

DETERMINING MICROHABITAT USE BY THE GULF COAST KANGAROO RAT
(*DIPODOMYS COMPACTUS*) USING MOTION SENSITIVE CAMERAS
AND ESTIMATING POPULATION DENSITY AT THEIR
NORTHERN DISTRIBUTION LIMIT

THESIS

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ABSTRACT

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SUPERVISING PROFESSOR: THOMAS R. SIMPSON

The Gulf Coast kangaroo rat (*Dipodomys compactus*) is a rarely studied species endemic to southern Texas. Throughout its range, it is intermittently distributed because of its presumed dependence on deep, sandy soils with sparse vegetation. I conducted my study in Guadalupe County, Texas, the northernmost limit of the species' distribution. I collected mark-recapture data during April, July, and September 2011 in order to estimate population density. My estimates for these sampling periods were 7.4, 7.3, and 6.8 kangaroo rats per hectare, respectively. I used motion-sensitive cameras to document activity patterns (visitation rates) of individual kangaroo rats at 80 camera stations spaced

4.5 m apart in a 2.5 ha field. The Daubenmire method was used to determine percent cover of five microhabitat variables at each camera station: bare ground, total vegetation, grass, forbs, and dead material. These data were collected during March and April 2012. My goal was to test whether the Gulf Coast kangaroo rat selects to forage on a substrate relatively devoid of dense vegetation as has been found for other *Dipodomys* species. I found a significant difference in the percent cover of bare ground and total vegetation between visited and non-visited camera stations. On average, visited stations had 45.9% bare ground and 37.8% vegetative cover whereas non-visited stations had 36.9% and 45.5% respectively. Although it inhabits a relatively mesic environment, the Gulf Coast kangaroo rat has similar population densities and selects for a bare foraging substrate, as do most of the arid-adapted *Dipodomys* species. My study also demonstrates that motion-sensitive cameras can be effectively used to determine microhabitat use of kangaroo rats. Camera surveillance is a valuable tool that could help us better understand this understudied species and other small rodent species.

CHAPTER I

INTRODUCTION

The Gulf Coast kangaroo rat (*Dipodomys compactus*) is a medium sized heteromyid rodent with five toes on each hind foot and a comparatively short tail (Baumgardner, 1991). They are strongly bipedal and are adapted to arid ecosystems (Bartholomew and Caswell 1951, Leaver and Daly 2001). Kangaroo rats (genus *Dipodomys*) are primarily seed eaters that use fur lined cheek pouches to store seeds while foraging on the surface (Morton et al. 1980, Vander Wall et al. 1998). Kangaroo rats use their forepaws to gather seeds into their cheek pouches (Shier and Randall 2004) and transport the seeds to their seed caches, within the burrow complex or near the surface (Tappe 1941).

The Gulf Coast kangaroo rat is a nocturnal species that spends the day in burrow systems and becomes very active during the night (Kennedy et al. 1973). The range of the Gulf Coast kangaroo rat extends from the southern gulf coast of Texas to the Rio Grande River and northward to south central Texas (Fig. 1). The Gulf Coast kangaroo rat is intermittently distributed on the Texas mainland, dependent on local soil conditions and vegetation. The Gulf Coast kangaroo rat requires deep, sandy soils for burrowing, while avoiding areas with dense herbaceous vegetation (Baumgardner and

Schmidly 1985, Oakley 2012). Burrows of the Gulf Coast kangaroo rat are easily identifiable and constructed as a complex system of tunnels with multiple entry points

The Texas Wildlife Conservation Action Plan (2005) lists the Gulf Coast kangaroo rat as a species of concern due to development and land use changes on the barrier islands.

The Gulf Coast kangaroo rats on the barrier islands of Texas differ from populations on the Texas mainland in several aspects. The barrier islands subspecies (*Dipodomys compactus compactus*) has grayish pelage and sometimes found with a red color phase (Baumgardner 1991). Habitat of the barrier island populations is sand dunes with sparse vegetation (Kennedy et al. 1973, Baumgardner 1991, Rissel 2011). On the Texas mainland, Gulf Coast kangaroo rats are brown in color and found on relatively flat terrain (Baumgardner and Schmidly 1985). There is little published research on Gulf Coast kangaroo rats on the barrier islands and even less on the Texas mainland.

Motion sensitive cameras are a relatively new technique used in animal ecology. These cameras utilize an infrared beam to detect movement and, when triggered, can take one to three photographs in succession. Motion sensitive cameras are used for a number of purposes in animal ecology, including monitoring nest predation, nesting behavior of birds, activity patterns, and assessing population parameters (Cutler and Swann 1999). Recent research involving these cameras has focused on larger species that have distinct coat patterns (such as tigers, leopards, jaguars, bobcats, and ocelots) to identify and quantify habitat use and population densities (Trolle and Kery 2003, Heilbrun et al. 2006, Royle et al. 2009).

Microhabitat is described as environmental variables that affect an individual organism's behavior (Morris 1987). Microhabitat analyses for kangaroo rats have been conducted using Sherman live traps and spotlights (Thompson 1982, Baumgardner and Schmidly 1985). Traditionally, sampling kangaroo rat microhabitat involved setting trap grids and measuring associated microhabitat parameters (Price and Kramer 1984). These methods, while accepted, are dependent on trapping success and success at observing individuals of the target species.

