SEASONAL DIETS OF GEMSBOK (*ORYX GAZELLA GAZELLA*) AT MASON MOUNTAIN WILDLIFE MANAGEMENT AREA, MASON COUNTY, TEXAS

THESIS

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By

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ABSTRACT

SEASONAL DIETS OF GEMSBOK (*ORYX GAZELLA GAZELLA*) AT MASON MOUNTAIN WILDLIFE MANAGEMENT AREA, MASON COUNTY, TEXAS

By

Amy Winters
Southwest Texas State University
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Supervising Professor: Thomas R. Simpson

I investigated the seasonal diets of gemsbok antelope (*Oryx gazella gazella*) at Mason Mountain Wildlife Management Area using microhistological analysis of fecal pellets. Plants in 2,000 samples were identified to genus or species. Vegetational surveys were conducted using the Daubenmire and line intercept methods. In order to determine selectivity, dietary use was compared to availability of food plants using the Manly's alpha measure of dietary preference index and a log-likelihood chi-square statistic with Bonferroni correction. Results indicated that gemsbok were predominately grazers with grasses comprising 74.35% of the diet. Browse made up 25% and forbs 0.65% of the annual diet. A total of 40 plant species were consumed by gemsbok during the year. I found that gemsbok grazed selectively. However, plant species that made up large proportions of the diet were not necessarily selected. The plants used in greatest quantity were little bluestem (*Schizachyrium scoparium*) (12.5%), side oats grama (*Bouteloua curtipendula*) (9.75%), twistedleaf yucca (*Yucca rupicola*)

(9.9%), and the category "other" (16.45%), which contained all species with less than 2% occurrence in the diet. Annually, selected plants were Canada wildrye (*Elymus canadensis*), *Chloris* sp., honey mesquite (*Prosopis glandulosa*), and twistedleaf yucca. Seasonally, the most selected plants were *Chloris* sp. and twistedleaf yucca in summer. Sideoats grama and vine-mesquite (*Panicum obtusum*) were selected in winter and spring. Plains lovegrass (*Eragrostis intermedia*) was selected in fall and winter. Canada wildrye was highly selected in fall. These results indicate a potential for competition between gemsbok and domestic livestock. In managing ranches with gemsbok present, the species should be considered when determining stocking rates and grazing regimes for domestic livestock.

INTRODUCTION

Many introduced species have adapted and flourished in Texas. Traweek (1995) reported that as of 1994, there were 155 counties with confined or free-ranging exotic hoofed stock. The number of exotic species increased from 13 in 1963 to 71 in 1994. Fifty-eight percent of all exotic animals in Texas occurred in the Edwards Plateau Ecological Region (Traweek 1995) and the Llano Uplift Natural Region (LBJ School of Public Affairs 1978). Despite growth of this industry in Texas, little research has been conducted to determine the food habits of many of the exotic species in the state.

In general, exotics do well in captivity in Texas (Texas Comptroller of Public Accounts 1998). The warm climate and mild winters of the Edwards Plateau and Llano Uplift regions of Texas are similar to that of their native lands.

During the 1960s and 1970s, the Texas Parks and Wildlife Department conducted several dietary studies of exotics at the Kerr Wildlife Management Area in Kerr County, Texas. These investigations were designed to document the food habits of several common species of exotics (axis deer, *Axis axis*; sika deer, *Cervus nippon*; fallow deer, *Dama dama;* aoudad sheep, *Ammotragus lervia*; and blackbuck antelope, *Antilope cervicapra*). The results were compared to dietary studies of white-tailed deer (*Odocoileus virginianus*) to evaluate the possibility of competition (Traweek and Welch 1992). These comparisons showed that many

species of exotics selected the same foods (forbs and browse) as white-tailed deer but could switch their diets to grasses when preferred items were not available. In addition, the studies showed that the preference for forbs and browse by the most common exotics places them in direct competition with sheep and goats. This research illustrated the need for dietary evaluations exotic ungulates in order to understand and predict competitive interactions with native animals.

The gemsbok (*Oryx gazella gazella*) is an antelope native to the thornveld (Knight 1991) of Sub-Saharan Africa. Their distribution is discontinuous and includes arid regions of South Africa, Angola, Botswana, Namibia, Tanzania, Zimbabwe, and parts of the Ethiopian coast (Macdonald 1984). The vegetation of the region is largely an open shrub savannah with scattered trees. The landscape becomes more open in areas of decreased precipitation (Knight 1991). Mungall (1994) stated that the range of gemsbok has expanded into the semiarid regions of the Kalahari desert since the time of European settlement.

In 1965, John Mecom imported several exotic species, including gemsbok, to the San Antonio Zoo (Mungall 1994). These animals were kept in quarantine at the zoo until successful reproduction allowed for release of excess offspring to private ranches.

Gemsbok were stocked on the White Sands Missile Range in New Mexico from 1969-1973 (Reid and Patrick 1983). This initial stocking in the United States resulted in the establishment of a sizable population. The current population in

New Mexico has expanded to 2,500 - 3,000 animals (S. Lerich personal comm. 1998).

Research on the natural history and ecology of gemsbok showed that grasses constituted 85% to 100% of the gemsbok diet in their native habitat during the dry season; thus the species was considered predominantly a grazer (Giesecke and Van Gylswyk 1975). Kingdon (1982) reported that *Setaria* spp., *Aristida* spp., *Sporobolus* spp., and *Chrysopogon* spp. were staple food items, and *Acacia* spp., *Disperma* spp., and *Adenia globosa* composed a small part of the diet.

Gemsbok in the southern Kalahari were predominantly grazers, but they did utilize forbs in the wet/hot season (Knight 1991). Knight (1991) determined that while gemsbok did not select woody species, woody plants frequently were consumed in proportion to their occurrence in the habitat. Dieckmann (1980) found that utilization of grasses by gemsbok in the Hester Malan Nature Reserve in western South Africa was limited by the overall scarcity of grass species in the nature reserve. However, the most preferred plant was Bushman grass (*Stipagrostis brevifolia).*

Information about an herbivore's diet in its native habitat is important to understanding the natural history of that species and its foraging activity. It is also important for land owners and managers to define the food habits of that species when introduced into a new environment with a different plant composition. Wood et al. (1970) conducted a food habits study prior to the release of gemsbok on public lands in New Mexico. Using feeding minutes, they found that gemsbok in a

320 acre game-proof pasture at Red Rock, New Mexico were predominately grazers. Grasses and sedges were utilized throughout the year. Johnsongrass (*Sorgum halepense*) received the highest use, followed by plains bristlegrass (*Setaria leucopila*), and Bermudagrass (*Cynodon dactylon*). They also noted the use of mesquite bean pods (*Prosopis juliflora*) and catclaw (*Acacia greggi*), especially in winter. In addition, gemsbok in New Mexico have been observed feeding on conyza (*Conyza coulteri*), buffalo gourd (*Cucurbita foetidissima*), globe mallow (*Nerisyrenia camporum*), cowpen daisy (*Verbesina enciloides*), and Russian thistle (*Salsola kali*) (Reid and Patrick 1983).

A study using microhistological identification of plants in fecal pellets of native and exotic ungulates on White Sands Missile Range, New Mexico (Smith et al. 1998), determined that the annual diet of gemsbok consisted of 83% grasses, 16% shrubs, and less than 1% forbs and unknowns. Dropseed grasses (*Sporobolus* sp.) and plains bristlegrass (*Setaria leucopila*) received the highest use. The most frequently eaten shrub was soaptree yucca (*Yucca elata*). Prickly pear (*Opuntia* sp.) and mesquite were also eaten in large amounts.

Ranching of non-native or exotic big game species is a profitable business in Texas. With the increased occurrence of venison as an item on upscale restaurant menus, the value of exotic species to the producer has grown. According to the Texas Comptroller of Public Accounts (1998), the average price for a wild game entrée in Texas restaurants is about $30. In 1997, Texas ranches earned $2.5 million from exotic and native venison production. This revenue was

about 20% of the total revenues of $12 to $15 million for venison production in the United States (Texas Comptroller of Public Accounts 1998).

Exotic game ranches also provide hunters with additional hunting opportunities by providing year-round hunting for non-indigenous species (Traweek and Welch 1992). Game ranches offer sportsmen a variety of hunting packages which may cost a few hundred dollars to several thousand dollars. (Winters, personal comm. 2002). More unusual animals, such as the gemsbok, may cost a hunter between $2,800 to $4,900 (Winters, personal comm. 2002). This revenue adds to the overall income of many Texas ranches.

To date, no dietary studies have been conducted on gemsbok in Texas. This basic ecological information may be important to those ranching exotic game in determining the feasibility of stocking gemsbok on their property. Also, knowledge of the seasonal food habits of gemsbok is needed in order for landowners/managers to assess the dietary overlap between gemsbok, domestic animals, and native ungulates. This information is necessary when developing harvest plans and determining proper stocking rates for livestock to ensure the ecological health of the property. Therefore, the objectives of this study were to determine the seasonal food habits and food selectivity of gemsbok in the Llano Uplift Natural Region of Texas.

MATERIALS AND METHODS

Study Site

This study took place at Mason Mountain Wildlife Management Area (hereafter MMWMA) in Mason County, Texas. The management area is located on the western part of the Llano Uplift Natural Region of Texas. Also called the Central Mineral Region, the Llano Uplift is characterized by granitic outcroppings and sandy soils. The plant community ranges from oak woodlands in sandy, well-watered areas to mesquite savannahs on loamier soils (LBJ School of Public Affairs 1978).

The population of gemsbok was confined to one 26 ha pasture (the Spring Pasture) by a 2.4 meter fence. This pasture varied in topography and consisted of nine distinct range sites. (Texas Parks and Wildlife Department unpublished data) (Fig. 1). The dominant soil type in this pasture is Shallow Granite. Other soil types include Sandy Loam, Granite Gravel, Gravelly Sandy Loam, Deep Sands, Sandstone Hill, and Red Sandy Loam.

