA	Loamy Prairie	Tight Soil Shortgrasses w/ Slash
Middle Bull	M bull	Loamy Sand Prairie	Post-Disturbance Sand Prairie
East Bull	E Bull	Loamy Sand Prairie	Post-Disturbance Sand Prairie
Entrance	EN	Loamy Sand Prairie	Sagebrush Prairie
North East Suitcase	NE Suit	Sandy	Sandhill Grassland with Shinnery
OX	OX	Sandy	Sandhill Grassland with Shinnery
Lone Canyon	LC	Sandy Bottomland	Riparian Grasland w/ Brush Piles
North Middle	NM	Sandy Bottomland	Riparian Grassland
North West Suitcase	NW Suit	Sandy Loam	Tight Soil Shortgrasses w/ Slash

Dissimilarity Matrices and AHC Dendrograms

Table 2 contains the Jaccard's Dissimilarity matrix comparing the complete species assemblage recorded in the drift fences for each year. In the matrix, a "0" indicates no dissimilarity, i.e. the species assemblages were the same. Conversely, a "1" indicates complete dissimilarity, i.e. no species shared in common. As Table 2 shows, the most similar years were 2004 and 2016. Dissimilarity matrices comparing each drift fence to each other are displayed in the Appendix. Appendix G compares the total recorded species assemblages for each fence (all years combined). The matrix shows that there was very little overlap in species assemblages between drift fences, with an average dissimilarity value of 0.71. Appendix H compares the 2016 species assemblage for each drift fence. Again, there were high dissimilarity values, with an average value of 0.81.

Table 2. Jaccard's Disimilarity Matrix based on presence of herptile species trapped during sampling years.

	2004	2013	2014	2016
2004	0	0.750	0.524	0.304
2013	0.750	0	0.545	0.737
2014	0.524	0.545	0	0.421
2016	0.304	0.737	0.421	0

The AHC dendrograms created from the proximity matrices are shown in Figures 3 and 4. The dendrograms show little significant clustering related to ecological site or vegetation description. There appears to be some clustering of 3 out of the 4 "Gravelly" sites in Figure 3. The "Loamy Sand Prairie" sites also show clustering of 3 out of the 4 sites. (Figure 3).

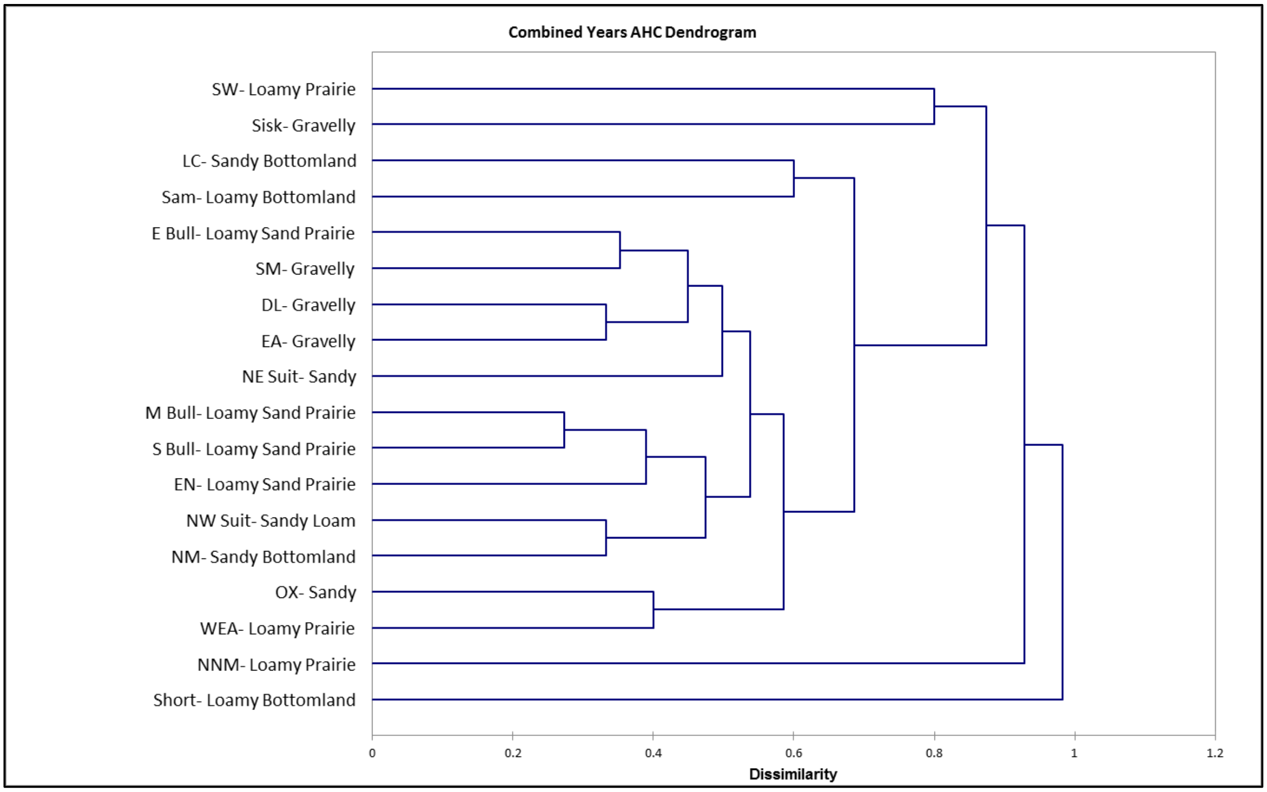


Figure 3. An AHC Dendrogram for all years combined. This dendrogram represents clusters of similar species assemblages based the unweighted pairwise option. At the end of each branch of the graph is the drift fence abbreviation and ecological site type.

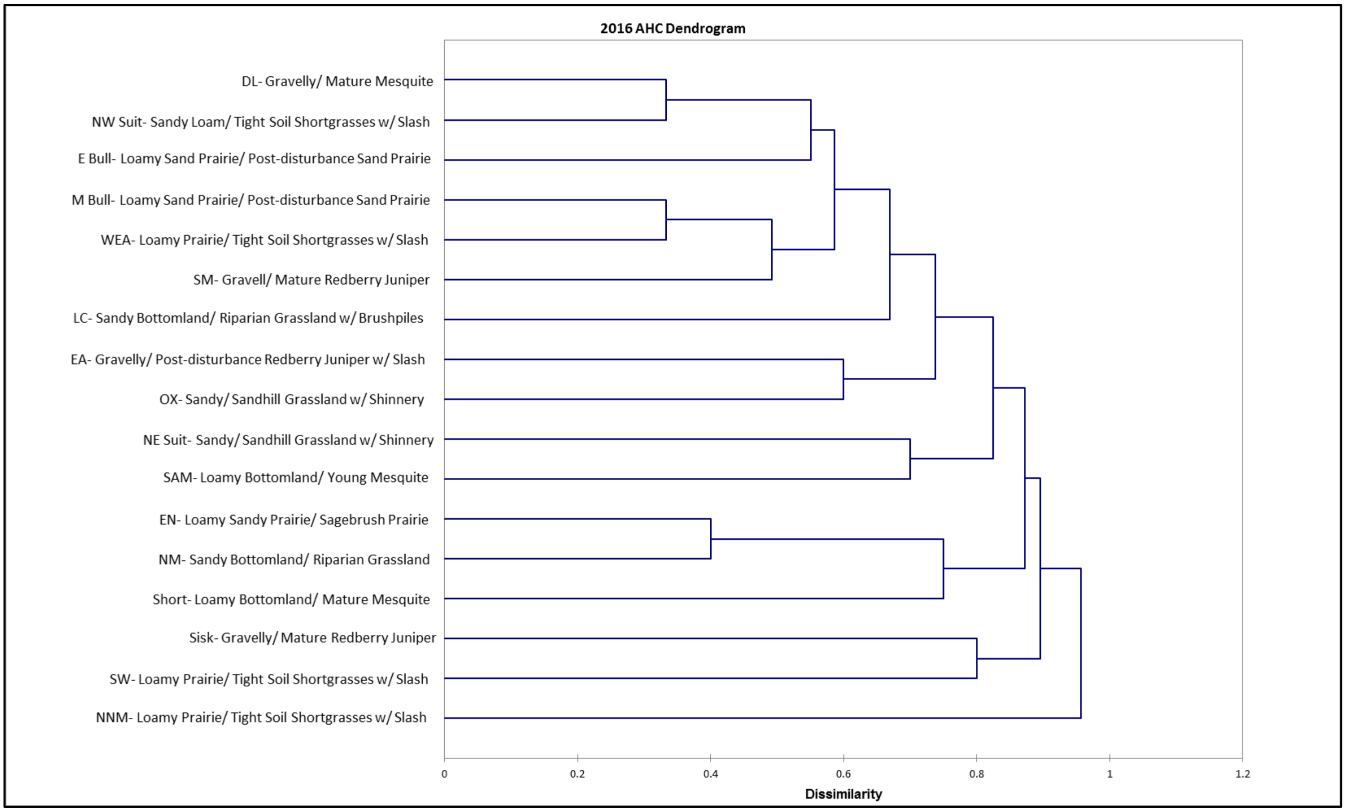


Figure 4. An AHC Dendrogram for 2016 only. This dendrogram represents clusters of similar species assemblages based on the unweighted pairwise option. At the end of each branch of the graph is the drift fence abbreviation, ecological site, and vegetation description.

As Figure 4 shows, there was little to no significant clustering of drift fence sites in 2016 based on either ecological sites or vegetation descriptions. In fact several of the closest clusters were between seemingly completely separate habitat types, such as “Gravelly/ Mature Mesquite” and “Sandy Loam/ Tight Soil Shortgrasses w/ Slash.” The only relatively close pairing that is intuitive is between a “Loamy Sand Prairie” and “Loamy Prairie” site.

Habitat Preferences

Potential habitat preferences were examined for the 3 species with the highest number of captures (*A. sexlineata*, *A. gularis*, and *P. obsoletus*). Appendix I contains a ranked list of the CPUE for each species at each drift fence for 2016 (allowing the use of vegetation descriptions).