Reported nighttime activity patterns of kangaroo rats vary according to the species. Kennedy et al. (1973) captured three Gulf Coast kangaroo rats and documented their activities in a lab setting. They determined that Gulf Coast kangaroo rats were very active during nighttime hours, with some activity during daylight hours for drinking and feeding. Other techniques have been used to assess nighttime activity patterns of kangaroo rats including hand held spotlights (Langford 1983), direct observation (Kaufman and Kaufman 1982) and food habit studies (Boal and Giovanni 2007). Ord's kangaroo rat (*Dipodomys ordii*) activity was greatest during the initial hours after sunset, as determined by spotlight counts (Langford 1983). However, Kaufman and Kaufman (1982) noted little activity after sunset with increasing activity later in the evening. Boal and Giovanni (2007) consider Ord's kangaroo rat to be active during diurnal periods based on food habit studies of hawks and direct observation.

Texas Parks and Wildlife (TPWD) lists the Gulf Coast kangaroo rat as a species of concern in their Wildlife Action Plan (2005) due to habitat loss by development. Natural history information about the Gulf Coast kangaroo rat from inland populations may provide important data which can be used to develop conservation plans for coastal

and mainland populations. In this study, I had three objectives. First, I determined the population density of the Gulf Coast kangaroo rat at its known northern-most distribution using a mark-recapture technique. Secondly, I tested the feasibility of using motion sensitive cameras to determine microhabitat use by kangaroo rats. Lastly, I used motion sensitive camera images to determine nighttime activity patterns of Gulf Coast kangaroo rats.

