SEASONAL DIETS OF GREATER KUDU (*TRAGELAPHUS STREPSICEROS*) IN THE LLANO UPLIFT ECOLOGICAL REGION OF TEXAS

THESIS

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ABSTRACT

SEASONAL DIETS OF GREATER KUDU (*TRAGELAPHUS STREPSICEROS*)

IN THE LLANO UPLIFT ECOLOGICAL REGION OF TEXAS

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I investigated the seasonal diets of greater kudu at Mason Mountain Wildlife Management Area (MMWMA) from May 2001 to February 2002 using microhistological analysis of fecal material. Forty-six fecal samples were collected during spring 2001 with 50 samples collected in each of the remaining seasons. Browse was the primary forage class utilized each season by greater kudu. Annually, the bulk of the diet was comprised of Texas/blackjack oak (*Quercus* spp.), live oak (*Q. fusiformis*), Ashe juniper (*Juniperus ashei*), mesquite (*Prosopis glandulosa*), prickly pear (*Opuntia* spp.) flameleaf sumac (*Rhus lanceolata*), and Texas persimmon (*Diospyros texana*). Vegetational analyses were conducted simultaneously with the fecal collection. Herbaceous plants were sampled using the Daubenmire method. Woody plants were sampled using the line-intercept method. Plant use by greater kudu was compared with the availability of plants at MMWMA to determine if greater kudu were selective in feeding. I used log-likelihood chi-square tests with Bonferroni corrected confidence intervals and Manly's alpha preference indices to test for selective foraging by greater kudu. During spring

2001, purple horsemint flowers (*Monarda citriodora*), Canada wildrye (*Elymus canadensis*), mesquite, and flameleaf sumac were selected. In summer 2001, greater kudu selected Texas/blackjack oak and mesquite. Greater kudu selected flameleaf sumac during autumn 2001. In winter 2002, greater kudu foraged selectively for Ashe juniper. The browse forage class composed the vast majority of plants consumed by greater kudu; thus, greater kudu could compete with other browsers, such as white-tailed deer, on a range site.

INTRODUCTION

In the 1930s, the release of nilgai antelope (*Boselaphus tragocamelus*) on the King Ranch in South Texas marked the first release of exotics in Texas (Traweek and Welch 1992). Since then ranching of exotic big game species has become a profitable business in Texas. Traweek (1995) reported 155 Texas counties had confined or free-ranging exotic hoofed stock. The number of exotic ungulate species in Texas increased from 13 in 1963 to 71 in 1994 (Traweek 1995). Sixty-eight percent of all confined exotic ungulate species in Texas occur in the Edwards Plateau ecological region (Traweek and Welch 1992).

One exotic that has increased in popularity with landowners and hunters is the greater kudu (*Tragelaphus strepsiceros*). Hunters may pay as much as $5,000.00 for a trophy bull greater kudu. The first greater kudu arrived in Texas at the San Antonio Zoo on 30 June 1965. The animals were kept in quarantine until a series of successful matings produced a surplus of animals at the zoo and allowed release of offspring to private ranchers (Mungall and Sheffield 1994).

The natural distribution of greater kudu is throughout the savanna regions of southern and eastern Africa. This distribution is within the political boundaries of Chad, Sudan, Central African Republic, Ethiopia, Kenya, Tanzania, Angola, Zambia, Namibia, Mozambique, Zimbabwe, Botswana, Swaziland, Eritrea, Uganda, Democratic Republic of the Congo, and South Africa (Estes 1991). In these countries, the species inhabits areas with stony and broken ground and thorn scrub (Mungall and Sheffield 1994) with

sufficient low and medium height growing woody plants to provide food and cover (Kingdon 1982). Greater kudu prefer a variety of savanna habitats. Simpson (1967) found that kudu showed preference for the Riverine/*Acacia* thickets and the Mopane/*Combretum*/*Grewia* scrub throughout the year on a game ranch in Zimbabwe. Greater kudu at Loskop Dam Nature Reserve in South Africa showed strong preference for habitats having a prominent shrub layer, a closed herb layer, and hillsides with slopes of more than 10° (Underwood 1978).

Greater kudu are primarily browsers that minimally utilize grasses. Wilson (1965) found only eight of 70 (11.4 %) rumen samples contained grasses, mainly during the wet season in Zimbabwe. In South Africa, Owen-Smith and Cooper (1985) reported an annual time budget in which greater kudu spent 62% of feeding time on browse, 19% on forbs, 12% on fruits, flowers, and pods, and 7% on grass. Other studies also have shown greater kudu to be primarily browsers (Owen-Smith and Cooper 1989, Owen-Smith 1979, Conybeare 1975, Wilson 1970) in Africa. Greater kudu can change their diet from browse species to other forage classes throughout the year (Owen-Smith and Cooper 1989) and consume a variety of plants. They consumed up to 59 different plant species per day in South Africa (Owen-Smith 1994).

Although kudu have been stocked on several ranches in central and southern Texas, basic ecological information for this exotic ungulate is lacking for Texas. To date, no research has been conducted to determine the food habits of greater kudu in Texas or in the United States. Such knowledge is necessary to appropriately manage populations and to assess the potential for competition with native wildlife and other exotic ungulates.

The white-tailed deer (*Odocoileus virginianus*) is primarily a browser in the Edwards Plateau ecological region (Waid et al. 1984, Bryant et al. 1981, and McMahan 1964). Therefore, dietary overlap between greater kudu and white-tailed deer could exist.

In recent years, various methods have been used for determining food habits of herbivores. The most commonly used methods are utilization techniques, direct observation of a focal animal, stomach analysis, and fecal analysis (Holechek et al. 1982a). Utilization (plant use), one of the oldest methods, has a serious disadvantage because large portions of plants will be lost from weathering, trampling, and usage by other animals, leading to an over estimation of use by target animals (Cook and Stoddart 1953). Direct observation, a widely used method has two disadvantages; difficulty in plant identification and plant quantification (Holechek et al. 1982a). Stomach analysis is another common method. However, its primary main disadvantage is that stomach analysis requires the sacrifice of the animal. This method would be inappropriate for research on ungulates as rare and valuable as greater kudu. In the last 20 years, fecal analysis has been one of the more common methods used to determine food habits of herbivores.

Fecal analysis has many advantages including noninterference with habits and movements of animals, unlimited sample size, and ease of sampling. However, the major disadvantage in fecal analysis is differential digestion of consumed plants (Holechek et al. 1982a). Storr (1961) reported differential digestion of annual plants (forbs) in fecal material of quokkas (*Setonix brachyurus*). Smith and Shandruk (1979) found fewer plants in fecal material than in rumen contents of pronghorn (*Antilocapra americana*). However, Johnson and Pearson (1981) and Mohammad et al. (1995) reported little

difference between esophageal samples, rumen samples, and fecal samples in cattle. Casebeer and Koss (1970) also indicated rumen contents and fecal material provided similar results in African grazers such as zebu cattle (*Bos indicus*), wildebeest (*Connochaetes taurinus*), common zebra (*Equus burchelli*), and Coke's hartebeest (*Alcelaphus buselaphus*). Chapuis et al. (2001) found rumen contents and fecal material were similar in European mouflon (*Ovis musimon*). Anthony and Smith (1974) indicated fecal analysis and volumetric rumen analysis to be quite similar in mule deer (*Odocoileus hemionus*) and white-tailed deer. Fecal analysis was chosen as the methodology for this study because of the many advantages of the technique; however, differential digestion might occur.

The objectives of this study were to 1) describe the seasonal diets of greater kudu in the Llano Uplift ecological region of Texas, 2) determine if greater kudu show feeding selectivity for plants by comparing plant use to availability at the study site, 3) discuss the comparison of greater kudu diets in Texas to Africa, and 4) discuss the possible foraging competition between white-tailed deer and greater kudu.

MATERIALS AND METHODS

Study Site

This research project took place at MMWMA, Mason County, Texas. Mason Mountain Wildlife Management Area is found in the Llano Uplift ecological region of Texas, which includes all of Llano County, most of Mason County, and parts of McCulloch, San Saba, Lampasas, Burnet, Blanco, and Gillespie counties (LBJ School of Public Affairs 1978). This region encompasses approximately 800,000 ha (Carter 1931). The average annual rainfall is 76 cm, with peaks in May or June and September (LBJ School of Public Affairs 1978). The average annual temperature is 19.7° C (Carter 1931) and fluctuates from 8.9° C in January to 27.2° C in July (Thomas et al. 1964, Walker 1949, Hahn 1945). The region is defined as a large dome of granite with rolling to hilly topography. Elevation ranges from 251 m to 686 m (LBJ School of Public Affairs 1978). The bedrock was formed in the Pre-Cambrian Era, and is one of the few places in Texas where rocks of this time period are found (Sellards et al. 1932). During the Cretaceous Period, a shallow sea covered this region and thousands of feet of sediments were deposited forming limestone (Sellards et al. 1932). Weathering through geologic time has exposed and altered the sedimentary and igneous rocks, which are more acidic in character. This weathering also has resulted in the exposure of large pockets of the Pre-Cambrian granites through the Cretaceous limestone. Therefore, the majority of parent materials of the soil are granites with some limestone (Carter 1931). Erosion has caused soil development to be shallow and the parent rocks to lie near the surface. The majority

of the soils are of the Tishomingo, Lancaster, Pototoc, Katemcy, and Pedernales series with the sandy loams of the Pedernales and Tishomingo series being the most extensive soil types of the region (Carter 1931).

Two subregions are included in the Llano Uplift ecological region, oak (*Quercus* spp.) and oak–hickory (*Carya texana*) woodlands and mesquite–white brush (*Aloysia gratissima*) savanna (LBJ School of Public Affairs 1978). The oak woodlands are found on sandy, granitic, well watered soils. Mesquite savannas occur on loamy, limestone soils. Two vegetation series dominate the Llano Uplift. Diamond (1993) described these as follows: Post Oak (*Quercus stellata*)–Blackjack Oak (*Q. marilandica*) Series is generally found on the sandier, granitic soils. This series is described as deciduous woodland. Plant species associated with this series include redbud (*Cercis canadensis*) and cedar elm (*Ulmus crassifolia*).

Plateau Live Oak–Midgrass Series is generally found on limestone derived soils, but also can be found to some extent on granitic soils. The series is described as an evergreen woodland intermixed with midgrass grassland on flats and gentle slopes. Canopy cover ranges from open to closed, with monoculture mottes of live oak present in some areas. Species composition varies with the soil type. Texas oak (*Q. buckleyi*), Ashe juniper, shin oak (*Q. sinuata*), post oak, blackjack oak, flameleaf sumac, skunkbush sumac (*Rhus aromatica*) are variously present. Shallow soils or disturbed areas often support Ashe juniper or mesquite dominated woodlands or shrublands. Under good range conditions, openings in these shrublands are midgrass grasslands with species such as little bluestem (*Schizachyrium scoparium*), sideoats grama (*Bouteloua curtipendula*), and curlymesquite (*Hilaria belangeri*).

Mason Mountain Wildlife Management Area was donated to Texas Parks and Wildlife Department by a private land owner in 1997. The rangeland was in poor range condition because of a high density of herbivores and overgrazing (Schwertner, personal comm.). By lowering the stocking rate of exotic ungulates and reestablishing a natural fire regime, the rangeland of MMWMA is now in fair to good range condition. Mason Mountain Wildlife Management Area is approximately 2120 ha. It is divided into seven pastures by 2.4 m high fences. The greater kudu are located in two pastures, Turkey and South Voca (Fig. 1), which are approximately 709 ha and 243 ha in size, respectively. White-tailed deer, axis deer (*Axis axis*), blackbuck antelope (*Antilope cervicapra*), sable antelope (*Hippotragus niger*), scimitar-horned oryx (*Oryx dammah*), and impala (*Aepyceros melampus*) also occur in these pastures.

Biologists for Texas Parks and Wildlife Department defined eight different habitat types for MMWMA with seven of these occurring in Turkey and South Voca pastures (Fig. 1). These habitat types are described as follows: The live oak habitat and mesquite–white brush habitat conforms to the description of the Plateau Live Oak–Midgrass Series of Diamond (1993). The canyons habitat is largely dominated by Texas oak, while the mixed oak habitat is dominated by blackjack oak, post oak, and live oak. The blackjack–post oak habitat is similar to the Post Oak–Blackjack Oak Series described by Diamond (1993). The xeric slopes habitat is dominated by Texas persimmon, prickly pear (*Opuntia* spp.), twisted-leaf yucca (*Yucca rupicola*), buckley yucca (*Yucca constricta*), agarita (*Berberis trifoliolata*), devil's-shoestring (*Nolina lindheimeriana*), Ashe juniper, and live oak. These species also are found in almost all habitats.

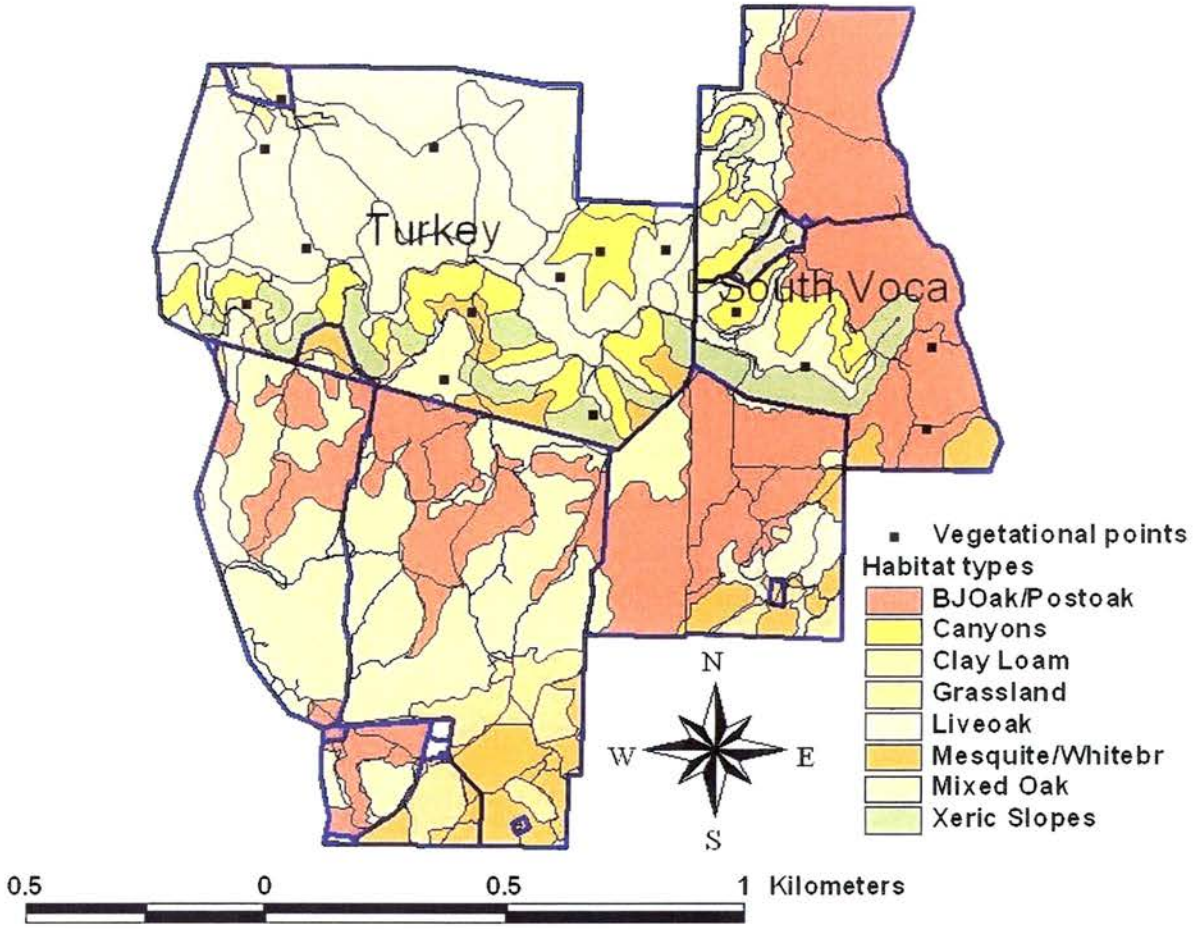

Figure 1. Habitat types and vegetational sampling points at Mason Mountain Wildlife Management Area, Mason County, Texas, 2001-2002.