Aspidoscelis gularis appears to show a preference for "gravelly" sites, with 4 out of the 5 top drift fence CPUEs being from that ecological site type. Vegetation descriptions at the top *A. gularis* sites were generally mature or post-disturbance redberry juniper (*Juniperus pinchotii*) or mesquite (*Prosopis glandulosa*). The highest CPUE recorded during the 2016 field season (1.00) were records of *A. gularis* at the Sisk drift fence, which was a gravelly hill with sparse post-disturbance redberry juniper, shortgrasses such as hairy grama (*Bouteloua hirsute*), and extensive areas of bare ground. *Aspidoscelis sexlineata* appears to show a preference for sandy sites, with 5 out of the 6 top CPUEs recorded at sites with some kind of sandy component (i.e. loamy sand prairie, sandy bottomland, etc.). Most of the top sites had some type of grassland as the dominant vegetation description. The exception was Dogleg, which had the 3rd highest *A. sexlineata* CPUE but was categorized as a gravelly hill with mature mesquite. The 2016 records for *Plestiodon obsoletus* did not show obvious habitat preferences, with the top CPUE sites consisting of a mix of sandy, loamy, and gravelly sites and vegetation descriptions including shinnery oak (*Quercus havardii*), mesquite, and juniper.

The combined years dataset (Appendix J) showed similar patterns as the 2016 data. *Aspidoscelis gularis* demonstrated a preference for gravelly sites, followed by sandy sites. *Aspidoscelis sexlineata* showed a preference primarily for sandy sites followed by gravelly sites. *Plestiodon obsoletus* again did not appear to have clear preferences, with the top 3 sites being loamy prairie, gravelly, and loamy bottomland.

Habitat Change Correlations

Table 5 contains a summary of how CPUE changed from 2004 to 2016 for each species at sites where habitat management had been carried out during the study period (12 sites) and where habitat management had not occurred (2 sites). The only species that demonstrated increased CPUE in relation to habitat management activities was *A. sexlineata*. Table 6 contains specific examples of how CPUE for *A. sexlineata* responded to management actions. This table presents the drift fence in question along with the CPUE for each year. The 2016 row displays the current vegetation at that site. The far right column summarizes the habitat management activities that occurred at that site during the study period (or shortly before it began).

Table 5. CPUE/ Habitat Change Correlation Summary

	***Aspidoscelis sexlineata* CPUE response**				
	Increased	Fluctuated	Decreased	No Change	No Data
Habitat Management	7	2	2	1	
No Habitat Management	1	1			
	***Aspidoscelis gularis* CPUE response**				
	Increased	Fluctuated	Decreased	No Change	No Data
Habitat Management	1	3			8
No Habitat Management		2			
	***Plestiodon obsoletus* CPUE response**				
	Increased	Fluctuated	Decreased	No Change	No Data
Habitat Management	1	1	9	1	
No Habitat Management		1	1		

Table 6. CPUE/ Habitat Change Correlations for *A. sexlineata*.

			Aspidoscelis sexlineata	
Drift Fence	**Year**	**Species CPUE**	**Habitat Description**	**Habitat Management Activities**
South Bull	2004	0.02		2004, 2013, and 2016- Mixed Severity Rx fires
South Bull	2013	0.00		2013- Juniper herbicide
South Bull	2014	0.29	Post-disturbance Sand Prairie- 5% cover	Note- exact drift fence location unknown
East Bull	2004	0.05		1999- Mixed severity Rx fire
East Bull	2013	0.22		2004- Surface Rx fire
East Bull	2014	0.71		2008, 2013, and 2016- Mixed severity Rx fires
East Bull	2016	0.29	Post-disturbance Sand Prairie- 5% cover	
Middle Bull	2004	0.10		2001- Mesquite herbicide
Middle Bull	2016	0.71	Post-disturbance Sand Prairie- 5% Cover	2013- Juniper Herbicide
				2004, 2008, 2013, and 2016- Mixed severity Rx fires
East Aermotor	2004	0.14		2010- Juniper herbicide
East Aermotor	2014	0.07		2011- Replacement wildfire
East Aermotor	2016	0.07	Post-Disturbance Redberry Juniper w/ Slash- 25% Cover	
Samson	2004	0.08		2011- Replacement wildfire
Samson	2016	0.29	Young Mesquite- 5% Cover	
Lone Canyon	2004	0.19		2015- Grubbing and Piling
Lone Canyon	2013	0.11		
Lone Canyon	2014	0.14		
Lone Canyon	2016	0.64	Riparian grassland w/ brushpiles- 5% Cover	
North Middle	2004	0.22		2007- Mixed severity Rx fire
North Middle	2013	0.00		2015- Rx fire (no change)
North Middle	2014	0.64		
North Middle	2016	0.57	Riparian Grassland- 5% Cover	
Dogleg	2004	0.05		2015- Rx fire (no change)
Dogleg	2013	0.00		
Dogleg	2014	0.29		
Dogleg	2016	0.57	Mature Mesquite- 45% Cover	
NW Suitcase	2004	0.02		2013- Mesquite Herbicide
NW Suitcase	2013	0.11		2016- Mixed severity Rx fire
NW Suitcase	2014	0.14		
NW Suitcase	2016	0.21	Tight Soil Shortgrasses w/ slash- 5% Cover	

The majority (7/12) of Y-arrays placed in pastures where habitat management was conducted during the study period recorded an increase in *A. sexlineata* CPUE. However, five Y-arrays in areas where habitat management had been conducted either recorded a decrease, fluctuation, or no change in CPUE. Only two areas with no habitat management were sampled, with one showing an increase in CPUE and one showing a fluctuation. *Aspidoscelis gularis* did not have enough data to make any sort of conclusions regarding how that species may respond to habitat management. Detections of *P. obsoletus* appeared to decrease across most of the study area, with 9/14 Y-arrays showing decreases. The majority of these decreases happened in habitat management areas, although that might not be significant because most of the areas sampled had habitat management. Only a single site had an increase in CPUE and that site did have a history of habitat management activities.

CHAPTER IV

DISCUSSION

Species Recorded

Given the habitat diversity present on the MWMA, it can be assumed that most, if not all, of the recorded species in Cottle County likely exist somewhere on the Matador. Given this assumption, the inability to detect 11 species (~25% of all species records in Cottle County) raised questions. Moreover, 11 species were only detected through fortuitous encounters and not as part of the systematic monitoring program. The fortuitous encounters also have no habitat or trend data associated with them. The fact that only about half the expected species present were documented by trapping is likely due to several reasons. First, the drift fences are not set up to capture large snakes, which represent of 11 of the 43 Cottle County species. The addition of snake funnels to the traps could remedy this (Yantis, in Fitzgerald 2012). The traps also are not likely to capture turtles (4 expected species), but this can be made up for with surveys designed to sample turtles (Vogt, in Lovich 2012). The Y-arrays were also not good for sampling some of the amphibian species known to occur in the area.

Sampling effort, both in terms of trap locations and trap days, would need to be systematically increased to improve the detection of species and ability to identify trends. The species accumulation curve constructed from all data available did not reach an asymptote, indicating that more trapping effort and a variety of survey methods would likely document occurrence of additional species at the Matador WMA (Cross et al. 2012). Additionally, most of the species recorded on the Matador were observed less than ten times, revealing little to no information about their population trends or habitat preferences. Greater trapping effort and consistency would permit more inferences to be drawn from the data. More detailed trapping method suggestions are provided in the "Recommendations" section.

Habitat Data

The complexity of habitats of the Matador is apparent in the 11 ecological site types and 72 vegetation description classes documented there. It is this habitat complexity that leads us to believe that more undocumented species of herps that are already known from Cottle County are likely to be present, plus the possibility of other county records. Habitat diversity also complicates monitoring efforts; a full-scale program with replicated trapping effort for every ecological site and vegetation type would be enormous and outside the reach of TPWD's resources. Thus, a prioritization system must be created to select what areas will be monitored.

A weakness in the vegetation data is that it is based solely on satellite data from 2011. At the very least, a new satellite classification effort should be made, and at best an actual ground-based vegetation survey should be done to collect more detailed data. Limitations in the habitat data prevented more detailed descriptions of potential habitat preferences. For example, the ecological site types are very course scale and do not take into account variation within those categories. For instance, the "gravelly" sites varied widely from areas with soil primarily composed of pea to golf ball sized pebbles, to areas with primarily soft red dirt and only a thin layer of scattered pebbles on the surface. The vegetation descriptions were also not perfect because they did not describe the full range of variation among sites. For instance, two sites categorized as "mature juniper" might vary widely in their percent cover of juniper and their associated grass/forb community.

Dissimilarity Matrices and AHC Dendrograms

The dissimilarity matrices and AHC dendrograms showed very little overlap in species assemblages among drift fences. Figure 3 (combined years) shows that the "gravelly" sites had similar species assemblages to each other and the “loamy sand prairie” sites had similar species assemblages to each other. However, some clusters did not make sense, with one of the closest clusters in Figure 4 (2016) being a “gravelly/mature mesquite” site and “sandy loam/tight soil shortgrasses w/ slash” site. Given the limited sample size (in terms of trap locations and days), it is not possible to determine whether clusters such as this represent actual similarities in species assemblages present in those areas or simply noise from sampling error. A larger sample size will be necessary to further explore the relationships between the species assemblages of these different habitat types. The lack of significant clustering prevents this analysis from being used as a way to group the ecological site types together for a stratified sampling protocol.

The dissimilarity matrix that compared the species assemblage recorded during each year of trapping showed 2004 and 2016 as having the most similar records of observed species. These years also had the highest trapping effort, indicating that increasing trapping effort improves the likelihood of documenting all species present.

Habitat Preferences

It is important to understand the limitations of the data used to analyze the habitat preferences for the three target species in this study. Even though the three species were chosen because they had the top three CPUEs of all the reptile species recorded during the study period, they still had fairly small sample sizes for a 12 year study. *Aspidoscelis sexlineata* had the most captures at 218, followed by *P. obsoletus* at 124 and *A. gularis* at 37. The habitat data that the CPUE was compared to was also limited, as described above. Even if larger sample sizes and better habitat descriptions had been available, this study would still not be sufficient to infer true habitat preferences because of insufficient study design. The trapping sites chosen were not selected with a random or stratified random protocol and do not sample the ecological site or vegetation description classes in proportion to their presence on the property. Thus, the fact that a certain species was found more often on a certain ecological site type could be due to a larger sampling effort on that type, and not an indication that that species statistically prefers that habitat type more than others.