Vegetation Survey

Vegetative surveys of Spring Pasture were conducted seasonally from March 1999 to November 1999. Percent cover for herbaceous species was estimated using the Daubenmire method (Daubenmire 1968). A modified Daubenmire

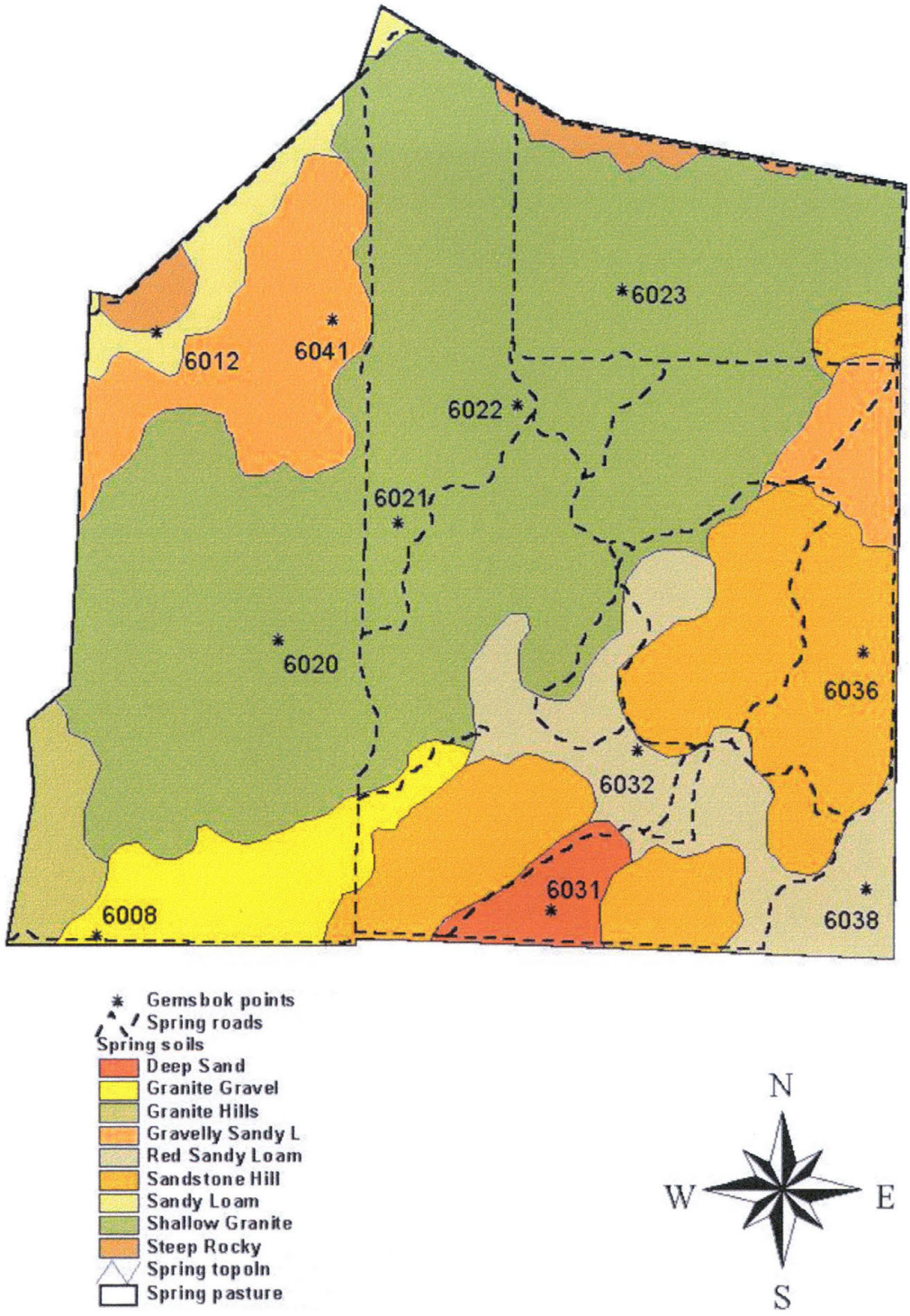

Figure 1. Soil map of the Spring Pasture at Mason Mountain Wildlife Management Area, Texas, 1999.

frame of 25 cm x 100 cm (0.25 m^2) was used. Prior to this study, the Texas Parks and Wildlife Department systematically located >20 permanent survey points in the Spring Pasture, laid out in a grid pattern. I selected a subset of 11 points from this group in a stratified random manner. The number of points selected from each range site was approximately proportional to the extent of the soil type in the pasture. Each season the 11 points were used as origins for randomly selected 100 m transects. Quadrats were randomly placed within 10 m intervals along each line. I used 110 quadrats to sample the vegetation with a total of 440 quadrats sampled in estimating the percent coverage for herbaceous species.

Once coverage was determined, the data were analyzed to determine the frequency of occurrence for each species. If a species comprised $\geq 2\%$ of a quadrat, it was considered to have occurred in the quadrat. Frequency of occurrence was calculated for each species by season and an annual total was calculated.

Woody plant frequency was measured once during spring using the same line transect origin points discussed above. Each species that intercepted more than 20 cm along each sampling unit (10 m interval) was counted as one occurrence. All occurrences were summed to give a total frequency of occurrence of all lines. This frequency of occurrence was used in seasonal and annual calculations.

Fecal Sample Collection

Fecal samples were attributed to gemsbok based on size. Following collection and comparison, I determined gemsbok fecal pellets (12.4 mm x 18 mm) to be much larger than pellets from white-tailed deer (8.9 mm x 12.8 mm), the only other large herbivore present. Fecal pellets > 24 hours old were determined by the moisture content of individual pellets. Samples were collected only if pellets were moist and tacky with a mucous coating. Only pellets > 24 hours old were collected. Pellets were removed from discreet fecal piles to maximize the number of different individual animals sampled.

Fifty fecal samples of 25 pellets each were collected concurrently with vegetational sampling each season. One thousand two hundred and fifty pellets were collected each season. Adequate sample size was determined by constructing species curves for each season (Appendix 5).

Fecal Analysis

Samples were stored separately in paper sacks and air dried for at least 36 hours. A two gram sub-sample of fecal material was randomly selected from each sample. The sub-samples were ground in a Wiley Mill and filtered through a 20 mesh screen to standardize fragment size. Ground samples were washed with water through a 40 mesh screen to remove fragments too small to be identified.

Holechek (1982) stated that one problem with microhistological analysis was the presence of plant pigments that made identification of epidermal

characters difficult. In order to remove any such pigments, each sample was soaked in a mixture of 50% household bleach and 50% water for three to five minutes and then rinsed thoroughly with water to remove the bleach.

Fecal sample slides were made by randomly selecting a small portion of the cleared and rinsed sample and placing it on a microscope slide with Mount-quick aqueous mounting medium. Two slides were made for each sample. Five fields of view per slide were randomly selected by rolling two twenty-sided dice and moving the microscope stage accordingly.

Each field of view was examined at 100x, and the plant epidermal fragment closest to the ocular pointer was identified to species. Only fragments with sufficient epidermal characters for identification were used (Lauten Green et al. 1985). Epidermal characteristics were used in species identification because the epidermis is the least digestible plant part that contains characters often unique to each species (Sparks and Malechek 1968). Reference slides of plants occurring in the pasture were made, and identification guides (Howard and Samuel 1979, Scott and Dahl 1980, Lauten Green et al. 1985) were used in identification of epidermal fragments.

In some cases, plants were identified only to genus because of my inability to separate species based on epidermal characters. This was the case with live oak (*Quercus virginiana*) and blackjack oak (*Quercus marilandica*). Also, some fragments were identifiable only to the genus *Sporabolus*. Other determinations were limited to genus because field classification of plants were

only to genus. This is true for the genera *Carex*, *Aristida*, *Chloris*, *Opuntia*, and *Vitis*.

Reference Slides

Reference slides of plants found in the Spring Pasture were made to assist in the identification of epidermal fragments in the fecal samples. Epidermal pieces were removed using a razorblade. If necessary, the epidermal piece was cleared of any pigments using a 1:1 mixture of household bleach and water. The piece then was placed on a microscope slide and mounted using Mount-quick aqueous mounting medium. Slides of both upper and lower epidermal pieces were made.

Food Plant Use

Plant use was defined as the percent composition of each species found in fecal samples. Percent composition was determined through microhistological analysis and was calculated in the same manner as Simpson (1980). For each season, the number of epidermal fragments observed of each species was divided by the total number of epidermal fragments identified (500 per season) and then multiplied by 100. An annual total was determined by summing the total number of epidermal fragments of each species and dividing by the total number of fragments (2,000). Plant species were considered a primary food if they composed $\geq 2\%$ of the diet by season. Those plants representing $> 2\%$ of the diet were combined, along with all unknown fragments, into the category "other."

Feeding Selectivity

The use of a plant is considered selective if it occurs in the diet in a greater proportion than its availability in the environment (Johnson 1980). In this study, usage was estimated using microhistological analysis of epidermal fragments in fecal samples. Availability was defined as m_i/M where m_i = the number of observations of available plant species i, and M = the total number of observations of all available plants = Σm_i (Krebs 1999). The number of available plant species (m_i) was the number of occurrences (quadrats or 10 m line transect segments) in which that plant comprised $\geq 2\%$ of coverage. M was equal to the total number of all occurrences.

The null hypothesis was no difference between the proportion of plants used in the diet and the proportion available in the environment. Count data of use (epidermal fragments in the diet by species) and availability (occurrences by species in Daubenmire frames or in transect intervals, as described above) were tested using a log-likelihood chi-square statistic (Manly et al. 1993). Proportion of occurrences in the diet (observed use) and in the environment (observed available) were used to construct confidence intervals for observed use.

Confidence intervals were modified using a Bonferroni Z correction statistic in order to create a uniform α value among all estimates of $\alpha = 0.05$ (Neu et al. 1974, Manly et al. 1993). For each season, the α value was corrected to reflect the appropriate number of confidence intervals estimated.

Availability reflects expected use and proportion of occurrences in the diet reflects observed use. If the confidence intervals for the observed use exceeded

the proportion available, the plant was said to be selected. If the confidence intervals for observed use fell within the proportion available, the plant was used in proportion to what its availability in the environment. If the confidence intervals fell below the proportion available, the plant was avoided.

In addition to log-likelihood chi-square results, a Manly's alpha measure of dietary preference index (Krebs 1999) was calculated for seasonal and annual diets. Using this equation, when $\alpha_i = 1/m$, where m = total number of food types, selective feeding or avoidance does not occur. For each plant species, if the calculated α_i was $>1/m$, then that plant was selected. If the calculated α_i was $< 1/m$ that plant was avoided.

RESULTS

Food Plant Use

Percent occurrence of plants in the diet based on forage class revealed that gemsbok were predominately grazers, with grasses making up 74.4% of their diet. Browse was consumed year-round and comprised 25.0% of the annual diet. Forbs composed an extremely small proportion (0.7%) of the diet (Fig. 2).

Gemsbok consumed 40 species during one year (Appendix 1). Overall annual use of plants consisted of 15 food items with a frequency of occurrence < 2.0% of the diet in fecal pellets (Fig. 3). Of these, 11 species comprised 90.0% of the total. The category "other" had the highest occurrence with 17.0%. Little bluestem (*Schizachyrium scoparium*) had the greatest use, making up 12.5% of the total. Twistedleaf yucca (*Yucca rupicola*) made up 9.9% and sideoats grama (*Bouteloua curtipendula*) contributed 9.8% of the diet.

Seasonally, use varied among several species. In winter, the diet consisted of 15 plants. Twelve of these food plants made up 91.2% of the winter diet. The six plants with highest use were plains lovegrass (*Eragrostis intermedia;* 11.0%), twistedleaf yucca (10.8%), little bluestem (10.6%), hairy grama (*Bouteloua hirsuta;* 10.2%), sideoats grama (8.0%), and Texas wintergrass (*Stipa leucotricha;* 7.2%) (Fig. 4). In addition, browse species of live oak / blackjack oak and post oak combined to make up 12.0% of the winter diet.