Range of Gulf Coast Kangaroo Rat

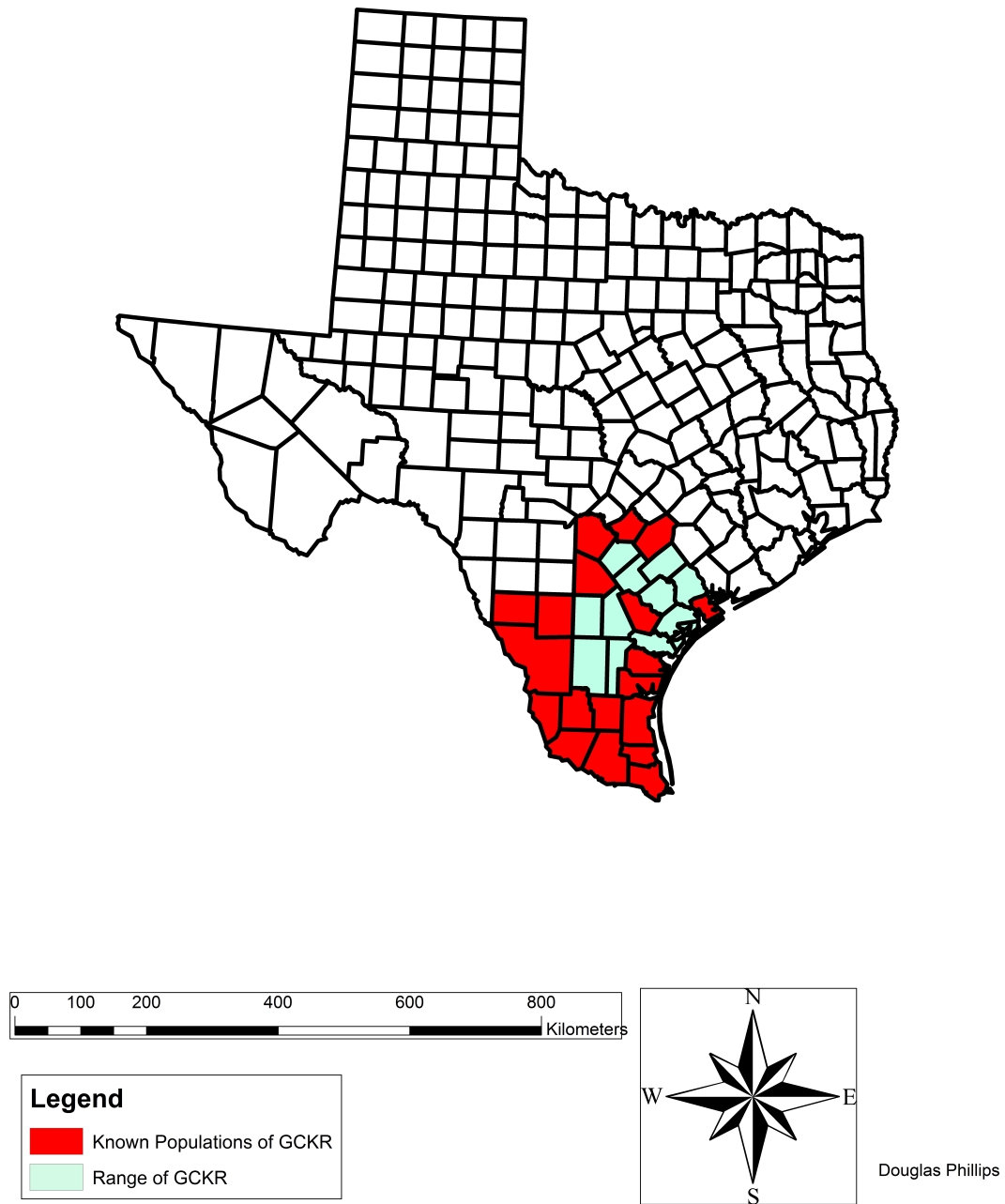


Figure 1: Distribution and known populations of the Gulf Coast kangaroo rat

CHAPTER II

MATERIALS AND METHODS

STUDY AREA

I conducted my research on Diamond Half Ranch in Guadalupe County, Texas (Fig. 2). Diamond Half Ranch (N 29.428947°, W -97.950751°) located on Highway 123 in Guadalupe County, Texas, is a privately owned working cattle ranch with an active hunting operation specializing in White-tailed deer (*Odocoileus virginianus*). Post oak (*Quercus stellata*) and Plateau Live Oak (*Quercus fusiformis*) are the dominant oaks on the ranch. Herbaceous vegetation on the ranch includes Yankeeweed (*Eupatorium compositifolium*). Yankeeweed is the dominant herbaceous plant found in two of the three selected study locations. Native and invasive grasses on the ranch include little bluestem (*Schizachyrium scoparium*), a native grass found throughout the ranch, and coastal bermuda (*Cynodon dactylon*), an invasive grass found on the southeastern portion of the ranch. The ranch soils are deep sands with patilo soils accounting for 49% and arenosa making up 29% of the soil composition. The typical profile of patilo extends from 0 to 2.1 meters, with the first 1.3 meters made up of fine sand. The remaining .8

meters is composed of a sandy clay loam. In addition, arenosa soil profile has a depth of 2.4 meters and is comprised of fine sand. (USDA, National Resources Conservation Service 2009). The study site is located on the Carrizo Sands geological formation. The Carrizo Sands is a narrow strip of sand that extends from south of San Antonio, Texas through east Texas and runs parallel with the Gulf of Mexico (McBryde 1933).

I selected three study locations based on deep sandy soils, sparse vegetation, and active Gulf Coast kangaroo rat burrows. All three locations are separated from each other by distance and vegetation. Location 1 is a 3.84-hectare field used primarily for grazing cattle and hunting. Location 2 is a 3.16-hectare subset of a larger approximately 218 ha coastal Bermuda pasture. Gulf Coast kangaroo rats occur intermittently throughout this pasture. Location 3 is a 2.52-hectare field that is used for cattle grazing

POPULATION ESTIMATES

I used Sherman live traps to capture and mark Gulf Coast kangaroo rats. Each location was surveyed for six nights. Traps were set in the late afternoon and baited with crimped oats. I checked traps at sunrise and documented all species of rodents captured. I marked kangaroo rats by locking a tag (National Band & Tag Company) in their ear. I recorded the location of capture and specific tag number then released the kangaroo rat at point of capture. The use of live animals was approved by the Texas State University-San Marcos Institutional Animal Care and Use Committee protocol number 1109-0817-09.

I set traps in a grid pattern. Each location required a different number of transects and traps depending on the size of the trap location. I trapped location 1 on the nights of 7 May 2011- 9 May 2011 and again on 15 May 2011- 17 May 2011. I set 200 live traps

at location 1 along 10 transects spaced 20m apart. Along each transect, live traps were spaced 10m apart. I trapped location 2 on the nights of 3 July 2011- 8 July 2011. I set 160 live traps in location 2 along 8 transects spaced 20m apart and each trap was spaced 10m apart. I trapped location 3 on 3 – 5 September 2011 and 11 - 13 September 2011. I set 120 Sherman traps along 6 transects spaced 20m apart. Each transect had 20 live traps spaced 10m apart.

I used the Schnabel Estimator to estimate population density (Schnabel 1938, Overton 1965). This is a mark-recapture model for closed populations over several trapping occasions (Overton 1965, Pierce et al. 2012).

CAMERA DEPLOYMENT

I used twenty Birdcam 2.0 cameras (Wingscapes Inc. Alabaster, Alabama) to document Gulf Coast kangaroo rat visitation and activities. These cameras were selected because they are small, portable and easy to deploy. In addition, the cameras are waterproof and offer high quality nighttime images with adjustable sensitivity. Camera sensitivity was set high, allowing the slightest movement to trigger the camera. One picture was taken per activation and the camera delay between pictures was set to one minute. A total of 240 camera trap nights were recorded.

I used location 3 for the motion sensitive camera captures from 27 March - 28 April 2011. A Wingscapes camera and camera arm were attached, to a 1.4-m rebar. I selected 80 camera stations throughout location 3 (Fig. 3). These stations were at least 4.5 meters apart. I deployed twenty cameras in one half of the field for three consecutive nights beginning on 27 March 2012. I placed one cup of crimped oats 2 m in front of the

camera system. The camera was positioned at an angle downward with the field of view covering the bait pile.

Following three nights of camera trapping, I moved the camera system to another station within the same half of the field. The cameras were deployed at least 4.5 m from the previous camera station. Following three consecutive camera nights, I deployed the camera systems to the second half of the field and followed the same procedure.

The cameras were operative from 1600 hours to just after sunrise (0700 hours). Each morning, I turned the cameras off and switched the memory cards. Each afternoon, I switched the cameras on and replenished the bait if needed. I downloaded the photos and checked for Gulf Coast kangaroo rat activity.

MICROHABITAT ANALYSIS

I used the Daubenmire technique to establish percent cover in front of each camera system. I placed a Daubenmire frame at four locations within each camera's field of view with the first location centered over the bait pile. I assigned cover classes to five variables with the Daubenmire frame; bare ground, grass, forbs, plant litter (dead herbaceous plant material), and total vegetation. I calculated a mean percent cover for each variable at each camera station.