The grassland habitat is dominated by grasses such as curlymesquite, purple threeawn (*Aristida purpurea*), hairy grama (*Bouteloua hirsuta*), sideoats grama, and Texas wintergrass (*Stipa leucotricha*). The dominant forbs are Mexican hat (*Ratibida columnaris*), wild carrot (*Daucus pusillus*), broomweed (*Amphiachyris dracunculoides*), and western ragweed (*Ambrosia psilostachya*).

Fecal Collection

A total of 196 freshly deposited fecal samples were collected seasonally from May 2001 to February 2002 with 20 pellets collected per sample. Seasons were designated as spring (15 May to 6 June), summer (25 July to 19 August), autumn (13 October to 10 November), and winter (19 January to 25 February). Forty-six fecal samples were collected during the spring season, and 50 fecal samples were collected in each of the remaining seasons in Turkey and South Voca pastures. A four wheel drive vehicle was necessary to locate kudu in rough terrain. Once located, greater kudu were observed and notes were written about their feeding habits and behavior until they left the area. Only freshly deposited fecal samples that were soft, moist, and covered by mucus were collected (Green 1987). This eliminated the possibility of collecting fecal material of another species. An effort was made to match the fecal sample collected to the animal. For example if a group of kudu consisted of 2 cows and 1 bull, one fecal sample per individual was collected. Fecal samples were collected from as many different individuals as possible. The location for each fecal sample was taken using a Garmin 12 XL GPS receiver, and the location data were entered into ArcView 3.3 (Fig. 2). Scott and Dahl (1980) reported freezing fecal material could cause cell walls of the plant

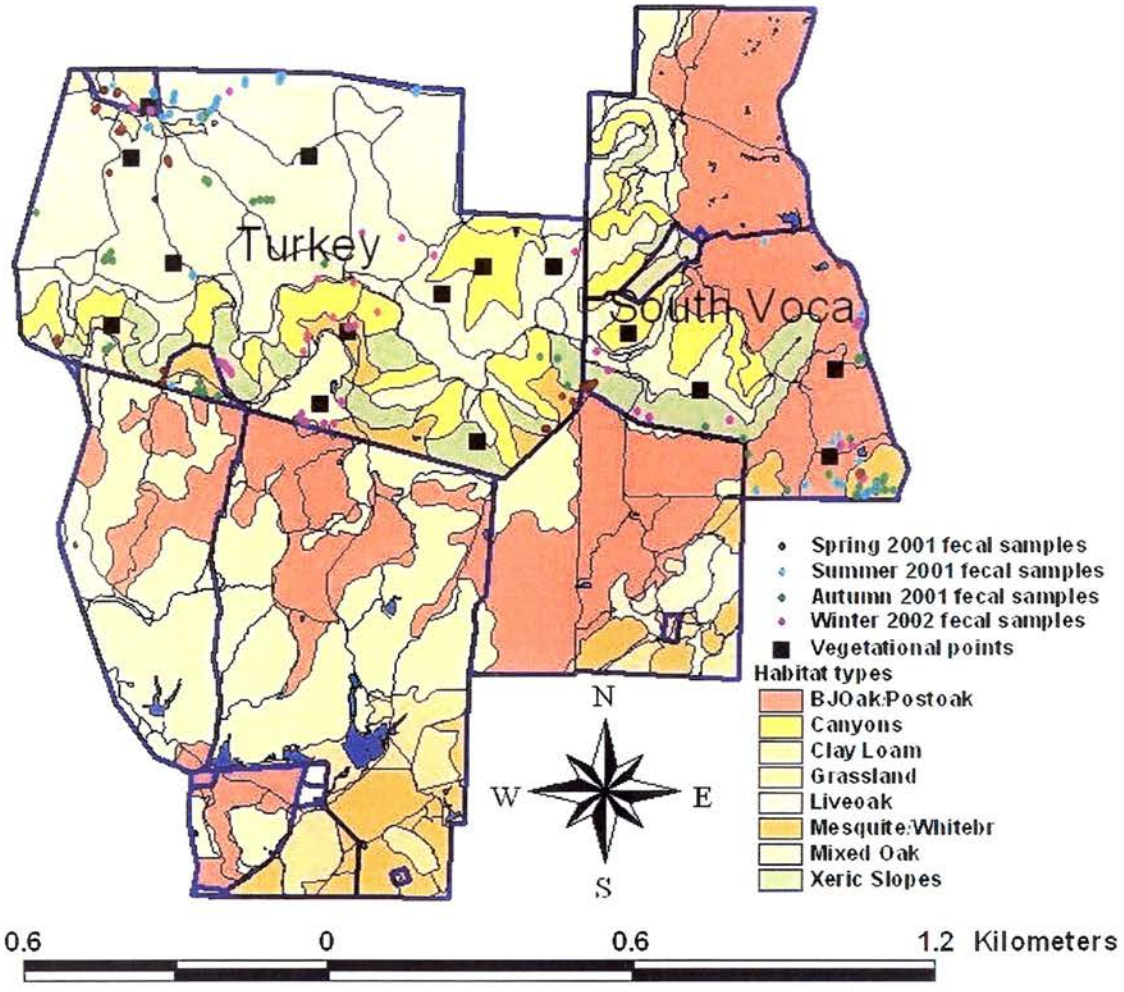

Figure 2. Locations for fecal samples collected each season at Mason Mountain Wildlife Management Area, Mason County, Texas, 2001-2002.

material to rupture; therefore, samples were air dried in paper sacks with paradichlorobenzene (moth ice crystals) to deter mold growth and insect herbivory damage.

Fecal Analysis

Approximately 2.0–2.5 g (3–4 pellets) of a fecal sample were ground in a Wiley mill using a 0.5 mm (40 mesh) screen delivery tube to standardize fragment size and for use on thinner slides (Litvaitis et al. 1996). Ground samples were soaked in undiluted sodium hypochlorite (household bleach) for 15–20 minutes to remove pigments. This is a modification of the method used by Holechek et al. (1982b) and Holechek and Valdez (1985). Samples were washed through a 0.2 mm (200 mesh) sieve to mix and remove dirt and small particles (Sparks and Malechek 1968) until the smell of bleach was removed from the sample. Two slides were prepared per sample with a small amount of fecal material spread evenly on the slides so approximately 3 large fragments per field of view where seen at 100X magnification (Scott and Dahl 1980). Mount-Quick "Aqueous" aqueous mounting medium was used to mount the fecal material under 22 mm X 22 mm cover slips. Sample slides were air dried for approximately 2 hr and then sealed with Permount® mounting medium. A Nikon binocular microscope was used for plant species identification. The epidermal fragment nearest the ocular lens pointer was identified to species (Sparks and Malechek 1968). Five fields of view per slide were selected randomly using a pair of twenty-sided dice. Each field was examined initially at 100X magnification and 400X magnification was used when the epidermal fragments

appeared unclear, a modified version of Holechek and Valdez (1985). Reference slides were used to identify epidermal fragments as close to the species level as possible. Because of the difficulty in separating Texas oak and blackjack oak at the species level, they were combined as (hereafter, TX/BJ oak) (*Quercus* spp.) in the analysis. The young sprouts or shoots of browse species also were combined as browse shoots, due to the difficulty in identifying them to the species level.

Reference Slides

Reference slides of leaves, stems, flowers, and fruits of plants found at MMWMA were made to identify epidermal fragments in the fecal material. The upper and lower epidermis of the leaf were removed by scraping away the mesophyll using a disposable scalpel. The epidermal pieces then were washed with water, dried, placed on a slide, and mounted with Permount® mounting medium. Species with a large amount of hair on the epidermis or a thick waxy cuticle were mounted with Mount-Quick "Aqueous" aqueous mounting medium. Plant species also were blended in an electric household blender with a mixture of household bleach and water, washed, and mounted the same way as the fecal material. Publications with photographs and dichotomous keys also were used to aid in the identification of epidermal fragments in the fecal material (Green et al. 1985, Scott and Dahl 1980).

Vegetational Analyses

Vegetational analyses were conducted simultaneously with the collection of fecal material. Prior to this study Texas Parks and Wildlife Department systematically located > 50 vegetational points throughout Turkey and South Voca pastures. Out of these vegetational points 16 were randomly selected throughout the seven different habitat types based upon the portion of each habitat (Fig. 1). The vegetational points were designated as the starting point for the vegetational sampling transect. At each vegetational point a randomly selected azimuth determined the direction of the 100 m transect, and a random numbers chart was used to select placement of 10 Daubenmire frames along each transect. Herbaceous plants were sampled and percent cover was estimated using the Daubenmire method (Daubenmire 1959) with a 100 cm X 25 cm Daubenmire frame. Woody plants were sampled and percent cover was estimated using the line-intercept method (Gates 1949). An azimuth also was selected randomly for placement of the 100 m transect for woody plant sampling. Dekker (1997) stated that the maximum browsing height of greater kudu was 2 m; therefore, a 2 m pole was used to distinguish between available and unavailable woody plants. If the living parts (leaves, flowers, and fruits) of the woody plants intercepted on or below the 2 m pole, they were classified as available. Herbaceous plants were sampled in all seasons, while woody plants were sampled in spring 2001 and winter 2002. A total of 160 Daubenmire frames and one hundred fifty 10 m intervals were used to estimate composition (percent occurrence) of herbaceous and woody plant species, respectively, in all seasons. One exception occurred during spring 2001 when 150 Daubenmire frames were used because of an absence of the food plot vegetational point.

Plant Use

Plant use was defined as the percent occurrence for each plant species in the fecal material (Sparks and Malechek 1968, Holechek and Gross 1982b). A plant was considered a principal food item if the percent occurrence was ≥ 3. Plant species also were combined into forage classes such as browse, grasses, forbs, and other. The other forage class category was a mixture of species having $< 3\%$ occurrence in each season, deer corn, and unknowns.

Plant Selectivity

If an animal is presented with a variety of food items, it will show preference (selectivity) for some and avoidance of others. Preference can be measured by comparing usage to availability of food items in the environment (Krebs 1999). Several methods have been used to indicate food preference. These include: rank preference method (Johnson 1980), forage ratio (Savage 1931, Williams and Marshall 1938), Manly's alpha (Manly et al. 1972), and log-likelihood chi-square tests (Manly et al. 1993). Because of the uncertainty of assigning individual fecal samples to specific animals, a Design I general study measuring preference was used in my study. This method states that all measurements are made at the population level and individuals are not recognized (Manly et al. 1993). The rank preference method applies to individuals and can not be used for a Design I study (Krebs 1999). Hobbs (1982) stated that preference indices, such as the forage ratio and Manly's alpha unaccompanied by confidence intervals, could be misleading, thus needing confidence intervals to be statistically valid. However, Krebs (1999) stated Manly's alpha appeared to be one of the

best indices of preference for most situations. Therefore, a log-likelihood chi-square test with estimated proportions of available resources was used with Manly's alpha preference index to support the results of the log-likelihood chi-square test.

The log-likelihood chi-square test was used to test the null hypothesis that greater kudu used plants proportional to their estimated availability. The alternative hypothesis was that greater kudu utilize plants more, i.e., show selectivity, or less i.e., avoidance, than expected based on the estimated availability of plants. To show plants being either selected or avoided, confidence intervals were constructed using the occurrence of plants in the fecal material (observed use) compared to their availability in the habitat (expected use). If no selectivity occurs, then greater kudu use plants proportional to their availability. To maintain 95% confidence intervals, plant use confidence intervals were corrected using the Bonferroni correction, which corrects the significance level to maintain a stable overall error rate by scaling down the α to α/n (Neu et al. 1974).

Usage for each plant was defined as the total occurrence of that species in the fecal material estimated by fecal analysis. Availability for each plant was calculated as described by Krebs (personal comm.). The number of occurrences for each available herbaceous plant was counted as the number of Daubenmire frames in which the plant made up more than 5% of the cover. The number of occurrences for each available woody plant species was the number of 10 m intervals in which the plant made up more than 5% of the cover. Browse shoot usage was estimated by proportionally distributing the total observations of browse shoots to the browse species in a given season based upon their percent occurrence. Deer corn and all unknowns were given a 1 for availability due to the difficulty of quantification. Roscoe and Byars (1971) stated that a

that a chi-square test could be used if the available observations averaged 6 or more for the 0.01 confidence level. This was applied to the log-likelihood chi-square tests.

Manly's alpha preference index (constant prey formula) (Manly et al. 1972) was calculated to support the log-likelihood chi-square test by estimating plant selectivity by greater kudu. A Manly's alpha index number greater than 1/m (m = total number of plants available) indicates preference while an index number less than 1/m indicates avoidance (Krebs 1999, Manly et al. 1972).

RESULTS

Plant Use

In spring, browse made up 80.2% of the greater kudu diet. Within the browse class, TX/BJ oak was present in the greatest amount (32.0%) followed by mesquite (11.5%), browse shoots (5.4%), elbowbush (*Foresteria pubescens*) (4.4%), skunkbush sumac and live oak (3.3%), and flameleaf sumac and devil's-shoestring (3.0%). Forbs made up 12.4% of the spring diet, with purple horsemint (flowers) (5.7%) and Indian blanket (flowers) (*Gaillardia pulchella*) being the dominant species. Grasses were 7% of the diet, with Canada wildrye (5.2%) as the most common grass. The category other consisted of browse shoots and 30 species with percent occurrences ranging from 0.2% to 2.8% (Table 1, Fig. 3). Complete results of the spring vegetational sampling for plant availability at MMWMA are in Appendices 1 and 2.

The summer diet was composed primarily of Browse (94.8%). Texas/blackjack oak was again present in the greatest amount (50.0%), followed by mesquite (14.6%), Texas persimmon (leaves, fruits, and seeds) (11.4%), and browse shoots (8.6%). Forbs did not occur in the summer diet, while grasses decreased slightly from spring to 5.0%. Milo (*Sorghum vulgare*) (3.8%) was the highest utilized grass. Browse shoots and 15 species with percent occurrences ranging from 0.2% to 2.0% composed the category other. (Table 2, Fig. 4). Complete results of the summer vegetational sampling for plant availability at MMWMA are in Appendix 3.

Table 1. Total occurrence and percent occurrence of plants consumed by greater kudu during spring 2001 at Mason Mountain Wildlife Management Area.