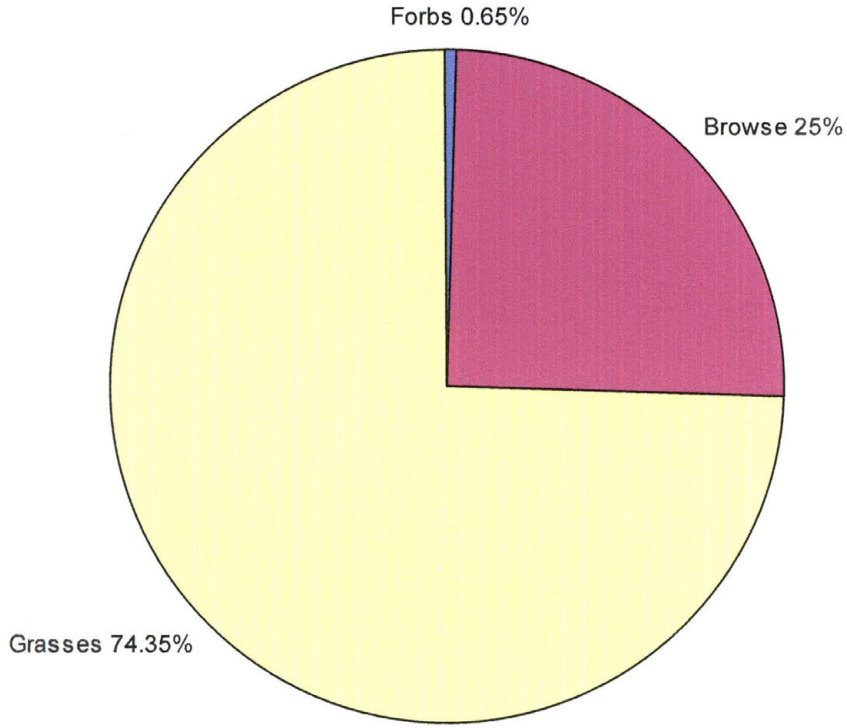

Figure 2. Forage class composition of gemsbok diets at Mason Mountain Wildlife Management Area, Texas in 1999.

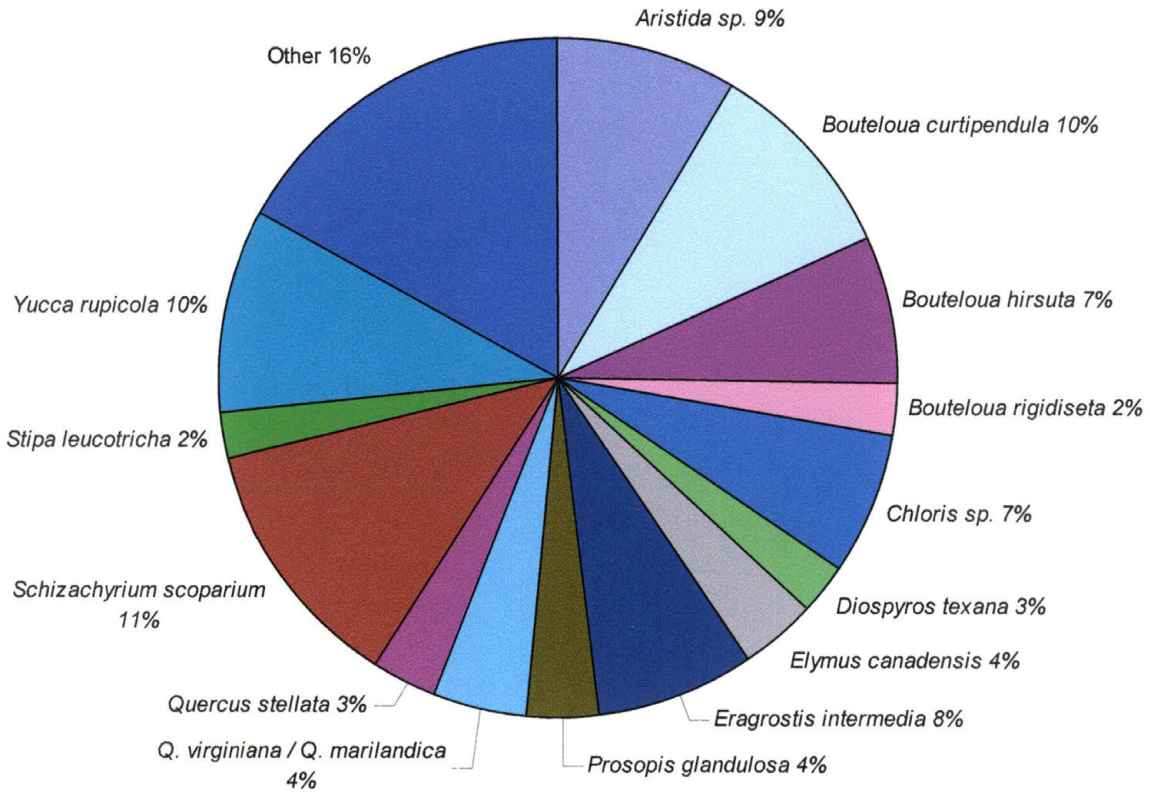

Figure 3. Species composition of the annual diet of gemsbok at Mason Mountain Wildlife Management Area, Texas during 1999.

Spring diet consisted of 16 food items. Twelve plants made up 90.4% of the diet. Fifty-seven percent of the spring diet was composed of the following: little bluestem (19.0%), twistedleaf yucca (10.8%), sideoats grama (10.4%), *Chloris* sp. (8.6%), and *Aristida* sp. (8.2%) (Fig. 5).

Thirteen items composed the summer diet. Of these 13 food items, 10 made up 89.8% of the diet. There was high utilization of honey mesquite (*Prosopis glandulosa*) (14.2%), both mast (52.1%) and foliage (47.9%). Also important in summer, little bluestem (13.4%), sideoats grama (10.6%), plains lovegrass (10.4%), and Mexican persimmon (*Diospyros texana*) (9.4%) were also important components in the summer diet (Fig. 6). Persimmon use by gemsbok included both fruit (70.2%) and foliage (29.8%).

Eight of 11 food items used in the fall composed 90.8% of the diet. The plants with the highest use in fall were *Aristida* sp. (19.4%), Canada wildrye (*Elymus canadensis*) (14.4%), twistedleaf yucca (12.2%), and "other" (15.8%), (Fig. 7).

Food Plant Selection

The proportion of plant species in the annual and seasonal diets differed significantly from the proportion available (annual: $\chi^2 = 395.5$, $p < 0.001$; winter: $\chi^2 = 197.8$, $p < 0.001$; spring: $\chi^2 = 221.2$, $p < 0.001$; summer: $\chi^2 = 262.7$, $p < 0.001$; fall: $\chi^2 = 199.4$, $p < 0.001$). I rejected the null hypothesis that use did not differ from availability in all cases. See Appendix 3 for availability results.

Confidence intervals (Appendix 2) on observed use indicated which plants

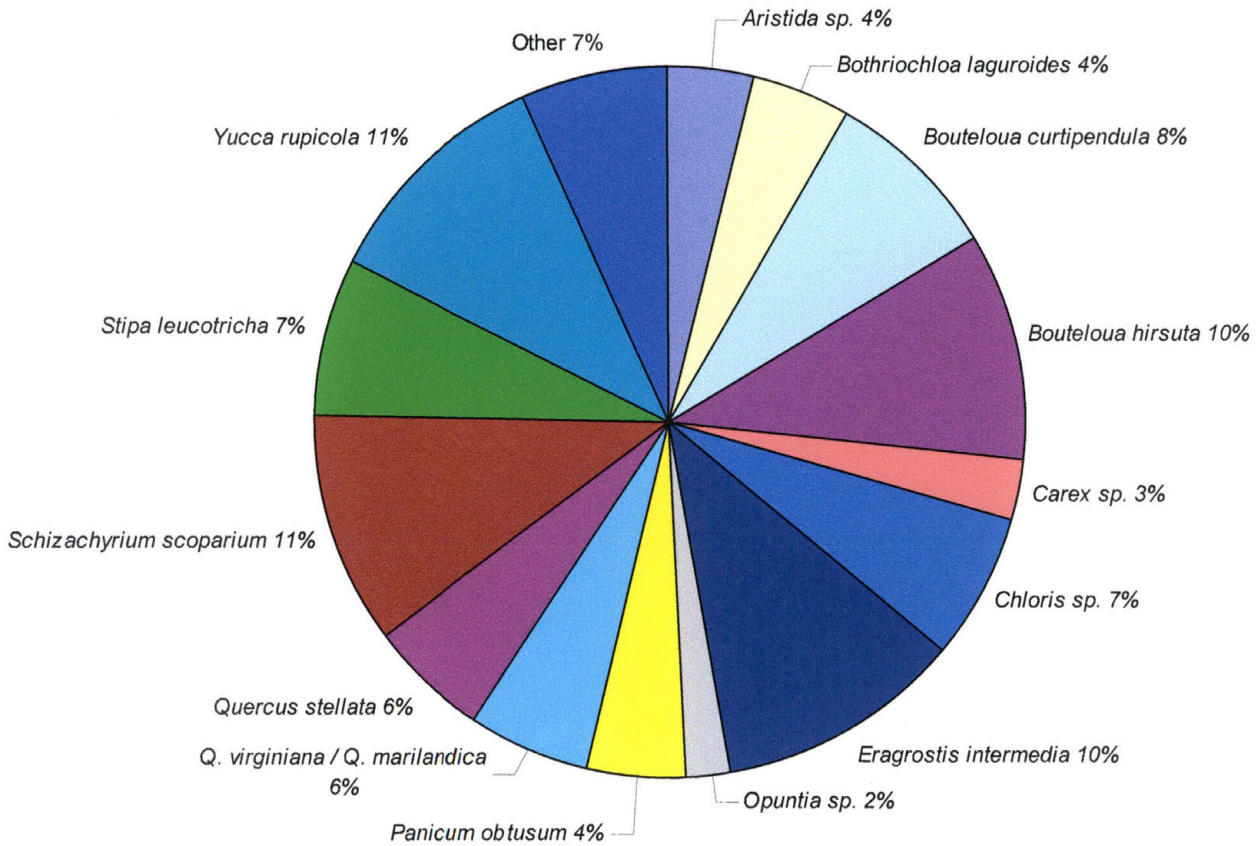

Figure 4. Species composition of the diet of gemsbok in winter of 1999 at Mason Mountain Wildlife Management Area, Texas.

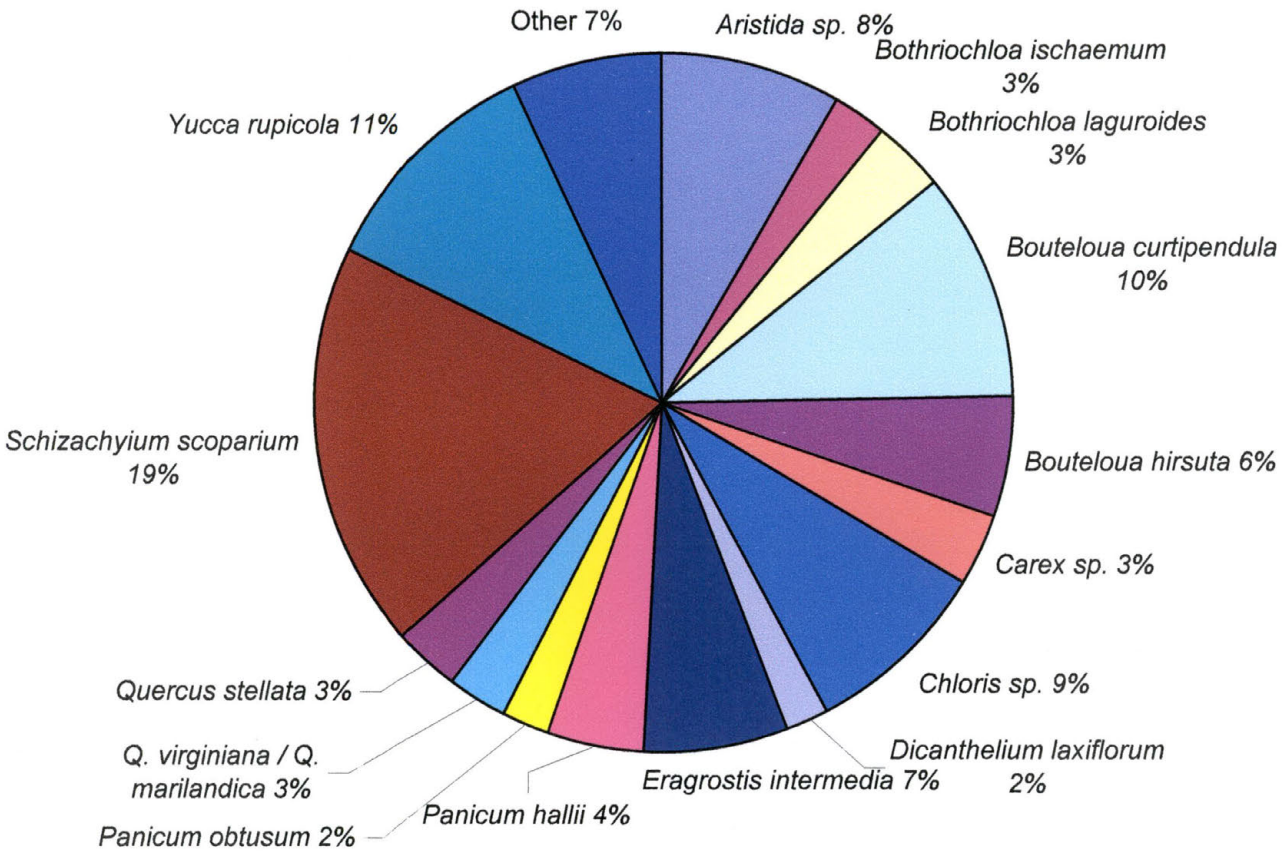

Figure 5. Species composition of the diet of gemsbok in spring of 1999 at Mason Mountain Wildlife Management Area, Texas.

