SMALL MAMMAL SURVEY OF GRIFFITH LEAGUE RANCH, BASTROP COUNTY, TEXAS

THESIS

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ABSTRACT

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The Lost Pines Region of Texas, on which the Griffith League Ranch is situated, is characterized by the occurrence of loblolly pines (*Pinus taeda*), post oaks (*Quercus stellata*), and blackjack oaks (*Q. marilandica*) and represents a unique ecosystem in Central Texas. However, little research has been done on the mammalian fauna of this area. My research project surveyed small mammals on GLR using the appropriate field methods, comparing species diversity within and between habitat types across all four seasons. A total trapping effort of 3,570 trap-nights was employed to capture small

rodent species and I verified the presence of 15 additional mammals out of the possible 44 native mammalian species previously identified from this region. New records were established for *Cryptotis parva*, *Sciurus carolinensis*, *Chaetodipus hispidus*, and *Reithrodontomys fulvescens*. The total abundance of rodents at GLR was low (2.5 individuals collected per 100 trap-nights) as were both overall species richness and diversity. This pattern probably is due largely to the low plant diversity, impact of imported red fire ants, and lack of fire management on the property. *Peromyscus leucopus* was the most abundant rodent at GLR, occurring in all habitat types. Open grassland sites on the property during fall and winter had the highest abundance of small mammals of any of the habitat types trapped at any time (6.0 and 4.7 individuals captured per 100 trap-nights, respectively).

CHAPTER I

INTRODUCTION TO THE STUDY

Griffith League Ranch is a 1,962 hectare (4,847-acre) property owned by the Boy Scouts of America and located in Bastrop County, Texas, about 55 kilometers (35 miles) east of Austin. The property lies within a triangular-shaped area that is bounded on the north by U.S. Highway 290, on the east by Texas Highway 91, and on the west by Texas Highway 95. The main entrance to the property is located off Farm Road 2336 and Oak Hill Cemetery Road.

The ranch is situated in the Lost Pines Region of Texas, an area of pine trees located about 240 kilometers (150 miles) southwest of the contiguous forests of East Texas and the southeastern United States (Schmidly, 2002). These trees represent the westernmost population of loblolly pines (*Pinus taeda*) and are thought to be a remnant of an Ice Age forest that once covered most of the eastern United States (Phelan, 1976). Little research has been done on the Lost Pines habitat; however, this pine-oak (*Quercus* sp.) forest is thought to represent an ecotone between the pine forests of East Texas and the oak-hickory (*Carya* sp.) forests of the Post Oak Woodlands (Davis and Schmidly, 1994). The Lost Pines Region is a gently rolling to hilly area characterized by the occurrence of loblolly pine, post oak (*Q. stellata*), blackjack oak (*Q. marilandica*), and hickory trees (Schmidly, 2002). Although oaks represent the climax species in the Lost

Pines area, the loblolly pines, at present, generally are dominant (Schmidly, 1983). Sandy soils of this region are uniformly low in nearly all plant nutrients but can be penetrated easily by tree roots and soak up and retain water like a sponge (Phelan, 1976). The dominant native grasses in the woodland clearings of this area include little bluestem (*Schizachyrium scoparius*), Indiangrass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*) (Wilkins and Broussard, 2000).

The Lost Pines Region is a unique habitat in Central Texas, situated where the eastern woodlands interface with the western plains vegetation and where the subtropic vegetation interfaces with that of the temperate zones (Phelan, 1976). This region has low species diversity of both plant and animal life, for few animals make use of pine trees either for food or shelter (Schmidly, 1983). In addition, intensive human use in the Lost Pines has impacted the flora and fauna of the area (Schmidly, 2002). The mammalian fauna of this region has been treated in the two works of eastern Texas mammals by McCarley (1959) and Schimdly (1983). According to this literature, there are no endemic vertebrates in this region. However, a total of 44 native mammalian species are thought to occur in this area of Texas, only 24 of which have been confirmed in Bastrop County by specimens collected in Texas and held in various museums, Texas Department of Health records, and Texas Parks and Wildlife Department distribution files. Also, seven native mammal species have been extirpated from and seven exotic mammal species have been introduced to the Lost Pines region (Davis and Schmidly, 1994). The area is home to some unique species of reptiles and amphibians, such as the endangered Houston Toad (*Bufo houstonensis*), that are not found in the surrounding areas (Koeppe, 2001).

Griffith League Ranch is composed of four distinct habitats: ponds, open grassland, loblolly pine-dominated woodlands, and post and blackjack oak-juniper mixed forests (White, 2003). Under private management, the forested areas of GLR were over-harvested for timber (Dr. M.J. Forstner, personal communication). This type of activity can reduce species diversity for both plant and animal communities because it creates stands of second-growth forest that are a similar age (Phelan, 1976). However, the commercial harvesting on GLR ceased about 30 years ago and, since then, little management has been attempted in these wooded areas. Open grasslands on GLR, on the other hand, were significantly overgrazed until recently by livestock (Dr. M.J. Forstner, personal communication). This type of intensive grazing also has been shown to be deleterious for many animal and plant communities, usually resulting in a decrease of overall diversity in the area (Bich et al., 1995; Jones and Bock, 2003).

The Boy Scouts of America obtained Griffith League Ranch in 1993 when Mary Lavinia Griffith Sanders, sole owner of the tract and long time resident, bequeathed it to them. The Capitol Area Council of The Boy Scouts of America Organization plans to develop the ranch as a high adventure Boy Scout camp. The ranch would be designed to provide them with more challenging, rigorous programs than currently can be found at camps designed for younger scouts. The proposed development includes such amenities as a conference center, ropes course, and six different program camps. However, the Boy Scouts also have shown a strong commitment to land stewardship, planning to manage some of the ranch's acreage to conserve a relatively large portion of unique Lost Pines ecosystem and, in turn, to enhance the survival and expansion of the various species that inhabit the area (Koeppe, 2001).

This project proposed to survey small mammals on Griffith League Ranch, comparing species diversity within and between habitat types and across all seasons. The primary purposes of the study, therefore, are: 1) to obtain baseline inventory data and document information on the presence, distribution, and abundance of small terrestrial mammals in the GLR area of the Lost Pines Region as well as Bastrop County; 2) to determine habitat affinity of small mammals relative to the dominant vegetation types in the area; 3) to analyze relative abundance and diversity of small mammals in the region with respect to season; and 4) to assess the impact the proposed Boy Scouts of America development might have on native mammalian fauna.

CHAPTER II

MATERIALS AND METHODS

Mammalian Sampling---Data were collected twice a month from December 2002 to December 2003 using Sherman live-traps and standard field methods. All trap lines were referenced using a handheld Global Positioning System (GPS) unit and were marked with a 1 m long piece of rebar. A total of 25 sites initially were identified in five different habitat types with five sites of each type being marked: open grassland, ponds, loblolly pine-dominated woodlands, post and blackjack oak-dominated forests, and loblolly pine-oak mixed woodlands. Each site was noted on an aerial photo of GLR and assigned a number of 1 to 25 (Appendix A).

Standard length Sherman live traps were used to capture most of the small ground-foraging mammals at the ranch. Between 20 and 40 Sherman traps were placed along a straight trap line at about 5 m intervals in each habitat type (with the exception of five pond sites that were not trapped). Each trap-night consisted of an even distribution of traps across all four habitat types with between 110 and 140 traps being used each time. Traps were set and baited with oatmeal in the late afternoon. The following morning two to three hours after sunrise, the traps were checked and the captured small mammals were identified to species. Using available literature, each specimen then was

identified to subspecies. Rodent sampling was conducted for a total trapping effort of 3,570 trap-nights.