I arcsine transformed the data since the data were percentages which have fixed limits. I used a multiple logistic regression to assess the influence these variables had on Gulf Coast kangaroo rat visitation. The response variable was visitation and the predictor variables were total vegetation, bare ground, grass, forbs, and plant litter (herbaceous and grass). I determined visitation by the number of images of Gulf Coast kangaroo rats at

each bait pile. If a Gulf Coast kangaroo rat visited the bait pile, but did not take the bait, then I did not count the images as a visitation. Next, I ran a logistic regression for each variable separately to assess the relationship between each variable and Gulf Coast kangaroo rat visitation.

I used a multivariate analysis of variance (MANOVA) to determine if any difference existed among camera stations with visitation and no visitation. The MANOVA tests whether any of the independent variable has an effect on the dependent variables. My dependent variables for the MANOVA were total vegetation, bare ground, grass, forbs and plant litter, while my independent variable was visitation.

While my MANOVA showed no significant difference among my dependent variables and my independent variable, I used a one-way analysis of variance (ANOVA) statistical test to determine if any microhabitat parameters impacted the visitation of Gulf Coast kangaroo rats. An ANOVA was run separately on each independent variable (total vegetation, bare ground, grass, forbs and plant litter). The one way ANOVA was run to test the effect of each independent variable based on visits or no visits.

I plotted visitation data as a scatter plot with the percent cover of each variable on the x-axis and number of visits on the y-axis. I added a linear best of fit line on the data points to determine if a relationship existed between the number of visits and the percent cover of each variable.

ACTIVITY PATTERNS

Activity patterns were constructed using the time stamp on the camera images. I recorded the number of kangaroo rat images appearing in the cameras field of view by

hourly blocks. The frequency of visits was calculated and plotted on the y-axis and the time of visits was plotted on the x-axis. I calculated the time of most activity by separating the early evening hours (2000- 2400) and the early morning hours (0100- 0600). I used the total number of pictures from the evening hours and from the morning hours and calculated the percentage of activity.