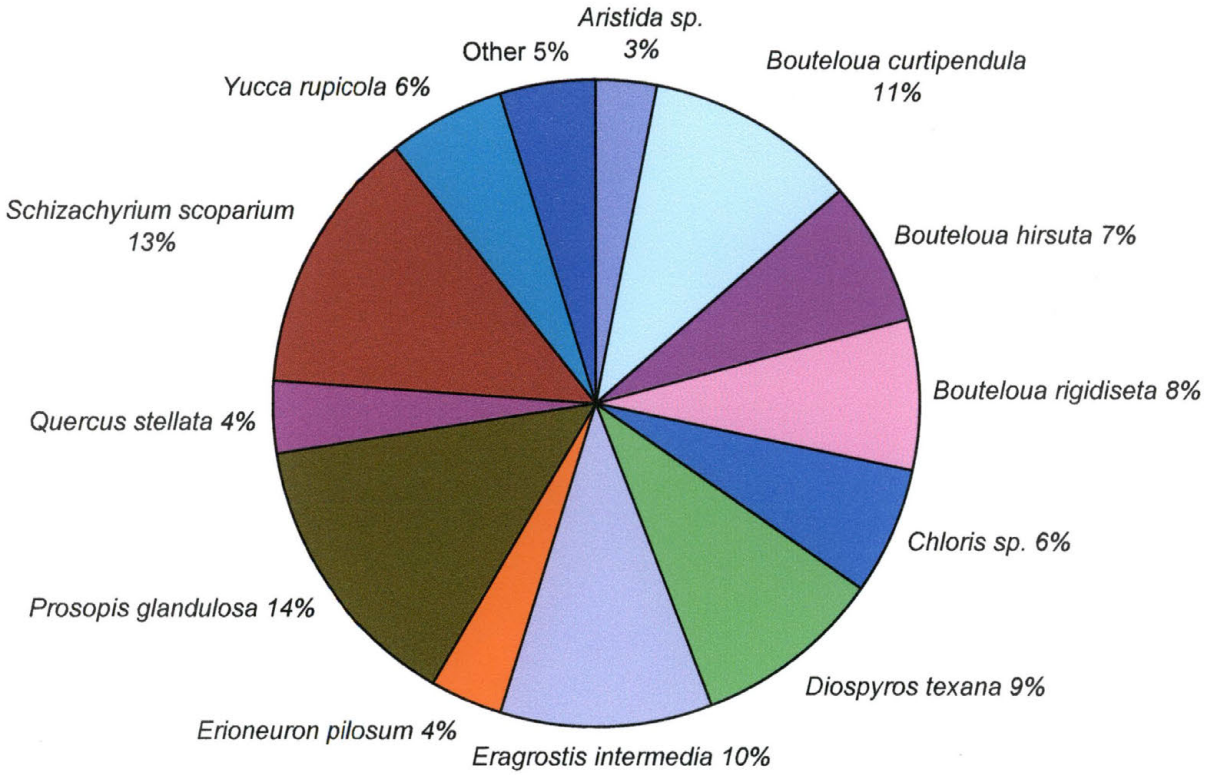

Figure 6. Species occurrence in gemsbok diets in the summer of 1999 at MMWMA, Texas.

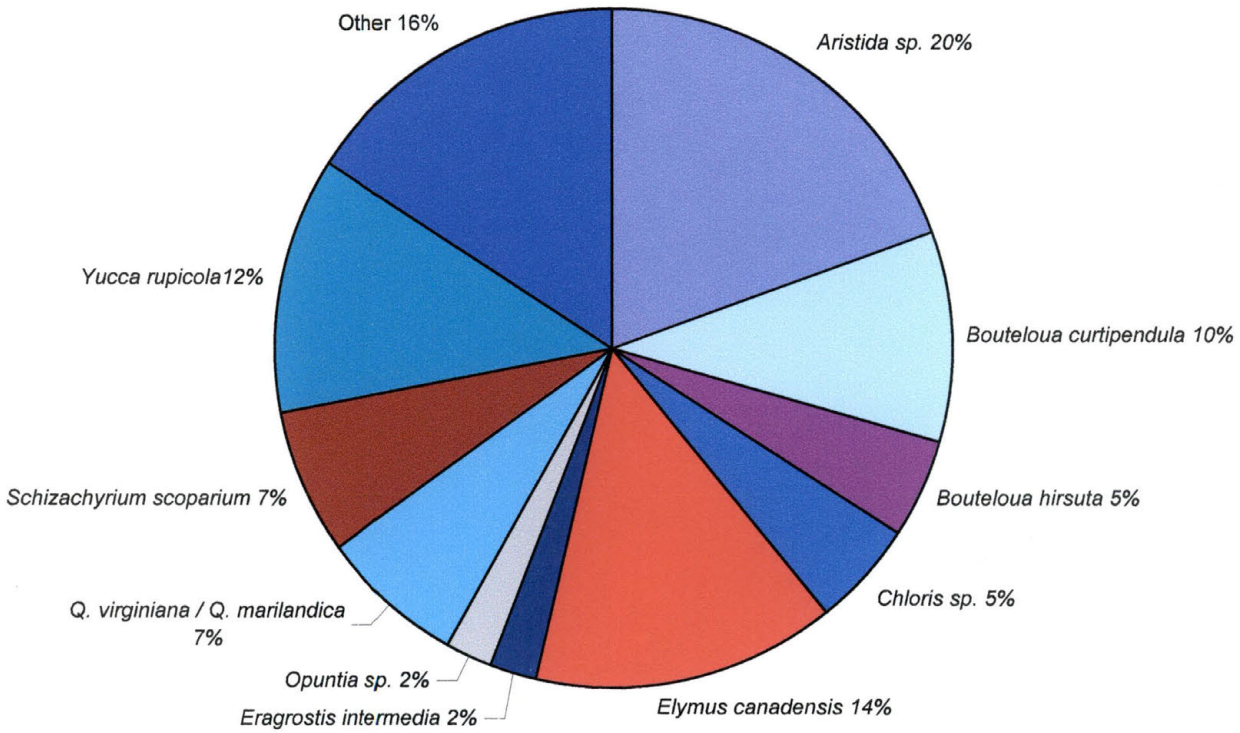

Figure 7. Species composition of the diet of gemsbok in fall of 1999 at Mason Mountain Wildlife Management Area, Texas.

were selected based on availability. Four plants were selected by gemsbok on an annual basis. *Chloris* sp., Canada wildrye, honey mesquite, and twistedleaf yucca had calculated α_i values that exceeded the critical value of $1/m$, thus indicating that they were consumed in greater proportion than was available (Fig. 8, Table 1). All other plants were used in proportion to availability.

Twistedleaf yucca and *Chloris* sp. were selected in winter. In addition, silver bluestem (*Bothriochloa laguroides*), sideoats grama, plains lovegrass, Texas wintergrass, and vine-mesquite (*Panicum obtusum*) were selected by gemsbok in winter. *Aristida* sp., *Opuntia* sp., and live oak / post oak were avoided (Fig. 9, Table 1). Plants selected in the spring included King Ranch bluestem (*Bothriochloa ischaemum*) and Halls panicum (*Panicum hallii*). As in winter, sideoats grama, silver bluestem, *Chloris* sp., vine-mesquite, and twistedleaf yucca were highly selected in the spring. Live oak / post oak and "other" were avoided (Fig. 10, Table 1). Honey mesquite beans and foliage were selected by gemsbok in summer. *Chloris* sp., Texas grama (*Bouteloua rigidiseta*), twistedleaf yucca, and hairy tridens (*Erioneuron pilosum*) were also used in greater proportions than availability. Avoided plants were *Aristida* sp. and the "other." All other plants were used in proportion to availability (Fig. 11, Table 1). *Chloris* sp., plains lovegrass, Canada wildrye, and twistedleaf yucca were selected in fall. *Opuntia* sp., little bluestem, and live oak / post oak were used less than their availability (Fig. 12, Table 1).