Data were collected on all species of mammals in all habitat types. Mammal presence was inferred from the study of fecal matter, tracks, sightings, gnawings, armadillo workings, and other signs. Additional information on rodents, gophers, shrews, and white-tailed deer was obtained from other research ongoing at the site.

The common and scientific names of the mammals follow Hall (1981) and Manning and Jones (1998). Introduced and non-native species are marked with an asterisk (*).

Data Analysis---The relative abundance of each rodent species was calculated for each habitat type trapped as the number of individuals of that species captured per 100 trap-nights. Relative and total abundance data then were compared with vegetational survey information to obtain habitat comparisons. Only rodents captured in Sherman live traps along permanent survey lines during the yearlong study were used in the analysis of habitat affinities. Mammals captured by other means, at other times, by other individuals, or in other areas were not included in habitat comparisons because the non-randomness of collecting and uneven catchability could introduce significant error into the analysis of abundance.

Species richness was calculated from the raw data. However, because sample sizes were different for each habitat type, it was not suitable to use the total number of species encountered within one habitat type as the species richness value for that community. Rarefaction analysis, however, has been shown to avoid this problem by

standardizing the number of individuals considered for each community. This analysis uses both the number of species present and number of individuals of each species to estimate a theoretical species richness for a given sample size. In this case, the sample size was set to ten (n=10) for each community, and the rarefaction program executed using EcoMeth Software. Other studies that have examined this type of analysis of species richness have found it to be satisfactory for comparing species richness between communities that were not sampled at the same intensities (Krebs, 1998).

Rodent relative abundance data was used to estimate species diversity. Logarithmic diversity was calculated by using the EcoMeth Software that relies on the Shannon-Weiner function to estimate species diversity. The function uses the number of species in a community and the proportion of the total sample belonging to each species to calculate diversity. This is used because, as the number of species within a community increases, the index value will increase as well. In other words, if all members of the community belonged to the same species, the value obtained from this function for diversity would be zero. The index is useful in allowing comparisons of diversity to be made between communities. For example, if two communities with the same number of individuals and species were compared, the one with the most individuals belonging to the same species would have the lower index value. Although the Shannon-Weiner function is popular for estimating species diversity, its use as a measure of diversity in theoretical situations has been criticized. However, studies of its effectiveness in empirical situations have found the function to be satisfactory for computing species diversity (Krebs, 1998).

Population density estimates were not made in this study for the overall abundance of rodents on the entire property as well as for each habitat type was too low to yield significant data from mark-recapture studies.

Vegetative Sampling---Vegetational data were taken from White (2003). His study used vegetative surveys conducted along 25 permanent line transects to obtain quantitative information on the density of woody species, horizontal visual obscurity, canopy cover of woody biomass, and percent ground cover of herbaceous vegetation. Vegetative sampling was performed once each season over the course of a year. The procedure used was a modified line-intercept method: three sample transects of 100 m in length separated by 120° were extended along a straight line from a fixed point in each permanent survey plot. All woody species that intercepted this line were recorded, and a 10 m x 10 m quadrat was used to determine the density of each woody species. This was measured only once at the beginning of the study and initially used to characterize the site into five different habitat types: open grassland, ponds, loblolly pine-dominated woodlands, post and blackjack oak-dominated forests, and loblolly pine-oak mixed woodlands. At all 25 sites each season, horizontal visual obscurity below 2.5 m was measured using a vegetative profile board (VPB) according to Nudds (1977). Ground and canopy cover were estimated for different classes of vegetation. For predominantly wooded sites, canopy coverage of woody species was estimated using a spherical densiometer along the line transect once during each season. For non-woody species in the five open grassland sites, a Daubenmire rectangular frame (25 cm x 100 cm) was placed on the ground at two points along the survey line, and all plants within the frame were identified to species and

classified as grass, forb, or sedge. Each plant then was classified as either native or exotic. Percent ground cover for each site was estimated from these data with respect to the five classifications that had been established.

CHAPTER III

DESCRIPTION OF HABITATS

After analysis of the data, it was determined that GLR contains four not five distinct ecological habitat types through PCA analysis (White, 2003): pond areas, open grassland sites, loblolly pine-dominated woodlands, and post and blackjack oak-juniper mixed forests (Appendix B). The pond sites occupy about 1% of the total acreage at GLR. There is one pond in a grassland habitat and one in an oak-juniper mixed habitat type. The remaining three ponds are located in the pine-dominated habitats.

The grassland sites occupy circa 16% of the total acreage of the ranch. These areas are dominated by introduced grasses such as Bahia grass (*Paspalum notatum*) and Bermuda grass (*Cynodon dactylon*). In fact, only 30% of the herbaceous vegetation along these sample transects was found to be native. The expected native species of Indiangrass was never observed at GLR in the grassland sites, and both little bluestem and switchgrass were found only rarely (White, 2003). These data attest to the fact that GLR has been used extensively within the last ten years for cattle grazing (Bich et al., 1995; Jones and Bock, 2003).

All remaining sites on the property are woodlands and have not been harvested for lumber for at least 30 years. Due to the historical timber management, most trees in these areas are of a similar age (Phelan, 1976). This, as well as the large amount of pine

debris, excessive shading, and fire suppression often employed at these sites cause the forest floor to be almost devoid of both new tree growth and herbaceous ground cover (Gavin et al., 1999; White, 2003). The little ground cover that is present is almost exclusively panic grasses (*Dichanthelium* spp.); however, the native species of little bluestem was relatively abundant along two of the oak-juniper sample transects. Although loblolly pines and blackjack and post oaks are considered some of the dominant native plants for this region of Texas, these species have increased above their historical proportion at the ranch. By contrast, the native species of hackberry (*Celtis* spp.) and elm (*Ulmus* spp.) trees that are expected at GLR are not abundant at all. These changes also are most likely the result of a combination of over-grazing, timber harvesting, and fire suppression on the property (Bich et al., 1995; Gavin et al., 1999; White, 2003).

The pine-dominated woodland sites occupy about 58% of the property and are situated on the eastern and southern parts of the ranch. In these areas, loblolly pines account for well over 50% of the woody vegetation. The fourth habitat type, the oak-juniper mixed forest, lies in the northwestern portion of the property. At these sites, oaks account for well over 50% of the total woody vegetation present while juniper accounts for only 20% to 40%. The oak-juniper sites cover about 25% of the property.

CHAPTER IV

RESULTS AND DISCUSSION

Relative Abundance--- In this study, I verified the presence of 19 mammalian species at GLR. None were exotic. Using the available literature, an additional seven mammal species were noted as being extirpated from the area, and 31 mammalian species (including six introduced ones) were identified as being of possible occurrence at the ranch (Table 1). In all, 42 *Peromyscus leucopus*, 25 *Baiomys taylori*, 13 *Chaetodipus hispidus*, 6 *Sigmodon hispidus*, and 4 *Reithrodontomys fulvescens* were captured during the study, giving a total abundance at GLR of 2.5 individuals collected per 100 trap-nights. By comparison, studies have found abundance values for rodents in the neighboring Edwards Plateau Region to be about 2.85 individuals captured per 100 trap-nights and in the Trans-Pecos Region to be as high as 3.65 individuals captured per 100 trap-nights (Becker, 1998; Wu et al., 1996). Of the five small rodent species captured along the permanent survey lines at the ranch, only two (*B. taylori* and *C. hispidus*) were unique to one habitat type (open grassland). The remaining three rodent species occurred in multiple habitats. However, only *P. leucopus* and *R. fulvescens* were captured along transects in all three habitat types. From no single sample transect were all five small

Table 1. The following mammalian species are reported in the literature as having current or historical distribution within or bordering GLR (Davis and Schmidly, 1994). The status of mammalian species is denoted by an X: V=verified; P=possible occurrence; E=extirpated species. Geographic range is denoted in the following manner: SW=statewide; TP=Trans-Pecos including the mountain and basin country west of the Pecos River; PC=Plains Country including the High Plains, Rolling Plains, Cross Timbers, and the Edwards Plateau; ET=East Texas including the Pineywoods, Central Texas Woodlands, Blackland Prairies, and Coastal Prairies and Marshes; RGP=Rio Grande Plains including the South Texas Brushlands; and EM=east of the 100th meridian. Non-native species are not included in the geographic distribution.