Given these limitations, it is perhaps better to refer to these findings as indications of habitat affinity, not true habitat preference. Our findings that *A. sexlineata* showed an affinity for sandy habitats is in line with the habitat description found in Powell et al. (2016). Powell et al. (2016) lists a wide variety of potential habitat types for this species, including: "open areas with sand or loose soil," "fields," and "grasslands." The top ecological site type for *A. gularis*, "gravelly," is not a habitat description commonly used in associated with this species, however the vegetation descriptions of tight soil shortgrasses and various stages of juniper growth is in line with the Powell et al. (2016) habitat description for the species. The Powell et al. (2016) field guide includes "prairie grasslands," "grasslands reverting to brush'" and "rocky hillsides" among the potential habitat types of *A. gularis*. The apparently high affinity showed for the Sisk site in 2016 (1.00 CPUE) contradicts published habitat preferences for *A. gularis*. The Sisk site is primarily open, dry clay/gravel soil with sparcely distributed shortgrass clumps and even sparcer juniper shrubs. This is in contrast to the findings of Schall (1977) who found *A. gularis* to have a preference for moist areas with dense vegetation, particularly grass. The records for *P. obsoletus* did not show clear habitat affinities, although it is worth noting that they were recorded at hilly, gravelly sites dominated by juniper, which seems to contradict the habitat description in Powell et al. (2016) of "grasslands, often along watercourses in drier areas." The findings of this study match the habitat descriptions of Fitch (1958), which includes grasslands as well as more rugged terrain and woodland areas.

Habitat Change Correlations

There does not appear to be any correlation between habitat management and CPUE in this dataset for *A. gularis* or *P. obsoletus*. The records for *A. gularis* are too few to make any inferences from. *Plestiodon obsoletus* decreased across the study area, which could conceivably be a response to the habitat management activities. However, the fact that *P. obsoletus* is often characterized as a grassland species makes it doubtful that habitat management activities meant to restore grassland would harm it. Even direct impacts such as mortality from fire or herbicides seem unlikely for this secretive species that tends to be closely associated with some type of cover (rocks, burrows, etc., Fitch 1958). It is possible that some other factor, such as disease or loss of food sources, could be impacting the population. This decline is worthy of future study.

The records for *A. sexlineata* suggest that habitat management activities meant to restore grassland may benefit this species, with 7/12 areas with habitat management showing an increase in CPUE. However, an increase in just over half of the managed areas is not substantial, and there were not enough unmanaged areas sampled to provide a meaningful baseline. Further monitoring should sample more areas without habitat management activities to provide a baseline of what the populations would be doing in the absence of habitat improvements.

Recommendations

Analysis of the current monitoring data has led to the development of four primary recommendations: 1) increase the length and consistency of sampling periods; 2) create a stratified sampling protocol; 3) improve the construction of the drift fences and install funnel traps; and 4) incorporate time-constrained searches into the monitoring program.

One of the biggest obstacles preventing these data from being used to infer habitat preferences or population trends was the limited sample sizes resulting from inconsistent sampling (4 out of 12 years) and short sampling periods (8-14 days a year for 3 of the 4 years). The limited effort spent on the monitoring program was primarily due to a lack of available resources. Each day that the traps are open a TPWD staff member has to check the traps, which involves driving a route over 30 miles long and takes at least 7 hours. To accumulate sufficiently large datasets to enable meaningful analyses, TPWD would need to essentially devote a staff member to the herp monitoring program during the entire sampling period each year. This is not feasible for either of the 2 biologists or 2 technicians employed there, as there are many other WMA projects that need their attention. That leaves it to the summer intern each year to collect the monitoring data. As such, TPWD must be able to: 1) secure funding for a summer intern each year; and 2) be willing to assign that intern to the herp monitoring program for a significant portion of the summer. A previous study in the Rolling Plains found that 85% of the species present on a property were detected during the first 5 weeks of trapping (Mceachern 2008). During the 2016 sampling period for this study, 85% of the known species on the Matador were detected during the 2 week sampling period (including fortuitous encounters). However, many of those species had only a few observations, which does not provide meaningful habitat association or population trend data. We recommend that the Matador staff sample for at least 2-5 weeks every summer to ensure that most species present are recorded, with longer sampling periods preferred to allow for statistically significant sample sizes to be collected.

The next recommendation is to create a stratified sampling protocol with replication. A stratified sampling protocol insures that all of the significant habitat types present are sampled roughly proportional to their occurrence on the study area (Fisher et al. 2012). Replication ensures that large enough sample sizes are collected for statistically significant inferences to be made (Hayek, in Fisher et al. 2012). Designing a stratified sampling protocol with replication is not a simple task, especially when resource constraints have to be taken into account. The Craters of the Moon National Monument case study in Fisher et al. (2012) provides a good blueprint for designing such a study.

The construction of the drift fences can be improved in two ways. First, adding snake funnels to the traps will increase their ability to sample large snakes, which they are currently missing (Fitzgerald 2012). Second, adding cover boards over the traps instead of inside the traps will give better protection from the weather to trapped animals and may increase capture success by attracting animals seeking shelter under the cover boards (Fitzgerald 2012).

The final recommendation is to incorporate time-constrained searches into the monitoring protocol. The large number of species that were recorded in 2016 through fortuitous encounters demonstrates that sampling methods other than drift fences can provide valuable information. Keeping track of effort spent (hours searching) allows for a standardized CPUE to be calculated for each year and thus population trends to be monitored. Time-constrained searches can be carried out through road cruising and hiking. Road cruising is likely the easiest and most productive method for most of the year. Road cruising routes have already been established on the Matador for monitoring *P. cornutum*, *T. ornata*, *C. atrox*, and *S. tergeminus* populations; however, there currently does not appear to be a formal time-constrained protocol in place for regularly monitoring these routes and most data collected on these species are based on fortuitous encounters. Regularly monitoring these routes and calculating CPUE will allow for a more accurate record of the population trends of these species and others that may be recorded. It is also worth mentioning that during March 2017 a short search of the Matador revealed the location of a cluster of *C. atrox* hibernacula, with the occupants sunning themselves outside their dens. Monitoring the emergence of the rattlesnakes from the hibernacula at this location each spring with time-constrained searches could be a good way to track the population trends of this species (Reed et al., in Lovich 2012).

Conclusion

Herpetofaunal monitoring at the Matador over the past 12 years has provided good preliminary information on the herpetofaunal community as well as ecological insights for several of the more common species. Unfortunately, small sample sizes, limited replication, and inconsistent sampling periods limit the applicability of these data for assessing habitat preferences and population trends. However, this can serve as a pilot study to develop a more comprehensive monitoring strategy at the Matador. By following the recommendations presented above, TPWD can collect valuable information regarding habitat preferences and population trends to help inform future management decisions.

REFERENCES

Böhm, M., B. Collen, J.E. Baillie, P. Bowles, J. Chanson, N. Cox, ... and A.G. Rhodin. 2013. The conservation status of the world's reptiles. Biological Conservation 157:372-385.

Cross, C.L., N. Ananjeva, N.L. Orlov, and A.W. Salas. 2012. Parametric analysis of reptile biodiversity data. Pp.273-282. In R.W. McDiarmid, M. S. Foster, C. Guyer, J. W. Gibbons, and N. Chernoff (eds.), Measuring and Monitoring Biological Diversity: Standard Methods for Reptiles. University of California Press, Berkeley, California.

Fisher, R.N. and M.S. Foster. 2012. Study design and sampling. Pp.27-50. In R.W. McDiarmid, M. S. Foster, C. Guyer, J. W. Gibbons, and N. Chernoff (eds.), Measuring and Monitoring Biological Diversity: Standard Methods for Reptiles. University of California Press, Berkeley, California.

Dixon, J. R. 2013. Amphibians and reptiles of Texas: with keys, taxonomic synopses, bibliography, and distribution maps. Third edition. Texas A & M University Press, College Station.,Texas.

Fitch, H. S. 1958. Habits and Adaptations of the Great Plains Skink (Eumeces obsoletus). Ecological Monographs 25(1): 59-83

Fitzgerald, L.A. 2012. Finding and capturing reptiles. Pp.77-88. In R.W. McDiarmid, M. S. Foster, C. Guyer, J. W. Gibbons, and N. Chernoff (eds.), Measuring and Monitoring Biological Diversity: Standard Methods for Reptiles. University of California Press, Berkeley, California.

Gardner, T.A., J. Barlow, C.A. Peres. 2007. Paradox, presumption and pitfalls in conservation biology: The importance of habitat change for amphibians and reptiles. Biological Conservation 138:166-179

Gibbons, J.W., D.E. Scott, T.J. Ryan, K.A. Buhlmann, T.D. Tuberville, B. Metts, J.L. Greene, T.M. Mills, Y.A. Leiden, S.M. Poppy, and C.T. Winne. 2000. The global decline of reptiles, deja vu amphibians. Biology and Science 50:653-66

Laurencio, D. and L. A. Fitzgerald. 2010. Environmental correlates of herpetofaunal diversity in Costa Rica. Journal of Tropical Ecology. 26: 251-531

Mceachern, W.D. 2008. Herpetofaunal community study in the Rolling Plains of Texas. Thesis. Angelo State University, San Angelo, Texas, USA.

Powell, R., R. Conant, and J. T. Collins. 2016. A field guide to reptiles and amphibians: eastern and central North America. 4Th edition. Houghton Mifflin Harcourt, Boston and New York.

QGIS Development Team. 2016. QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://www.qgis.org/

Lovich, R.E. 2012. Techniques for reptiles in difficult-to-sample habitats Pp.167-196. In R.W. McDiarmid, M. S. Foster, C. Guyer, J. W. Gibbons, and N. Chernoff (eds.), Measuring and Monitoring Biological Diversity: Standard Methods for Reptiles. University of California Press, Berkeley, California.