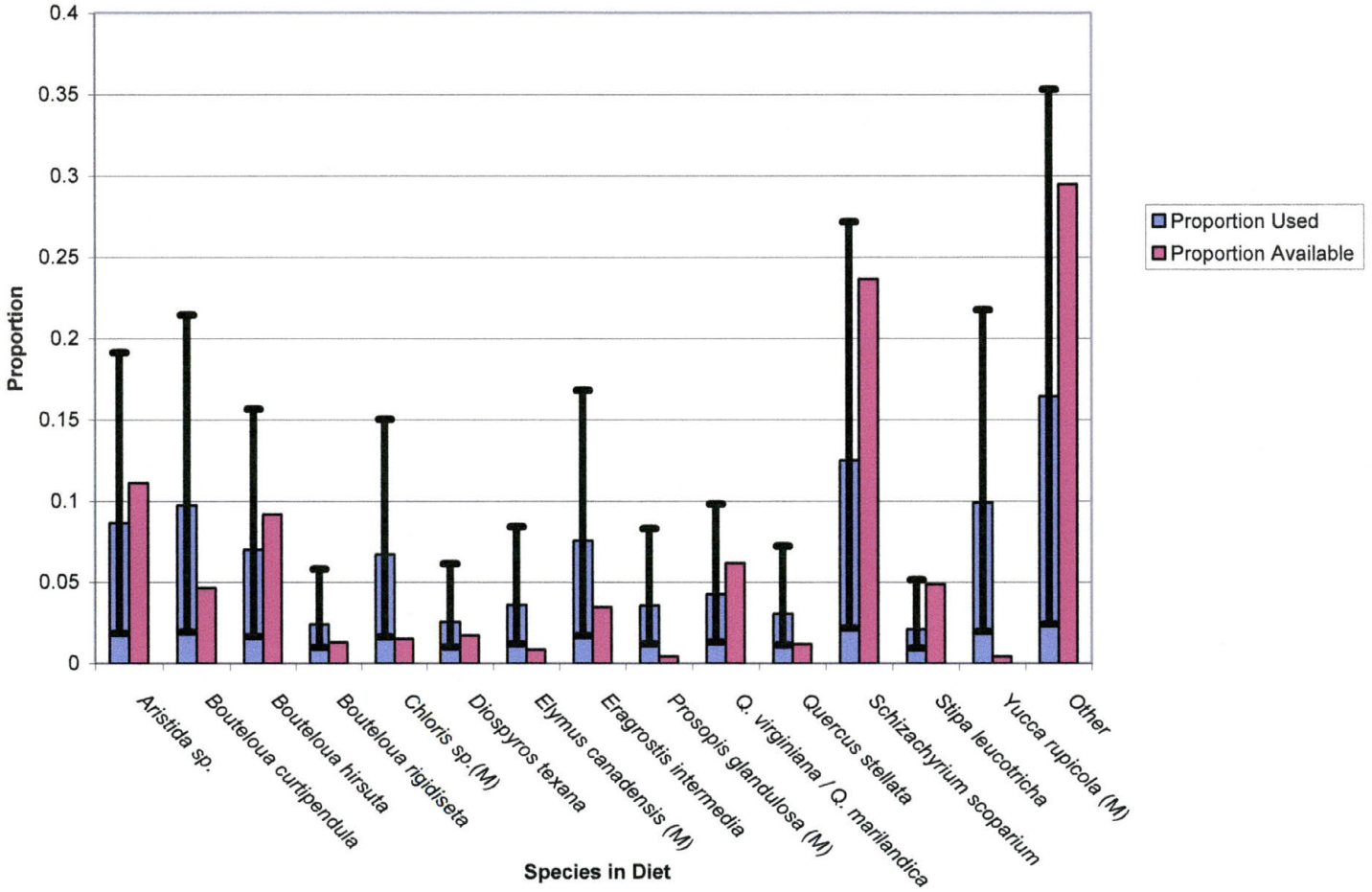

Figure 8. Comparison of species use to availability in the annual diet of gemsbok in the Spring Pasture at Mason Mountain Wildlife Management Area, Texas, 1999. Hypothesis of proportional use was rejected (X^2 = 395.474, $p<0.001$). Error bars represent 95% confidence intervals with Bonferroni correction. (M) indicates use greater than expected.

Table 1. Seasonal and annual Manly's alpha index of dietary preference ($\alpha = 1/m$, where m = total number of food types available) for plants selected by gemsbok at Mason Mountain Wildlife Management Area, Texas, 1999 When $\alpha_i > 1/m$, that plant was selected

Season	Plant species	α_i	$1/m$
Winter			0.067
	Bothriochloa laguroides	0.142	
	Bouteloua curtipendula	0.172	
	Chloris sp.	0.088	
	Eragrostis intermedia	0.102	
	Panicum obtusum	0.095	
	Stipa leucotricha	0 093	
	Yucca rupicola	0.174	
Spring			0.063
	Bothriochloa ischaemum	0.153	
	Bothriochloa laguroides	0 100	
	Bouteloua curtipendula	0.123	
	Chloris sp.	0.085	
	Panicum hallii	0.086	
	Panicum obtusum	0.130	
	Yucca rupicola	0.159	
Summer			0 077
	Chloris sp.	0.146	
	Erioneuron pilosum	0.246	
	Prosopis glandulosa	0.243	
Fall			0 091
	Chloris sp.	0 198	
	Elymus canadensis	0.163	
	Eragrostis intermedia	0.174	
	Yucca rupicola	0.241	
Annual			0.067
	Chloris sp.	0.083	
	Elymus canadensis	0.078	
	Prosopis glandulosa	0.153	
	Yucca rupicola	0.427	

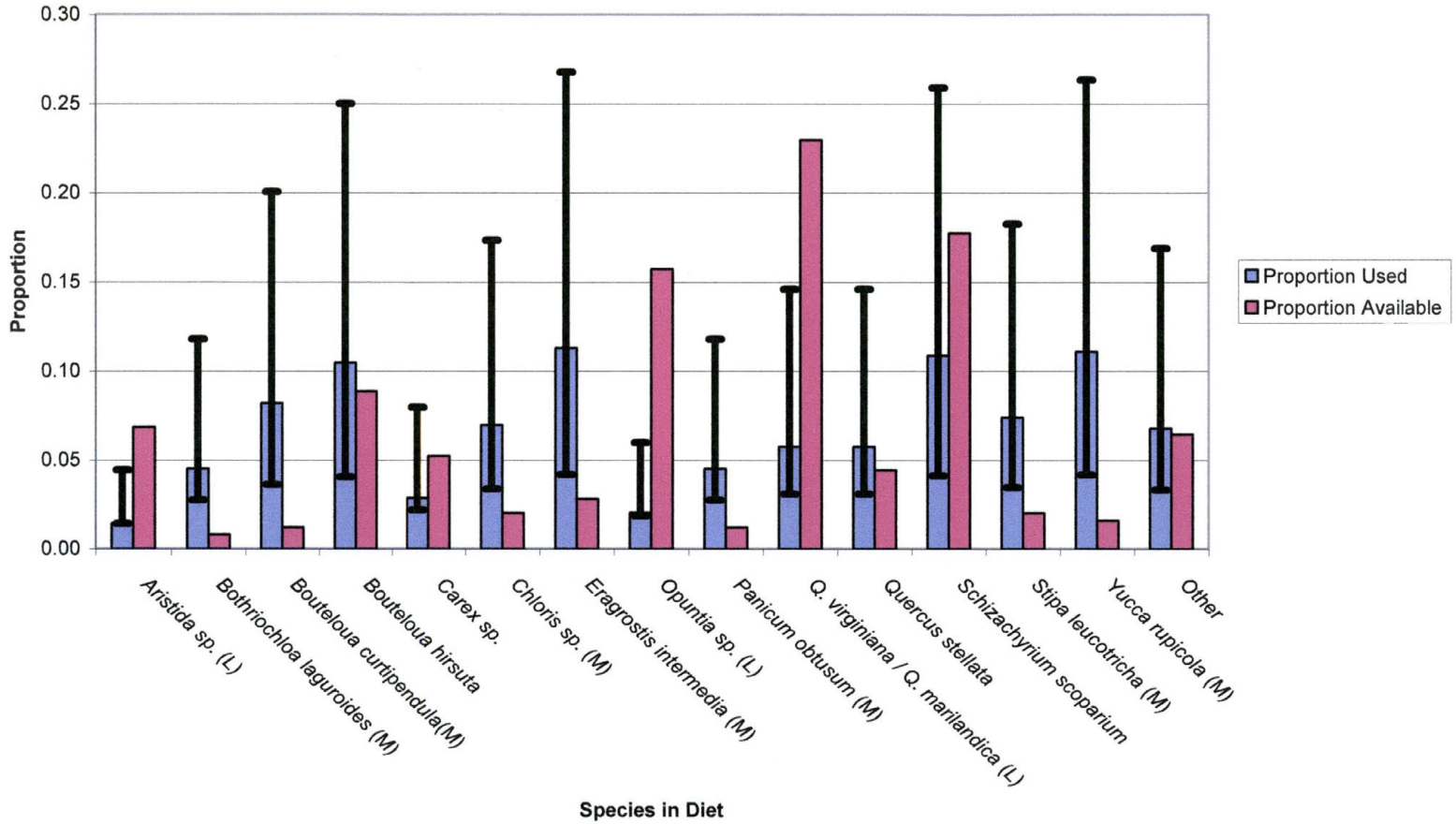

Figure 9. Comparison of species use to availability in the winter diet of gemsbok in the Spring Pasture at Mason Mountain Wildlife Management Area, Texas, 1999. Hypothesis of proportional use was rejected (X^2 = 197.810, $p < 0.001$). Error bars represent 95% confidence intervals with Bonferroni correction. (M) indicates use greater than expected. (L) indicates use less than expected.

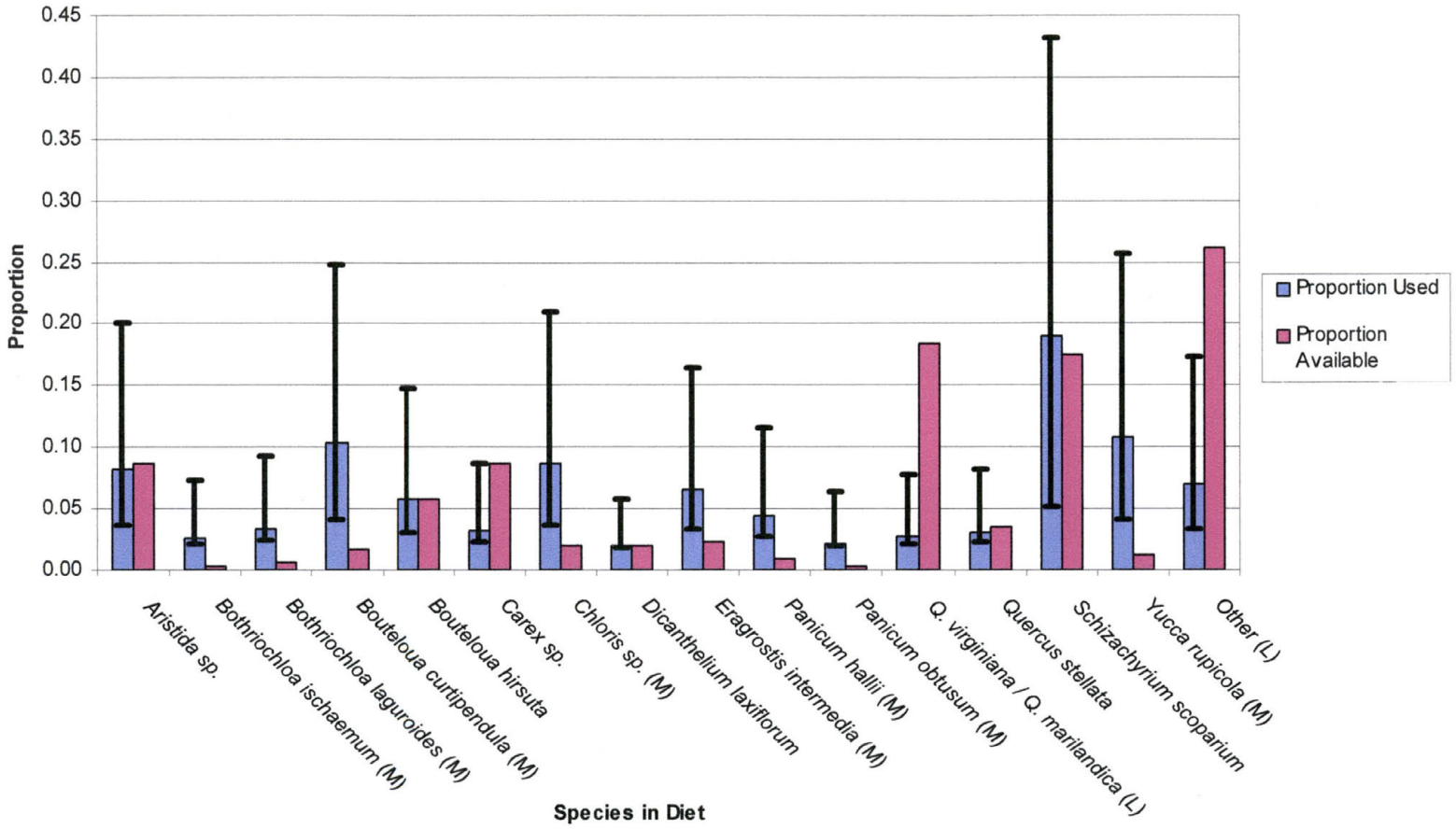

Figure 10. Comparison of species use to availability in the spring diet of gemsbok in the Spring Pasture at Mason Mountain Wildlife Management Area, Texas, 1999. Hypothesis of proportional use was rejected (X^2 = 221.194, p < 0.001). Error bars represent 95% confidence intervals with Bonferroni correction. (M) indicates use greater than expected. (L) indicates use less than expected.