Species	Common Name	Total Occurrence	Percent Occurrence
	Leaves, Shoots, and Stalks		
Browse			**77.6**
Quercus spp.	TX/BJ oak	147	32.0
Prosopis glandulosa	Mesquite	53	11.5
Browse shoots	Browse shoots	25	5.4
Foresteria pubescens	Elbowbush	20	4.3
Rhus aromatica	Skunkbush sumac	15	3.3
Quercus fusiformis	Live oak	15	3.3
Rhus lanceolata	Flameleaf sumac	14	3.0
Nolina lindheimeriana	Devil's-shoestring	14	3.0
Yucca spp.	Yucca stalk	7	1.5
Quercus stellata	Post oak	7	1.5
Matelea reticulata	Green milkweed vine	7	1.5
Toxicodendron radicans	Poison ivy	6	1.3
Diospyros texana	Texas persimmon	6	1.3
Quercus sinuata	Shin oak	5	1.1
Cercis canadensis	Redbud	5	1.1
Vitis monticola	Sweet mountain grape	3	0.7
Ptelea trifoliata	Wafer-ash	3	0.7
Yucca rupicola	Twisted-leaf yucca	1	0.2
Smilax bona-nox	Greenbriar	1	0.2
Phoradendron tomentosum	Mistletoe	1	0.2
Opuntia spp.	Prickly pear	1	0.2
Eysenhardtia texana	Kidneywood	1	0.2
Forbs			**2.6**
Tradescantia sp.	Spiderwort	4	0.9
Krameria lanceolata	Ratany	4	0.9
Unknown forb		2	0.4
Croton monanthogynus	One-seed croton	1	0.2
Achillea millifolium	Yarrow	1	0.2
Grasses			**7.0**
Elymus canadensis	Canada wildrye	24	5.2
Erioneuron pilosum	Hairy tridens	2	0.4
Eragrostis intermedia	Plains lovegrass	2	0.4
Schizachyrium scoparium	Little bluestem	1	0.2
Buchloe dactyloides	Buffalograss	1	0.2
Bouteloua curtipendula	Sideoats grama	1	0.2
Aristida purpurea	Purple threeawn	1	0.2
	Flowers, Fruits, and Seeds		
Browse			**2.6**
Berberis trifoliolata	Agarita fruit	5	1.1
Berberis trifoliolata	Agarita seed	3	0.7
Opuntia spp.	Prickly pear flower	2	0.4
Yucca spp.	Yucca flower	1	0.2
Acacia roemeriana	Catclaw acacia fruit	1	0.2
Forbs			**9.8**
Monarda citriodora	Purple horsemint flower	26	5.7
Gaillardia pulchella	Indian blanket flower	13	2.8
Ratibida columnifera	Mexican hat flower	4	0.9
Erigeron modestus	Prairie fleabane flower	2	0.4
Unknowns			**0.4**
Unknown fruit		1	0.2
Unknown flower		1	0.2

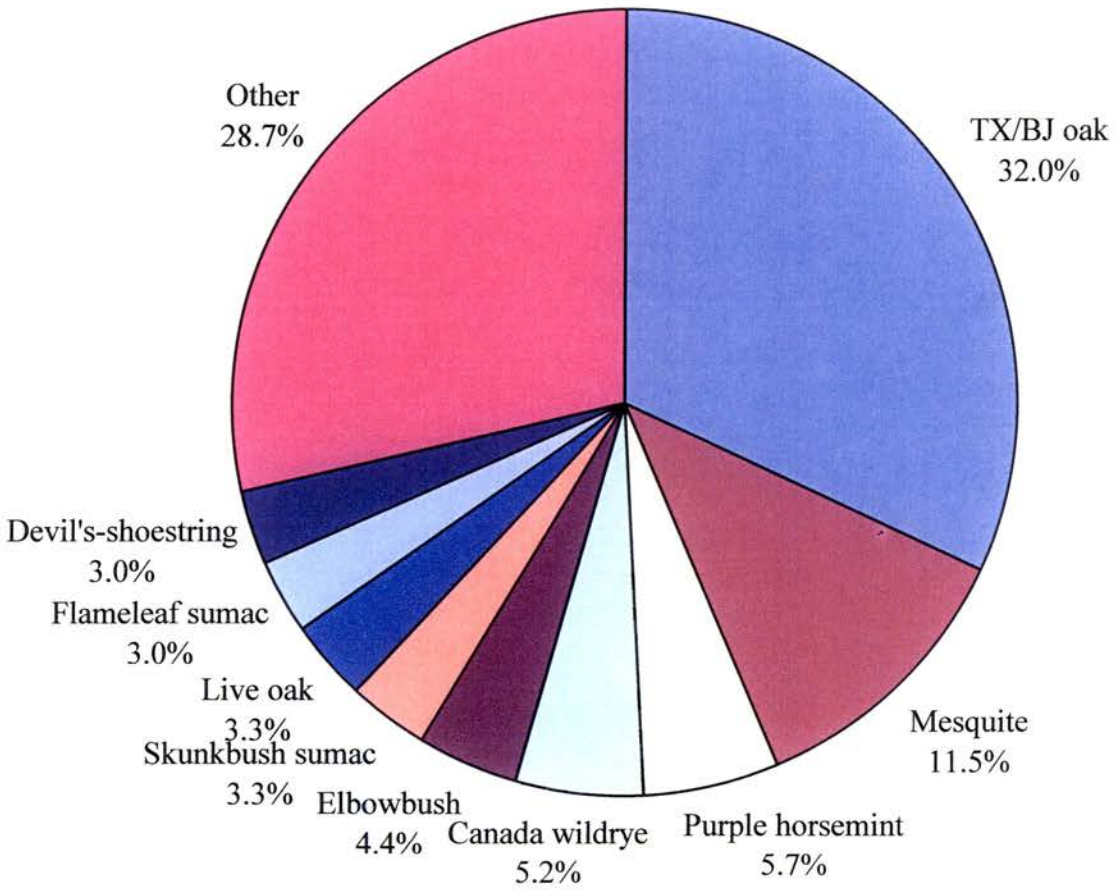

Figure 3. Percent occurrence of plants utilized by greater kudu during spring 2001 at Mason Mountain Wildlife Management Area.

Table 2. Total occurrence and percent occurrence of plants consumed by greater kudu during summer 2001 at Mason Mountain Wildlife Management Area.

Species	Common Name	Total Occurrence	Percent Occurrence
	Leaves and Shoots		
Browse			**86.0**
Quercus spp.	TX/BJ oak	250	50.0
Prosopis glandulosa	Mesquite	73	14.6
Browse shoots	Browse shoots	43	8.6
Diospyros texana	Texas persimmon	13	2.6
Opuntia spp.	Prickly pear	10	2.0
Foresteria pubescens	Elbowbush	9	1.8
Rhamnus caroliniana	Carolina buckthorn	6	1.2
Quercus stellata	Post oak	6	1.2
Rhus aromatica	Skunkbush sumac	5	1.0
Rhus lanceolata	Flameleaf sumac	4	0.8
Celtis reticulata	Netleaf hackberry	4	0.8
Ziziphus obtusifolia	Lotebush	3	0.6
Phoradendron tomentosum	Mistletoe	2	0.4
Smilax bona-nox	Greenbriar	1	0.2
Nolina lindheimeriana	Devil's-shoestring	1	0.2
Grasses			**5.0**
Sorghum vulgare	Milo	19	3.8
Eragrostis intermedia	Plains lovegrass	4	0.8
Erioneuron pilosum	Hairy tridens	1	0.2
Aristida purpurea	Purple threeawn	1	0.2
Unknown			**0.2**
Summer unknown		1	0.2
	Fruits and Seeds		
Browse			**8.8**
Diospyros texana	Texas persimmon fruit	24	4.8
Diospyros texana	Texas persimmon seed	20	4.0

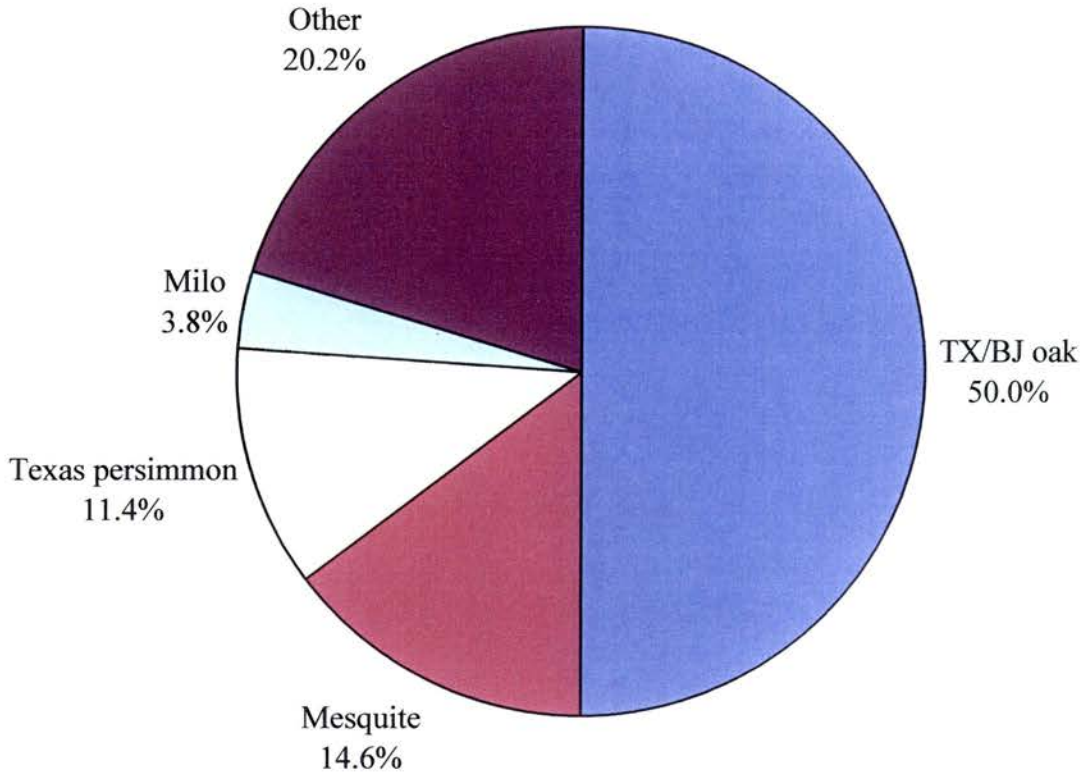

Figure 4. Percent occurrence of plants utilized by greater kudu during summer 2001 at Mason Mountain Wildlife Management Area.

During autumn, browse composed 85.6% of the greater kudu diet. Texas/Blackjack oak (39.6%), prickly pear (pads, fruits, and seeds) (16.2%), flameleaf sumac (12.8%), browse shoots (6.8%), and mesquite (4.4%) made up the majority of plants in the browse forage class. Forbs were 0.4% of the autumn diet. Grasses made up 5.0% of the autumn diet with sideoats grama (2.2%) and little bluestem (1.6%) being the most common. The category other included deer corn, browse shoots, and 21 species with percent occurrences ranging from 0.2% to 4.8% (Table 3, Fig. 5). Complete results of the autumn vegetational sampling for plant availability at MMWMA are in Appendix 4.

Browse was 90.0% of the winter diet, which was second only to the summer diet. Live oak leaves and shoots (41.2%) and Ashe juniper (31.2%) included over 70% of the browse forage class followed by lesser amounts of prickly pear (pads) (9.4%), devil's-shoestring (4.6%), and twisted-leaf yucca (3.4%). Yarrow (*Achillea millifolium*) (0.2%) was the only forb in the winter diet. Grasses in the winter diet (9.0%) were the highest for any season with Texas wintergrass (6.0%) being the most common. The category other included browse shoots and 8 species, ranging from 0.2% to 1.0% of the diet (Table 4, Fig. 6). Complete results of the winter vegetational sampling for plant availability at MMWMA are in Appendices 5 and 6.

In the annual diet, browse accounted for 87.4% of the forage consumed by greater kudu. Within the browse class, TX/BJ oak (30.4%) was utilized the most, followed by live oak (11.4%), Ashe juniper (8.2%), mesquite (7.6%), prickly pear (pads, fruits, and seeds) (7.2%), flameleaf sumac (4.2%), and Texas persimmon (leaves, fruits, and seeds) (3.5%). Forbs made up 3.5% of the annual diet with purple horsemint (flowers) (1.3%)

Table 3. Total occurrence and percent occurrence of plants consumed by greater kudu during autumn 2001 at Mason Mountain Wildlife Management Area.

Species	Common Name	Total Occurrence	Percent Occurrence
	Leaves and Shoots		
Browse			**67.0**
Quercus spp.	TX/BJ oak	198	39.6
Rhus lanceolata	Flameleaf sumac	57	11.4
Browse shoots	Browse shoots	34	6.8
Prosopis glandulosa	Mesquite	22	4.4
Phoradendron tomentosum	Mistletoe	5	1.0
Diospyros texana	Texas persimmon	4	0.8
Rhus aromatica	Skunkbush sumac	3	0.6
Quercus stellata	Post oak	3	0.6
Quercus fusiformis	Live oak	3	0.6
Yucca spp.	Yucca stalk	2	0.4
Yucca rupicola	Twisted-leaf yucca	2	0.4
Foresteria pubescens	Elbowbush	1	0.2
Nolina lindheimeriana	Devil's-shoestring	1	0.2
Grasses			**5.0**
Bouteloua curtipendula	Sideoats grama	11	2.2
Schizachyrium scoparium	Little bluestem	8	1.6
Bouteloua rigidiseta	Texas grama	2	0.4
Triticum aestivum	Wheat	1	0.2
Eragrostis intermedia	Plains lovegrass	1	0.2
Setaria leucopila	Plains bristlegrass	1	0.2
Erioneuron pilosum	Hairy tridens	1	0.2
Forbs			**0.2**
Commelina erecta	Day flower	1	0.2
Unknown			**4.8**
Fall and winter unknown		24	4.8
	Flowers, Fruits, and Seeds		
Browse			**18.6**
Opuntia spp.	Prickly pear seed	65	13.0
Opuntia spp.	Prickly pear fruit/pad	16	3.2
Rhus lanceolata	Flameleaf sumac seed	4	0.8
Juniperus ashei	Ashe juniper fruit	4	0.8
Rhus lanceolata	Flameleaf sumac fruit	3	0.6
Quercus spp.	Acorns	1	0.2
Forbs			**0.2**
Erigeron modestus	Prairie fleabane flower	1	0.2
Deer corn	Deer corn	21	**4.2**

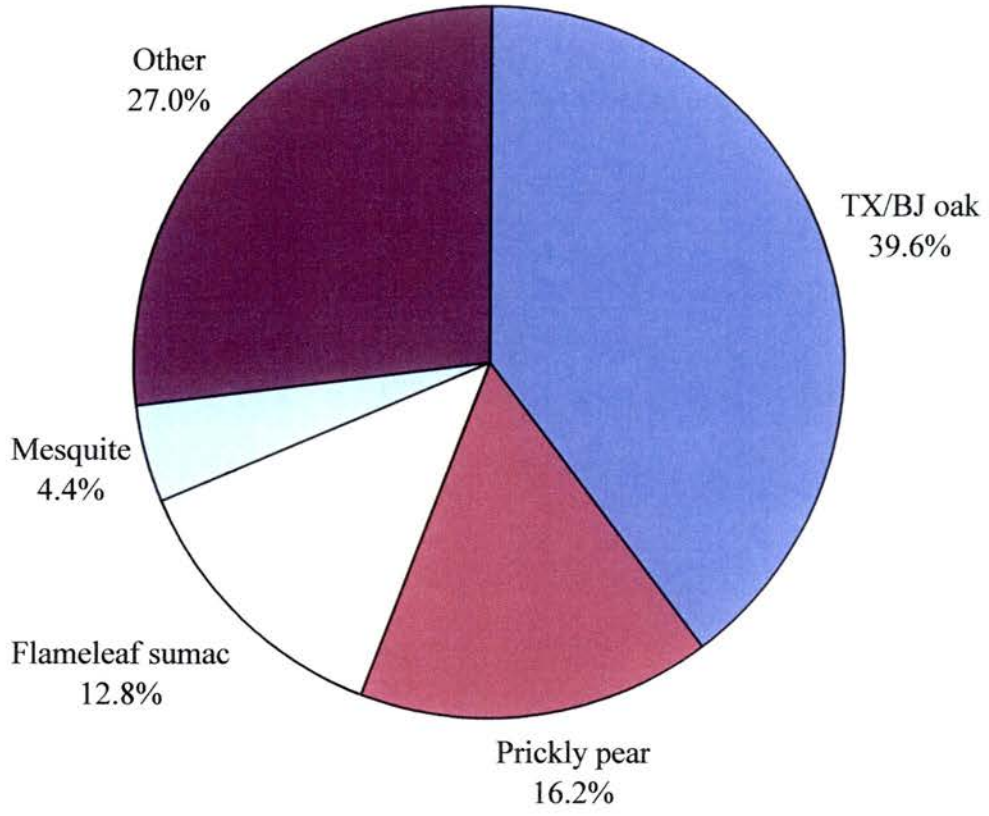

Figure 5. Percent occurrence of plants utilized by greater kudu during autumn 2001 at Mason Mountain Wildlife Management Area.