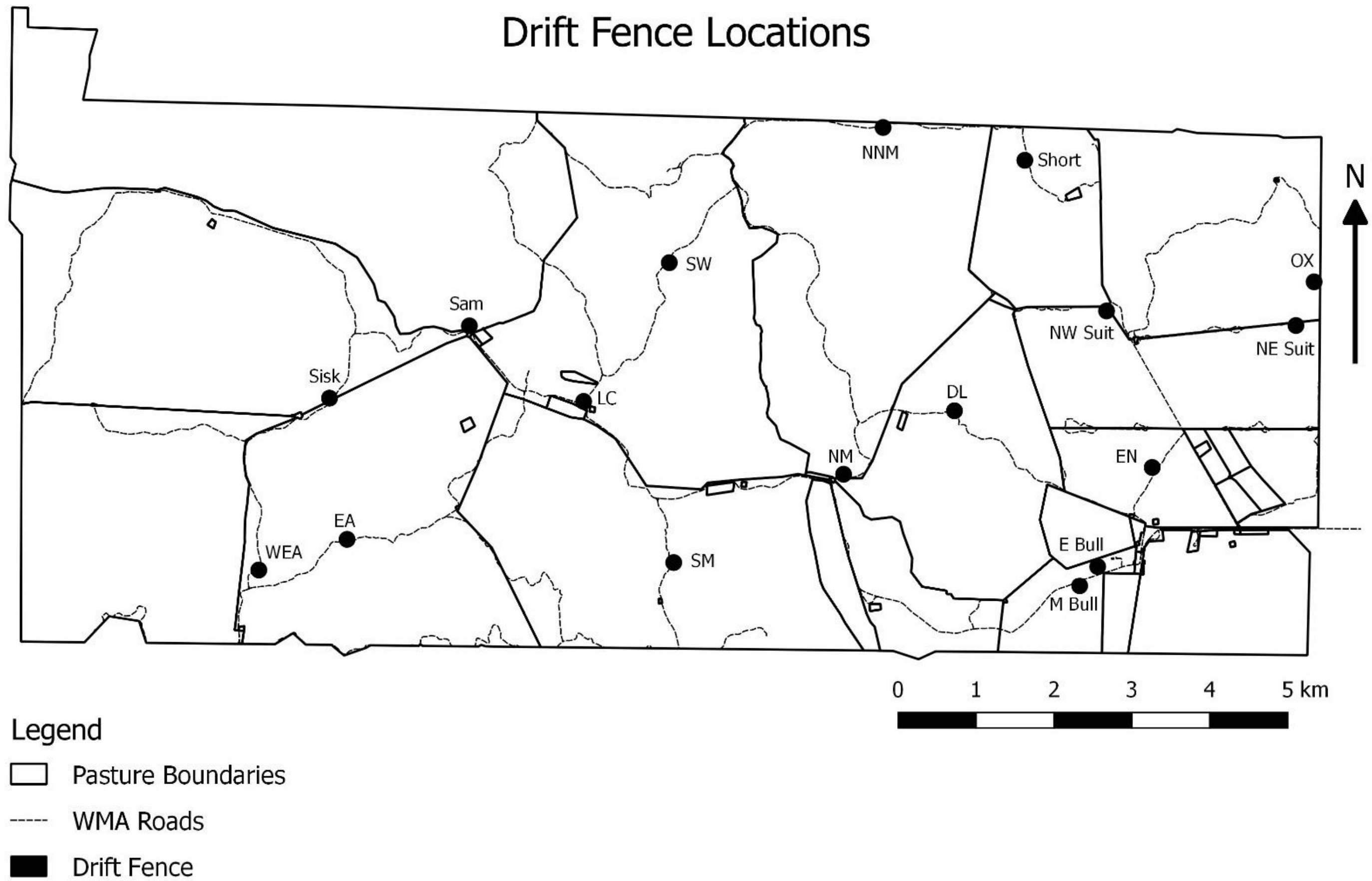
Schall, J. J. 1977. Thermal Ecology of Five Sympatric Species of Cnemidophorus (Sauria: Teiidae). Herpetologica 33(3): 261-272

United States Department of Agriculture Natural Resources Conservation Service [USDA NRCS]. 2012. Ecological Site Description. https://esis.sc.egov.usda.gov/About.aspx Accessed March 2017

APPENDIX A

FENCE	DATE/TIME OPENED	DATE/TIME CLOSED	DAYS OPEN		FENCE	DATE/TIME OPENED	DATE/TIME CLOSED	DAYS OPEN
S Bull	6/3/2004	8/2/2004	60		E Bull	7/14/2014	7/28/2014	14
SM	6/7/2004	7/15/2004	38		S Bull	7/14/2014	7/28/2014	14
EA	6/17/2004	7/15/2004	28		DL	7/14/2014	7/28/2014	14
WEA	6/17/2004	7/15/2004	28		EA	7/14/2014	7/28/2014	14
Sam	6/8/2004	7/15/2004	37		EN	7/14/2014	7/28/2014	14
LC	6/8/2004	7/15/2004	36		LC	7/14/2014	7/28/2014	14
NM	6/3/2004	8/2/2004	60		NM	7/14/2014	7/28/2014	14
DL	6/3/2004	8/2/2004	60		OX	7/14/2014	7/28/2014	14
NW Suit	6/7/2004	7/21/2004	44		SM	7/14/2014	7/28/2014	14
OX	6/8/2004	7/21/2004	43		NW Suit	7/14/2014	7/28/2014	14
NE Suit	6/7/2004	7/21/2004	44					
EN	6/7/2004	7/21/2004	44		SM	6/16/2016	6/30/2016	14
M Bull	6/3/2004	8/2/2004	59		EA	6/16/2016	6/30/2016	14
E Bull	6/2/2004	8/2/2004	61		WEA	6/16/2016	6/30/2016	14
					Sam	6/16/2016	6/30/2016	14
E Bull	7/24/2013	8/2/2013	9		LC	6/16/2016	6/30/2016	14
S Bull	7/24/2013	8/2/2013	9		NM	6/16/2016	6/30/2016	14
DL	7/24/2013	8/2/2013	9		DL	6/16/2016	6/30/2016	14
EN	7/24/2013	8/2/2013	9		NW Suit	6/16/2016	6/30/2016	14
LC	7/24/2013	8/2/2013	9		OX	6/16/2016	6/30/2016	14
NM	7/24/2013	8/2/2013	9		NE Suit	6/16/2016	6/30/2016	14
OX	7/24/2013	8/2/2013	9		EN	6/16/2016	6/30/2016	14
SM	7/24/2013	8/2/2013	9		M Bull	6/16/2016	6/30/2016	14
NE Suit	7/24/2013	8/2/2013	9		E Bull	6/16/2016	6/30/2016	14
NW Suit	7/24/2013	8/2/2013	9		NNM	6/21/2016	6/30/2016	9
					SW	6/21/2016	6/30/2016	9
					Short	6/21/2016	6/30/2016	9
					Sisk	6/21/2016	6/30/2016	9

APPENDIX B


Drift Fence Locations
NNM
Short
SW
OX
Sam
NW Suit
NE Suit
Sisk
LC
DL
NM
EN
EA
WEA
SM
E Bull
M Bull
N
0
1
2
3
4
5 km
Legend
Pasture Boundaries
WMA Roads
Drift Fence

APPENDIX C

Cottle County Records	Drift Fence Captures- # of records	Fortuitous Encounters- # of records	Total recorded at Matador
Ambystoma mavortium	Ambystoma mavortium- 14	Coluber flagellum testaceus- 2	Ambystoma mavortium
Scaphiopus couchii	Scaphiopus couchii- 16	Anaxyrus debilis- 1	Scaphiopus couchii
Spea bombifrons	Spea bombifrons- 7	Aspidoscelis spp.- 8	Spea bombifrons
Acris blanchardi	Anaxyrus debilis- 110	Phrynosoma cornutum- 55	Anaxyrus debilis
Anaxyrus cognatus	Anaxyrus punctatus- 25	Crotalus atrox- 8	Anaxyrus punctatus
Anaxyrus debilis	Anaxyrus speciosus- 11	**Heterodon platirhinos- 6**	Anaxyrus speciosus
Anaxyrus punctatus	Anaxyrus woodhousii- 5	Anaxyrus woodhousii- 1	Anaxyrus woodhousii
Anaxyrus speciosus	Lithobates blairi- 9	Heterodon nasicus- 3	Lithobates blairi
Anaxyrus woodhousii	Gastrophryne olivacea- 124	Crotaphytus collaris- 1	Gastrophryne olivacea
Lithobates blairi	Phrynosoma cornutum- 6	Thamnophis marcianus- 1	Phrynosoma cornutum
Lithobates catesbeianus	Sceloporus consobrinus- 35	Sistrus tergeminus- 2	Sceloporus consobrinus
Gastrophryne olivacea	Plestiodon obsoletus- 124	Trachemys scripta- 1	Plestiodon obsoletus
Kinosternon flavescens	Scincella lateralis- 1	Terrapene ornata- 4	Scincella lateralis-
Terrapene ornata	Aspidoscelis gularis- 37	Kinosternon flavescens- 1	Aspidoscelis gularis
Trachemys scripta	Aspidoscelis sexlineata- 218	Lampropeltis getula- 1	Aspidoscelis sexlineata
Apalone spinifera	Rena dulcis- 27	Pituophis catenifer- 1	Rena dulcis
Crotaphytus collaris	Arizona elegans- 5	Total species = 16	Arizona elegans
Cophosaurus texanus	Hypsiglena jani- 4		Hypsiglena jani
Holbrookia maculata	Lampropeltis getula- 2		Lampropeltis getula
Phrynosoma cornutum	Rhinocheilus lecontei- 2		Rhinocheilus lecontei
Sceloporus consobrinus	Sonora semiannulata- 1		Sonora semiannulata
Plestiodon obsoletus	Tantilla nigriceps- 10		Tantilla nigriceps
Scincella lateralis	**Tantilla gracillis- 4**		**Tantilla gracillis**
Aspidoscelis gularis	Total species = 23		Coluber flagellum testaceus
Aspidoscelis sexlineata			Crotalus atrox
Rena dulcis			**Heterodon platirhinos**
Arizona elegans			Heterodon nasicus
Coluber constrictor			Crotaphytus collaris
Diadophis punctatus			Thamnophis marcianus
Pantherophis emoryi			Sistrus tergeminus
Heterodon nasicus			Trachemys scripta
Hypsiglena jani			Terrapene ornata
Lampropeltis getula			Kinosternon flavescens
Coluber flagellum			Pituophis catenifer
Nerodia erythrogaster			Total species = 34
Pituophis catenifer			
Rhinocheilus lecontei	(shaded cell)	= Potential County Record	
Sonora semiannulata			
Tantilla nigriceps			
Thamnophis marcianus			
Crotalus atrox			
Crotalus viridis			
Sistrurus catenatus			
Total= 43			