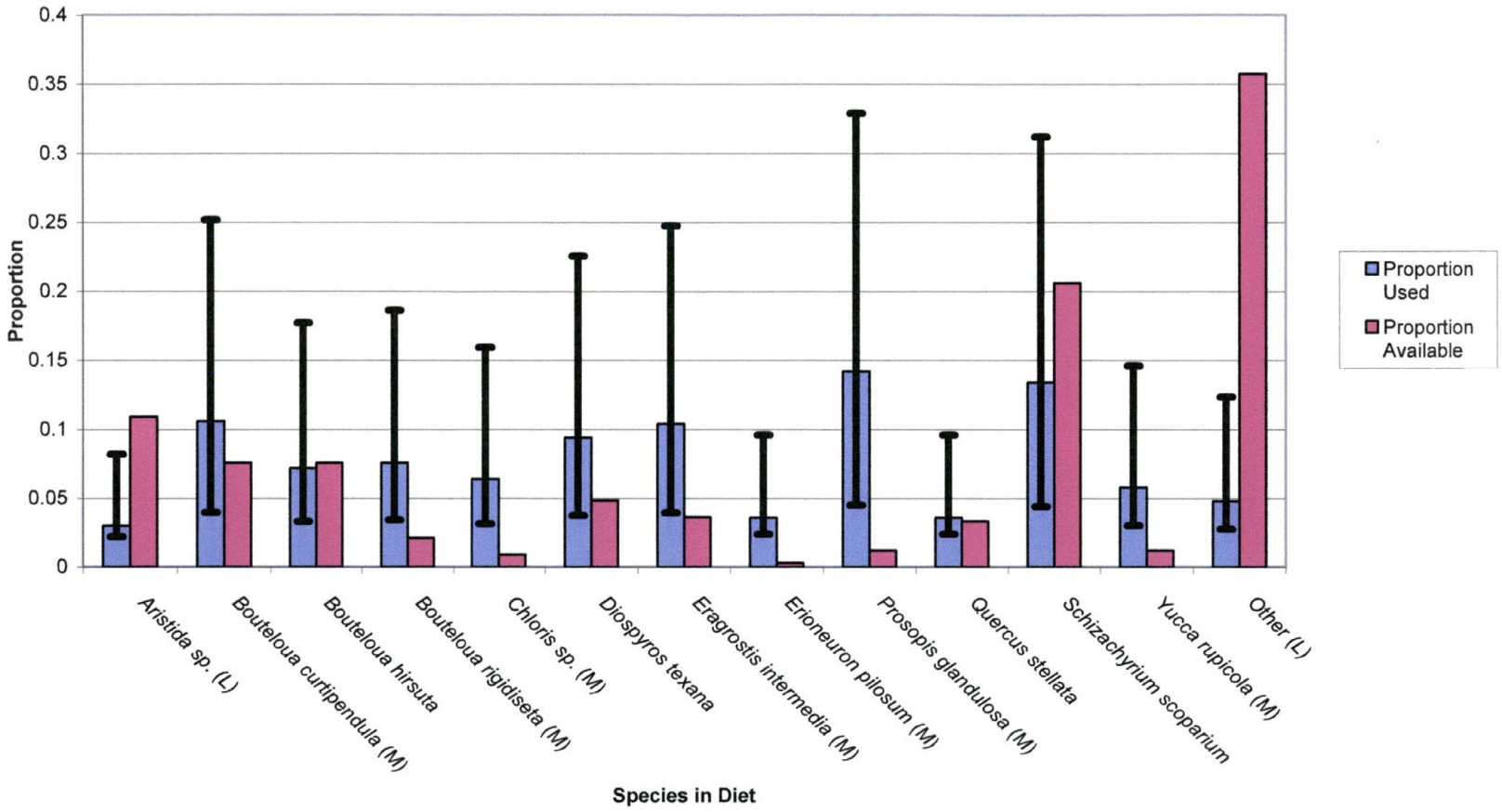

Figure 11. Comparison of species use to availability in the summer diet of gemsbok in the Spring Pasture at Mason Mountain Wildlife Management Area, Texas, 1999. Hypothesis of proportional use was rejected ($X^2 = 262.692$, $p < 0.001$). Error bars represent 95% confidence intervals with Bonferroni correction. (M) indicates use greater than expected. (L) indicates use less than expected.

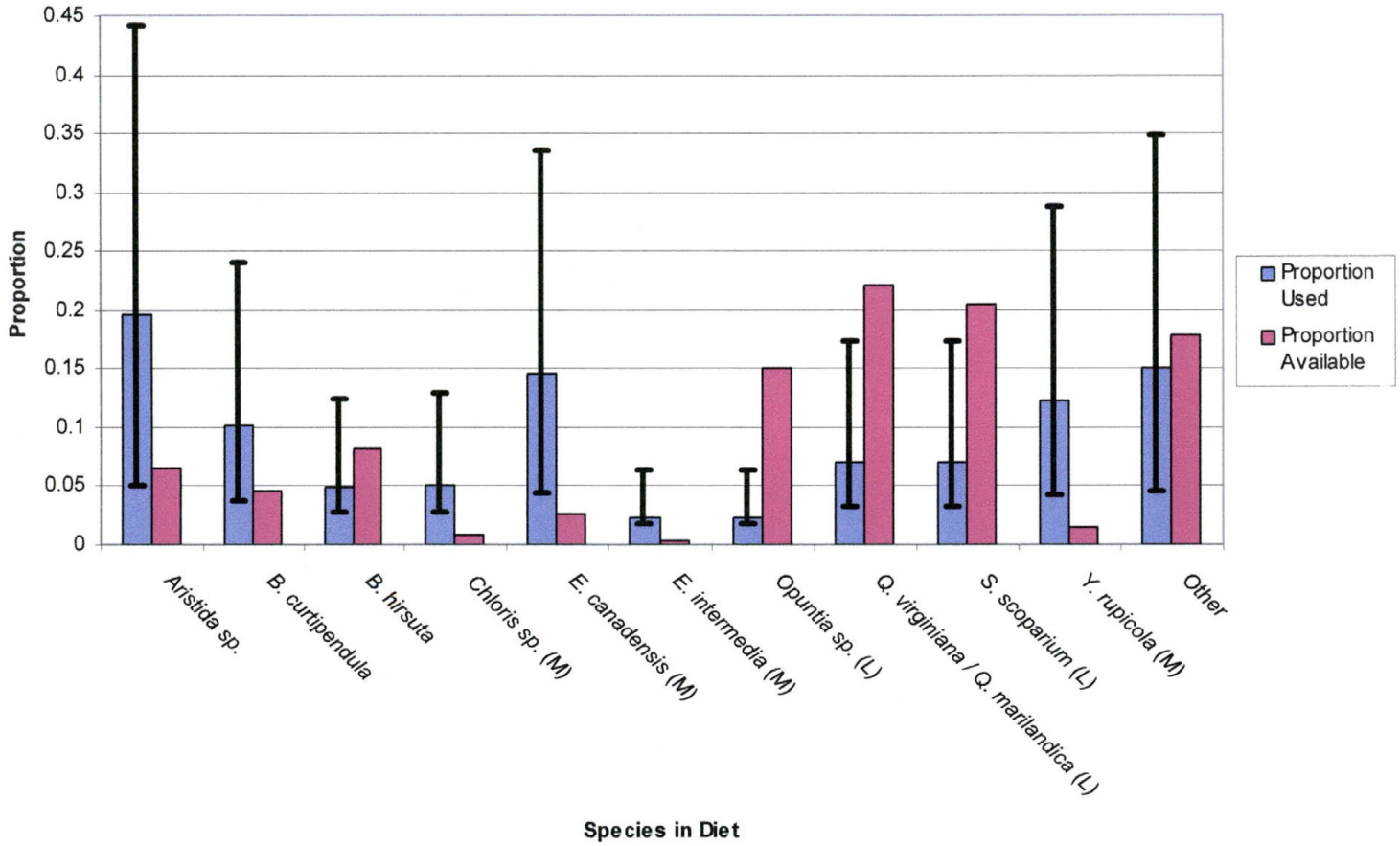

Figure 12. Comparison of species use to availability in the fall diet of gemsbok in the Spring Pasture at Mason Mountain Wildlife Management Area, Texas, 1999. Hypothesis of proportional use was rejected (X^2 = 199.433, $p < 0.001$). Error bars represent 95% confidence intervals with Bonferroni correction. (M) indicates use greater than expected. (L) indicates use less than expected.

DISCUSSION

Gemsbok diets at MMWMA contained a higher proportion of browse (25%) than expected, consisting mainly of honey mesquite foliage and mast, twistedleaf yucca leaves, oak leaves (*Quercus* sp.), and Mexican persimmon fruit and foliage. Mungall (1994) estimated the annual diet of scimitar-horned oryx (*Oryx dammah*), a close relative of gemsbok, in Texas to be 94% grasses, 5% browse, and 1% forbs. However, Dieckmann (1980) determined the gemsbok of the Hester Malan Nature Reserve in Africa often fed on browse. He attributed this mainly to a lack of available grasses and a high moisture content in browse species during wet seasons. Knight (1991) also determined that while gemsbok of the southern Kalahari were predominately grazers, bean pods of several species of *Acacia* were utilized in proportion to availability. In addition, tsama melons (*Citrullus lanatus*) were utilized during seasonal droughts. Gemsbok at White Sands Missile range were grazers, with grasses contributing 83% of the overall diet (Smith et al. 1998). However, their study also revealed a high use of browse (16%), including species of *Prosopis* and *Yucca*, both high in moisture. Reid and Patrick (1983) and Knight (1991) also suggested that gemsbok utilized green plant parts and browse species with a high moisture content supporting my findings.

Smith et al. (1998) found that gemsbok diets in White Sands, New Mexico

were limited to eight grass species and three browse species. Gemsbok at MMWMA ate a variety of food items. This is illustrated by the percent composition of the "other" category in the annual diet (16.45%). This is also evidenced by the number of food types required to make up 90% of the diet for each season. For example, in spring the diet consisted of 16 food types. Twelve of these plants comprised 90.4% of the diet.

In many cases, a plant may comprise a large percentage of the overall diet, but may not be a selected food item. Further, a plant may be abundant in the environment, and therefore, heavily utilized, but not in a proportion greater than its availability. *Aristida* sp. and little bluestem are good examples of this case. While little bluestem made up 12.5% of the annual diet, it was not used in greater proportion in any season than its availability. Based on Manly's alpha values, these plants were avoided in all seasons. In fall, about 20% of the diet consisted of *Aristida* sp., but it was a common plant and not used in proportion to availability. The Manly's alpha value indicated it was avoided.

The findings of this study of the diet of gemsbok in Texas were similar to the results of studies of gemsbok in New Mexico and Africa. Smith et al. (1998) found that gemsbok in New Mexico utilized succulents such as yucca most of the year. At MMWMA, twistedleaf yucca was a selected food annually and seasonally. Yucca made up 6–12% of the diet seasonally. In this study, plains lovegrass was a selected species in fall and winter. Knight (1991) found *Eragrostis lehmanniana*, an African lovegrass species, was a selected food by gemsbok in the Kalahari of Africa.