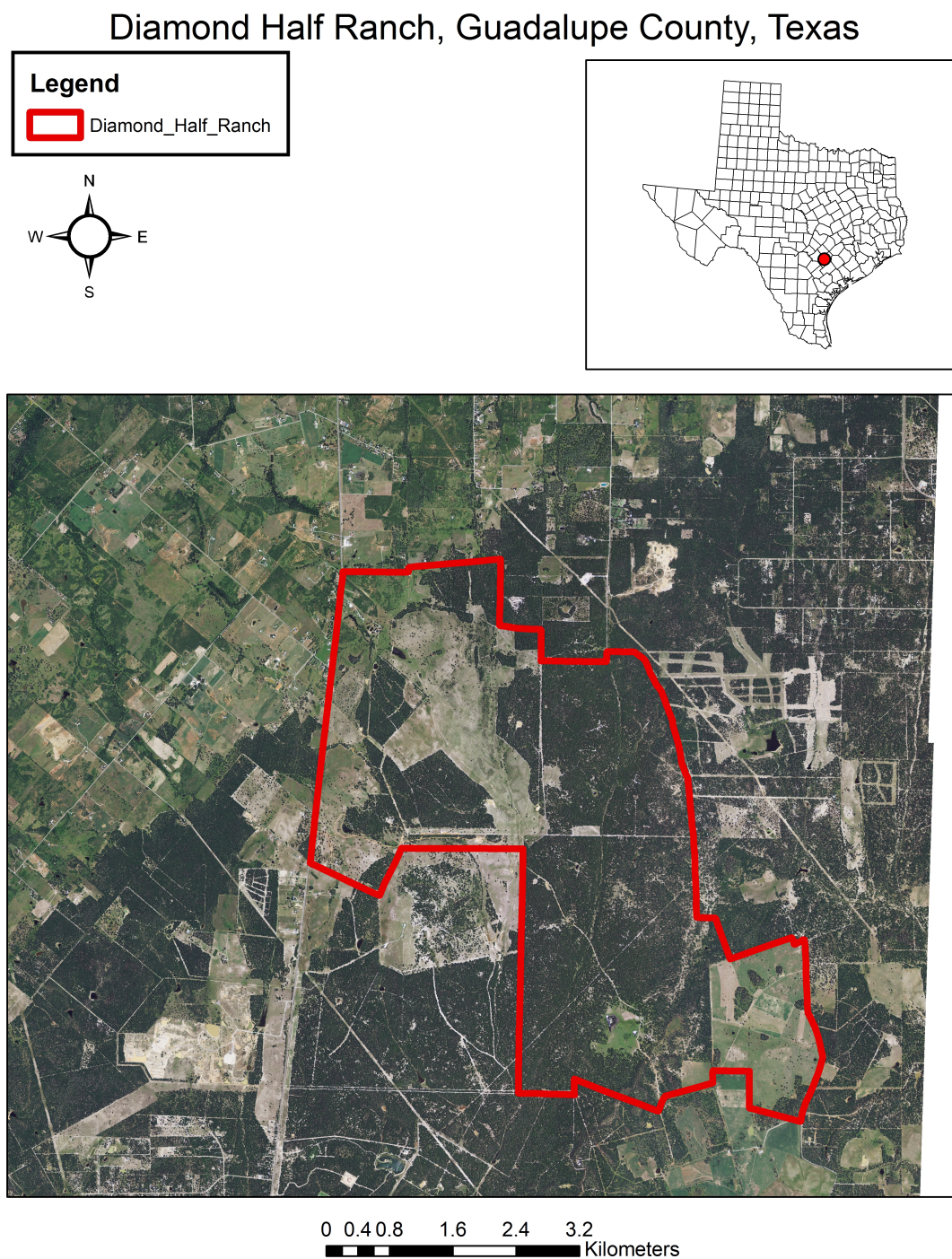


Figure 2: Location of Diamond Half Ranch- Guadalupe County, Texas

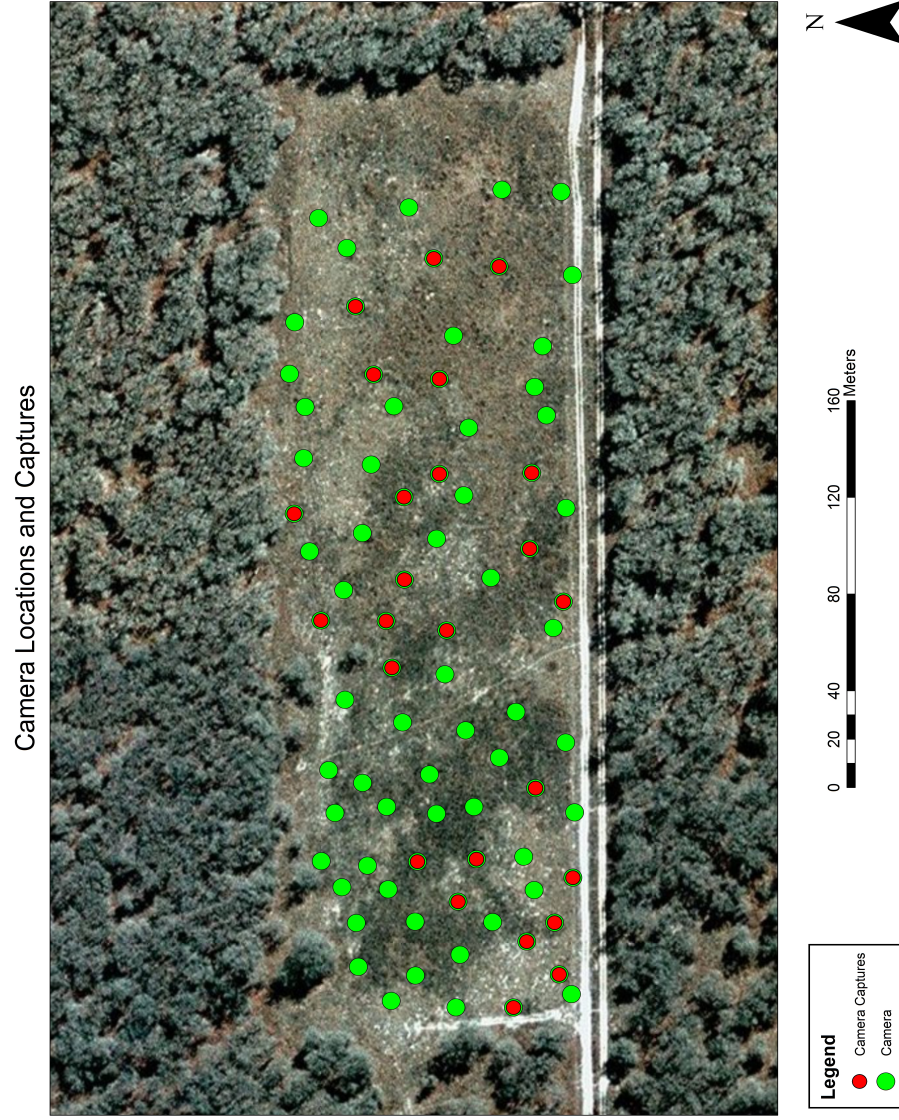


Figure 3: Camera stations distributed through location 3. Cameras with visitation highlighted red

CHAPTER III

RESULTS

POPULATION ESTIMATES

I captured 65 individual Gulf Coast kangaroo rats and recaptured 23 from all three study locations. Across the ranch, I trapped for 2,880 trap nights and had a total trap success rate of 3% (Table 1). I captured a total of 37 Gulf Coast kangaroo rats at location 1 (23 individuals and 14 recaptures). I had a 3% trap success rate at location 1 with a population estimate of 7.4 Gulf Coast kangaroo rats per hectare and a population estimate of 28.4. I captured 17 individuals with 4 recaptures at location 2. This was a trapping success rate of 2% at location 2 with a population estimate of 6.8 Gulf Coast kangaroo rats per hectare and a total population of 21.5. At location 3, I captured 15 Gulf Coast kangaroo rats and 5 recaptures. This effort yielded a capture success rate of 2% with a population estimate of 7.26 Gulf Coast kangaroo rats per hectare and a total population of 18.3.

CAMERA RESULTS

Motion sensitive cameras captured 723 images of Gulf Coast kangaroo rats within the camera field of view. A total of 470 Gulf Coast kangaroo rat images were captured

at bait piles over 240 camera nights in location 3. Gulf Coast kangaroo rat images appeared in the camera field of view at 26 camera stations (33%) and appeared at bait piles at 24 camera stations (30%).

MICROHABITAT ANALYSIS

The mean percent cover across all 80 camera stations were total vegetation 44%, bare ground 39%, grass 16%, forbs 27%, and plant litter 20%. The means for the microhabitat parameters were calculated on visits and no visits from the non-transformed data. The only microhabitat parameter with a higher percentage of cover for visits compared to no visits was bare ground (45.95% vs. 36.95%). All other parameters had higher mean percentages for no visits (Fig. 4).