APPENDIX D

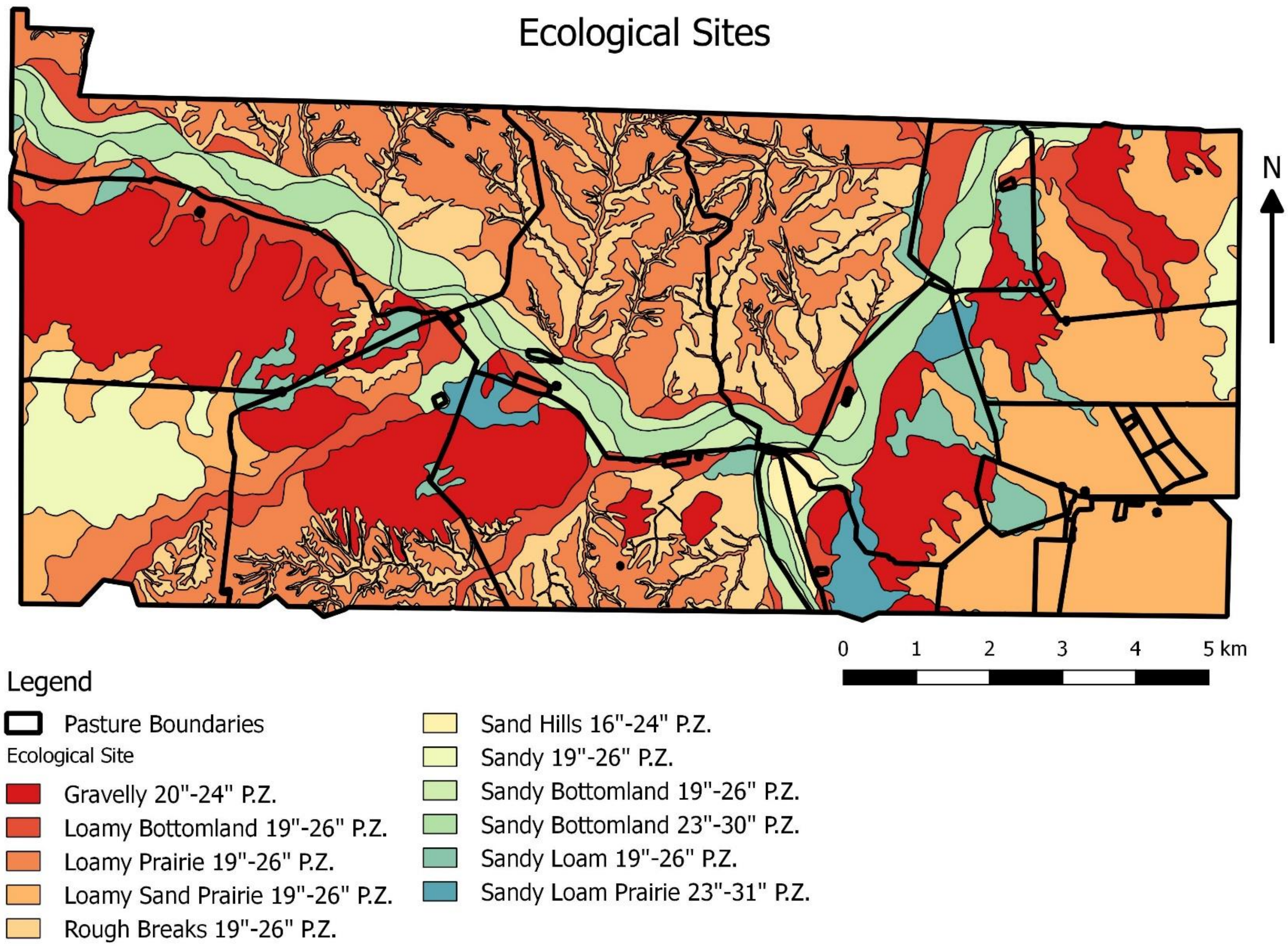
Drift Fence	Year	Raw Data by Species											
		Rena dulcis	Lithobates blairi	Rhinocheilus lecontei	Scaphiopus couchii	Sceloporus consobrinus	Spea bombifrons	Tantilla gracilis	Tantilla nigriceps	Phrynosoma cornutum	Sonora semiannulata	Lampropeltis splendida	Scinella lateralis
South Bull	2004	0	0	0	0	0	0	0	0	0	0	0	0
South Bull	2013	2	0	0	0	0	0	0	0	0	0	0	0
South Bull	2014	1	0	0	0	3	0	0	1	0	0	0	0
South Middle	2004	4	1	0	0	2	1	0	0	0	0	0	0
South Middle	2013	0	0	0	0	0	0	0	0	0	0	0	0
South Middle	2014	0	0	0	0	0	0	0	0	0	0	0	0
South Middle	2016	0	2	0	0	1	0	1	0	0	0	0	0
East Aermotor	2004	2	0	0	0	1	0	0	0	0	0	0	0
E aermotor	2014	0	0	0	1	0	0	0	0	0	0	0	0
East Aermotor	2016	2	0	0	0	1	0	0	0	0	0	0	0
W East Aermotor	2004	2	0	0	0	0	0	0	0	0	0	0	0
W East Aermotor	2016	0	0	0	0	1	0	0	0	1	0	0	0
Samson	2004	0	1	0	0	0	0	0	0	0	0	0	0
Samson	2016	0	0	0	1	0	0	1	0	1	0	0	1
Lone Canyon	2004	0	1	0	0	0	0	1	0	0	0	0	0
Lone Canyon	2013	0	0	0	0	2	0	0	0	0	0	0	0
Lone Canyon	2014	0	0	0	0	0	0	0	0	0	0	0	0
Lone Canyon	2016	0	1	1	0	0	0	1	0	1	0	1	0
North Middle	2004	0	1	0	0	3	0	0	1	0	0	0	0
North Middle	2013	0	0	0	0	2	0	0	0	0	0	0	0
North Middle	2014	0	0	0	0	0	0	0	0	0	0	0	0
North Middle	2016	0	0	0	0	0	0	0	1	0	0	0	0
Dogleg	2004	2	0	1	1	1	0	0	0	0	0	0	0
Dogleg	2013	0	0	0	0	0	0	0	0	0	0	0	0
Dogleg	2014	0	0	0	3	0	0	0	0	0	0	0	0
Dogleg	2016	2	0	0	0	0	0	0	0	0	0	0	0
NW Suitcase	2004	1	2	0	0	2	0	0	1	0	0	0	0
NW Suitcase	2013	1	0	0	0	0	0	0	0	0	0	0	0
NW Suitcase	2014	1	0	0	1	0	0	0	0	0	0	0	0
NW Suitcase	2016	1	0	0	0	0	0	0	0	0	0	0	0
OX	2004	0	0	0	0	2	0	0	0	2	0	0	0
OX	2013	0	0	0	0	0	0	0	0	0	0	0	0
OX	2014	0	0	0	0	3	0	0	0	0	0	0	0
OX	2016	0	0	0	0	0	0	0	0	0	0	0	0
NE Suitcase	2004	0	0	0	0	1	1	0	0	0	0	0	0
NE Suitcase	2013	0	0	0	0	0	0	0	0	0	0	0	0
NE Suitcase	2016	0	0	0	1	0	0	0	0	1	0	0	0
Entrance	2004	0	0	0	0	3	0	0	1	0	0	0	0
Entrance	2013	0	0	0	0	1	0	0	0	0	0	0	0
Entrance	2014	0	0	0	2	0	0	0	0	0	0	0	0
Entrance	2016	2	0	0	0	0	0	0	1	0	0	0	0
Middle Bull	2004	1	0	0	0	1	1	0	1	0	0	0	0
Middle Bull	2016	0	0	0	0	1	0	0	0	0	0	0	0
East Bull	2004	1	0	0	0	4	4	0	2	0	1	0	0
East Bull	2013	0	0	0	0	0	0	0	0	0	0	0	0
East Bull	2014	1	0	0	4	0	0	0	0	0	0	0	0
East Bull	2016	0	0	0	0	0	0	0	0	0	0	0	0

		CPUE by Species											
Drift Fence	Year	Rena dulcis	Lithobates blairi	Rhinocheilus lecontei	Scaphiopus couchii	Sceloporus consobrinus	Spea bombifrons	Tantilla gracilis	Tantilla nigriceps	Phrynosoma cornutum	Sonora semiannulata	Lampropeltis splendida	Scinella lateralis
South Bull	2004	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
South Bull	2013	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
South Bull	2014	0.07	0.00	0.00	0.00	0.21	0.00	0.00	0.07	0.00	0.00	0.00	0.00
South Middle	2004	0.11	0.03	0.00	0.00	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.00
South Middle	2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
South Middle	2014	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
South Middle	2016	0.00	0.14	0.00	0.00	0.07	0.00	0.07	0.00	0.00	0.00	0.00	0.00
East Aermotor	2004	0.07	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
East Aermotor	2014	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
East Aermotor	2016	0.14	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
W East Aermotor	2004	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
W East Aermotor	2016	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.07	0.00	0.00	0.00
Samson	2004	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Samson	2016	0.00	0.00	0.00	0.07	0.00	0.00	0.07	0.00	0.07	0.00	0.00	0.07
Lone Canyon	2004	0.00	0.03	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Lone Canyon	2013	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lone Canyon	2014	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lone Canyon	2016	0.00	0.07	0.07	0.00	0.00	0.00	0.07	0.00	0.07	0.00	0.07	0.00
North Middle	2004	0.00	0.02	0.00	0.00	0.05	0.00	0.00	0.02	0.00	0.00	0.00	0.00
North Middle	2013	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North Middle	2014	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North Middle	2016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00
Dogleg	2004	0.03	0.00	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dogleg	2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dogleg	2014	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dogleg	2016	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NW Suitcase	2004	0.02	0.05	0.00	0.00	0.05	0.00	0.00	0.02	0.00	0.00	0.00	0.00
NW Suitcase	2013	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NW Suitcase	2014	0.07	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NW Suitcase	2016	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OX	2004	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.05	0.00	0.00	0.00
OX	2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OX	2014	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OX	2016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NE Suitcase	2004	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00
NE Suitcase	2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NE Suitcase	2016	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00
Entrance	2004	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.02	0.00	0.00	0.00	0.00
Entrance	2013	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Entrance	2014	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Entrance	2016	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00
Middle Bull	2004	0.02	0.00	0.00	0.00	0.02	0.02	0.00	0.02	0.00	0.00	0.00	0.00
Middle Bull	2016	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00
East Bull	2004	0.02	0.00	0.00	0.00	0.07	0.07	0.00	0.03	0.00	0.02	0.00	0.00
East Bull	2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
East Bull	2014	0.07	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
East Bull	2016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