Table 4. Total occurrence and percent occurrence of plants consumed by greater kudu during winter 2002 at Mason Mountain Wildlife Management Area.

Species	Common Name	Total Occurrence	Percent Occurrence
	Leaves and Shoots		
Browse			**90.0**
Quercus fusiformis	Live oak	195	39.0
Juniperus ashei	Ashe juniper	156	31.2
Opuntia spp.	Prickly pear	47	9.4
Nolina lindheimeriana	Devil's-shoestring	23	4.6
Yucca rupicola	Twisted-leaf yucca	17	3.4
Quercus fusiformis	Live oak shoots	11	2.2
Diospyros texana	Texas persimmon	1	0.2
Grasses			**9.0**
Stipa leucotricha	Texas wintergrass	30	6.0
Elymus canadensis	Canada wildrye	5	1.0
Bouteloua rigidiseta	Texas grama	4	0.8
Carex planostachys	Cedar sedge	3	0.6
Triticum aestivum	Wheat	2	0.4
Bouteloua curtipendula	Sideoats grama	1	0.2
Forbs			**0.2**
Achillea millifolium	Yarrow	1	0.2
Unknown			**0.8**
Fall and winter unknown		4	0.8

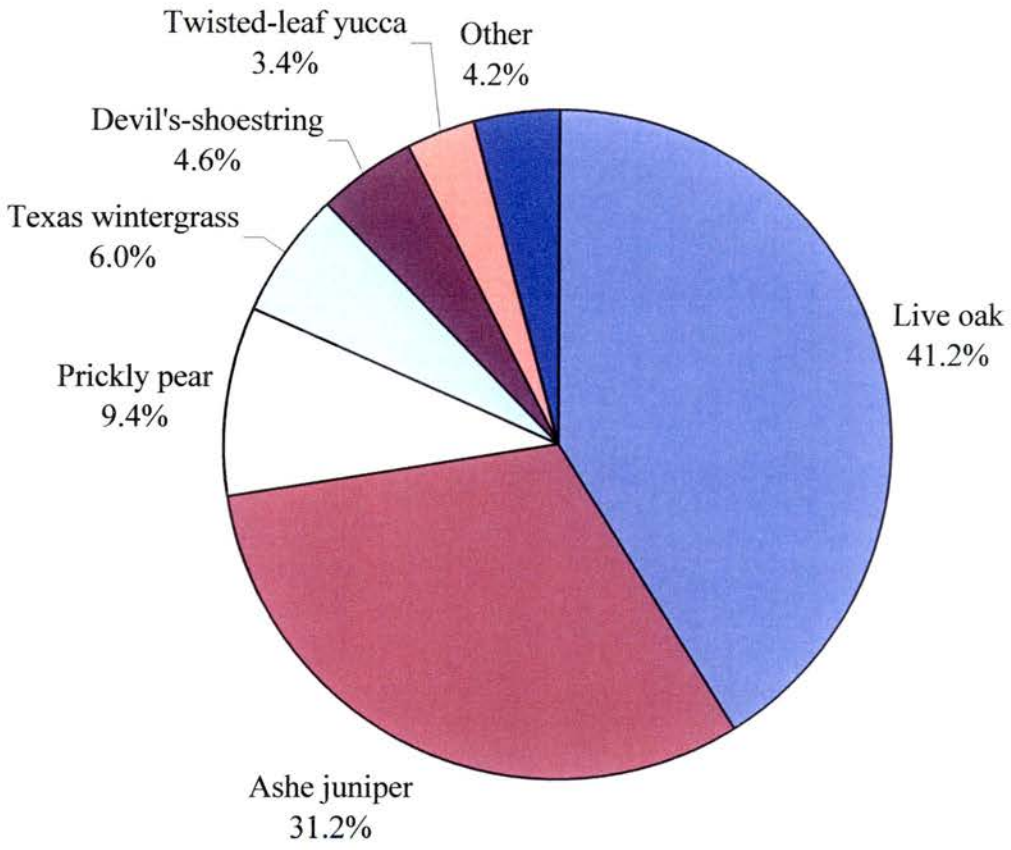

Figure 6. Percent occurrence of plants utilized by greater kudu during winter 2002 at Mason Mountain Wildlife Management Area.

being the most prevalent. Texas wintergrass (1.5%), Canada wildrye (1.5%), and milo (1.0%) were the primary grasses consumed in the grass forage class (6.5%). The category other consisted of 47 species with values ranging from 0.1% to 2.0% (Table 5, Fig. 7, 8).

Plant Selectivity

The null hypothesis that greater kudu use plants proportionally to their estimated availability during spring was rejected ($\chi^2 = 218.801$, $p < 0.001$). Greater kudu selected TX/BJ oak, mesquite, purple horsemint (flowers), Canada wildrye, and flameleaf sumac which had availability values below the lower confidence interval on observed use. Elbowbush, skunkbush sumac, and devil's-shoestring were utilized proportionally to their estimated values and had availability values within the confidence intervals of observed use. Greater kudu showed avoidance of live oak. The availability value was above the higher confidence interval on observed use (Table 6, Fig. 9). Manly's alpha preference index scores for food items in the spring diet (Table 10) differed in some instances from the chi-square analysis. Manly's alpha preference index scores suggested that greater kudu preferred purple horsemint (flowers), Canada wildrye, and flameleaf sumac, but avoided TX/BJ oak and mesquite. Elbowbush, skunkbush sumac, live oak, and devil's-shoestring were avoided by greater kudu based on Manly's alpha (Table 10).

During summer, greater kudu did not use plants proportionally to their estimated availability, thus the null hypothesis was rejected ($\chi^2 = 155.344$, $p < 0.001$). Texas/blackjack oak, mesquite, and Texas persimmon (leaves, fruits, and seeds) were selected due to their availability values being below the lower confidence interval.

Table 5. Total occurrence and percent occurrence of plants consumed by greater kudu annually at Mason Mountain Wildlife Management Area, 2001-2002

Species	Common Name	Total Occurrence	Percent Occurrence	Species	Common Name	Total Occurrence	Percent Occurrence
	Leaves and Shoots						
Browse				**Forbs**			
Quercus spp	TX/BJ oak	595	30.4	*Tradescantia* sp	Spiderwort	4	0 2
Quercus fusiformis	Live oak	213	10 9	*Krameria lanceolata*	Ratany	4	0.2
Juniperus ashei	Ashe juniper	156	8 0	*Commelina erecta*	Day flower	1	0.1
Prosopis glandulosa	Mesquite	148	7 6	*Achillea millifolium*	Yarrow	2	0 1
Browse shoots	Browse shoots	102	5.2	Unknown forb		2	0 1
Rhus lanceolata	Flameleaf sumac	75	3 8	*Croton monanthogynus*	One-seed croton	1	0 1
Opuntia spp	Prickly pear	58	3 0				
Nolina lindheimeriana	Devil's-shoestring	39	2.0	**Unknowns**			
Forestiera pubescens	Elbowbush	30	1 5	Fall and winter unknown		28	1 4
Diospyros texana	Texas persimmon	24	1 2	Summer unknown		1	0.1
Rhus aromatica	Skunkbush sumac	23	1 2		**Flowers, Fruits, and Seeds**		
Yucca rupicola	Twisted-leaf yucca	20	1 0	**Browse**			
Quercus stellata	Post oak	16	0 8	*Opuntia* spp	Prickly pear seed	65	3 3
Quercus fusiformis	Live oak shoots	11	0 6	*Diospyros texana*	Texas persimmon fruit	24	1 2
Yucca spp	Yucca stalk	9	0 5	*Diospyros texana*	Texas persimmon seed	20	1 0
Phoradendron tomentosum	Mistletoe	8	0.4	*Opuntia* spp	Prickly pear fruit/pad	16	0 8
Matelea reticulata	Green milkweed vine	7	0 4	*Berberis trifoliolata*	Agarita fruit	5	0 3
Toxicodendron radicans	Poison ivy	6	0 3	*Rhus lanceolata*	Flameleaf sumac seed	4	0 2
Rhamnus carolinana	Carolina buckthorn	6	0 3	*Juniperus ashei*	Ashe juniper fruit	4	0.2
Quercus sinuata	Shin oak	5	0 3	*Rhus lanceolata*	Flameleaf sumac fruit	3	0 2
Cercis canadensis	Redbud	5	0 3	*Berberis trifoliolata*	Agarita seed	3	0 2
Celtis reticulata	Netleaf hackberry	4	0 2	*Opuntia* spp.	Prickly pear flower	2	0.1
Ptelea trifoliata	Wafer-ash	3	0 2	*Yucca* spp	Yucca flower	1	0.1
Vitis monticola	Sweet mountain grape	3	0.2	*Acacia roemeriana*	Catclaw acacia fruit	1	0 1
Ziziphus obtusifolia	Lotebush	3	0 2	*Quercus* spp	Acorns	1	0 1
Eysenhardtia texana	Kidneywood	1	0 1	**Forbs**			
Smilax bona-nox	Greenbriar	2	0.1	*Monarda citriodora*	Purple horsemint flower	26	1 3
Grasses				*Gaillardia pulchella*	Indian blanket flower	13	0 7
Stipa leucotricha	Texas wintergrass	30	1 5	*Ratibida columnifera*	Mexican hat flower	4	0.2
Elymus canadensis	Canada wildrye	29	1 5	*Erigeron modestus*	Prairie fleabane flower	3	0 2
Sorghum vulgare	Milo	19	1.0	**Unknowns and Deer corn**			
Bouteloua curtipendula	Sideoats grama	13	0 7	Unknown flower		1	0.1
Schizachyrium scoparium	Little bluestem	9	0 5	Unknown fruit		1	0.1
Eragrostis intermedia	Plains lovegrass	7	0.4	Deer corn	Deer corn	21	1 1
Bouteloua rigidiseta	Texas grama	6	0 3				
Erioneuron pilosum	Hairy tridens	4	0 2				
Triticum aestivum	Wheat	3	0 2				
Carex planostachys	Cedar sedge	3	0 2				
Aristida purpurea	Purple threeawn	2	0 1				
Buchloe dactyloides	Buffalograss	1	0 1				
Setaria leucopila	Plains bristlegrass	1	0 1				

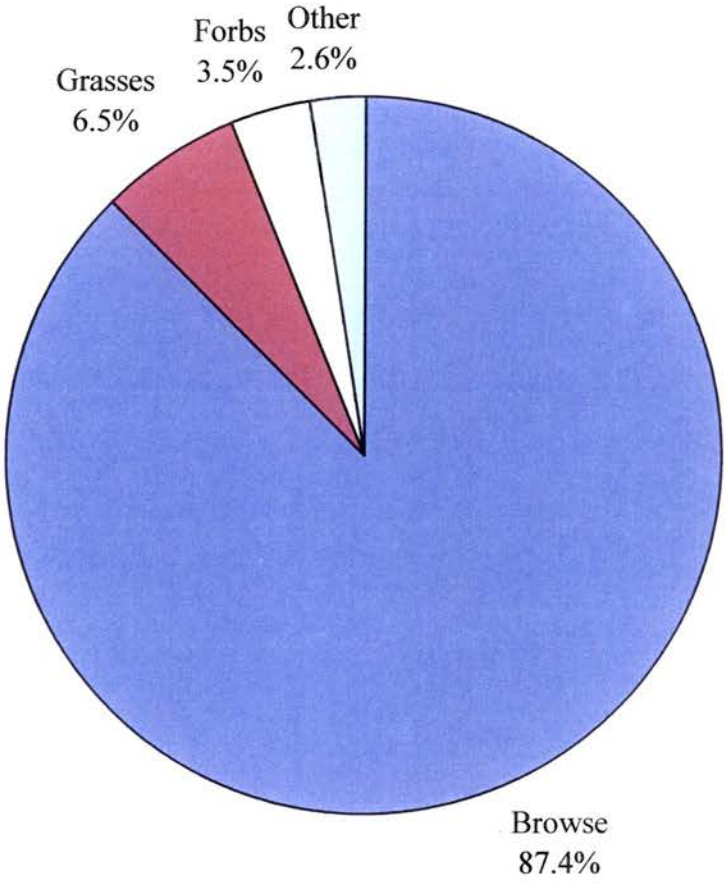

Figure 7. Forage class percentages of plants in the annual diet of greater kudu at Mason Mountain Wildlife Management Area, 2001-2002.

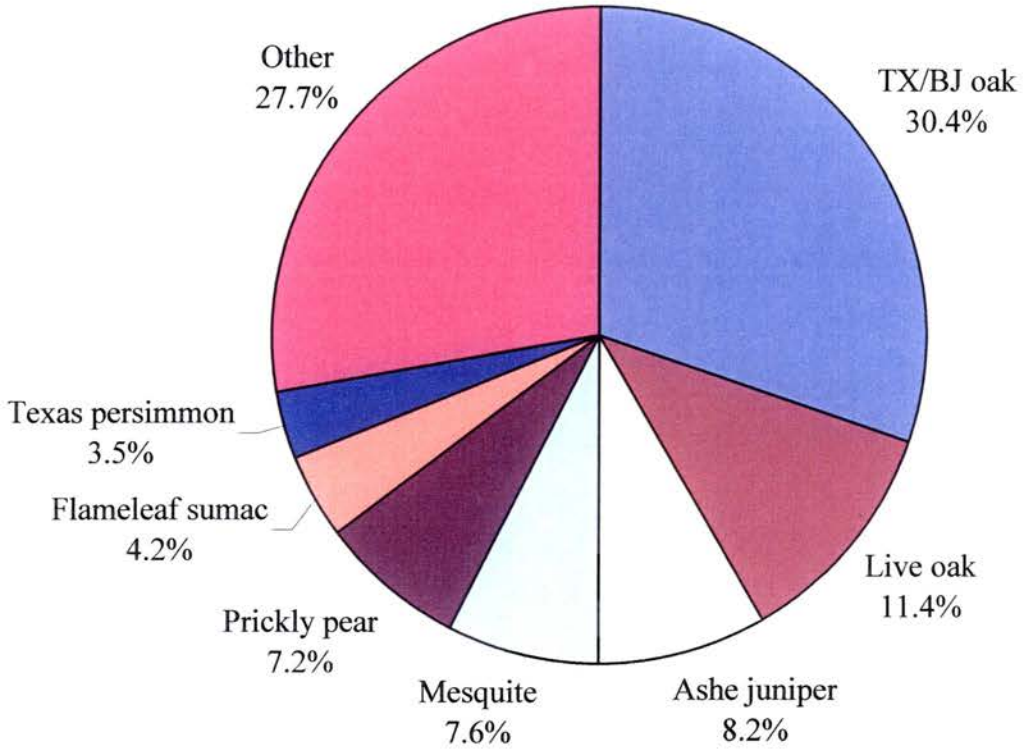

Figure 8. Percent occurrence of plants utilized by greater kudu annually at Mason Mountain Wildlife Management Area, 2001-2002.