Because of economic value of individual gemsbok, techniques requiring sacrifice of an animal were unacceptable; therefore, fecal analysis was the best method for determining their food habits. Concerns of differential digestion causing some plants to be overestimated or underestimated in microhistological analysis of feces were allayed by the results of several studies. Alipayou et al. (1992) determined that fecal analysis was a useful tool for identifying components of ruminant diets because the accuracy of the method was not strongly affected by differential digestion. Paired rumen and fecal sample analyses were used in the investigation of the diet of elk (*Cervus elaphus*) in North Dakota (Osborn et al. 1997). The two techniques showed similar results, and thus, fecal analysis proved to be a useful method of determining elk diets. Therefore, based on these data, fecal analysis was considered a sufficient methodology for assessing food habits and selectivity of gemsbok in Texas.

My findings suggested that gemsbok may complement forb-eating animals, as they rarely consume forbs. Some competition with white-tailed deer may occur in late summer and fall when deer diets shift heavily towards browse and gemsbok utilize sizable proportions of some browse plants.

However, gemsbok must be considered when determining stocking rates for livestock. Because gemsbok are large-size grazers, their consumption of grasses may compete with other domestic or exotic grazers. Macdonald (1984) listed the average weight of an adult male gemsbok as 200 kg. When determining stocking rates, the gemsbok Animal Unit Equivalent is roughly 0.44, or 44% of the amount of forage that a 454 kg cow and her calf would consume in

a day. While keeping gemsbok and domestic grazers in the same pastures, it is important that managers consider possible competitive interactions, calculate appropriate stocking rates, and monitor the condition of plants on their property.

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APPENDIX 1

Frequency of occurrence and annual percent frequency of plant species found in the diet of gemsbok antelope at Mason Mountain Wildlife Management Area, Texas, 1999

	Number of Identifications					
Species	Winter	Spring	Summer	Fall	Total # ID's	% Frequency
Aristida sp.	20	41	15	97	173	8.65
Bothriochloa ischaemum	0	13	0	0	13	0.65
Bothriochloa laguroides	22	17	0	0	39	1 95
Bouteloua curtipendula	40	52	53	50	195	9.75
Bouteloua hirsuta	51	29	36	24	140	7
Bouteloua rigidiseta	2	2	38	6	48	2.4
Bouteloua trifida	0	4	0	0	4	0.2
Brachiaria ciliatissima	0	9	4	0	13	0.65
Buchloe dactyloides	0	7	0	2	9	0 45
Carex sp.	14	16	0	9	39	1.95
Chloris sp.	34	43	32	25	134	6 7
Croton monathogynus	0	0	0	5	5	0.25
Dicanthelium laxiflorum	5	10	7	0	22	1.1
Dicanthelium oligosanthes	4	0	0	6	10	0 5
Digitaria cognata	9	0	0	0	9	0.45
Diospyros texana	0	4	47	0	51	2.55
Elymus canadensis	0	0	0	72	72	3 6
Eragrostis intermedia	55	33	52	11	151	7.55
Eragrostis secundiflora	0	0	2	0	2	0 1
Eragrostis sessilispica	4	0	0	6	10	0.5
Erioneuron pilosum	0	1	18	6	25	1 25
Geranium carolinianum	0	2	0	3	5	0.25
Nolina lindheimeriana	2	3	0	0	5	0.25
Opuntia sp.	10	1	1	11	23	1.15
Panicum hallii	0	22	0	0	22	1.1
Panicum obtusum	22	11	0	0	33	1.65
Prosopis glandulosa	0	0	71	0	71	3.55
Q. virginiana / Q. marilandica	28	14	8	35	85	4 25
Quercus stellata	28	15	18	0	61	3.05
Schizachyrium scoparium	53	95	67	35	250	12.5
Solanum elagnifolium	0	0	2	1	3	0.15
Sporabolus asper	5	0	0	8	13	0 65
Sporabolus cryptandrus	2	1	0	0	3	0.15
Sporabolus sp.	0	0	0	3	3	0.15
Stipa leucotricha	36	0	0	6	42	2.1
Tridens albescens	0	0	0	6	6	0.3
Tridens flavus	0	0	0	1	1	0 05
Unidentified	0	0	0	4	4	0.2
Vitis sp.	0	1	0	7	8	0.4
Yucca rupicola	54	54	29	61	198	9.9

APPENDIX 2

Upper and lower 95% confidence limits with Bonferroni correction for log-likelihood chi-square comparison of seasonal use of plant species by gemsbok versus availability of plants in the environment at Mason Mountain Wildlife Management Area, Texas, 1999

Season	Plant Species	Upper 95% CL	Lower 95% CL
Winter			
	Aristida sp.	0.0302	0
	Bothriochloa laguroides	0.0728	0.0175
	Bouteloua curtipendula	0.1187	0 0456
	Bouteloua hirsuta	0.1455	0.064
	Carex sp.	0.051	0 0065
	Chloris sp	0 1037	0.0359
	Eragrostis intermedia	0.155	0.0708
	Opuntia sp	0.0394	0.0017
	Panicum obtusum	0.0728	0.0175
	Q.virginiana / Q. marilandica	0.0885	0.0265
	Quercus stellata	0 0885	0.0265
	Schizachyrium scoparium	0.1503	0 0674
	Stipa leucotricha	0 1087	0 0391
	Yucca rupicola	0 1526	0.0691
	Other	0.1012	0.0343
Spring			
	Aristida sp.	0.1183	0.0457
	Bothriochloa ischaemum	0 047	0.005
	Bothriochloa laguroides	0.058	0.01
	Bouteloua curtipendula	0.1443	0 0637
	Bouteloua hirsuta	0.0889	0 0271
	Carex sp.	0.0553	0.0087
	Chloris sp	0.1231	0.0489
	Dicanthelium laxiflorum	0.0385	0.0015
	Eragrostis intermedia	0.0988	0.0332
	Panicum hallii	0 0711	0.0169
	Panicum obtusum	0.0414	0 0026
	Q.virginiana / Q. marilandica	0.0498	0 0062
	Quercus stellata	0 0525	0.0075
	Schizachyrium scoparium	0.2419	0.1381
	Yucca rupicola	0 149	0.067
	Other	0.1037	0.0363
Summer			
	Aristida sp.	0.0521	0 0079
	Bouteloua curtipendula	0.1458	0.0662
	Bouteloua hirsuta	0.1054	0.0386
	Bouteloua rigidiseta	0 1103	0.0417
	Chloris sp.	0.0956	0 0324
	Diospyros texana	0.1317	0.0563
	Eragrostis intermedia	0.1435	0.0645

Appendix 2, continued

Season	Plant Species	Upper 95% CL	Lower 95% CL
Summer			
	Erioneuron pilosum	0.0601	0.0119
	Prosopis glandulosa	0.1871	0.0969
	Quercus stellata	0.0601	0.0119
	Schizachyrium scoparium	0.178	0 09
	Yucca rupicola	0.0882	0 0278
	Other	0 0756	0.0204
Fall			
	Aristida sp.	0.2461	0.145
	Bouteloua curtipendula	0.1392	0.0624
	Bouteloua hirsuta	0.0757	0.021
	Chloris sp.	0.0783	0.0225
	Elymus canadensis	0.1901	0.1003
	Eragrostis intermedia	0.0409	0 0034
	Opuntia sp.	0.0409	0.0034
	Q. virginiana / Q. marilandica	0.1032	0.0379
	Schizachyrium scoparium	0.1032	0.0379
	Yucca rupicola	0.1648	0.0811
	Other	0.1969	0.1056
Annual			
	Aristida sp.	0.105	0.068
	Bouteloua curtipendula	0 117	0.078
	Bouteloua hirsuta	0 0867	0.0533
	Bouteloua rigidiseta	0.034	0.014
	Chloris sp.	0.0834	0.0506
	Diospyros texana	0.0358	0.0152
	Elymus canadensis	0.0482	0.0238
	Eragrostis intermedia	0 0928	0.0582
	Prosopis glandulosa	0 0476	0.0234
	Q. virginiana / Q. marilandica	0.0557	0.0293
	Quercus stellata	0 0418	0.0192
	Schizachyrium scopanum	0 1467	0.1033
	Stipa leucotricha	0.0304	0 0116
	Yucca rupicola	0 1186	0.0794
	Other	0 1888	0.1402

APPENDIX 3

Seasonal and annual percent frequency of occurrence of plants in availability samples at Mason Mountain Wildlife Management Area, Texas, 1999. The number of occurrences in quadrats is shown in the parentheses.

	Percent Frequency				
Species	Winter	Spring	Summer	Fall	Annual
Aristida sp.	6.9 (17)	8.7 (27)	10.9 (36)	6.6 (17)	11.1 (103)
Bothriochloa ischaemum		0 4 (1)			
Bothriochloa laguroides	0.1 (2)	0.6 (2)			
Bouteloua curtipendula	1.2 (3)	1.6 (5)	7.6 (25)	4.6 (12)	4.6 (43)
Bouteloua hirsuta	8.9 (22)	5.8 (18)	7 6 (25)	8.1 (21)	9.2 (85)
Bouteloua rigidiseta			2 1 (7)		1 3 (12)
Carex sp.	5.2 (13)	8.7 (27)			
Chloris sp.	2.0 (5)	1.9 (6)	0 9 (3)	0 8 (2)	1.5 (14)
Dicanthelium laxiflorum		1.9 (6)			
Diospyros texana			4.8 (16)		1.7 (16)
Elymus canadensis				2.7 (7)	0.9 (8)
Eragrostis intermedia	2.8 (7)	2.3 (7)	3.6 (12)	0.4 (1)	3.5 (32)
Erioneuron pilosum			0.3 (1)		
Opuntia sp.	15.7 (39)			15.1 (39)	
Panicum hallii		1.0 (3)			
Panicum obtusum	1.2 (3)	0 4 (1)			
Prosopis glandulosa			1.2 (4)		0.4 (4)
Q. virginiana / Q. marilandica	23.0 (57)	18 4 (57)		22 0 (57)	6.2 (57)
Quercus stellata	4.4 (11)	3 5 (11)	3.3 (11)		1.2 (11)
Schizachyrium scoparium	17.7 (44)	17 4 (54	20.6 (68)	20.5 (53)	23 7 (219)
Stipa leucotricha	2.0 (5)				4.9 (45)
Yucca rupicola	1 6 (4)	1.3 (4)	1.2 (4)	1.5 (4)	0 4 (4)
Other	6.5 (16)	26.1 (81)	35.8 (118)	17 8 (46)	29.5 (273)
Total	(248)	(310)	(330)	(259)	(926)