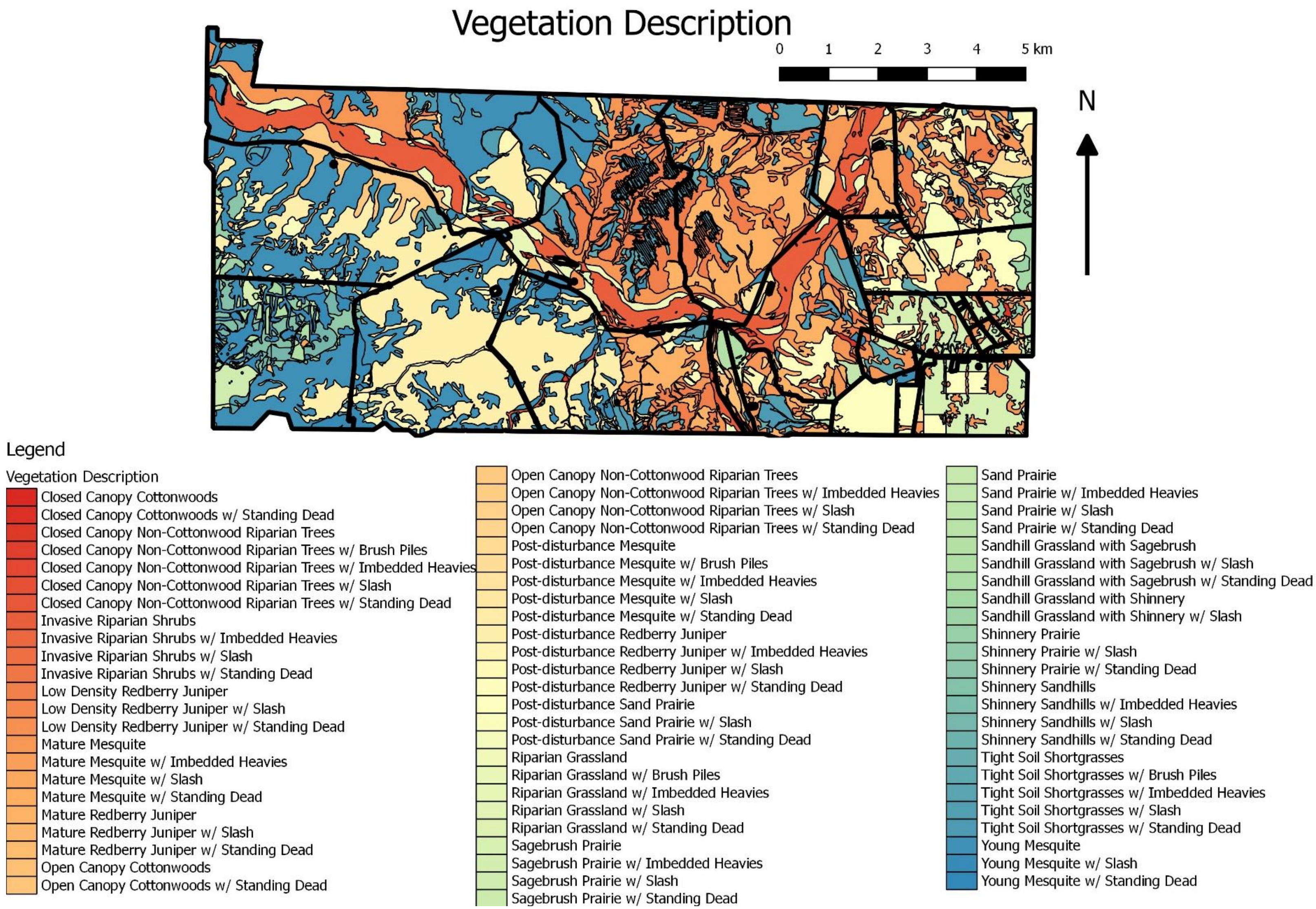
		Raw Data by Species										
Drift Fence	Year	Arizona elegans	Anaxyrus debilis	Anaxyrus punctatus	Anaxyrus spp.	Anaxyrus speciosus	Anaxyrus woodhousii	Aspidoscelis gularis	Aspidoscelis sexlineatus	Plestiodon obsoletus	Gastrophryne olivacea	Hypsiglena jani
South Bull	2004	0	2	0	0	0	0	0	1	8	6	1
South Bull	2013	0	0	0	0	0	0	0	0	1	0	0
South Bull	2014	0	3	0	0	1	0	0	4	0	3	0
South Middle	2004	0	1	3	3	0	0	2	10	13	0	1
South Middle	2013	0	0	0	1	0	0	2	4	1	0	0
South Middle	2014	0	15	0	33	4	0	1	4	0	7	0
South Middle	2016	0	1	0	0	0	0	4	4	0	1	0
East Aermotor	2004	0	0	1	1	0	0	1	4	1	0	0
E aermotor	2014	0	0	0	1	2	0	2	1	1	1	0
East Aermotor	2016	0	0	0	0	0	0	3	1	1	0	0
W East Aermotor	2004	0	0	0	0	0	0	0	2	11	0	0
W East Aermotor	2016	0	3	0	0	0	1	0	1	0	1	0
Samson	2004	0	1	2	1	0	0	0	3	6	0	0
Samson	2016	1	0	0	0	1	1	0	4	2	0	0
Lone Canyon	2004	1	1	2	1	0	0	0	7	4	2	0
Lone Canyon	2013	0	0	0	8	0	0	0	1	1	0	0
Lone Canyon	2014	0	5	0	1	0	0	0	2	1	5	0
Lone Canyon	2016	0	1	0	0	0	0	0	9	1	2	0
North Middle	2004	0	0	0	0	0	0	0	13	11	1	0
North Middle	2013	0	0	0	12	0	0	0	0	1	0	0
North Middle	2014	0	12	0	79	0	0	1	9	1	7	0
North Middle	2016	1	0	0	0	0	0	0	8	0	1	0
Dogleg	2004	0	0	5	4	0	1	1	3	8	1	0
Dogleg	2013	0	0	0	1	0	0	2	0	0	0	0
Dogleg	2014	0	12	0	7	0	0	0	4	4	4	0
Dogleg	2016	0	11	0	0	0	0	2	8	1	2	0
NW Suitcase	2004	0	1	4	2	0	0	0	1	5	0	0
NW Suitcase	2013	0	0	0	0	0	0	0	1	1	0	0
NW Suitcase	2014	0	10	0	0	1	0	1	2	1	3	0
NW Suitcase	2016	0	3	0	0	0	0	0	3	0	3	0
OX	2004	0	0	5		0	0	0	25	1	0	0
OX	2013	0	0	0	1	0	0	0	3	3	0	0
OX	2014	0	6	0	2	0	1	0	4	0	0	0
OX	2016	0	0	0	0	0	0	0	6	1	0	0
NE Suitcase	2004	0	0	2	0	0	0	0	26	3	0	0
NE Suitcase	2013	0	0	0	0	0	0	1	3	1	0	0
NE Suitcase	2016	0	1	0	0	0	0	0	0	2	0	0
Entrance	2004	0	0	0	0	0	0	0	0	3	0	0
Entrance	2013	0	0	0	0	0	0	0	0	1	0	0
Entrance	2014	0	3	0	1	0	0	0	1	1	0	0
Entrance	2016	1	0	0	0	0	0	0	1	0	0	0
Middle Bull	2004	0	3	0	0	0	0	0	6	8	3	0
Middle Bull	2016	0	4	0	0	0	0	0	10	0	2	0
East Bull	2004	0	3	1	0	0	0	0	3	11	0	1
East Bull	2013	0	0	0	0	0	0	1	2	4	0	0
East Bull	2014	0	7	0	1	2	0	0	10	0	3	0
East Bull	2016	0	1	0	0	0	0	1	4	0	0	0