Species	Common Name	V	P	E	Geographic Range
Didelphis virginiana	Virginia Opossum	X			SW
Blarina carolinensis	Southern Short-tailed Shrew		X		ET
Blarina hylophaga	Elliot's Short-tailed Shrew	X			EM
Cryptotis parva	Least Shrew	X			EM
Scalopus aquaticus	Eastern Mole	X			EM
Myotis velifer	Cave Myotis Bat		X		TP, PC, RGP
Lasionycteris noctivagans	Silver-haired Bat		X		SW
Pipistrellus subflavus	Eastern Pipistrelle		X		EM
Eptesicus fuscus	Big Brown Bat		X		TP, PC, ET
Lasiurus borealis	Eastern Red Bat		X		SW
Lasiurus cinereus	Hoary Bat		X		SW
Lasiurus intermedius	Northern Yellow Bat		X		EM
Nycticeius humeralis	Evening Bat		X		EM
Tadarida brasiliensis	Brazilian Free-tailed Bat		X		SW
Nyctinomops macrotis	Big Free-tailed Bat		X		TP, PC, RGP
Dasypus novemcinctus	Nine-banded Armadillo	X			EM
Sylvilagus aquaticus	Swamp Rabbit		X		ET
Sylvilagus floridanus	Eastern Cottontail	X			SW
Lepus californicus	Black-tailed Jackrabbit		X		SW

Table 1. (cont.)

Species	Common Name	V	P	E	Geographic Range
Spermophilus tridecemlineatus	Thirteen-lined Ground Squirrel		X		PC, ET
Sciurus carolinensis	Gray Squirrel	X			ET
Sciurus niger	Eastern Fox Squirrel	X			EM
Glaucomys volans	Flying Squirrel		X		ET
Geomys attwateri	Attwater's Pocket Gopher	X			ET
Chaetodipus hispidus	Hispid Pocket Mouse	X			SW
Castor canadensis	American Beaver		X		SW
Reithrodontomys fulvescens	Fulvous Harvest Mouse	X			SW
Reithrodontomys montanus	Plains Harvest Mouse		X		TP, PC, ET
Peromyscus leucopus	White-footed Mouse	X			SW
Peromyscus maniculatus	Deer Mouse		X		SW
Baiomys taylori	Northern Pygmy Mouse	X			EM
Sigmodon hispidus	Hispid Cotton Rat	X			SW
Neotoma floridana	Eastern Woodrat		X		EM
*Rattus norwegicus**	Norway Rat		X		
*Rattus rattus**	Roof Rat		X		
*Mus musculus**	House Mouse		X		
*Myocastor coypus**	Nutria		X		
Canis latrans	Coyote	X			SW
Canis lupus	Gray Wolf			X	TP, PC, RGP
Canis rufus	Red Wolf			X	EM
*Vulpes vulpes**	Red Fox		X		
Urocyon cinereoargenteus	Gray Fox		X		SW
Ursus americanus	Black Bear			X	SW
Bassariscus astutus	Ringtail		X		SW

Table 1. (cont.)

Species	Common Name	V	P	E	Geographic Range
Procyon lotor	Common Raccoon	X			SW
Mustela frenata	Longtail Weasel		X		SW
Mustela vison	Mink			X	EM
Taxidea taxus	American Badger		X		SW
Lontra canadensis	River Otter		X		PC, RGP, ET
Spilogale putorius	Eastern Spotted Skunk	X			EM
Mephitis mephitis	Striped Skunk	X			SW
Puma concolor	Mountain Lion			X	SW
Panthera onca	Jaguar			X	EM
Lynx rufus	Bobcat		X		SW
*Sus scrofa**	Feral Pig		X		
Odocoileus virginianus	White-tailed Deer	X			SW
Antilocapra americana	Pronghorn			X	TP, PC, RGP

rodents collected (Table 2).

Examining all habitats and line transects, *P. leucopus* was the dominant small rodent species at Griffith League Ranch; however, this mouse only was collected once during the study along a sample transect in the open grassland. The OJ5 habitat had the highest relative abundance of this rodent with a value of 3.2 individuals captured per 100 trap-nights. *B. taylori*, on the other hand, had the highest abundance value (5.6 individuals collected/100 trap-nights) along the OG2 line transect. In fact, this site had the highest total abundance of small mammals at the ranch with a value of 7.4 individuals collected per 100 trap-nights. The OJ6 habitat had the lowest total abundance (0.0 individuals captured/100 trap-nights) for no rodents were collected during along this line transect. Species occurrence and relative abundance by habitat type are presented in Table 2.

Species Richness---Species richness was compared at all permanent line transects excluding OJ6 at which no specimens were collected. Of the remaining 24 sites, OG3 had the highest species richness value (3.6667). The OG2 and OG5 line transects ranked second and third in species richness with values of 3.50 and 3.0, respectively. The remaining permanent survey lines had low species richness with values at or around 1.0 because only one or two rodent species were collected at each of these sites. Overall, species richness was much higher in all the open grassland sites at Griffith League Ranch (3.3109) than at either the oak-juniper mixed or pine-dominated transects (1.4545 and 2.0160, respectively).

Table 2. Results of the live-trap study on GLR for all habitat types. Numbers in parentheses indicate the total number of individuals of that species collected during the experiment. The remaining numbers indicate relative abundance of the species for each habitat type expressed as the number of individuals captured per 100 trap-nights. Abbreviations are as follows: OG=open grassland habitat; LP=loblolly pine-dominated habitat; OJ=post and blackjack oak-juniper mixed habitat.

	GRASSLAND HABITAT TYPE					
Species	OG1	OG2	OG3	OG4	OG5	OG_{TOTAL}
C. hispidus (13)	1.0	0.6	0 4	0 9	5 3	1.4
R.. fulvescens (4)	0.5		0 4			0.2
P. leucopus (42)		0 6				0 1
B. taylori (25)		5.6	2.9	5.2	1.3	2.8
S. hispidus (6)	0 5	0 6	0.7		0 7	0.6
Total	2 0	7.4	4.4	6 1	7 3	5 1

Table 2. (cont.)

	WOODED HABITAT TYPES																
Species	OJ1	OJ2	OJ3	OJ4	OJ5	OJ6	OJ_{TOTAL}	LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LP9	LP_{TOTAL}
C. hispidus (13)																	
R. fulvescens (4)				0.7			0 1									0.7	0.1
P. leucopus (42)	2.2	2 9	2 2	1.4	3.2		2.1	0.4	0.6	1.0	2 6	1.5	1 9	0 6	1.1	1.5	1 2
B. taylori (25)																	
S. hispidus (6)														0 6			0.1
Total	2.2	2.9	2 2	2 1	3.2	0.0	2 2	0.4	0.6	1.0	2.6	1.5	1.9	1.2	1 1	2.2	1.4

Species Diversity---Species diversity was compared at all permanent survey lines excluding OJ6 at which no individuals were collected. Species diversity ranged from 0.0 to 4.0 for each sample transect. The most diverse habitat was OG1, while the OG2 and OG3 transects in the open grassland areas both had diversity values of 2.0994. The OG5 survey line had a diversity value of 1.2832. All remaining sites had diversity values at or near 0.0, for only one or two species were captured along these transects. As with species richness, overall diversity was highest in the open grassland habitats (1.4271) and lower in the both the oak-juniper mixed and pine-dominated habitats (0.9210 and 0.9384, respectively).