Milo had an availability value within the confidence intervals of observed use and was utilized proportionally to its availability (Table 7, Fig. 10). Manly's alpha preference index scores for food items in the summer diet (Table 11) differed in some instances from the chi-square analysis. Greater kudu preferred TX/BJ oak, mesquite, and milo; however, avoided Texas persimmon (leaves, fruits, and seeds).

In autumn, the null hypothesis that greater kudu fed on plants proportional to their estimated availability was rejected ($\chi^2 = 256.753$, $p < 0.001$). Texas/blackjack oak, flameleaf sumac, and prickly pear (pads, fruits, and seeds) availability values were below the lower confidence interval on observed use. This illustrated greater kudu selected these plants. Greater kudu utilized mesquite in proportion to its availability, which had an availability value within the confidence intervals of observed use (Table 8, Fig. 11). Manly's alpha preference index scores for food items differed in some instances from the chi-square analysis (Table 12). Manly's alpha supported greater kudu preference for flameleaf sumac, but suggested avoidance for TX/BJ oak, mesquite, and prickly pear (pads, fruits, and seeds).

The null hypothesis that greater kudu used plants proportional to their estimated availability during winter was rejected ($\chi^2 = 171.775$, $p < 0.001$). Live oak, Ashe juniper, and devil's-shoestring had availability values below the lower confidence interval on observed use, thus showing greater kudu selected these food plants. Twisted-leaf yucca, which had an availability value within the confidence intervals on observed use, was utilized in proportion to its availability. Greater kudu avoided prickly pear (pads) and Texas wintergrass. These plants had availability values above the higher confidence interval on observed use (Table 9, Fig. 12). Manly's alpha preference index scores for

food items differed in some instances from the chi-square analysis (Table 13). Manly's alpha supported greater kudu preference for Ashe juniper, but suggested greater kudu avoided live oak, prickly pear (pads), devil's-shoestring, twisted-leaf yucca, and Texas wintergrass.

Table 6. Comparison of the observed use and expected use of plants in the spring diet of greater kudu at Mason Mountain Wildlife Management Area, 2001. Hypothesis of proportional use was rejected ($\chi 2 = 218.801$, $p < 0.001$).

Plant Species	Expected Use (Availability)	Observed Use (In Diet)	95% Confidence Interval On Observed Use	Plants Utilized More (M) Or Less Than Expected (L)
TX/BJ oak	0.0888	0.3457	$0.2834 < p < 0.4079$	M
Mesquite	0.0232	0.1239	$0.0808 < p < 0.1670$	M
Purple horsemint (flower)	0.0039	0.0565	$0.0263 < p < 0.0867$	M
Canada wildrye	0.0039	0.0522	$0.0231 < p < 0.0813$	M
Elbowbush	0.0425	0.0478	$0.0199 < p < 0.0758$	-
Skunkbush sumac	0.0116	0.0348	$0.0108 < p < 0.0588$	-
Live oak	0.1506	0.0348	$0.0108 < p < 0.0588$	L
Flameleaf sumac	0.0039	0.0326	$0.0094 < p < 0.0559$	M
Devil's-shoestring	0.0116	0.0304	$0.0079 < p < 0.0529$	-
Other	0.6602	0.2460	$0.1853 < p < 0.2973$	-

Table 7. Comparison of the observed use and expected use of plants in the summer diet of greater kudu at Mason Mountain Wildlife Management Area, 2001. Hypothesis of proportional use was rejected ($\chi 2 = 155.344$, $p < 0.001$).

Plant Species	Expected Use (Availability)	Observed Use (In Diet)	95% Confidence Interval On Observed Use	Plants Utilized More (M) Or Less Than Expected (L)
TX/BJ oak	0.1855	0.5580	$0.5008 < p < 0.6152$	M
Mesquite	0.0484	0.1620	$0.1196 < p < 0.2044$	M
Texas persimmon	0.0565	0.1160	$0.0791 < p < 0.1529$	M
Milo	0.0161	0.0380	$0.0160 < p < 0.0600$	-
Other	0.6935	0.1260	$0.0878 < p < 0.1642$	-

Table 8. Comparison of the observed use and expected use of plants in the autumn diet of greater kudu at Mason Wildlife Management Area, 2001. Hypothesis of proportional use was rejected ($\chi 2 = 256.753$, $p < 0.001$).

Plant Species	Expected Use (Availability)	Observed Use (In Diet)	95% Confidence Interval On Observed Use	Plants Utilized More (M) Or Less Than Expected (L)
TX/BJ oak	0.0958	0.4420	$0.3848 < p < 0.4992$	M
Flameleaf sumac	0.0042	0.1420	$0.1018 < p < 0.1822$	M
Mesquite	0.0250	0.0480	$0.0234 < p < 0.0726$	-
Prickly pear	0.0875	0.1620	$0.1196 < p < 0.2044$	M
Other	0.7875	0.2060	$0.1594 < p < 0.2526$	-

Table 9. Comparison of the observed use and expected use of plants in the winter diet of greater kudu at Mason Mountain Wildlife Management Area, 2002. Hypothesis of proportional use was rejected ($\chi 2 = 171.775$, $p < 0.001$).

Plant Species	Expected Use (Availability)	Observed Use (In Diet)	95% Confidence Interval On Observed Use	Plants Utilized More (M) Or Less Than Expected (L)
Live oak	0.2143	0.4120	$0.3528 < p < 0.4712$	M
Ashe juniper	0.0143	0.3120	$0.2563 < p < 0.3677$	M
Prickly pear	0.1500	0.0940	$0.0589 < p < 0.1291$	L
Devil's-shoestring	0.0143	0.0460	$0.0208 < p < 0.0712$	M
Twisted-leaf yucca	0.0500	0.0340	$0.0122 < p < 0.0558$	-
Texas wintergrass	0.2857	0.0600	$0.0314 < p < 0.0886$	L
Other	0.2714	0.0420	$0.0179 < p < 0.0661$	-

Table 10. Manly's alpha preference index scores for plants in the spring diet of greater kudu at Mason Mountain Wildlife Management Area, 2001(scores > 0.100 indicate preference).

Plant Species	Manly's Alpha
TX/BJ oak	0.073
Mesquite	0.101
Purple horsemint (flower)	0.275
Canada wildrye	0.254
Elbowbush	0.021
Skunkbush sumac	0.056
Live oak	0.004
Flameleaf sumac	0.159
Devil's-shoestring	0.049
Other	0.007

Table 11. Manly's alpha preference index scores for plants in the summer diet of greater kudu at Mason Mountain Wildlife Management Area, 2001(scores > 0.200 indicate preference).

Plant Species	Manly's Alpha
TX/BJ oak	0.275
Mesquite	0.306
Texas persimmon	0.188
Milo	0.215
Other	0.017

Table 12. Manly's alpha preference index scores for plants in the autumn diet of greater kudu at Mason Mountain Wildlife Management Area, 2001(scores > 0.200 indicate preference).

Plant Species	Manly's Alpha
TX/BJ oak	0.108
Flameleaf sumac	0.798
Mesquite	0.045
Prickly pear	0.043
Other	0.006

Table 13. Manly's alpha preference index scores for plants in the winter diet of greater kudu at Mason Mountain Wildlife Management Area, 2002 (scores > 0.143 indicate preference).

Plant Species	Manly's Alpha
Live oak	0.067
Ashe juniper	0.762
Prickly pear	0.022
Devil's-shoestring	0.112
Twisted-leaf yucca	0.024
Texas wintergrass	0.007
Other	0.005

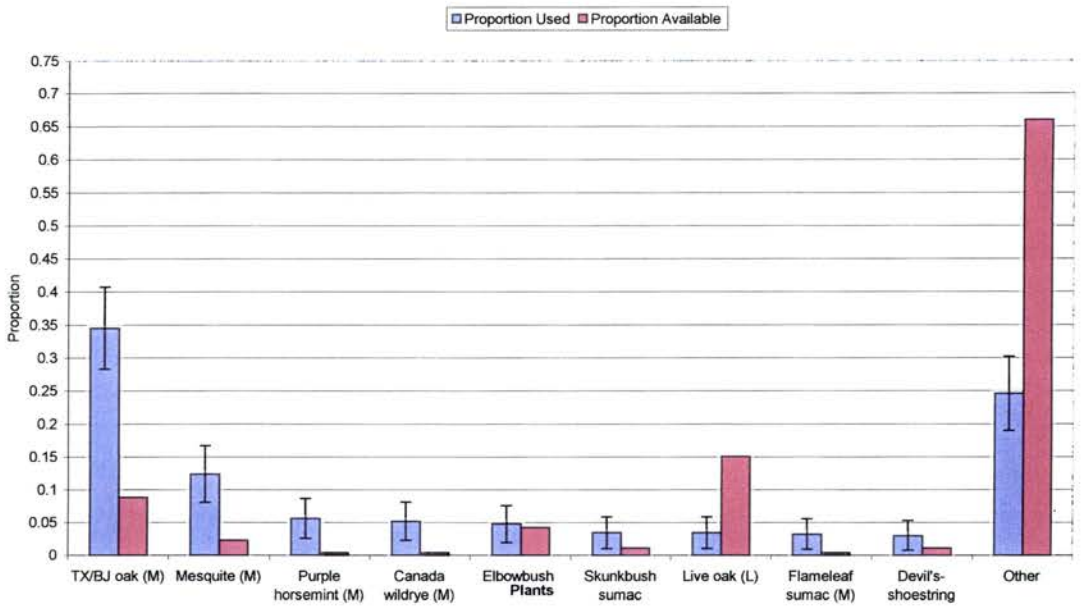

Figure 9. Comparison of use to availability of plants during spring 2001 at Mason Mountain Wildlife Management Area. Error bars represent 95% confidence intervals corrected using the Bonferroni correction. Plants utilized by greater kudu more (M) or less (L) than expected are indicated.

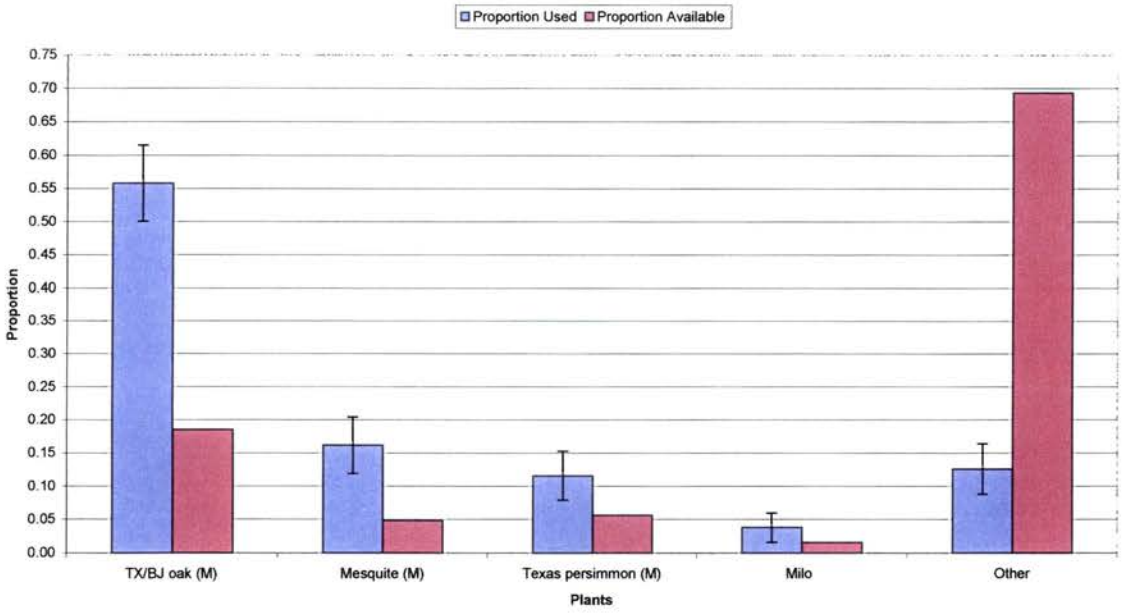

Figure 10. Comparison of use to availability of plants during summer 2001 at Mason Mountain Wildlife Management Area. Error bars represent 95% confidence intervals corrected using the Bonferroni correction. Plants utilized by greater kudu more (M) or less (L) than expected are indicated.

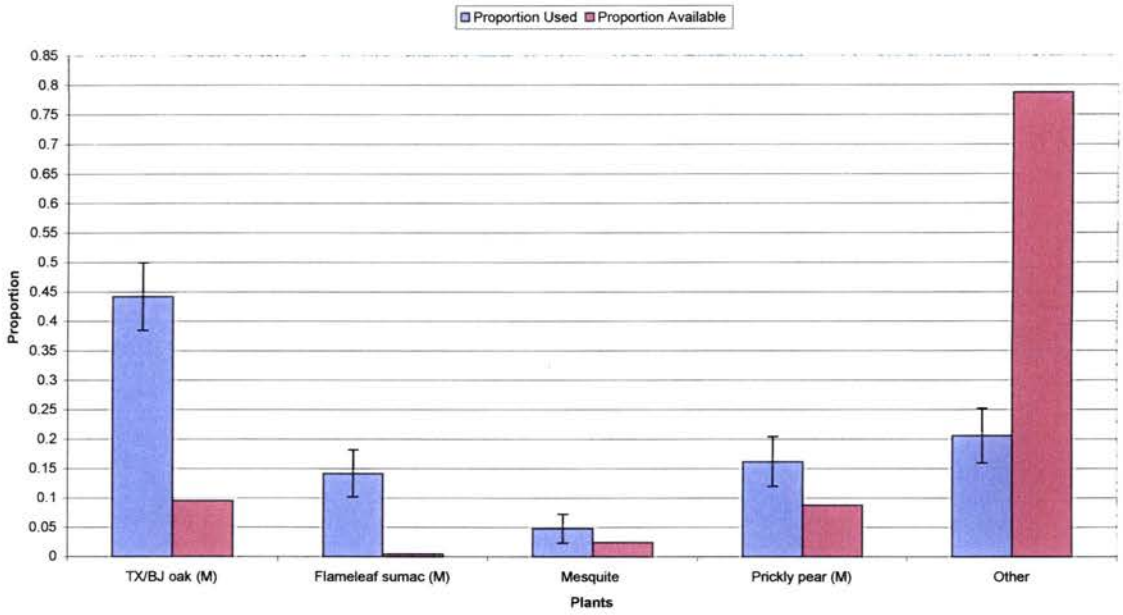

Figure 11. Comparison of use to availability of plants during autumn 2001 at Mason Mountain Wildlife Management Area. Error bars represent 95% confidence intervals corrected using the Bonferroni correction. Plants utilized by greater kudu more (M) or less (L) than expected are indicated.