		CPUE by Species										
Drift Fence	Year	Arizona elegans	Anaxyrus debilis	Anaxyrus punctatus	Anaxyrus spp.	Anaxyrus speciosus	Anaxyrus woodhousii	Aspidoscelis gularis	Aspidoscelis sexlineatus	Plestiodon obsoletus	Gastrophryne olivacea	Hypsiglena jani
South Bull	2004	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.02	0.13	0.10	0.02
South Bull	2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00
South Bull	2014	0.00	0.21	0.00	0.00	0.07	0.00	0.00	0.29	0.00	0.21	0.00
South Middle	2004	0.00	0.03	0.08	0.08	0.00	0.00	0.05	0.26	0.34	0.00	0.03
South Middle	2013	0.00	0.00	0.00	0.11	0.00	0.00	0.22	0.44	0.11	0.00	0.00
South Middle	2014	0.00	1.07	0.00	2.36	0.29	0.00	0.07	0.29	0.00	0.50	0.00
South Middle	2016	0.00	0.07	0.00	0.00	0.00	0.00	0.29	0.29	0.00	0.07	0.00
East Aermotor	2004	0.00	0.00	0.04	0.04	0.00	0.00	0.04	0.14	0.04	0.00	0.00
East Aermotor	2014	0.00	0.00	0.00	0.07	0.14	0.00	0.14	0.07	0.07	0.07	0.00
East Aermotor	2016	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.07	0.07	0.00	0.00
W East Aermotor	2004	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.39	0.00	0.00
W East Aermotor	2016	0.00	0.21	0.00	0.00	0.00	0.07	0.00	0.07	0.00	0.07	0.00
Samson	2004	0.00	0.03	0.05	0.03	0.00	0.00	0.00	0.08	0.16	0.00	0.00
Samson	2016	0.07	0.00	0.00	0.00	0.07	0.07	0.00	0.29	0.14	0.00	0.00
Lone Canyon	2004	0.03	0.03	0.06	0.03	0.00	0.00	0.00	0.19	0.11	0.06	0.00
Lone Canyon	2013	0.00	0.00	0.00	0.89	0.00	0.00	0.00	0.11	0.11	0.00	0.00
Lone Canyon	2014	0.00	0.36	0.00	0.07	0.00	0.00	0.00	0.14	0.07	0.36	0.00
Lone Canyon	2016	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.64	0.07	0.14	0.00
North Middle	2004	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.18	0.02	0.00
North Middle	2013	0.00	0.00	0.00	1.33	0.00	0.00	0.00	0.00	0.11	0.00	0.00
North Middle	2014	0.00	0.86	0.00	5.64	0.00	0.00	0.07	0.64	0.07	0.50	0.00
North Middle	2016	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.00	0.07	0.00
Dogleg	2004	0.00	0.00	0.08	0.07	0.00	0.02	0.02	0.05	0.13	0.02	0.00
Dogleg	2013	0.00	0.00	0.00	0.11	0.00	0.00	0.22	0.00	0.00	0.00	0.00
Dogleg	2014	0.00	0.86	0.00	0.50	0.00	0.00	0.00	0.29	0.29	0.29	0.00
Dogleg	2016	0.00	0.79	0.00	0.00	0.00	0.00	0.14	0.57	0.07	0.14	0.00
NW Suitcase	2004	0.00	0.02	0.09	0.05	0.00	0.00	0.00	0.02	0.11	0.00	0.00
NW Suitcase	2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.11	0.00	0.00
NW Suitcase	2014	0.00	0.71	0.00	0.00	0.07	0.00	0.07	0.14	0.07	0.21	0.00
NW Suitcase	2016	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.21	0.00
OX	2004	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.58	0.02	0.00	0.00
OX	2013	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.33	0.33	0.00	0.00
OX	2014	0.00	0.43	0.00	0.14	0.00	0.07	0.00	0.29	0.00	0.00	0.00
OX	2016	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.07	0.00	0.00
NE Suitcase	2004	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.59	0.07	0.00	0.00
NE Suitcase	2013	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.33	0.11	0.00	0.00
NE Suitcase	2016	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00
Entrance	2004	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00
Entrance	2013	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00
Entrance	2014	0.00	0.21	0.00	0.07	0.00	0.00	0.00	0.07	0.07	0.00	0.00
Entrance	2016	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00
Middle Bull	2004	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.10	0.14	0.05	0.00
Middle Bull	2016	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.71	0.00	0.14	0.00
East Bull	2004	0.00	0.05	0.02	0.00	0.00	0.00	0.00	0.05	0.18	0.00	0.02
East Bull	2013	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.22	0.44	0.00	0.00
East Bull	2014	0.00	0.50	0.00	0.07	0.14	0.00	0.00	0.71	0.00	0.21	0.00
East Bull	2016	0.00	0.07	0.00	0.00	0.00	0.00	0.07	0.29	0.00	0.00	0.00

APPENDIX E


Ecological Sites
N
0
1
2
3
4
5 km
Legend
Pasture Boundaries
Ecological Site
Gravelly 20"-24" P.Z.
Loamy Bottomland 19"-26" P.Z.
Loamy Prairie 19"-26" P.Z.
Loamy Sand Prairie 19"-26" P.Z.
Rough Breaks 19"-26" P.Z.
Sand Hills 16"-24" P.Z.
Sandy 19"-26" P.Z.
Sandy Bottomland 19"-26" P.Z.
Sandy Bottomland 23"-30" P.Z.
Sandy Loam 19"-26" P.Z.
Sandy Loam Prairie 23"-31" P.Z.

APPENDIX F


Vegetation Description
0 1 2 3 4 5 km
N
Legend
Vegetation Description
Closed Canopy Cottonwoods
Closed Canopy Cottonwoods w/ Standing Dead
Closed Canopy Non-Cottonwood Riparian Trees
Closed Canopy Non-Cottonwood Riparian Trees w/ Brush Piles
Closed Canopy Non-Cottonwood Riparian Trees w/ Imbedded Heavies
Closed Canopy Non-Cottonwood Riparian Trees w/ Slash
Closed Canopy Non-Cottonwood Riparian Trees w/ Standing Dead
Invasive Riparian Shrubs
Invasive Riparian Shrubs w/ Imbedded Heavies
Invasive Riparian Shrubs w/ Slash
Invasive Riparian Shrubs w/ Standing Dead
Low Density Redberry Juniper
Low Density Redberry Juniper w/ Slash
Low Density Redberry Juniper w/ Standing Dead
Mature Mesquite
Mature Mesquite w/ Imbedded Heavies
Mature Mesquite w/ Slash
Mature Mesquite w/ Standing Dead
Mature Redberry Juniper
Mature Redberry Juniper w/ Slash
Mature Redberry Juniper w/ Standing Dead
Open Canopy Cottonwoods
Open Canopy Cottonwoods w/ Standing Dead
Open Canopy Non-Cottonwood Riparian Trees
Open Canopy Non-Cottonwood Riparian Trees w/ Imbedded Heavies
Open Canopy Non-Cottonwood Riparian Trees w/ Slash
Open Canopy Non-Cottonwood Riparian Trees w/ Standing Dead
Post-disturbance Mesquite
Post-disturbance Mesquite w/ Brush Piles
Post-disturbance Mesquite w/ Imbedded Heavies
Post-disturbance Mesquite w/ Slash
Post-disturbance Mesquite w/ Standing Dead
Post-disturbance Redberry Juniper
Post-disturbance Redberry Juniper w/ Imbedded Heavies
Post-disturbance Redberry Juniper w/ Slash
Post-disturbance Redberry Juniper w/ Standing Dead
Post-disturbance Sand Prairie
Post-disturbance Sand Prairie w/ Slash
Post-disturbance Sand Prairie w/ Standing Dead
Riparian Grassland
Riparian Grassland w/ Brush Piles
Riparian Grassland w/ Imbedded Heavies
Riparian Grassland w/ Slash
Riparian Grassland w/ Standing Dead
Sagebrush Prairie
Sagebrush Prairie w/ Imbedded Heavies
Sagebrush Prairie w/ Slash
Sagebrush Prairie w/ Standing Dead
Sand Prairie
Sand Prairie w/ Imbedded Heavies
Sand Prairie w/ Slash
Sand Prairie w/ Standing Dead
Sandhill Grassland with Sagebrush
Sandhill Grassland with Sagebrush w/ Slash
Sandhill Grassland with Sagebrush w/ Standing Dead
Sandhill Grassland with Shinnery
Sandhill Grassland with Shinnery w/ Slash
Shinnery Prairie
Shinnery Prairie w/ Slash
Shinnery Prairie w/ Standing Dead
Shinnery Sandhills
Shinnery Sandhills w/ Imbedded Heavies
Shinnery Sandhills w/ Slash
Shinnery Sandhills w/ Standing Dead
Tight Soil Shortgrasses
Tight Soil Shortgrasses w/ Brush Piles
Tight Soil Shortgrasses w/ Imbedded Heavies
Tight Soil Shortgrasses w/ Slash
Tight Soil Shortgrasses w/ Standing Dead
Young Mesquite
Young Mesquite w/ Slash
Young Mesquite w/ Standing Dead

APPENDIX G

Combined Years Dissimilarity Matrix																		
	S Bull	SM	EA	WEA	Sam	LC	NM	DL	NW Suit	OX	NE Suit	EN	M Bull	E Bull	NNM	Short	Sisk	SW
S Bull	0	0.467	0.538	0.500	0.778	0.733	0.538	0.600	0.385	0.615	0.733	0.417	0.273	0.333	0.818	1.000	0.923	0.909
SM	0.467	0	0.429	0.600	0.611	0.625	0.533	0.500	0.400	0.688	0.533	0.706	0.533	0.353	0.857	1.000	0.867	0.929
EA	0.538	0.429	0	0.583	0.688	0.800	0.615	0.333	0.333	0.692	0.500	0.615	0.615	0.400	0.909	1.000	0.700	0.900
WEA	0.500	0.600	0.583	0	0.667	0.583	0.583	0.417	0.538	0.400	0.583	0.583	0.455	0.647	0.900	1.000	0.800	1.000
Sam	0.778	0.611	0.688	0.667	0	0.600	0.688	0.647	0.647	0.571	0.600	0.688	0.833	0.714	1.000	0.917	0.857	1.000
LC	0.733	0.625	0.800	0.583	0.600	0	0.615	0.667	0.667	0.692	0.714	0.800	0.714	0.737	0.909	1.000	0.917	1.000
NM	0.538	0.533	0.615	0.583	0.688	0.615	0	0.571	0.333	0.692	0.615	0.500	0.500	0.588	1.000	0.889	0.818	0.778
DL	0.600	0.500	0.333	0.417	0.647	0.667	0.571	0	0.429	0.538	0.462	0.571	0.571	0.471	0.923	1.000	0.636	0.917
NW Suit	0.385	0.400	0.333	0.538	0.647	0.667	0.333	0.429	0	0.733	0.571	0.462	0.462	0.375	0.923	1.000	0.750	0.818
OX	0.615	0.688	0.692	0.400	0.571	0.692	0.692	0.538	0.733	0	0.455	0.583	0.583	0.647	1.000	1.000	0.909	1.000
NE Suit	0.733	0.533	0.500	0.583	0.600	0.714	0.615	0.462	0.571	0.455	0	0.615	0.615	0.500	1.000	1.000	0.818	0.900
EN	0.417	0.706	0.615	0.583	0.688	0.800	0.500	0.571	0.462	0.583	0.615	0	0.364	0.500	0.909	0.889	0.917	0.900
M Bull	0.273	0.533	0.615	0.455	0.833	0.714	0.500	0.571	0.462	0.583	0.615	0.364	0	0.400	0.909	1.000	0.917	0.900
E Bull	0.333	0.353	0.400	0.647	0.714	0.737	0.588	0.471	0.375	0.647	0.500	0.500	0.400	0	0.800	1.000	0.813	0.867
NNM	0.818	0.857	0.909	0.900	1.000	0.909	1.000	0.923	0.923	1.000	1.000	0.909	0.909	0.800	0	1.000	1.000	1.000
Short	1.000	1.000	1.000	1.000	0.917	1.000	0.889	1.000	1.000	1.000	1.000	0.889	1.000	1.000	1.000	0	1.000	1.000
Sisk	0.923	0.867	0.700	0.800	0.857	0.917	0.818	0.636	0.750	0.909	0.818	0.917	0.917	0.813	1.000	1.000	0	0.800
SW	0.909	0.929	0.900	1.000	1.000	1.000	0.778	0.917	0.818	1.000	0.900	0.900	0.900	0.867	1.000	1.000	0.800	0