Comparison of Habitat Types---The open grassland habitat had the highest abundance value. Also, all species captured at GLR were collected at least once during the yearlong study in one of the five open grassland sites. *B. taylori* was the most commonly collected rodent in the grassland habitat with a relative abundance of 2.8 individuals captured per 100 trap-nights. The next most abundant species was *C. hispidus* with a relative abundance of 1.4 individuals collected per 100 trap-nights. Of the five grassland sites, OG2 and OG5 had the highest total abundance values with 7.4 and 7.3 individuals captured per 100 trap-nights, respectively (Table 2). The grassland habitat had between approximately 60% to 90% ground cover depending on the season and low plant species diversity, providing limited food and cover for most rodent species (White, 2003). In addition, imported red fire ants (*Solenopsis invicta*) were abundant at these sites, possibly decreasing and/or altering the overall abundance of small rodents when fire ant activity was high during spring and summer (Lechner and Ribble, 1996; Pederson et al., 2003).

The oak-juniper mixed habitat type had the higher overall abundance values of the two forested habitat types at the ranch (2.2 individuals captured/100 trap-nights). With the exception of one *R. fulvescens* that was captured during the fall along transect OJ4, the only small mammal collected at these sites was *P. leucopus* (2.1 individuals captured/100 trap-nights) (Table 2). Although native oaks and junipers dominate these habitats, the presence of large loblolly pine trees at these sites (from 11% to 43% of the canopy cover) probably accounted for some of the low abundance of small mammals along these transects. The large amount of pine litter on the forest floor and shading created by these pines cause a lack of substantial native ground cover to grow in these areas, providing limited suitable habitat to most rodent species (White, 2003). This problem has been exacerbated by the often employed practice of fire suppression on the property (Gavin et al., 1999).

The remaining nine sites were classified as pine-dominated habitats. At these sites, three species were collected (*P. leucopus*, *R. fulvescens*, and *S. hispidus*) with an overall abundance value of 1.4 individuals captured per 100 trap-nights. *P. leucopus* was more abundant than the other two rodent species; however, this mouse had a low abundance value of 1.2 individuals captured per 100 trap-nights. Interestingly, survey line LP4 had a significantly higher total abundance (2.6 individuals collected/100 trap-nights) than did any of the other pine-dominated sites (Table 2). This transect also had the greatest percent canopy cover of yaupon (*Ilex vomitoria*) (White, 2003). Like the oak-juniper sites, the species diversity and abundance in the pine habitat also suffered from the excessive shading and debris created by pine trees as well as the widely used practice of fire suppression at the ranch (Gavin et al., 1999; White, 2003). Here the effect

was much more pronounced as the overall abundance of rodents along these transects was about 2/3 of what it was along transects in the oak-juniper mixed habitats.

Comparison Across Seasons---Fall had the greatest overall abundance of any season at GLR (9.8 individuals captured/100 trap-nights). The open grassland sites had the highest relative abundance during this season with 6.0 individuals captured per 100 trap-nights. The oak-juniper habitat had one-half this abundance during the fall (3.1 individuals/100 trap-nights), while the pine habitat had an abundance of only 0.7 individuals collected per 100 trap-nights. The winter also had higher overall abundance values (9.4 individuals captured/100 trap-nights) than did either the spring or summer in all habitat types. The open grassland sites had the highest abundance of rodents during this season (4.7 individuals collected/100 trap-nights), while the oak-juniper and pine-dominated sites had significantly lower values (2.9 and 1.8 individuals captured/100 trap-nights, respectively) (Table 3).

The spring and summer seasons had much lower overall abundance values (7.6 and 7.5 individuals captured/100 trap-nights, respectively) than did either the winter or fall. During both of these seasons, the open grassland sites had the highest relative abundance values, each with 4.8 individuals collected per 100 trap-nights. However, in the spring, the habitat with the second greatest relative abundance values was pine-dominated (1.6 individuals captured/100 trap-nights), while, in the summer, it was the oak-juniper mixed habitat at 1.1 individuals per 100 trap-nights that had the next highest abundance values (Table 3).

It is unlikely that this pattern is due solely to the reproductive cycle of the small

Table 3. Results of the live-trap study on GLR for all seasons. Numbers in parentheses indicate the total number of individuals of that species captured during the experiment. The numbers in the table indicate relative abundance of the species for each habitat type expressed as the number of individuals captured per 100 trap-nights. Abbreviations are as follows: OG=open grassland habitat; LP=loblolly pine- dominated habitat; OJ=post and blackjack oak-juniper mixed habitat.

	SEASON											
Species	Winter Habitats			Spring Habitats			Summer Habitats			Fall Habitats		
	OG	LP	OJ	OG	LP	OJ	OG	LP	OJ	OG	LP	OJ
C. hispidus (13)	1.1			1 4			1.6			1 7		
R.. fulvescens (4)				0 5				0 2		0 4		0 4
P. leucopus (42)		1.8	2.9		1.6	1 2	0 4	1 1	1.4		0.5	2 7
B. taylori (25)	3.6			2 4			2 4			2.6		
S. hispidus (6)				0.5			0 4			1.3	0.2	
Totals	4.7	1.8	2.9	4 8	1.6	1.2	4.8	1.3	1.4	6 0	0 7	3 1

rodents at the ranch as all the species collected are known to breed throughout the year (Davis and Schmidly, 1994). Instead, it is probably due to a combination of factors, including the length of the night, percent of overcast and rainy nights within the season, activity of fire ants. The nights were longer and a greater proportion of them were overcast and rainy during the fall and winter seasons, providing nocturnal species, such as the rodents at GLR, optimal cover. However, it also has been reported in the literature and I observed that the activity level of the fire ants was significantly higher during spring and summer than fall and winter (Lechner and Ribble, 1996; Pederson et al., 2003).

CHAPTER V

ACCOUNTS OF SPECIES

The following 18 accounts of mammal species inhabiting GLR are based on mammals collected or observed during the yearlong study. Habitat preferences observed at GLR are included in each account. Additional information for each species is presented from the appropriate scientific literature (Davis and Schmidly, 1994; Schmidly, 1983). The arrangement of taxa and nomenclature follow Hall (1981) and Manning and Jones (1998).

Didelphis virginiana virginiana
Kerr, 1792
Virginia Opossum

The opossum was observed only once at GLR near the house and outbuildings on the property. However, the caretaker of the ranch has observed this marsupial many times in previous years around these same areas. The opossum is primarily an inhabitant of deciduous woodlands but also is found in prairies, marshes, and farmlands as well as in close association with man (Davis and Schmidly, 1994).

Blarina hylophaga hylophaga
Elliot, 1899
Elliot's Short-tailed Shrew

At GLR, the Elliot's short-tailed shrew was collected with pitfall traps at the open grassland sites near the oak-juniper mixed and pine-dominated habitat types and confirmed by genetic karyotyping (Morris, 2003). As this shrew is difficult to distinguish from *B. carolinensis* except by karyotype, it has only been verified in three Texas counties to date: Bastrop, Aransas, and Montague. In this county, the specimen was collected in grassy vegetation with an overstory of loblolly pine trees (Davis and Schmidly, 1994).