Results of the multiple logistic regression analysis with all five predictors indicate that no relationship between the independent variables (microhabitat parameters) and the dependent variable (visitation), with a low r^2 value of 0.159. The r^2 (coefficient of determination) represents the percentage of the total variation that is explained in the regression. None of the predictor variables were significant (Table 2) indicating no relationship exists between the independent variables and the dependent variable. The logistic regression for each variable was calculated separately; total vegetation ($P = 0.008$) and bare ground ($P = 0.043$) were significant. Low r^2 values for total vegetation ($r^2 = 0.149$) and bare ground ($r^2 = 0.079$) indicate little correlation between the habitat parameter and the visitation of kangaroo rats. Grass, forbs, and plant litter did not have significant results ($P > 0.05$).

The MANOVA was not significant ($F_{5,74} = 1.81$, $P = 0.122$) indicating that visited camera stations did not differ from those without visitation with regard to the five microhabitat variables analyzed simultaneously as dependent variables. However, the ANOVAs were more insightful (Table 3). Visited camera stations had significantly less ($P < 0.05$) total vegetation and significantly more ($P < 0.05$) bare ground than did non-visited stations (Table 3, Fig. 4).

Points with Gulf Coast kangaroo rat visitation were plotted against each ground cover variable to determine whether a relationship existed between the percent of ground cover and the number of visits. Total vegetation, bare ground, forbs, and plant litter did not show a relationship between percent ground cover and visits. However, the scatter plot for grass showed that as percentage of grass decreased the total number of visits by Gulf Coast kangaroo increased (Fig. 5).

ACTIVITY PATTERNS

Activity patterns were recorded using timestamps from the Birdcam 2.0 camera photos. All 723 images were used in constructing activity periods. No image of Gulf Coast kangaroo rats were recorded before sunset and after sunrise, with the earliest recorded time of activity was 2053 hours and the latest active time was 0622 hours. The most active time periods for Gulf Coast kangaroo rats were recorded at 0100 hours (16%) and at 0300 hours (16%) (Fig. 6). Gulf Coast kangaroo rats were less active from 2000-2400 hours, accounting for 27% of the total activity. Seventy-two percent of total activity occurred between 0100- 0600 hours.

Table 1: Captures, population estimates, and trap success of *Dipodomys compactus* at Diamond Half Ranch, Guadalupe County, Texas

Study Site	Captures	Recaptures	Pop/ha	Pop Est.	Success
Location 1	37	14	7.4	28.4	3%
Location 2	17	4	6.8	21.5	2%
Location 3	15	5	7.26	18.3	2%

Table 2: Results from the multiple logistic
regression with five predictor variables

	Coefficient	SE	df	Sig
Total Veg	-.096	.064	1	.135
Bare Ground	.018	.032	1	.572
Grass	.004	.043	1	.928
Forbs	.004	.060	1	.951
Plant litter	-.011	.030	1	.721
Constant	1.992	2.889	1	.490

Table 3: Results from one-way ANOVA's between points with visits and
no visits for each independent variable

Microhabitat parameter	Source	SS	MS	<i>F</i>	<i>P</i>
Total Vegetation	Between Groups	307.47	307.47	5.58	0.02
	Within Groups	4290.66	55.01		
Bare Ground	Between Groups	435.17	435.17	4.14	0.04
	Within Groups	8190.67	105.01		
Grass	Between Groups	58.41	58.41	.795	0.37
	Within Groups	5724.73	73.39		
Forbs	Between Groups	135.31	135.31	2.13	0.14
	Within Groups	4947.85	63.43		
Plant litter	Between Groups	178.06	178.06	1.32	0.25
	Within Groups	10493.64	134.53		

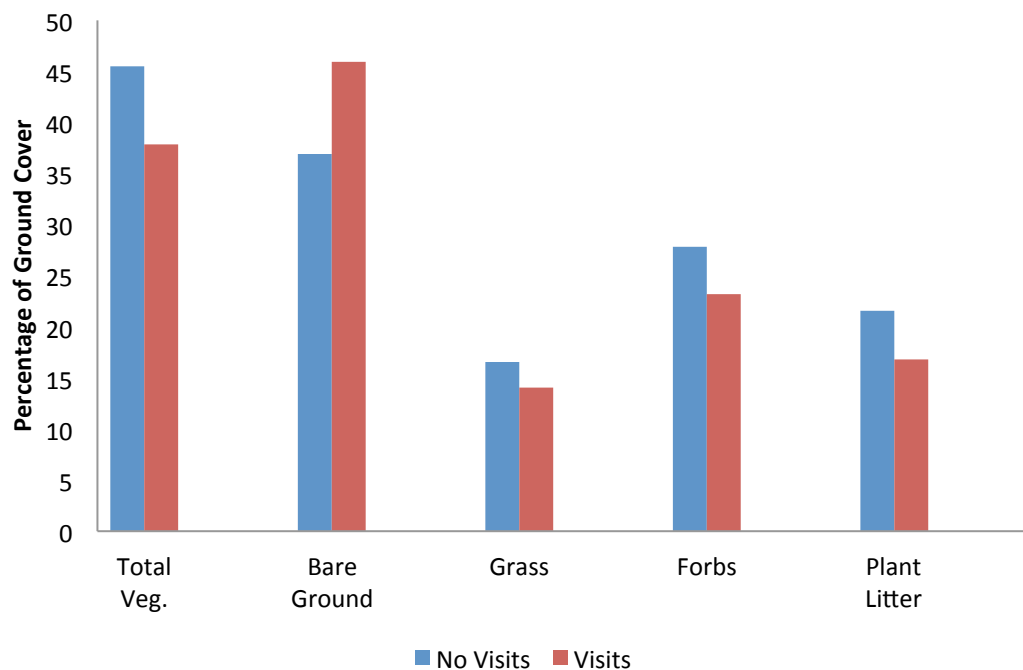


Figure 4: Means of ground cover between camera stations with no visits and visits