APPENDIX H

2016 Dissimilarity Matrix

	WEA	SW	SM	Short	Sisk	OX	SAM	NWS	NM	NNM	NES	EN	LC	EA	E Bull	Bull	DL
WEA	0	1.000	0.556	1.000	0.750	0.857	0.750	0.571	0.750	1.000	0.750	0.889	0.636	0.778	0.714	0.333	0.667
SW	1.000	0	0.875	1.000	0.800	1.000	1.000	1.000	0.800	1.000	1.000	0.800	1.000	0.833	0.750	1.000	0.857
SM	0.556	0.875	0	1.000	0.778	0.875	0.857	0.625	0.778	1.000	0.900	0.900	0.545	0.667	0.571	0.429	0.556
Short	1.000	1.000	1.000	0	1.000	1.000	0.889	1.000	0.750	1.000	1.000	0.750	1.000	1.000	1.000	1.000	1.000
Sisk	0.750	0.800	0.778	1.000	0	1.000	0.818	0.857	0.857	1.000	0.857	1.000	0.917	0.875	0.833	0.857	0.750
OX	0.857	1.000	0.875	1.000	1.000	0	0.778	0.800	0.800	1.000	0.800	0.800	0.778	0.600	0.750	0.800	0.667
SAM	0.750	1.000	0.857	0.889	0.818	0.778	0	0.917	0.818	1.000	0.700	0.818	0.714	0.833	0.909	0.917	0.846
NWS	0.571	1.000	0.625	1.000	0.857	0.800	0.917	0	0.667	0.833	0.857	0.667	0.700	0.714	0.600	0.400	0.333
NM	0.750	0.800	0.778	0.750	0.857	0.800	0.818	0.667	0	1.000	1.000	0.400	0.818	0.875	0.833	0.667	0.750
NNM	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.833	1.000	0	1.000	0.833	0.909	0.857	1.000	1.000	0.875
NES	0.750	1.000	0.900	1.000	0.857	0.800	0.700	0.857	1.000	1.000	0	1.000	0.700	0.875	0.833	0.857	0.750
EN	0.889	0.800	0.900	0.750	1.000	0.800	0.818	0.667	0.400	0.833	1.000	0	0.917	0.714	0.833	0.857	0.750
LC	0.636	1.000	0.545	1.000	0.917	0.778	0.714	0.700	0.818	0.909	0.700	0.917	0	0.833	0.800	0.700	0.636
EA	0.778	0.833	0.667	1.000	0.875	0.600	0.833	0.714	0.875	0.857	0.875	0.714	0.833	0	0.667	0.714	0.429
E Bull	0.714	0.750	0.571	1.000	0.833	0.750	0.909	0.600	0.833	1.000	0.833	0.833	0.800	0.667	0	0.600	0.500
Bull	0.333	1.000	0.429	1.000	0.857	0.800	0.917	0.400	0.667	1.000	0.857	0.857	0.700	0.714	0.600	0	0.571
DL	0.667	0.857	0.556	1.000	0.750	0.667	0.846	0.333	0.750	0.875	0.750	0.750	0.636	0.429	0.500	0.571	0

APPENDIX I

Aspidoscelis gularis 2016			
CPUE	Drift Fence	Ecological Site	Vegetation Description
1.00	Sisk	Gravelly	Post-Disturbance Redberry Juniper
0.33	Stonewall	Loamy Prairie	Tight Soil Shortgrasses w/ Slash
0.29	South Middle	Gravelly	Mature Redberry Juniper
0.21	East Aermotor	Gravelly	Post-Disturbance Redberry Juniper w/ Slash
0.14	Dogleg	Gravelly	Mature Mesquite
0.07	East Bull	Loamy Sand Prairie	Post-Disturbance Sand Prairie
0.00	Shorty	Loamy Bottomland	Mature Mesquite
0.00	North North Middle	Loamy Prairie	Tight Soil Shortgrasses w/ Slash
0.00	Middle Bull	Loamy Sand Prairie	Post-Disturbance Sand Prairie
0.00	Entrance	Loamy Sand Prairie	Sagebrush Prairie
0.00	Lone Canyon	Sandy Bottomland	Riparian Grasland w/ Brush Piles
0.00	NE Suitcase	Sandy	Sandhill Grassland with Shinnery
0.00	North Middle	Sandy Bottomland	Riparian Grassland
0.00	NW Suitcase	Sandy Loam	Tight Soil Shortgrasses w/ Slash
0.00	OX	Sandy	Sandhill Grassland with Shinnery
0.00	Samson	Loamy Bottomland	Young Mesquite
0.00	W East Aermotor	Loamy Prairie	Tight Soil Shortgrasses w/ Slash

Aspidoscelis sexlineata 2016			
CPUE	Drift Fence	Ecological Site	Vegetation Description
0.71	Middle Bull	Loamy Sand Prairie	Post-Disturbance Sand Prairie
0.64	Lone Canyon	Sandy Bottomland	Riparian Grasland w/ Brush Piles
0.57	Dogleg	Gravelly	Mature Mesquite
0.57	North Middle	Sandy Bottomland	Riparian Grassland
0.43	OX	Sandy	Sandhill Grassland with Shinnery
0.29	East Bull	Loamy Sand Prairie	Post-Disturbance Sand Prairie
0.29	Samson	Loamy Bottomland	Young Mesquite
0.29	South Middle	Gravelly	Mature Redberry Juniper
0.21	NW Suitcase	Sandy Loam	Tight Soil Shortgrasses w/ Slash
0.07	East Aermotor	Gravelly	Post-Disturbance Redberry Juniper w/ Slash
0.07	Entrance	Loamy Sand Prairie	Sagebrush Prairie
0.07	W East Aermotor	Loamy Prairie	Tight Soil Shortgrasses w/ Slash
0.00	Shorty	Loamy Bottomland	Mature Mesquite
0.00	Sisk	Gravelly	Post-Disturbance Redberry Juniper
0.00	North North Middle	Loamy Prairie	Tight Soil Shortgrasses w/ Slash
0.00	Stonewall	Loamy Prairie	Tight Soil Shortgrasses w/ Slash
0.00	NE Suitcase	Sandy	Sandhill Grassland with Shinnery

Plestiodon obsoletus 2016			
CPUE	Drift Fence	Ecological Site	Vegetation Description
0.14	NE Suitcase	Sandy	Sandhill Grassland with Shinnery
0.14	Samson	Loamy Bottomland	Young Mesquite
0.07	Dogleg	Gravelly	Mature Mesquite
0.07	East Aermotor	Gravelly	Post-Disturbance Redberry Juniper w/ Slash
0.07	Lone Canyon	Sandy Bottomland	Riparian Grasland w/ Brush Piles
0.07	OX	Sandy	Sandhill Grassland with Shinnery
0.00	Shorty	Loamy Bottomland	Mature Mesquite
0.00	Sisk	Gravelly	Post-Disturbance Redberry Juniper
0.00	North North Middle	Loamy Prairie	Tight Soil Shortgrasses w/ Slash
0.00	Stonewall	Loamy Prairie	Tight Soil Shortgrasses w/ Slash
0.00	Middle Bull	Loamy Sand Prairie	Post-Disturbance Sand Prairie
0.00	East Bull	Loamy Sand Prairie	Post-Disturbance Sand Prairie
0.00	Entrance	Loamy Sand Prairie	Sagebrush Prairie
0.00	North Middle	Sandy Bottomland	Riparian Grassland
0.00	NW Suitcase	Sandy Loam	Tight Soil Shortgrasses w/ Slash
0.00	South Middle	Gravelly	Mature Redberry Juniper
0.00	W East Aermotor	Loamy Prairie	Tight Soil Shortgrasses w/ Slash

APPENDIX J

Plestiodon obsoletus 2004-2016		
CPUE	Drift Fence	Ecological Site
0.27	WEA	Loamy Prairie
0.19	SM	Gravelly
0.16	Sam	Loamy Bottomland
0.15	E Bull	Loamy Sand Prairie
0.13	DL	Gravelly
0.13	NM	Sandy Bottomland
0.11	M Bull	Loamy Sand Prairie
0.11	S Bull	Loamy Sand Prairie
0.10	LC	Sandy Bottomland
0.09	NE Suit	Sandy
0.09	NWSuit	Sandy Loam
0.06	OX	Sandy
0.06	EN	Loamy Sand Prairie
0.05	EA	Gravelly

Aspidoscelis gularis 2004-2016		
CPUE	Drift Fence	Ecological Site
0.12	SM	Gravelly
0.11	EA	Gravelly
0.05	DL	Gravelly
0.02	E Bull	Loamy Sand Prairie
0.01	NE Suit	Sandy
0.01	NWSuit	Sandy Loam
0.01	NM	Sandy Bottomland
0.00	S Bull	Loamy Sand Prairie
0.00	WEA	Loamy Prairie
0.00	Sam	Loamy Bottomland
0.00	LC	Sandy Bottomland
0.00	OX	Sandy
0.00	EN	Loamy Sand Prairie
0.00	M Bull	Loamy Sand Prairie

Aspidoscelis sexlineata 2004-2016		
CPUE	Drift Fence	Ecological Site
0.47	OX	Sandy
0.43	NE Suit	Sandy
0.31	NM	Sandy Bottomland
0.29	SM	Gravelly
0.26	LC	Sandy Bottomland
0.22	M Bull	Loamy Sand Prairie
0.19	E Bull	Loamy Sand Prairie
0.16	DL	Gravelly
0.14	Sam	Loamy Bottomland
0.11	EA	Gravelly
0.09	NWSuit	Sandy Loam
0.07	WEA	Loamy Prairie
0.06	S Bull	Loamy Sand Prairie
0.02	EN	Loamy Sand Prairie