Cryptotis parva parva
Say, 1823
Least Shrew

The least shrew was collected by Susannah Morris (2003) at GLR in pitfall traps placed in the open grassland areas in oak-juniper mixed habitat types. These shrews usually inhabit open fields and prairies, using the surface runways of grassland rodents, especially those of the *Sigmodon* species (Davis and Schmidly, 1994). This is a new record for Bastrop County.

Scalopus aquaticus alleni
Baker, 1951
Eastern Mole

Although the eastern mole was neither captured nor observed at GLR, the mounded entrances to this species' burrow were found in several of the open grassland sites, especially as they merged into the forested regions. In East Texas, these mammals

prefer loose, well-drained soils, such as those found in sandy floodplains and stream banks, and the light loamy soils of grasslands, pastures, and woodlands. They tend to avoid heavy clay or stony soils (Schmidly, 1983).

Dasypus novemcinctus mexicanus
Peters, 1964
Nine-banded Armadillo

The nine-banded armadillo was neither collected nor observed during this study. In addition, no armadillo burrows were discovered; however, their workings (digging) were observed numerous times during the spring in the sandy soils around the ponds at GLR. In general, armadillos prefer wooded riparian areas, but they do occur in habitats ranging from swampy to relatively dry (Schmidly, 1983).

Sylvilagus floridanus alacer
Bangs, 1896
Eastern Cottontail

The eastern cottontail was not collected on the property; however, it was observed at GLR near the edge of one of the grassland sites. This species is a denizen of brushlands and marginal areas, such as old fields, grassy valleys, agricultural regions, edge habitats, mesquite grasslands, and other scrub areas (Davis and Schmidly, 1994).

Sciurus carolinensis carolinensis
Gmelin, 1788
Eastern Gray Squirrel

The eastern gray squirrel was observed several times in the oak-juniper mixed wooded areas at GLR. They were usually observed in forested areas with a high post and

blackjack oak concentration. Gray squirrels commonly live in dense stands of oak trees mixed with hickories as these nuts comprise the bulk of this squirrel's diet (Davis and Schmidly, 1994). This is a new record for Bastrop County.

Sciurus niger ludovicianius
Custis, 1806
Eastern Fox Squirrel

The eastern fox squirrel was observed often in the oak-juniper mixed and pine-dominated habitat types at GLR. This species was also noted near the house and outbuildings on the property. The optimal habitat for these fox squirrels appears to be a mixed forest of mature oak and hickory trees broken into small, irregularly shaped tracts and connected by strips of woodland (Davis and Schmidly, 1994).

Geomys attwateri
Merriam, 1895
Attwater's Pocket Gopher

Although no pocket gophers were collected or observed during the study, this mammal's presence was verified by observation of gopher holes and workings on the property. This species typically occurs in sandy soils, such as that found at GLR, where the topsoil is 10 cm or more in depth. Clay soils are usually avoided. (Davis and Schmidly, 1994).

Chaetodipus hispidus hispidus
Baird, 1858
Hispid Pocket Mouse

The hispid pocket mouse was collected from all of the open grassland sites at the ranch over the course of the yearlong study. However, it was most abundant along transect OG5 at the eastern edge of the property. These pocket mice prefer habitats with sandy soils covered with scattered to moderate stands of herbaceous vegetation, such as the grassland sites at Griffith League Ranch, and avoid areas of dense grass and brush cover (Davis and Schmidly, 1994). This is a new record for Bastrop County.

Reithrodontomys fulvescens aurantius
J.A. Allen, 1895
Fulvous Harvest Mouse

The fulvous harvest mouse was collected from several different habitat types at GLR but always near an edge between two habitat types. This mouse is one of the most abundant species of rodent in eastern Texas, occurring principally in fields or ecotones between grass and deciduous/coniferous forests (Schmidly, 1983). This is a new record for Bastrop County.

Peromyscus leucopus leucopus
Rafinesque, 1818
White-footed Mouse

The white-footed mouse was the most abundant rodent species on the property and was found in all three habitat types trapped. However, this species was captured only once during the study at any of the grassland sites; all other collections came from the two wooded habitat types. In addition, it was almost twice as common in the oak-juniper

mixed habitat than it was along all the pine-dominated transects. In general, these mice are most abundant in East Texas in woodlands and bottomlands and are almost completely absent from prairie lands (Davis and Schmidly, 1994).

Baiomys taylori taylori
Thomas, 1887
Northern Pygmy Mouse

The northern pygmy mouse was the most abundant rodent species in the open grassland sites at GLR and, in fact, was found only in this habitat type. This species was most abundant along survey lines OG2 and OG5. Originally found only on the coastal prairies in Texas, this mouse has expanded its range along grassland corridors opened by agriculture in the oak-hickory forests. They prefer grassy areas such as old fields, pastures, and highway right-of-ways. This species usually occurs in association with *Sigmodon hispidus* (Schmidly, 1983).

Sigmodon hispidus texianus
Audubon and Bachman, 1853
Hispid Cotton Rat

The hispid cotton rat was collected primarily from the open grassland habitats at GLR, but one sample was taken from a pine-dominated habitat. It was equally abundant along all the grassland transects (with the exception of the OG4 survey line from which it was not collected). In eastern Texas, the cotton rat has been noted in all vegetative regions. During favorable conditions, it can be present in greater numbers at a site than any other native Texas mammal (Schmidly, 1983).

Canis latrans frustrur
Woodhouse, 1851
Coyote

In the Lost Pines area, coyotes generally occupy woody vegetation that is broken by open or cultivated fields (Schmidly, 1983). Only one was observed on the property crossing an open grassland site at dusk; however, their scat was found several times along the roadways and in the wooded areas of the property.

Procyon lotor fuscipes
Mearns, 1914
Common Raccoon

Raccoons were numerous at GLR and were observed in all habitat types. Common raccoons are primarily inhabitants of broadleaf woodlands, but they also are common in mixed-pine forests. In addition, they are found in riparian areas, cultivated and abandoned farmlands, and around human habitations. However, they rarely occur far from water (Davis and Schmidly, 1994).

Mephitis mephitis mesomelas
Lichenstein, 1832
Striped Skunk

Although this skunk was neither collected nor observed at the ranch during this study, they were noted as road kill along the highways leading to the property. This mustelid is the most common in Texas, inhabiting wooded and brush habitats as well as rocky outcrops. However, when these sites are absent, the striped skunk will seek out and use the burrows of other animals, such as those of armadillos or foxes (Davis and Schmidly, 1994).

Spilogale putorius interrupta
Rafinesque, 1820
Eastern Spotted Skunk

This mustelid was not observed or collected at GLR during this study; however, one dead specimen (too damaged to salvage) was found along a roadway near the site. Closely resembling *M. mephitis*, the spotted skunk is much more active than *M. mephitis* and occurs largely in wooded areas and tall-grass prairies. Also, it is found often in close association with humans, burrowing in farmlands and under houses (Davis and Schmidly, 1994).

Odocoileus virginianus texana
Mearns, 1898
White-tailed Deer

White-tailed deer, though the only cervid seen on the property during the study, was far from common. However, they were observed in all habitats on GLR. In general, these deer occur in all vegetation types with the highest numbers usually in timbered areas, especially bottomland hardwoods (Schmidly, 1983).

CHAPTER VI

SPECIES OF POSTULATED OCCURRENCE

The following 32 accounts of mammalian species were reported in the literature as having historic or current distribution within or bordering GLR, but were neither collected nor observed during the study (Davis and Schmidly, 1994; Schmidly, 1983). The mammals may be found to exist at the ranch upon further census activities at the site.