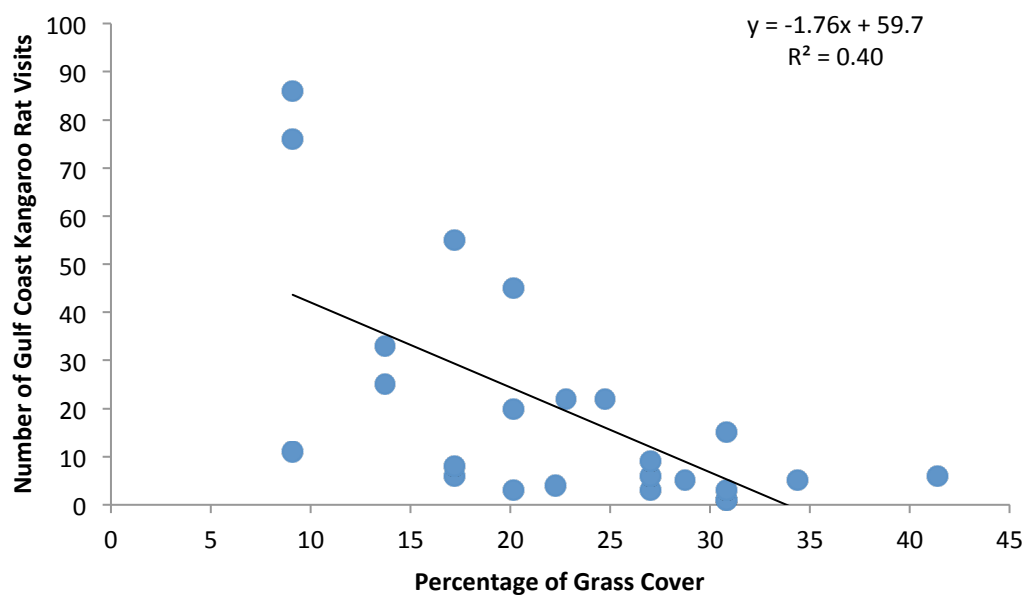


Figure 5: Scatter plot of percent grass cover and number of kangaroo rat visits taken from camera stations with visits

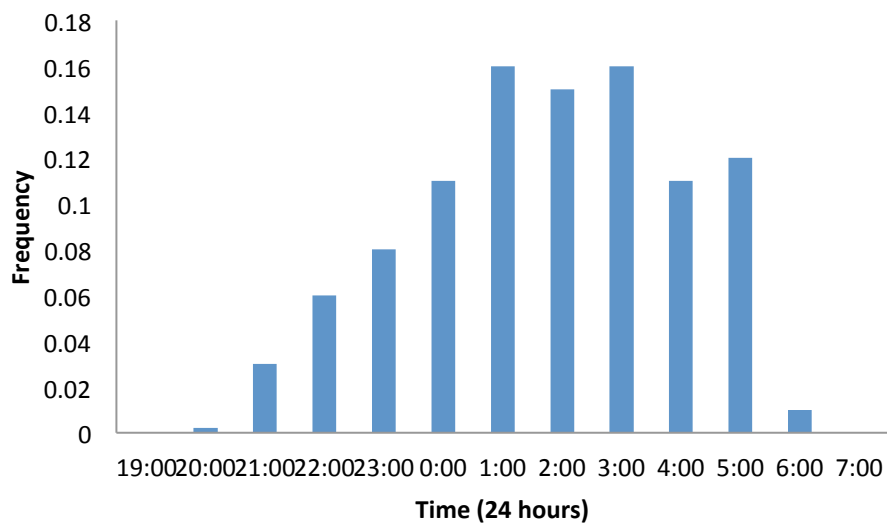


Figure 6: Activity patterns of the Gulf Coast kangaroo rat. Frequency recorded as percentage of time active through all camera-trapping nights

CHAPTER IV

DISCUSSION

My population estimates (7.4, 7.26, and 6.8 /ha) of kangaroo rats are higher than previous studies of this species. On Texas barrier islands, McCoig (1983) estimated a population density of five kangaroo rats per ha while Rissel (2011) estimated a population density of 3.6 kangaroo rats per ha. Baumgardner and Schmidly (1985) did not estimate population densities of kangaroo rats in South Central Texas. My trap success rate (2 – 3%) is within the range of Baumgardner and Schmidly (1985) with 4 percent trap success. Rissel (2011) had a 5 percent trap success on the barrier islands. Kenagy (1976) noted Agile kangaroo rats (*Dipodomys agilis*) and Merriam's kangaroo rats (*D. merriami*) readily enter Sherman live traps and return to traps repeatedly. According to my experience, this is not the case for the Gulf Coast kangaroo rat which appears to be a trap shy rodent and not easily caught.