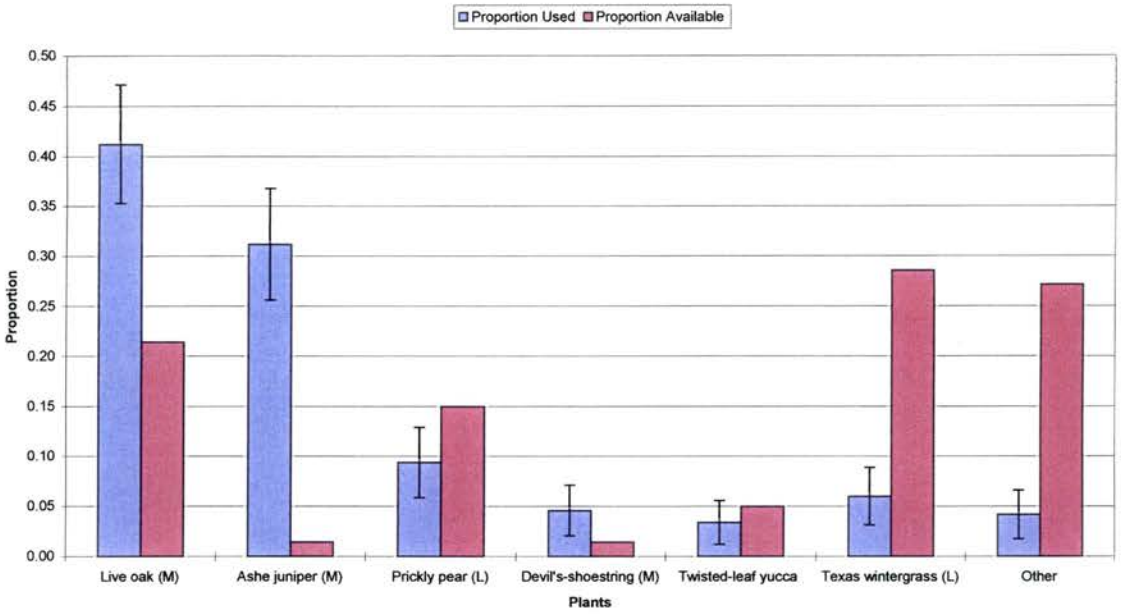

Figure 12. Comparison of use to availability of plants during winter 2002 at Mason Mountain Wildlife Management Area. Error bars represent 95% confidence intervals corrected using the Bonferroni correction. Plants utilized by greater kudu more (M) or less (L) than expected are indicated.

DISCUSSION

At MMWMA, the annual diet showed that greater kudu were primarily browsers (Fig. 7). The use of forbs depended upon seasonal availability, which was affected by climatic changes. Grasses were consumed slightly in all seasons. Texas/blackjack oak was the most common utilized plant in spring, summer, and autumn diets. Live oak and Ashe juniper were the prominently utilized plants during winter. Browse shoots occurred in the diet in every season with the greatest amount being in summer. This is not surprising as greater kudu utilized browse to the greatest extent in summer. Wilson (1970) also found twigs of plants in greater kudu stomach contents. Owen-Smith (1979) and Owen-Smith and Cooper (1985), using the direct observation method, found greater kudu to be principally browsers in all seasons in southern Africa. *Acacia* spp. were highly utilized throughout most seasons in South Africa (Owen-Smith and Cooper 1989, Owen-Smith and Cooper 1985, Owen-Smith 1979, Wilson 1970, Wilson 1965); conversely, *Acacia* spp. at MMWMA were not. Of the four species of Fabaceae found on MMWMA, mesquite was utilized the most (7.6%).

Browse was the dominant forage class (80.2%) in greater kudu diets during spring. Forbs (12.4%) also were used considerably. Texas/blackjack oak, mesquite, purple horsemint (flowers), Canada wildrye, and flameleaf sumac were selected based on the chi-square analysis. Results of the Manly's alpha analysis suggested greater kudu had preference for purple horsemint (flowers), Canada wildrye, and flameleaf sumac. Both

analyses suggested greater kudu had strong selectivity for purple horsemint (flowers) and Canada wildrye during spring.

During spring on MMWMA, young sprouts of browse species and an abundance of forbs and young green grass became available. Greater kudu actively foraged for these young palatable resources. Owen-Smith (1979) and Owen-Smith and Cooper (1985) found greater kudu spent 63% and 66% of their feeding time on browse during the early wet season (spring) in South Africa, respectively. Owen-Smith (1979) reported greater kudu spent 37% of their feeding time on forbs during the early wet season; in contrast Owen-Smith and Cooper (1985) reported that greater kudu spent only 17% of their time foraging on forbs. Owen-Smith and Cooper (1985) noted greater kudu minimally consumed grasses (4.0%) during the early wet season. Greater kudu consumed flowers when available (Owen-Smith and Cooper 1985). Wilson (1965) also reported that greater kudu stomach contents contained flowers in southern Africa.

Greater kudu utilized browse to the greatest extent in summer (94.8%), possibly because forbs are rarely found in this season, TX/BJ oak, mesquite, and Texas persimmon (leaves, flowers, and fruits) were consumed in the greatest amounts. Results of the chi-square analysis suggested greater kudu selected TX/BJ oak, mesquite, and Texas persimmon (leaves, flowers, and fruits). Results of the Manly's alpha analysis also suggested greater kudu preferred TX/BJ oak and mesquite. The chi-square analysis indicated greater kudu selected Texas persimmon (leaves, flowers, and fruits); however, the Manly's alpha analysis suggested avoidance. The Manly's alpha preference index number (0.188) for Texas persimmon (leaves, flowers, and fruits) almost indicated preference (0.200). Therefore, greater kudu probably do prefer Texas persimmon

during summer. Milo also had high utilization in summer. Availability values for milo were near the lower confidence interval on observed use and with Manly's alpha preference index number suggesting preference; greater kudu probably do select milo. Milo was available in a food plot and Texas persimmon fruits were abundant at that time.

In the late growing season (summer), greater kudu spent 60% of their feeding time on browse, 22% on forbs, 4% on fruits and pods, and 14% on grasses in South Africa (Owen-Smith and Cooper 1985). Owen-Smith (1979) found greater kudu spent 30% of their feeding time on browse, 60% on forbs, and 10% on fruits and pods in the late growing season in South Africa. Wilson (1965) reported greater kudu utilized *Diospyros* spp. fruits and cultivated crops of green maize when available in southern Africa.

During autumn, browse comprised the bulk (85.6%) of the greater kudu diet with other (9.0%), grasses (5.0%), and forbs (0.4%) making up the remaining forage categories. Based on the chi-square test, TX/BJ oak, flameleaf sumac, and prickly pear (pads, fruits, and seeds) were selected. Mesquite was utilized proportionally to its availability. Results of the Manly's alpha analysis indicated that greater kudu preferred flameleaf sumac and avoided the other autumn plants. Therefore, greater kudu probably have strong selectivity for flameleaf sumac during this season.

Deer corn was utilized to some extent in autumn (4.8%), which was available through deer feeders during deer hunts. Prickly pear seeds were found considerably more often than fruits possibly because of the large number of seeds found in a single fruit. In southern Africa during the early dormant season (autumn), greater kudu spent 53% of their feeding time on browse, 21% on forbs, 20% on fruits and pods, and 6% on grasses

their feeding time on browse, 21% on forbs, 20% on fruits and pods, and 6% on grasses (Owen-Smith and Cooper 1985). Wilson (1970) reported 85% of greater kudu stomach contents contained prickly pear (*Opuntia megacantha*) in May (early dormant season) at Kyle National Park in Zimbabwe.

Browse was the dominant forage class (90.0%) in the winter diet. Greater kudu also utilized grasses (9.0%). The chi-square analysis indicated greater kudu showed selectivity for live oak, Ashe juniper, and devil's-shoestring during winter. Results of the Manly's alpha analysis supported the chi-square analysis, in that, greater kudu showed preference for Ashe juniper but suggested avoidance for the other winter plants. Based on these analyses greater kudu show selectivity for Ashe juniper during winter.

During winter, deciduous browse species were not available for greater kudu at MMWMA; as a result, greater kudu changed their selectivity. In southern Africa, greater kudu spent 63% of their feeding time on browse, 8% on forbs, 23% on fruits and pods, and 6% on leaf litter in the late dormant season (winter) (Owen-Smith and Cooper 1985).

According to my results, greater kudu are primarily browsers that utilize forbs and grasses minimally at MMWMA. This agrees with studies done in Africa. Greater kudu utilized a variety of different plants and plant parts (flowers and fruits) throughout the year at MMWMA. Studies in Africa showed comparable results.

Comparison of Greater Kudu and White-tailed Deer Diets

Annually in the Edwards Plateau ecological region of Texas, white-tailed deer spent 61.0% of their feeding time on browse, 31.0% on forbs, and 8.0% on grasses on excellent range (Bryant et al. 1981). With poor range condition, time spent on browse

Waid et al. (1984) found the annual diet of white-tailed deer consisted mostly of browse (56.2%) and forbs (35.0%). In the annual diet of greater kudu at MMWMA, browse made up 87.4%, grasses 6.5%, and forbs 3.5% and other 2.6%. McMahan (1964) described Texas oak as a preferred white-tailed deer food. Greater kudu utilized TX/BJ oak extensively in all seasons except winter. Because white-tailed deer prefer Texas oak and greater kudu showed selectivity for TX/BJ oak in most seasons, competition between white-tailed deer and greater kudu could occur. Everitt and Drawe (1974) documented white-tailed deer heavily utilized prickly pear and Texas persimmon fruits when available in South Texas. Greater kudu likewise utilized these plants, but did not show selectivity for them. Greater kudu and white-tailed deer could compete for these plants as well. Ashe juniper comprised 22.2% with live oak making up 17.0% of the winter diet of white-tailed deer in the Edwards Plateau ecological region (Waid et al. 1984). Bryant et al. (1981) reported white-tailed deer utilized live oak extensively during winter on excellent range condition. Ashe juniper was utilized heavily on the poor range condition site (Bryant et al. 1981). Live oak (41.2%) and Ashe juniper (31.2%) had the highest percent occurrences in the greater kudu diet during winter; greater kudu similarly selected both plants based on the results of the chi-square analysis. Due to the scarcity of browse species in winter and the intensive use by greater kudu and white-tailed deer, there could be competition for these plants in winter.

Fecal Analysis

Fecal analysis has many advantages including noninterference with habits and movements of animals, unlimited sample size, and ease of sampling (Holechek et al. 1982a). The major disadvantage in fecal analysis is differential digestion of consumed plants (Holechek et al. 1982). Storr (1961) and Smith and Shandruk (1979) reported differential digestion in fecal analysis of other herbivores; although, Casebeer and Koss (1970), Chapuis et al. (2001), and Anthony and Smith (1974) reported rumen contents and fecal material to be similar in herbivores. The ability to identify flower epidermal fragments (petals), a fragile part of a plant, in the fecal material would suggest minimal differential digestion. An answer to this question requires feeding known food plants to captive animals and creating an equation that adjusts for differential digestion. Captive greater kudu were not available at MMWMA during the study, and with the requirement of extensive time and intensive labor, an equation was not developed.

Sample size for fecal analysis was determined to be adequate as shown by the plant species curve graphs in Appendices 7–10.

Management Implications

Greater kudu are large ungulates and because of their size and energy demands must consume large amounts of food each day. Owen-Smith (1979) reported greater kudu spent on a year-round average over 60% of their foraging time feeding in South Africa. The vast majority of plants consumed were in the browse forage class; thus, greater kudu could compete with other browsers, such as white-tailed deer and goats on a

range site. Greater kudu also could compete with axis deer and blackbuck antelope due to seasonal utilization of forbs and grasses by greater kudu and seasonal utilization of browse by these animals. According to my results, greater kudu could be stocked with grazers, such as cattle, European mouflon (*Ovis musimon*), and oryx (*Oryx* spp.) with little competition for food plants. A landowner also should consider the competition for water and space. These must be taken into consideration if a landowner wants to stock greater kudu. Greater kudu appear to be doing well at MMWMA under intensive management practices.

Further studies are needed to determine greater kudu seasonal diets in combination with other ungulates to accurately indicate forage competition at MMWMA. Further studies also are needed at MMWMA to determine seasonal diet differences in sex and age classes. Future studies could be done to establish a correction factor for differential digestion or to compare rumen contents to fecal contents for evidence of differential digestion. Greater kudu seasonal diet studies also should be done where greater kudu occur throughout the different ecological regions of Texas and in the United States.

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Appendix 1. Daubenmire percent coverages of herbaceous plants during spring 2001 at Mason Mountain Wildlife Management Area.

Scientific Name	Common Name	Percent Coverage	Scientific Name	Common Name	Percent Coverage
Litter	Litter	37 10	*Krameria lanceolata*	Ratany	0 08
Bare ground	Bare ground	16 17	*Evolvulus nuttallianus*	Silky evolvulus	0 07
Stipa leucotricha	Texas wintergrass	2 93	*Lechea tenuifolia*	Narrow-leaf pinweed	0 07
Bifora americana	Prairie bishop's-weed	2 31	*Centaurium beyrichii*	Mountain pink	0 07
Daucus pusillus	Wild carrot	1 92	*Salvia farinacea*	Mealy sage	0 07
Plantago rhodosperma	Redseed plantain	1 82	*Schoenocaulon texanum*	Green lily	0 07
Evax prolifera	Bighead evax	1 68	*Bouteloua rigidiseta*	Texas grama	0 05
Wedelia hispida	Hairy wedelia	1 57	*Sida filicaulis*	Sida	0 05
Chaetopappa bellidifolia	Dwarf white aster	1 36	*Acacia angustissima*	Prairie acacia	0 05
Parietaria pensylvanica	Pennsylvania pellitory	1 28	*Lepidium virginicum*	Peppergrass	0 05
Limnodea arkansana	Ozark grass	0 83	*Paronychia lindheimeri*	Lindheimer's nailwort	0 05
Setaria reverchonii	Reverchon bristlegrass	0 73	*Phlox roemeriana*	Golden-eye phlox	0 05
Lupinus texensis	Texas bluebonnet	0 67	*Chamaesarcha sordida*	False Nightshade	0 05
Digitaria cognata	Fall witchgrass	0 64	*Lindheimera texana*	Texas star	0 03
Croton monathogynus	One-seed croton	0 49	*Dyschoriste linearis*	Snake herb	0 03
Scutellaria drummondii	Drummond's skullcap	0 49	*Schrankia uncinata*	Sensitive briar	0 03
Bromus japonicus	Japanese brome	0 48	*Tridens flavus*	Purpletop tridens	0 03
Coreopsis basalis	Coreopsis	0 46	*Aphanostephus* sp	Lazy daisy	0 03
Plantago patagonica	Patagonia plantain	0 44	*Panicum obtusum*	Vinemesquite	0 03
Erodium texanum	Stork's bill	0 37	*Gaillardia pulchella*	Indian blanket	0 03
Paspalum pubiflorum	Hairy seed paspalum	0 37	*Hedyotis nigricans*	Baby's breath	0 03
Aristida purpurea	Purple threeawn	0 35	*Achillea millefolium*	Yarrow	0 02
Amphiachyris dracunculoides	Annual broomweed	0 31	*Callirhoe involucrata*	Wine cup	0 02
Oxalis spp	Wood-sorrel	0 30	*Linum rigidum*	Stiff stem flax	0 02
Thelesperma filifolium	Thelesperma	0 30	*Mentzelia oligosperma*	Stick-leaf	0 02
Verbena bipinnatifida	Prairie verbena	0 29	*Gaura coccinea*	Scarlet gaura	0 02
Erioneuron pilosum	Hairy tridens	0 29	*Helianthemum georgianum*	Rockrose	0 02
Tragia ramosa	Noseburn	0 28	*Euphorbia prostrata*	Prostrate spurge	0 02
Indigofera miniata	Scarlet pea	0 27	*Erigeron modestus*	Prairie fleabane	0 02
Brazoria scutellarioides	Prairie brazoria	0 25	*Asclepias* sp	Milkweed	0 02
Teucrium laciniatum	Cut-leaf germander	0 22	*Artemisia ludoviciana*	Louisiana sagewort	0 02
Helenium badium	Brown bitterweed	0 22	*Muhlenbergia lindheimeri*	Lindheimer's muhly	0 02
Bouteloua curtipendula	Sideoats grama	0 18	*Liatris mucronata*	Gay-feather	0 02
Mendodora heterophylla	Redbud	0 15	*Erigeron philadelphicus*	Fleabane daisy	0 02
Ratibida columnaris	Mexican hat	0 15	*Dalea nana*	Dwarf nana	0 02
Ambrosia psilostachya	Western ragweed	0 14	*Cuscuta indecora*	Dodder	0 02
Bouteloua trifida	Red grama	0 14	*Carex planostachys*	Cedar sedge	0 02
Torilis arvensis	Hedge-parsley	0.14			
Gnaphalium sp	Cudweed	0 14			
Dichanthelium acuminatum	Woolly dichanthelium	0 12			
Solanum dimidiatum	Western horse-nettle	0 12	Daubenmire percent coverage classes		
Elymus canadensis	Canada wildrye	0 10	(1 = 0-5%, 2 = 6-25%, 3 = 26-50%, 4 = 51-75%, 5 = 76-95%, 6 = 95-100)		
Monarda citriodora	Purple horsemint	0 10			
Stillingia texana	Queen's delight	0 10	Daubenmire class midpoints		
Gaillardia suavis	Pincushion daisy	0 10	(1 = 2 5, 2 = 15 5, 3 = 38, 4 = 63, 5 = 85 5, 6 = 97 5)		
Carex perdentata	Conspicuously-toothed caric sedge	0 10			
Gilia rididula	Blue gilia	0 10	Species % coverage = midpoint total of species/total number of frames(150)		