Blarina carolinensis minima
Lowery, 1943
Southern Short-tailed Shrew

The distribution of this shrew is primarily the eastern one-fourth of Texas; however, there was one record of this mammal from Bastrop State Park in Bastrop County (Davis and Schmidly, 1994). Recent work, though, suggests that this was most likely a misidentification of a *B. hylophaga* specimen rather than a *B. carolinensis minima* (Morris, 2003). This short-tailed shrew occurs in forested areas and their associated openings. Lack of adequate food and cover has probably excluded this insectivore from GLR.

Myotis velifer incautus
J.A. Allen, 1896
Cave Myotis

This bat roosts in rock crevices, old buildings, carports, under bridges, and in abandoned cliff swallow nests, and they appear shortly after sunset. Records of occurrence do exist for Bastrop County (Davis and Schmidly, 1994).

Lasionycteris noctivagans
Le Conte, 1831
Silver-haired Bat

The silver-haired bat is an exclusive tree dweller, using xeric areas only during migration. It roosts in tree cavities, spaces under loose bark, caves, rock crevices, and buildings (Davis and Schmidly, 1994). In addition, it is to be looked for during the spring and fall migration (McGee and Manning, 2000). This bat is broadly but erratically distributed across North America and Texas; the nearest known records of occurrence are from Medina and San Saba counties to the west of Bastrop County (Davis and Schmidly, 1994).

Pipistrellus subflavus subflavus
F. Cuvier, 1832
Eastern Pipistrelle

The eastern pipistrelle is known to use such daytime retreats as caves, deep crevices, buildings, and other man-made structures offering concealment and is associated primarily with woodland areas. Records for this bat are available for the adjacent counties of Williamson and Travis (Davis and Schmidly, 1994).

Eptesicus fuscus fuscus
Palisot de Beauvois, 1796
Big Brown Bat

The big brown bat is not particularly widespread in eastern Texas, occurring only in pine-oak forests and long-leaf pine vegetational regions, roosting in loose bark and tree cavities. The nearest known records are from Bexar and McLennan counties (Schmidly, 1983).

Lasiurus borealis
Müller, 1776
Eastern Red Bat

There are no records of this bat in Bastrop County; however, it has been found in adjacent Travis County. However, the eastern red bat is one of the most common bats in eastern Texas, occurring in all major vegetation regions. It favors wooded areas, including pine, mixed pine-hardwood, oak, and riparian forests (Schmidly, 1983).

Lasiurus cinerus cinerus
Palisot de Beauvois, 1796
Hoary Bat

The hoary bat has a statewide distribution, but is relatively rare. Few records exist from the Lost Pines region as well as the surrounding areas. While there is currently no record of this species from Bastrop County, records do exist for neighboring Travis County. This bat is migratory and frequents wooded areas where it roosts in the open by hanging from a branch or twig (Davis and Schmidly, 1994). It is likely to occur in Texas during the summer and fall as it migrates through the area (McGee and Manning, 2000).

Lasiurus intermedius floridanus
Miller, 1902
Northern Yellow Bat

Little is known about the northern yellow bat. However, its distribution appears to coincide with that of the Spanish moss in which it roosts. This probably explains the lack of occurrence of this bat at the ranch (if, in fact, they are not present), for there is little Spanish moss on the site. No records exist of this species for Bastrop County; however, it has been found in Travis County immediately to the west (Davis and Schmidly, 1994).

Nycticeius humeralis humeralis
Rafinesque, 1818
Evening Bat

The evening bat frequently is found in forested areas and watercourses, utilizing the available hollow trees as roosting sites and nurseries. However, these bats also will use attics and other man-made structures as roosts if natural sites are unavailable. Specimens have been collected year round and as close to GLR as Travis and Guadalupe counties; however, no records exist for Bastrop County (Davis and Schmidly, 1994).

Tadarida brasiliensis mexicana
Saussure, 1860
Brazilian Free-tailed Bat

The Brazilian free-tailed bat has not been recorded in Bastrop County; however, records of occurrence do exist for the neighboring county of Travis. In eastern Texas, these bats exclusively reside in buildings without regard to the site, style, age, repair, or human use of it. They are best observed shortly before or after sunset (Schmidly, 1983).

Nyctinomops macrotis
Gray, 1839
Big Free-tailed Bat

The big free-tailed bat has only been recorded in Brazos and Matagorda counties. It is rare in collections and appears to prefer rugged, rocky country in both low- and upland habitats (Davis and Schmidly, 1994). This preference probably accounts for their lack of occurrence at GLR if, in fact, they do not occur there.

Sylvilagus aquaticus
Bachman, 1837
Swamp Rabbit

The swamp rabbit inhabits poorly drained river bottoms and coastal marshes. These rabbits are found in eastern Texas, but there are no records of occurrence for Bastrop County (possibly due to a lack of suitable habitat in the area). The adjacent county of Travis, however, does have a record of this lagomorph (Davis and Schmidly, 1994).

Lepus californicus merriami
Mearns, 1890
Black-tailed Jackrabbit

The black-tailed jackrabbit is rare in the oak-hickory and pine-oak regions of eastern Texas, occurring only in prairie-type communities with black clayey soils. While these types of habitats do not occur at GLR, this jackrabbit has been recorded at other locations in Bastrop County (Schmidly, 1983).

Spermophilus tridecemlineatus texensis
Merriam, 1898
Thirteen-lined Ground Squirrel

These ground squirrels are most common in the Texas Panhandle, reaching the eastern limits of their distribution in East Texas. In this region, they are found in grasslands as well as in golf courses, cemeteries, and parks. As timber has been cut in the Post Oak Woodlands, this species has successfully established new colonies in the sandy soils of pastures, fencerows, and the borders of highways in this area (Schmidly, 1983). Bastrop County is on the edge of this species distribution, but records do exist for Guadalupe County to the east (Davis and Schmidly, 1994).

Glaucomys volans texensis
Howell, 1915
Southern Flying Squirrel

Flying squirrels are found throughout the forested regions of eastern Texas (except for that portion south of the Colorado River) and in wooded areas along the streams of the coastal prairie. They occur in both low- and upland deciduous wooded habitats, and their abundance seems to be controlled more by the quantity of hollow trees for nesting and available food than by the tree species involved. Griffith League Ranch is at the edge of this rodent's distribution in Texas, but records do exist for Bastrop County (Schmidly, 1983).

Castor canadensis texensis
Bailey, 1905
American Beaver

Beavers are essentially aquatic, occurring in ponds, streams, lakes, or rivers. Although large rivers and lakes offer suitable habitats, beavers seem to prefer smaller bodies of water, such as narrow creeks, tributaries leading into major rivers, and small ponds. Virtually extirpated by the end of the nineteenth century, the beaver population has rebounded within the last 75 years as a result of the decline in the value of beaver pelts and the reintroduction of the species to places from which they had disappeared. However, there are no records for Bastrop County (Schmidly, 1983).

Reithrodontonys montanus griseus
Bailey, 1905
Plains Harvest Mouse

The plains harvest mouse is limited to the western portion of eastern Texas in the blackland prairie region. It most commonly occurs in prairie communities and in old fields where dense stands of bluestem grow on dark prairie soils. The lack of such habitat probably explains this rodent's lack of occurrence at GLR, if indeed they are not present. In fact, there are no records of this mouse for Bastrop County (Schmidly, 1983).