Camera images were of high quality, capturing a great deal of Gulf Coast kangaroo rat activity. Gulf Coast kangaroo rats were observed foraging, jumping, seed caching, sand bathing and digging (clearing) burrows. The cameras also captured images of other species of rodents and herptofauna such as the Eastern harvest mouse (*Reithrodontomys fulvescens*), coral snake (*Micrurus tener*), Texas glossy snake (*Arizona elegans*), and American bullfrog (*Rana catesbeiana*).

The use of motion sensitive cameras in analyzing the relationships between Gulf Coast kangaroo rats and microhabitat factors was an effective method. The mean percent cover of bare ground was higher where Gulf Coast kangaroo rats visited the bait pile, while the mean percent cover for total vegetation (grass and forbs) was higher where no visitation occurred. While it is known that the Gulf Coast kangaroo rat inhabits areas of deep sandy soil and sparse vegetation (Baumgarner and Schmidly 1981, Baumgardner and Schmidly 1985, Baumgardner 1991), my camera data also verify this knowledge. Compared to trapping, the use of cameras to photograph kangaroo rats has several advantages as a tool for determining microhabitat use. Trapping rodents can cause unwarranted stress and possible death while the use of cameras is much less invasive. In the case of a trap shy species like the Gulf Coast kangaroo rat, it is much more likely that species presence will be recorded by a camera allowing unrestricted free movement than by capture in a live trap. An additional advantage of using cameras over Sherman traps is that live traps only record one visit per night, while cameras can record multiple visits over the course of the night. A disadvantage of live traps is interference by other wildlife species. During the trapping segment of my study, I observed incidents of trap disturbance by other wildlife. Twelve times (nights 5 and 6) my traps were carried off into the surrounding wooded area, possibly by predators such as coyotes or badgers. Eight of the traps recovered had been crushed, while three had the exterior doors ripped open and one trap was never recovered. If kangaroo rats were inside of these traps, their visits were not recorded.

Nighttime activity patterns of kangaroo rats vary among species. Kangaroo rats (Genus *Dipodomys*) are reported to be exclusively nocturnal (Kenagy 1973). However,

Kennedy et al. (1973) noted that in a lab setting, the Gulf Coast kangaroo rat used small amounts of daytime light for drinking and feeding. Boal and Giovanni (2007) noted that Ord's kangaroo rat displays rare daytime activity, determined by observation and food habit studies of birds of prey. My camera traps did not detect any activity during daylight hours by Gulf Coast kangaroo rats. While other species of kangaroo rats are more active at sunset and sunrise (Kaufman and Kaufman 1982, Langford 1983), the Gulf Coast kangaroo rat is more active during the middle of the night (2300-0100 hours). Activity during the middle of the night could be a way to decrease predation. However, activity pattern data in this study were collected during early spring. Variables such as temperature and food availability could be important factors that determine the Gulf Coast kangaroo rats nightly activity patterns. More research is needed to determine the seasonal variation of activity patterns.

Habitat destruction from land use change (agriculture and development) is the primary reason the Gulf Coast kangaroo rat has been labeled as a Species of Concern by Texas Parks and Wildlife. This new method of determining microhabitat use by motion sensitive cameras offers researchers a way to noninvasively measure microhabitat parameters in a natural setting. Knowledge gained from motion sensitive cameras aids in the management of this species by assessing which microhabitat parameters are important for the Gulf Coast kangaroo rat. Cattle grazing could be an important component of habitat management for the Gulf Coast kangaroo rat. Grazing cattle reduce the amount of vegetation (grass and forbs) while increasing the amount of bare ground, which is necessary for the Gulf Coast kangaroo rat. Stephen's kangaroo rat (*Dipodomys stephensi*) and Merriam's kangaroo rats (*D. merriami*) have been shown to respond

favorably to grazing animals as a form of habitat management (Reynolds 1958, Kelt et al. 2005). Gulf Coast kangaroo rats and Merriam's kangaroo rats have been shown to be more abundant on disturbed sites in comparison to undisturbed sites (Bailey 1905, Reynolds 1958, Baumgardner and Schmidly 1985). Bailey (1905) noted that the Gulf Coast kangaroo rat was found in poor soils and had abundant populations in areas that were overgrazed.

The conservation of this species is important to other wildlife. Kangaroo rats are a food source for species of birds, reptiles, and carnivores (Kotler 1984, Randall and Stephens 1987, Daly et al. 1990, Longland and Price 1991, Pierce et al. 1992). Their burrow complexes could be important for the survival of other species. I observed lizards using their burrows to conceal themselves as I walked through the fields. Toads and spiders were observed using kangaroo rat burrows during the middle of the day to retreat from heat of the sun. More research is needed to determine the extent that these species use kangaroo rat burrows. Kangaroo rats cache seeds of grass and forbs in their burrows and at the opening of their burrows. Seed caching at these locations serve as seed germination sites, which can promote and maintain plant species diversity (Guo 1996).

Motion sensitive camera capabilities have evolved in the field of wildlife ecology. The uses of motion sensitive cameras have steadily grown for population estimates, food habit, and behavior studies. This new camera method determined the Gulf Coast kangaroo rat visited areas with a higher percentage of bare ground while avoiding areas with a higher percentage of vegetation. In the future, researchers can use this methodology as an additional tool to determine the microhabitat requirements of imperiled species of kangaroo rats that are difficult to capture or observe. Using motion

sensitive cameras can reduce the need of using Sherman live traps to determine microhabitat use of other species of kangaroo rats, reducing the invasive nature of live trapping.

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