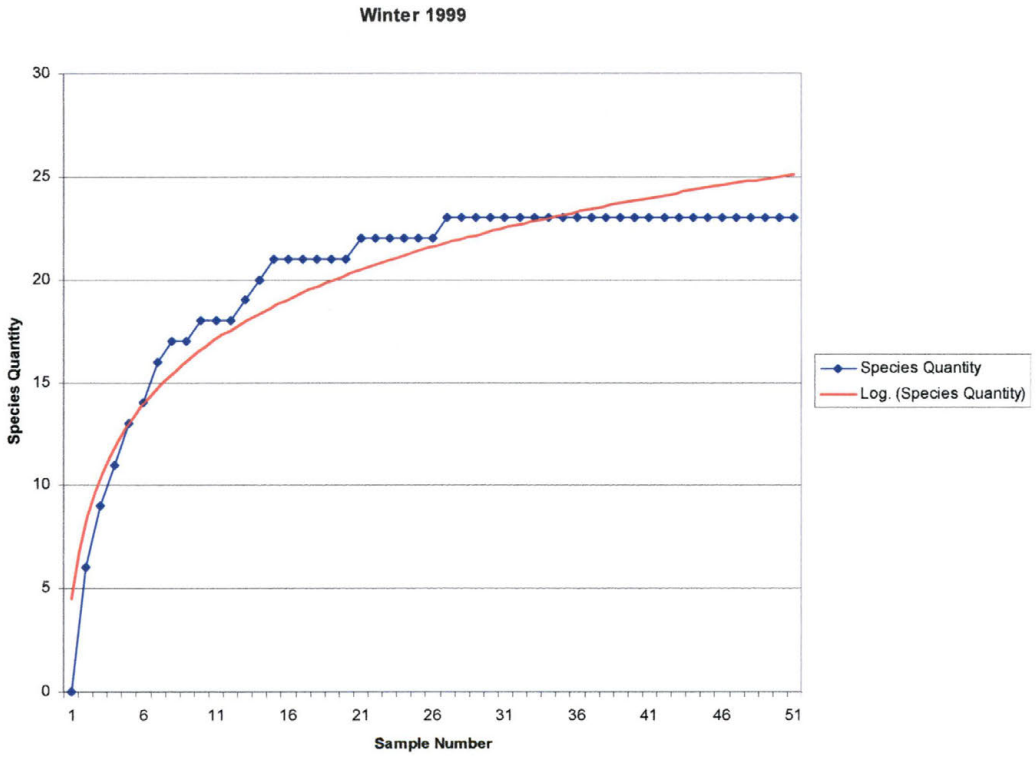
APPENDIX 4

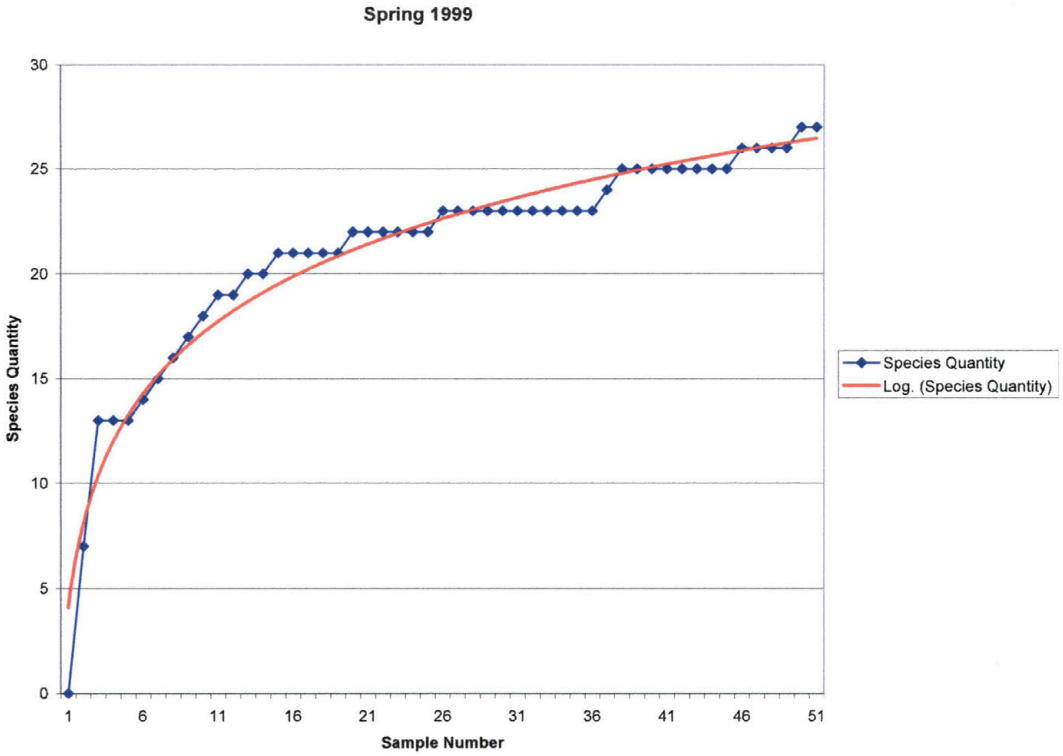
List of scientific names and common names of food plants, found in the diet of gemsbok.

Scientific Name	Common Name
Acacia sp.	Acacia
Aristida sp.	Threeawn grasses
Bothriochloa ischaemum	King Ranch bluestem
Bothriochloa laguroides	Silver bluestem
Bouteloua curtipendula	Sideoats grama
Bouteloua hirsuta	Hairy grama
Bouteloua rigidiseta	Texas grama
Carex sp.	Sedges
Chloris sp.	Windmillgrasses
Chrysopogon sp.	Chrysopogon grasses
Conyza coulteri	Conyza
Cucurbita foetidissima	Buffalo gourd
Cynodon dactylon	Bermudagrass
Dicanthelium laxiflorum	Openflower rosettegrass
Diospyros texana	Mexican persimmon
Elymus canadensis	Canada wildrye
Eragrostis intermedia	Plains lovegrass
Erioneuron pilosum	Hairy tridens
Nerisyrenia camporum	Globe mallow
Opuntia sp.	Pricklypear
Panicum hallii	Halls panicum
Panicum obtusum	Vine-mesquite
Prosopis glandulosa	Honey mesquite
Q. virginiana/ Q marilandica	Live oak / Blackjack oak
Quercus stellata	Post oak
Salsola kali	Russian thistle
Schizachyrium scoparium	Little bluestem
Setaria leucopila	Plains bristlegrass
Setaria sp.	Bristlegrasses
Sorgum halepense	Johnson grass
Sporobolus sp.	Dropseed grasses
Stipagrostis sp.	Bushman grasses
Stipa leucotricha	Texas wintergrass
Verbesina enciloides	Cowpen daisy
Yucca elata	Soaptree yucca
Yucca rupicola	Twistedleaf yucca

APPENDIX 5

Species curves for plants found in the seasonal diet of gemsbok at Mason Mountain Wildlife Management Area, Texas, 1999.

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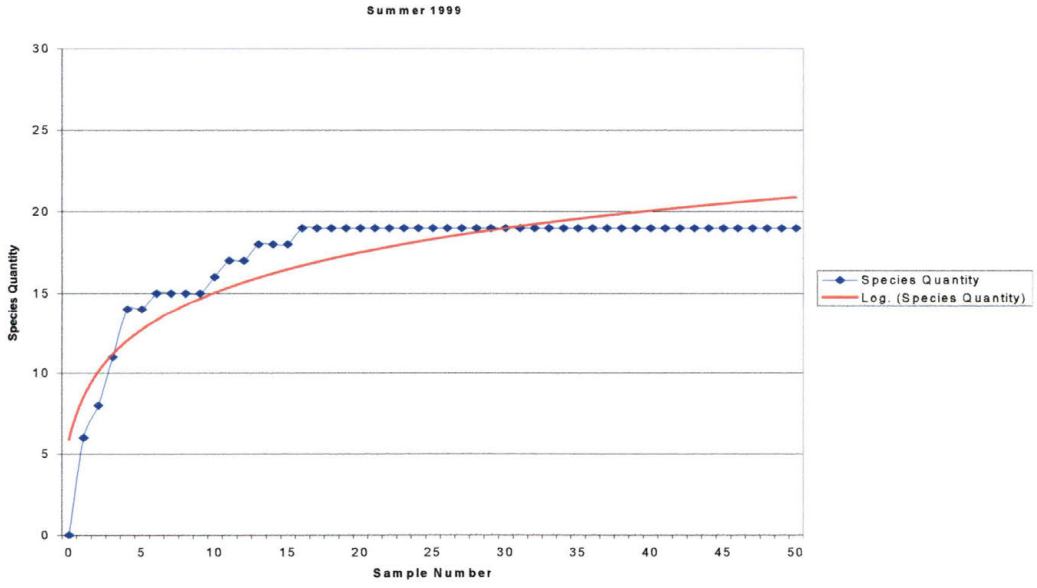
Species Quantity
Log. (Species Quantity)


Summer 1999
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Sample Number
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25
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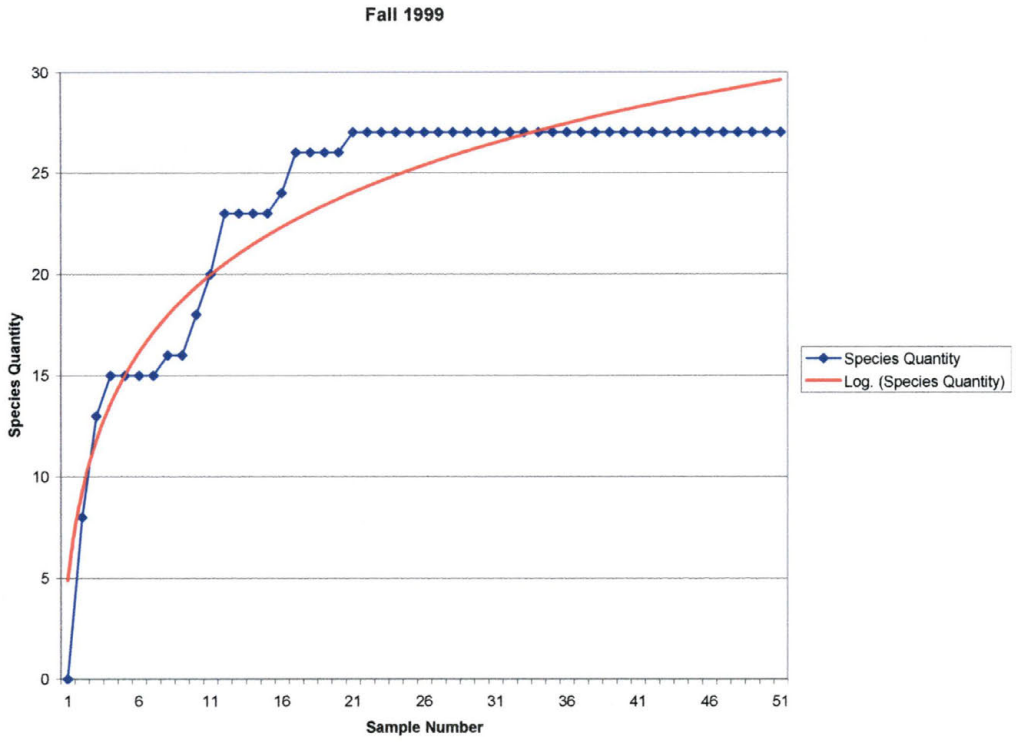
35
40
45
50
Species Quantity
Log. (Species Quantity)


Fall 1999
Species Quantity
Sample Number
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5
10
15
20
25
30
1
6
11
16
21
26
31
36
41
46
51
Species Quantity
Log. (Species Quantity)

VITA

Amy Marie Winters was born on June 17, 1970 in Alpine, Texas. She is the daughter of Richard Wall Winters, Jr., and Carla Jean Jenkins. She is the step-daughter of Walter Wilson Jenkins. She graduated from Anderson High School in Austin, Texas, in 1988. She entered Southwest Texas State University in San Marcos, Texas, in the fall of 1988 and graduated with a Bachelor of Arts with a double major in History and Political Science in 1993. In 1998, she entered the Graduate School of Southwest Texas State University, San Marcos, Texas, to earn a Master of Science degree in Wildlife Ecology. She has worked as an Instructional Assistant for Wildlife Management, Techniques in Wildlife Management, Ecology, and Zoology. She is a two-time recipient of the Houston Safari Club Scholarship.

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