Peromyscus maniculatus pallesceus
J.A. Allen, 1896
Deer Mouse

The deer mouse is not known from Bastrop County; however, records of occurrence do exist for the adjacent counties of Travis, Williamson, and Caldwell. In general, this species occupies a variety of habitats ranging from mixed forests to open

grasslands. However, weed-choked fencerows appear to offer almost ideal habitat (Davis and Schmidly, 1994).

Neotoma floridana attwateri
Mearns, 1897
Eastern Woodrat

This woodrat occupies both mixed woodlands and river bottoms. It normally uses underground burrows in the Lost Pines region of Texas, but it will resort to surface nests at the base of trees. However, records for this species do not exist in Bastrop County; the nearest counties with records are the adjacent ones of Williamson, Travis, and Caldwell (Davis and Schmidly, 1994).

Rattus norwegicus *
Norway Rat

This rat is common throughout Texas and lives as a commensal in close association with man (Davis and Schmidly, 1994). However, they also are found in or around human associations in rural areas (Manning and Jones, 1998). Feral populations primarily occupy vegetation that is tall and rank, unlike what is present at GLR. Records do exist, though, for Bastrop County (Schmidly, 1983).

Rattus rattus *
Roof Rat

Roof rats occur throughout eastern Texas in towns and on farms in close association with man and his structures. They may be found in grocery and drug stores, warehouses, theaters, poultry stores, cotton gins, grain warehouses, barns, and corncribs.

However, few roof rats have ever been found in farmhouses themselves, for this rat usually frequents the higher elevations found in rafters and crossbeams. Records of occurrence do exist for Bastrop County (Schmidly, 1983).

Mus musculus *
House Mouse

House mice usually live in close association with man. However, feral populations do exist in fields, watercourses, and other areas of dense vegetation. Regardless, records do not exist for Bastrop County. From the neighboring counties of Travis, Williamson, and Caldwell, on the other hand, feral populations have been documented (Schmidly, 1983).

*Myocastor coypus**
Nutria

This semiaquatic rodent, a native to South America, represents a recent addition to the fauna of eastern Texas. Nutria occupy a wide variety of aquatic habitats, including swamps and marshes as well as the shores of rivers and lakes. They frequent both salt and fresh water habitats. While no records exist for Bastrop County, there are records from the adjacent counties of Travis, Caldwell, Williamson, and Fayette (Schmidly, 1983).

Vulpes vulpes fulva
Desmaret, 1820
Red Fox

Records of occurrence for the red fox do exist for Bastrop County, Texas. In general, these carnivores favor mixed woodlands interspersed with farms and pastures, denning in underground burrows, in crevices of a rocky outcrop, or in cavities under boulders (Davis and Schmidly, 1994).

Urocyon cinereoargenteus floridanus
Rhoads, 1895
Common Gray Fox

The gray fox is an inhabitant of woodland areas, particularly mixed hardwood forests. It dens in rock crevices, underground burrows, and hollow logs and trees. This species is known from Bastrop County (Davis and Schmidly, 1994).

Bassariscus astutus flavus
Rhoads, 1894
Ringtail

Ringtails live in a variety of habitats within their range but do show a preference for rocky areas, such as rock piles, stone fences, and canyon walls. They occur less commonly in woodland areas and buildings, which probably explains their lack of presence at GLR. This species is known, however, from Bastrop County (Davis and Schmidly, 1994).

Mustela frenata arthuri
Hall, 1927
Long-tailed Weasel

Few specimens of long-tailed weasels have been collected in the Lost Pines region of Texas. The nearest record to GLR comes from Colorado County to the east. In general, these weasels occupy a variety of habitats, usually coinciding with the ranges of the pocket gophers and ground squirrels on which they prey (Davis and Schmidly, 1994).

Taxidea taxus berlandieri
Baird, 1858
American Badger

Although the badger is fairly common in the western and southern portions of Texas, it has only recently been recorded in eastern Texas. No records of occurrence for the badger yet occur in Bastrop County; however, the neighboring county of Travis does have records of this species. The badger prefers open country, such as prairies and plains, in areas with loose, sandy soils and tends to avoid rocky soils and heavily wooded areas (Schmidly, 1983).

Lontra candensis lataxina
F. Cuvier, 1823
Northern River Otter

Otters occur in marshes, freshwater swamps, and permanent streams and tributaries throughout eastern Texas. They occupy a variety of aquatic habitats as they are mobile and capable of changing locations at any time. Ideal habitat for the otter is a clear deep-water swamp, which supplies both food and shelter, adjacent to a large, log-filled, fish-producing lake, which furnishes additional food and abundant water for

swimming or playing. Although there are no records of this species from Bastrop County, the nearby counties of Colorado and Lavaca do have records of the otter (Davis and Schmidly, 1983).

Lynx rufus texensis
J.A. Allen, 1895
Bobcat

Bobcats occupy a variety of habitats, but they appear to prefer rocky canyons and outcrops. If these sites are unavailable as they are at GLR, however, bobcats will resort to thickets of pines, oaks, and junipers for protection and den sites. This species is known from Bastrop County (Davis and Schmidly, 1994).

*Sus scrofa**
Feral Pig

Feral hog habitat consists of diverse forests with some openings, a moderate litter layer to support soil invertebrates, and the presence of ground vegetation affording green forage, roots, and tubers. Hogs are also found on marsh and grass-sedge flats in East Texas, particularly if wild grapes are common. During hot summer months, "wallows," or depressions dug in the mud by feral hogs, are much in evidence near marshes or standing water (Schmidly, 1983).

CHAPTER VII

CONCLUSIONS

GLR, like many wooded areas of East Texas, has a history of both commercial harvesting and over-grazing. Although the property now is under the stewardship of the Boy Scouts of America, these deleterious activities continued until recently. While timber harvesting ceased about 30 years ago, over-grazing was only stopped within the last decade (Dr. M.J. Forstner, personal communication). Therefore, the ranch currently is in a state of recovery. Due to this as well as the overall low biodiversity of the Post Oak Woodlands and the Lost Pines region, both the open grassland and wooded sites at GLR are not diverse in terms of vegetation, both woody and herbaceous species. However, vegetation is essential for most animals, providing them with a mixture of plants to use as food, cover, and shelter. Thus, the low diversity of plant species at GLR lately has contributed to low mammal diversity as well.

Peromyscus leucopus was the most abundant small mammal at Griffith League Ranch, occurring is all habitat types. The relative abundance of this rodent did fluctuate with both season and habitat (Table 3). Though these mice are most common in the bottomlands of east-central Texas, they are found also in woodlands with post oaks, such as occur over much of the ranch (Davis and Schmidly, 1994).

Baiomys taylori, on the other hand, had the highest relative abundance values at GLR but were restricted to the five open grassland sites (Table 2). These mice are opportunistic, extending their original range of the coastal marshes to the include most of Texas today. They prefer grassy areas, especially old fields and pastures (Davis and Schmidly, 1994). This exemplifies the grassland sites at GLR and, thus, helps to account for their abundance.

The grassland sites at GLR represent isolated, biogeographic regions within the ranch. Although they occupy much less acreage than do the woodland sites, the grassland sites had much higher relative and total abundance values for the rodent species collected than did either of the other habitat types. Species richness and diversity were, however, quite low for these habitat types. Due in part to the low diversity of vegetation already discussed, the diversity and abundance of small mammals in the grassland sites at GLR also may have been severely impacted by the presence of imported red fire ants in these areas. These insects not only removed bait from traps, but also killed several of the small rodents that had been captured. Although there is some disagreement in the literature, it appears that fire ants may prevent or alter the establishment of both *B. taylori* and *Sigmodon hispidus* colonies (Lechner and Ribble, 1996; Pederson et al., 2003).