Appendix 2 Line-intercept data for woody plants during spring 2001 at Mason Mountain Wildlife Management Area

Scientific Name	Common Name	Total Length (Meters)	Available Length (Meters)	Percent Cover of Species (Total)	Percent Cover of Species (Available)
Quercus fusiformis	Live oak	211 55	68 45	14 10	4 56
Quercus marilandica	Blackjack oak	86 70	55 00	5.78	3 67
Quercus sinuata	Shin oak	52 70	46 45	3.51	3 10
Berberis trifoliolata	Agarita	42 05	42 05	2 80	2 80
Opuntia spp.	Prickly pear	20 05	20 05	1 34	1 34
Quercus buckleyi	Texas oak	134 15	16 35	8 94	1 08
Yucca rupicola	Twisted-leaf yucca	15 75	15 75	1 05	1 05
Condalia viridis	Green condalia	14 66	14 66	0 98	0 98
Diospyros texana	Texas persimmon	10 05	7 85	0 67	0 52
Prosopis glandulosa	Mesquite	7 75	6 70	0 52	0 45
Forestiera pubescens	Elbowbush	5 10	5 10	0 34	0 34
Ziziphus obtusifolia	Lotebush	4 80	4 80	0 32	0 32
Celtis reticulata	Netleaf hackberry	8 60	4.40	0 57	0 29
Bumelia lanuginosa	Gum bumelia	7 10	3 30	0 47	0 22
Yucca constricta	Buckley yucca	2 90	2 90	0 19	0 19
Juniperus ashei	Ashe juniper	2 90	2 90	0 19	0 19
Nolina lindheimeriana	Devil's-shoestring	2 26	2 26	0 15	0 15
Acacia roemeriana	Catclaw acacia	2 25	2 25	0 15	0 15
Quercus stellata	Post oak	2.00	2 00	0 13	0 13
Mimosa biuncifera	Catclaw mimosa	2 00	2 00	0 13	0 13
Ungnadia speciosa	Mexican buckeye	1 55	1 55	0 10	0 10
Toxicodendron radicans	Poison ivy	1 40	1.40	0 09	0 09
Smilax bona-nox	Greenbriar	1 10	1 10	0 07	0 07
Vitis monticola	Sweet mountain grape	0 90	0 90	0 06	0 06
Zanthoxylum hirsutum	Prickly ash	0 80	0 80	0 05	0 05
Ulmus americana	American elm	0 80	0 80	0 05	0 05
Rhus aromatica	Skunkbush sumac	0 55	0.55	0 04	0 04
Viburnum rufidulum	Rusty blackhaw	0 60	0 60	0.04	0 04
Eysenhardtia texana	Texas kidneywood	0 15	0 15	0 01	0 01
Cercis canadensis	Redbud	0 20	0 20	0 01	0 01
Rhus lanceolata	Flameleaf sumac	0 20	0 20	0 01	0 01

Available food plants are defined as ≤ 2 m in height
Percent cover = length of species/total length of intercept lines (1500)

Appendix 3. Daubenmire percent coverages of herbaceous plants during summer 2001 at Mason Mountain Wildlife Management Area

Scientific Name	Common Name	Percent Coverage	Scientific Name	Common Name	Percent Coverage
Litter	Litter	52 17	*Thelesperma filifolium*	Thelesperma	0 06
Bare ground	Bare ground	15 74	*Krameria lanceolata*	Ratany	0 05
Panicum hallii	Hall panicum	2 38	*Salvia farinacea*	Mealy sage	0 05
Wedelia hispida	Hairy wedelia	1 38	*Buchloe dactyloides*	Buffalograss	0.05
Stipa leucotricha	Texas wintergrass	1 28	*Hedyotis nigricans*	Baby's breath	0 05
Solanum rostratum	Buffalo bur	1 00	Unknown #5	Unknown #5	0 03
Bouteloua curtipendula	Sideoats grama	0 91	*Thelesperma simplicifolium*	Navajo tea	0 03
Carex planostachys	Cedar sedge	0 91	*Pseudognaphalium obtusifolium*	Fragrant cudweed	0 03
Schizachyrium scoparium	Little bluestem	0 80	*Helenium badium*	Brown bitterweed	0 03
Amphiachyris dracunculoides	Annual broomweed	0 60	*Salvia texana*	Blue sage	0 03
Croton monanthogynus	One-seed croton	0 58	*Callirhoe involucrata*	Winecup	0 02
Ratibida columnaris	Mexican hat	0 51	*Solanum dimidiatum*	Western horse-nettle	0 02
Aristida purpurea	Purple threeawn	0 49	Unknown #1	Unknown #1	0 02
Hilaria berlangeri	Curlymesquite	0 48	*Bouteloua rigidiseta*	Texas grama	0 02
Tragia ramosa	Noseburn	0 39	*Passiflora tenuiloba*	Slender-lobe passion flower	0 02
Evolvulus nuttallianus	Silky evolvulus	0 27	*Solanum elaeagnifolium*	Silver-leaf nightshade	0 02
Muhlenbergia lindheimeri	Lindheimer's muhly	0 24	*Schrankia uncinata*	Sensitive briar	0 02
Verbena canescens	Gray vervain	0 19	*Psoralea tenuiflora*	Scurfy pea	0 02
Scutellaria drummondii	Drummond's skullcap	0 19	*Brazoria scutellarioides*	Prairie brazoria	0 02
Sorghum vulgare	Milo	0 19	*Erioneuron pilosum*	Hairy tridens	0.02
Sida filicaulis	Sida	0 16	*Digitaria cognata*	Fall witchgrass	0 02
Teucrium laciniatum	Cut-leaf germander	0.14	*Dichanthelium* sp	Dichanthelium species	0 02
Verbena bipinnatifida	Prairie verbena	0 13	*Melampodium leucanthum*	Blackfoot daisy	0 02
Ambrosia psilostachya	Western ragweed	0 11			
Liatris mucronata	Gay-feather	0 11			
Furena squarrosa	Umbrella grass	0 10	Daubenmire percent coverage classes		
Juncus sp	Rush species	0 10	(1 = 0-5%, 2 = 6-25%, 3 = 26-50%, 4 = 51-75%, 5 = 76-95%, 6 = 95-100)		
Elymus candensis	Canada wildrye	0 10			
Panicum ramosum	Browntop millet	0 10	Daubenmire class midpoints		
Brickellia cylindraceae	Brickell-bush	0 10	(1 = 2 5, 2 = 15 5, 3 = 38, 4 = 63, 5 = 85 5, 6 = 97 5)		
Bothriochloa laguroides	Silver bluestem	0 09			
Evolvulus sericeus	White evolvulus	0 06	Species % coverage = midpoint total of species/total number of frames (160)		

Appendix 4 Daubenmire percent coverages of herbaceous plants during autumn 2001 at Mason Mountain Wildlife Management Area

Scientific Name	Common Name	Percent Coverage	Scientific Name	Common Name	Percent Coverage
Litter	Litter	30 43	*Dichanthelium laxiflorum*	Openflower dichanthelium	0 11
Bare ground	Bare ground	14 17	*Paspalum floridanum*	Florida paspalum	0 11
Bouteoua curtipendula	Sideoats grama	4 83	*Achillea millefolium*	Yarrow	0 10
Schizachyrium scoparium	Little bluestem	4 79	*Vernonia lindheimeri*	Woolly ironweed	0 10
Carex planostachys	Cedar sedge	3 62	*Geranium carolinianum*	Wild geranium	0 10
Stipa leucotricha	Texas wintergrass	3 47	Unknown #8	Unknown #8	0 10
Wedelia hispida	Hairy Wedelia	3 20	*Cirsium texanum*	Texas thistle	0 10
Croton monanthogynus	One-seed croton	2 73	*Carex* sp	Sedge species	0 10
Amphiachyris dracunculoides	Annual broomweed	2 67	*Oenothera* sp.	Primrose species	0 10
Sida filicaulis	Sida	1 65	*Phyllanthus polygonoides*	Knotweed leaf-flower	0 08
Hilaria berlangeri	Curlymesquite	1 39	*Evolvulus nuttallianus*	Silky evolvulus	0 05
Ratibida columnifera	Mexican hat	1 22	*Indigofera miniata*	Scarlet pea	0 05
Verbena halei	Texas vervain	1 08	*Dalea lasiathera*	Purple dalea	0 05
Oxalis dillenii	Yellow wood-sorrel	0 78	*Liatris mucronata*	Gay-feather	0 05
Bouteloua trifida	Red grama	0 72	*Pseudognaphalium obtusifolium*	Fragrant cudweed	0 05
Scutellaria drummondii	Drummond's skullcap	0 67	*Melampodium leucanthum*	Blackfoot daisy	0 05
Verbena bipinnatifida	Prairie verbena	0 66	*Solanum dimidiatum*	Western horse-nettle	0.03
Plantago patagonica	Patagonia plantain	0 62	*Eragrostis intermedia*	Plains lovegrass	0 03
Digitaria cognata	Fall witchgrass	0 61	*Dyssodia pentachaeta*	Paralena	0 03
Oxalis drummondii	Purple wood-sorrel	0 49	*Dichanthelium* sp	Dichanthelium species	0 03
Triticum aestivum	Wheat	0 48	*Helenium amarum*	Yellow bitterweed	0 02
Sporobolus asper	Tall dropseed	0 46	*Daucus pusillus*	Wild carrot	0 02
Erodium texanum	Stork's bill	0 45	*Chloris verticillata*	Tumble windmillgrass	0 02
Solanum rostratum	Buffalo bur	0 45	*Thelesperma* sp.	Thelesperma species	0 02
Ambrosia psilostachya	Western ragweed	0 42	*Eriochloa sericea*	Texas cupgrass	0.02
Aristida purpurea	Purple threeawn	0 35	*Tridens muticus*	Slim tridens	0 02
Verbena pumila	Low verbena	0 32	*Solanum eleagnifolium*	Silver-leaf nightshade	0 02
Pyrrhopappus sp	Texas dandelion	0 29	*Thelesperma simplicifolium*	Navajo tea	0 02
Evolvulus sericeus	White evolvulus	0 28	*Artemisia ludoviciana*	Louisiana sagewort	0 02
Plantago rhodosperma	Redseed plantain	0 28	*Paronychia lindheimeri*	Lindheimer's nailwort	0.02
Euphorbia prostrata	Prostrate spurge	0 27	*Bromus japonicus*	Japanese brome	0 02
Parietaria pensylvanica	Pennsylvania pellitory	0 27	*Erioneuron pilosum*	Hairy tridens	0 02
Verbena canescens	Gray vervain	0 27	*Schoenocaulon texanum*	Green lily	0.02
Salvia texana	Blue sage	0 27	*Erigeron* sp.	Fleabane	0 02
Bouteloua rigidiseta	Texas grama	0 24	*Cyperus globulosus*	Flat sedge	0 02
Bouteloua hirsuta	Hairy grama	0 24	*Paspalum plicatulum*	Brownseed paspalum	0 02
Salvia farinacea	Mealy sage	0 21			
Brickella cylindraceae	Brickell-bush	0 21			
Tragia ramosa	Noseburn	0 19			
Lechea tenuifolia	Narrow-leaf pinweed	0 18	Daubenmire percent coverage classes		
Panicum hallii	Hall panicum	0 18	(1 = 0-5%, 2 = 6-25%, 3 = 26-50%, 4 = 51-75%, 5 = 76-95%, 6 = 95-100)		
Dichanthelium acuminatum	Woolly dichanthelium	0 16			
Schrankia uncinata	Sensitive briar	0 16	Daubenmire class midpoints		
Callirhoe involucrata	Winecup	0 14	(1 = 2 5, 2 = 15 5, 3 = 38, 4 = 63, 5 = 85 5, 6 = 97 5)		
Bothriochloa laguroides	Silver bluestem	0 13			
Unknown #11	Pea species	0 13	Species % coverage = midpoint total of species/total number of frames(160)		

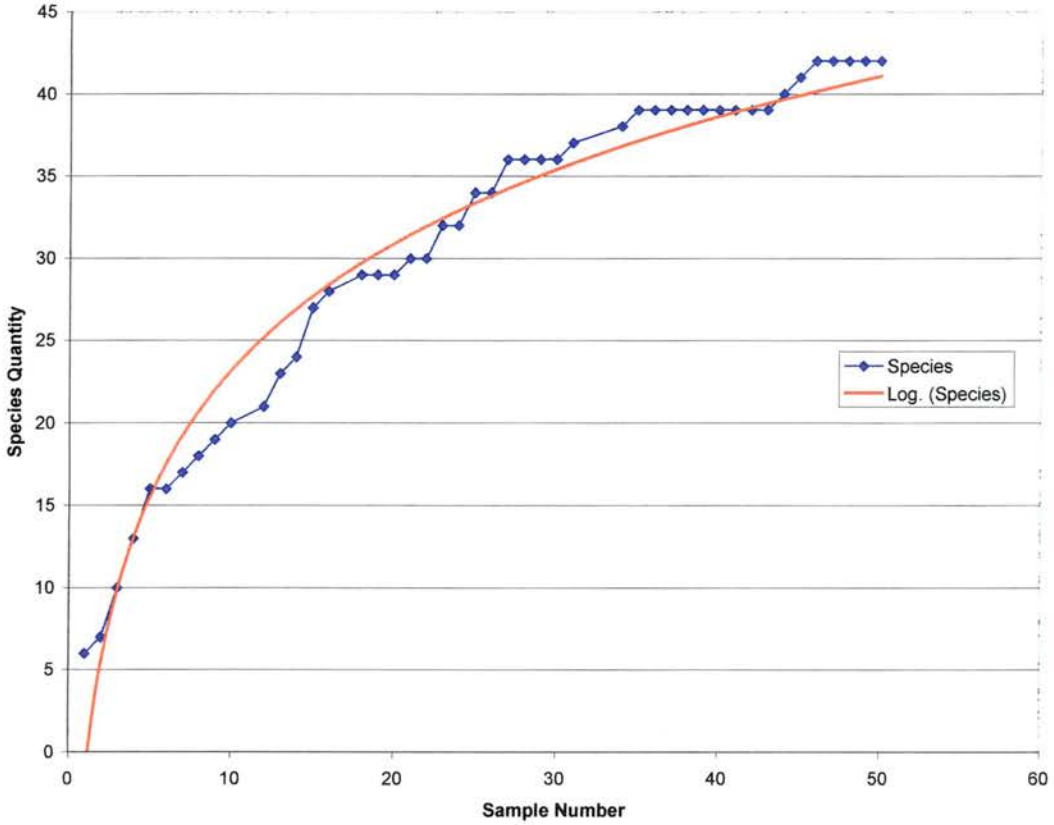
Appendix 5 Daubenmire percent coverages of herbaceous plants during winter 2002 at Mason Mountain Wildlife Management Area.