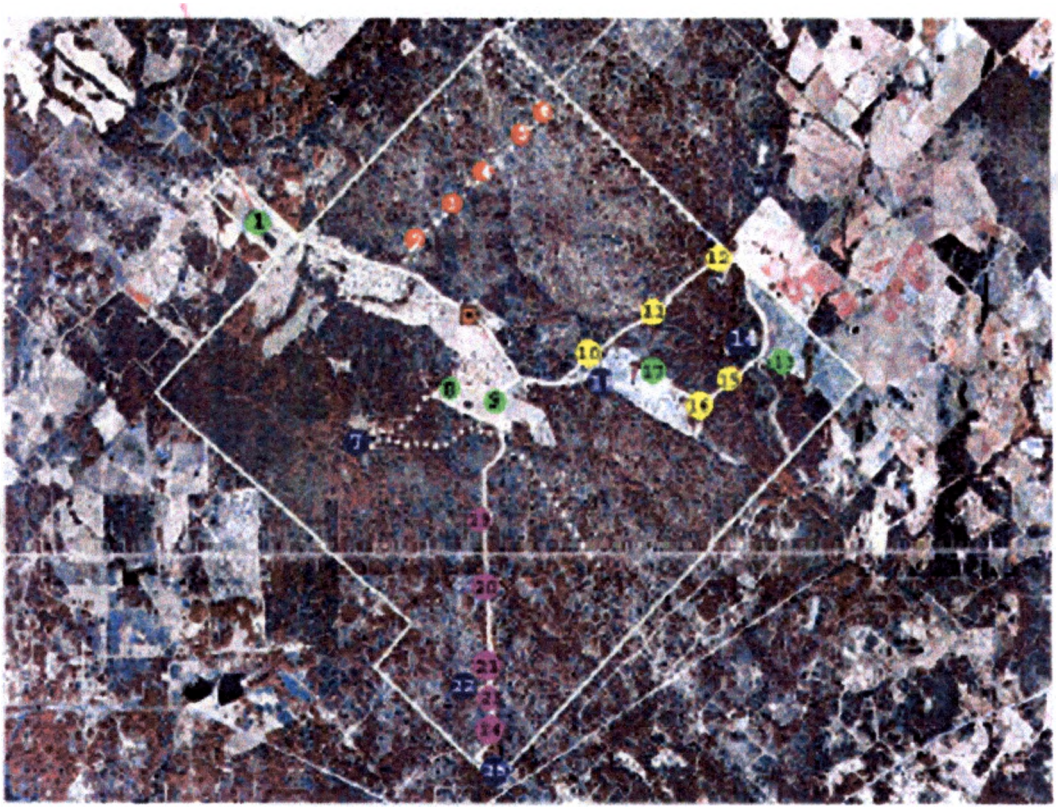
Fall and winter seasons had the highest total abundances during this yearlong study for all rodents collected with the exception of *P. leucopus*. This mouse had its highest total abundance during the spring. As all species captured breed continuously throughout the year, it is likely that other factors cause this pattern. Perhaps it is due to the longer nights, more rainy, overcast weather, or the lower predator/fire ant numbers usually observed during the winter and fall.

The proposed development of GLR by the Boy Scouts of America suggests considerable changes to the property, with most of this development occurring either in or along existing pasturelands. However, a large tract of land would be developed as a nature preserve to conserve some Lost Pines habitat. To increase biodiversity in this area as well as the rest of GLR, the plan includes the planting of native grasses, shrubs, and forbs at selected sites. Selective logging and reforestration of the wooded areas is proscribed to thin the forests, to increase diversity in tree ages, and to augment overall biodiversity. In addition, revegetation and fire management are suggested at the grassland sites to increase the abundance and diversity of native grasses and forbs. Fire management will be especially effective as the native flora and fauna of GLR are fire-adapted (Koeppe, 2001). Given the low levels of diversity and abundance at GLR today of plant and animal species, these actions should provide significant help fostering an increasing biodiversity on the property.

It is important to note that GLR still is in a period of substantial recovery. Before the Boy Scouts of America commence further development of the ranch, more mammalian research should be conducted along the permanent sample lines established at GLR. Differences in species composition, distribution, abundance, and diversity should be monitored and evaluated. Such future research both before and after development could be used to indicate habitat quality as well as the effectiveness of any management practices for improving the biodiversity of the native flora and fauna that will be or have been used at GLR.

APPENDIX A

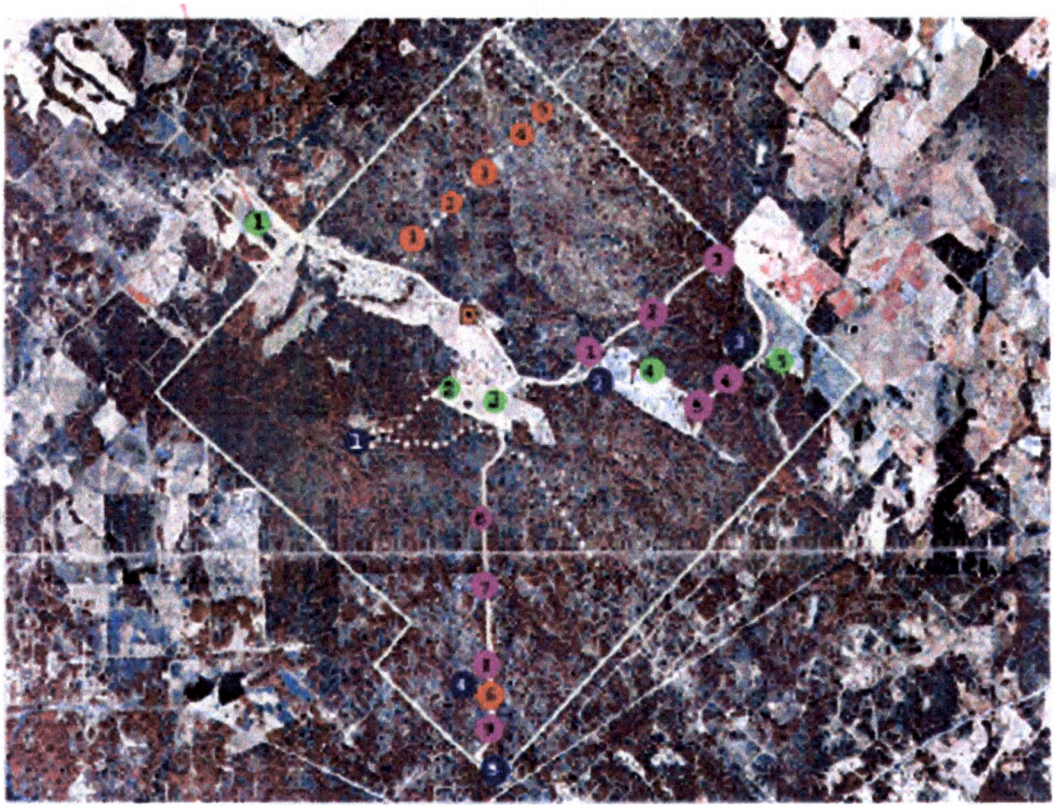
GRIFFITH LEAGUE RANCH



- Open Grasslands
- Oak/Juniper Mixed Habitats
- Loblolly Pine Habitats
- Mixed Habitats
- Pond Areas

APPENDIX B

GRIFFITH LEAGUE RANCH



- Open Grasslands
- Oak/Juniper Mixed Habitats
- Loblolly Pine-Dominated Habitats
- Pond Areas

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