Scientific Name	Common Name	Percent Coverage	Scientific Name	Common Name	Percent Coverage
Litter	Litter	47 53	*Pseudognaphalium obtusifolium*	Fragrant cudweed	0 10
Bare ground	Bare ground	13 98	*Gaura coccinea*	Scarlet gaura	0 09
Stipa leucotricha	Texas wintergrass	6 47	*Cooperia drummondii*	Rain-lily	0 09
Carex planostachys	Cedar sedge	2 97	*Lechea tenuifolia*	Narrow-leaf pinweed	0.08
Triticum aestivum	Wheat	2 56	*Dalea nana*	Dwarf nana	0 06
Plantago rhodosperma	Redseed plantain	2 05	*Cirsium texanum*	Texas thistle	0 06
Daucus pusillus	Wild carrot	1 38	*Anemone heterophylla*	Wind-flower	0 06
Coreopsis spp	Coreopsis species	1 38	*Geranium carolinianum*	Wild geranium	0 05
Ratibida columnifera	Mexican hat	1 34	*Centaurium beyrichii*	Mountain pink	0 05
Erodium texanum	Stork's bill	1 07	*Bouteloua rigidiseta*	Texas grama	0 05
Lindheimera texana	Texas star	0 98	*Bouteloua hirsuta*	Hairy grama	0 05
Erodium circutarium	Filaree	0 84	*Allium canadense*	Wild onion	0 05
Scutellaria drummondii	Drummond's skullcap	0 73	Pea species	Pea species	0 03
Verbena canescens	Gray vervain	0 60	*Parietaria pensylvanica*	Pennsylvania pellitory	0 03
Schizachyrium scoparium	Little bluestem	0 59	*Melampodium leucanthum*	Blackfoot daisy	0 03
Plantago patagonica	Patagonia plantain	0 51	*Marrubium vulgare*	Common horehound	0 03
Teucrium laciniatum	Cut-leaf germander	0 46	*Evolvulus sericeus*	White evolvulus	0 03
Aristida purpurea	Purple threeawn	0 40	*Callirhoe involucrata*	Wine cup	0 03
Bouteoua curtipendula	Sideoats grama	0 37	*Sporobolus asper*	Tall dropseed	0 02
Oxalis dillenii	Yellow wood-sorrel	0 30	*Schoenocaulon texanum*	Green lily	0 02
Verbena bipinnatifida	Prairie verbena	0 27	*Oenothera* sp	Primrose species	0 02
Ambrosia psilostachya	Western ragweed	0 27	*Evolvulus nuttallianus*	Silky evolvulus	0 02
Verbena pumila	Low verbena	0 24	*Erioneuron pilosum*	Hairy tridens	0 02
Medicago sp	Medicago species	0 24	*Digitaria cognata*	Fall witchgrass	0 02
Salvia texana	Blue sage	0 21			
Unknown #2	Unknown #2	0 19	Daubenmire percent coverage classes		
Oxalis drummondii	Purple wood-sorrel	0 19	(1 = 0-5%, 2 = 6-25%, 3 = 26-50%, 4 = 51-75%, 5 = 76-95%, 6 = 95-100)		
Salvia farinacea	Mealy sage	0 18			
Hilaria berlangeri	Curlymesquite	0 14	Daubenmire class midpoints		
Achillea millefolium	Yarrow	0 14	(1 = 2 5, 2 = 15 5, 3 = 38, 4 = 63, 5 = 85 5, 6 = 97.5)		
Dichanthelium sp.	Dichanthelium species	0 13			
Dichanthelium acuminatum	Woolly dichanthelium	0 13	Species % coverage = midpoint total of species/total number of frames(160)		

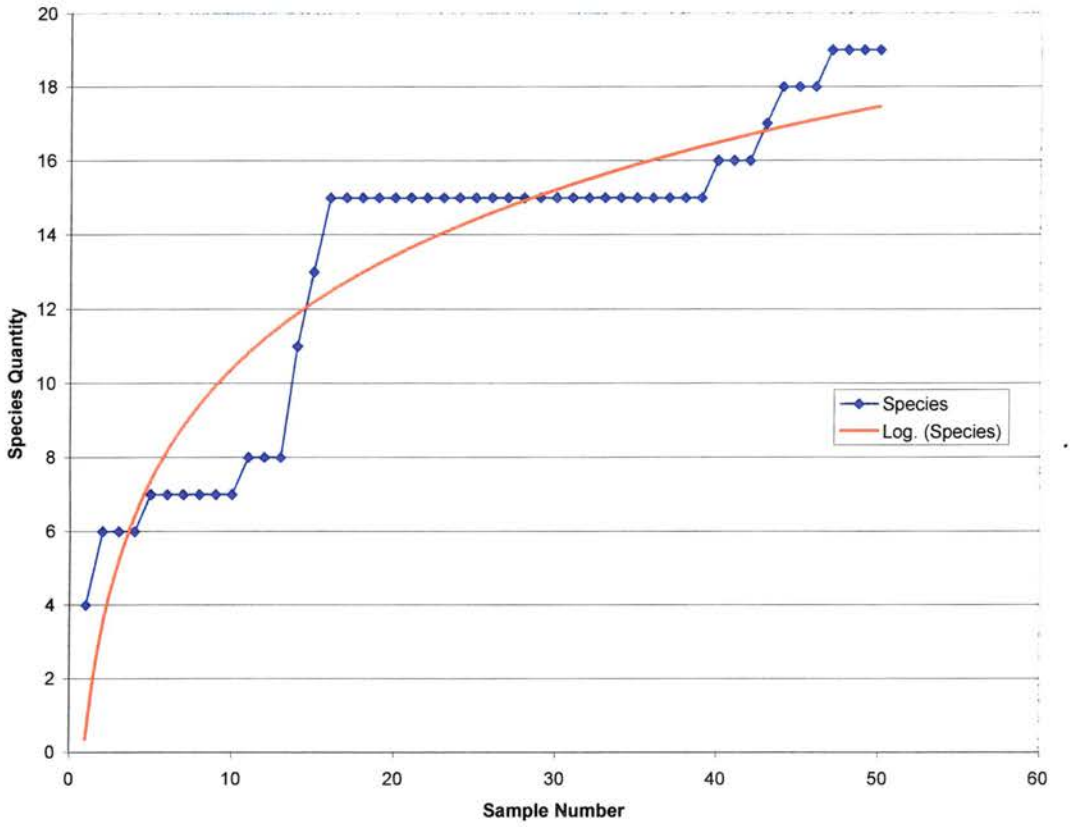
Appendix 6 Line-intercept data for woody plants during winter 2002 at Mason Mountain Wildlife Management Area.

Scientific Name	Common Name	Total Length (Meters)	Available Length (Meters)	Percent Cover of Species (Total)	Percent Cover of Species (Available)
Berberis trifoliolata	Agarita	32 59	32.59	2.17	2 17
Bumelia lanuginosa	Gum bumelia	0 20	0.20	0.01	0 01
Diospyros texana	Texas persimmon	0.85	0.85	0.06	0.06
Juniperus ashei	Ashe juniper	3 38	3.38	0 23	0.23
Nolina lindheimeriana	Devil's-shoestring	2.26	2 26	0 15	0 15
Opuntia leptocaulis	Pencil cactus	0.1	0.1	0.01	0.01
Opuntia spp	Prickly pear	43.93	43 93	2 93	2 93
Quercus fusiformis	Live oak	246.29	103 21	16.42	6.88
Smilax bona-nox	Greenbriar	6.78	6.78	0.45	0.45
Yucca constricta	Buckley yucca	11.72	11.72	0.78	0.78
Yucca rupicola	Twisted-leaf yucca	6 16	6 16	0.41	0 41

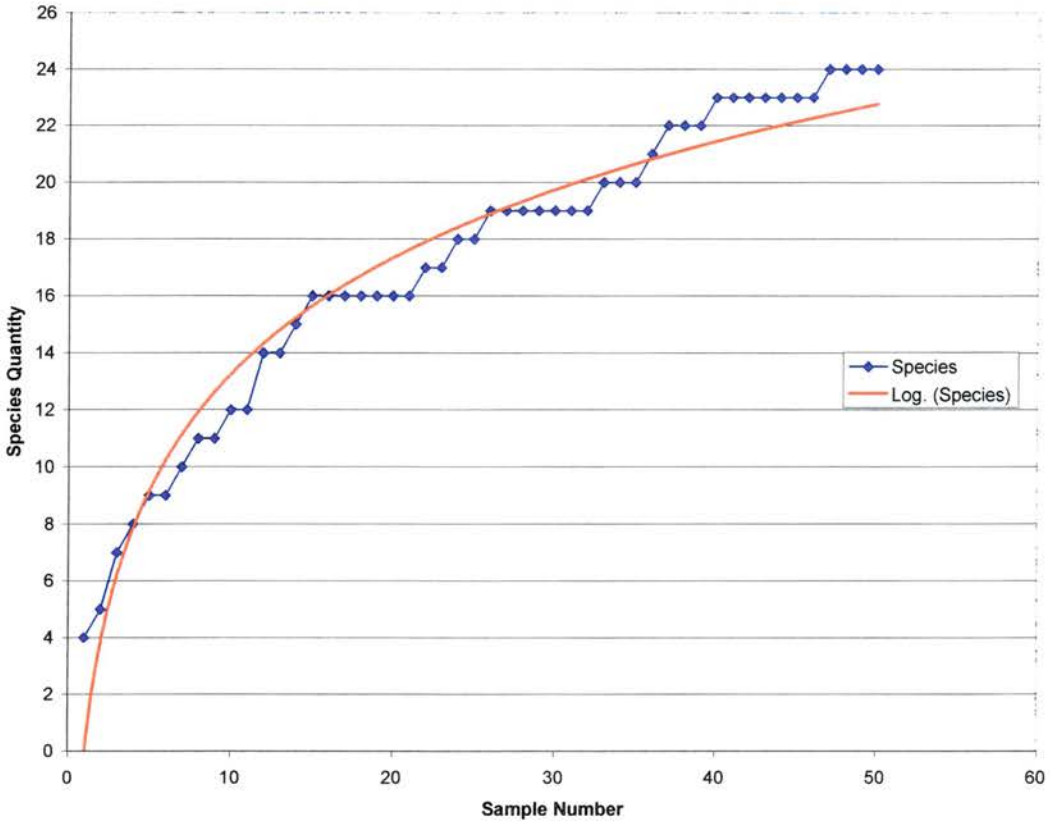
Available food plants are defined as ≤ 2 m in height
Percent cover = length of species/total length of intercept lines (1500)



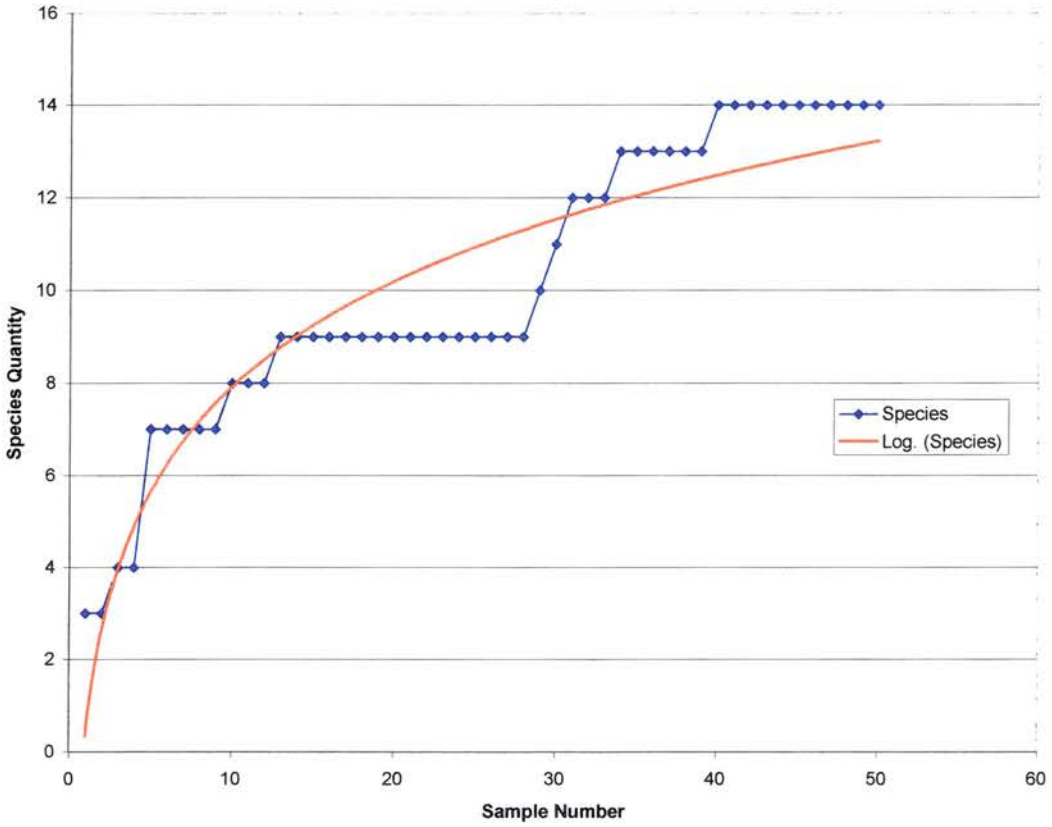
Appendix 7. Plant species found per fecal sample plotted with a logarithmic trendline during spring 2001 at Mason Mountain Wildlife Management Area.



Appendix 8. Plant species found per fecal sample plotted with a logarithmic trendline during summer 2001 at Mason Mountain Wildlife Management Area.



Appendix 9. Plant species found per fecal sample plotted with a logarithmic trendline during fall 2001 at Mason Mountain Wildlife Management Area.



Appendix 10. Plant species found per fecal sample plotted with a logarithmic trendline during winter 2002 at Mason Mountain Wildlife Management Area.

VITA

Shawn Gray was born in Odessa, Texas, on January 17, 1977. He is the son of Steve and Susan Gray. After attending Levelland High School, he entered South Plains College in Levelland, Texas, and began his undergraduate course work. He received a Bachelor of Science in Wildlife and Fisheries Management in 1999 from Texas Tech University in Lubbock, Texas. While at Texas Tech University he completed internships with U. S. Fish and Wildlife Service and Texas Parks and Wildlife Department. In 2000, he entered the graduate program in Wildlife Ecology at Southwest Texas State University in San Marcos, Texas. While at Southwest Texas State University he completed an internship with Texas Parks and Wildlife Department and worked as an instructional assistant for Modern Biology II and Field Biology of Plants.

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