

Final Report  
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**Nutritional Concerns of Pronghorn Antelope  
on Anderson Mesa and Garland Prairie,  
Arizona.**



Submitted by

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## ABSTRACT

A study to determine the potential impact of diet composition and quality on the fawn recruitment of two pronghorn antelope (*Antilocapra americana*) herds in northern Arizona (Garland Prairie and Anderson Mesa) was conducted in 2002. Diet composition of the two herds was determined at four critical reproductive stages (late gestation, parturition, lactation, and conception) using microhistological analysis of fecal material. Diet quality was evaluated using two fecal indicators, diaminopamelic acid (DAPA) and fecal nitrogen. The Garland Prairie pronghorn diets had significantly higher plant species diversity with an average of 47 different species in each biological period, while the Anderson Mesa pronghorn diets had an average of 33 different plant species. Garland Prairie diets were consistently dominated by forbs (66 – 83 %) followed by shrubs (12 – 30 %) and lastly grass (1 – 7 %). Anderson Mesa diets were much more variable with forbs declining from an initial 61 % to a low of 25 %, grass also declined from an initial high of 22.5 % to a low of 8.6%, while shrubs increased over time from an initial low of 16 % to a final high of 66 %. Garland Prairie pronghorn demonstrated significantly higher overall preferences for forbs than Anderson Mesa pronghorn, and both herds demonstrated an overall avoidance of grasses. Diaminopamelic acid output of Garland Prairie pronghorn was 35 to 129 % higher than pronghorn on Anderson Mesa suggesting a diet with a higher nutrient quality. Fecal nitrogen values were inconclusive. The overall conclusion was that the Garland Prairie pronghorn had a more diverse forage selection and with a higher nutrient quality.

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Keywords: Pronghorn Antelope, *Antilocapra americana*, Food Habits, Diet Quality, Diaminopamelic Acid, Fecal Nitrogen.

## INTRODUCTION

Pronghorn antelope populations on Anderson Mesa have demonstrated a significant decline from an estimated high of 1,185 animals in 1985 to an estimated low of 220 in 2001 (AZGFD, unpublished data). The exact cause of this decline is not fully known, however low fawn recruitment is considered a contributing factor. The average fawn recruitment for Anderson Mesa over the last decade is only 11.7 fawns per 100 doe. During the same period, the Garland Prairie antelope population, located approximately 50 km west, had a 37 fawn per 100 doe fawn recruitment (AZGFD, unpublished data).

While a number of factors may impact the differences in recruitment between these two populations, a major consideration would be the nutritional status of the doe during critical periods of the reproductive cycle. To evaluate the significance of the nutrient status as a factor limiting recruitment in the Anderson Mesa population, it is first necessary to determine the composition and quality of Anderson Mesa pronghorn diets during biologically critical periods. The objectives of this study were:

1. To describe the diet composition of both the Anderson Mesa and Garland Prairie antelope populations during critical reproductive periods.
2. To evaluate the nutritional quality of those diets during those reproductive periods using indirect indicators of diet quality.

## STUDY AREA

We selected two study areas in Coconino county of Arizona (Figure 1.). The Anderson Mesa study area is encompassed 9,681 approximately 13 km southeast of Flagstaff, Arizona

(111.5°W: 35.1°N), and is a portion of game management unit 5B. Elevation on Anderson Mesa varied between 6,700 and 7,200 feet (Neff and Woolsey, 1979). The Garland Prairie study area encompassed 5,540 hectares approximately 27 km west of Flagstaff, Arizona (111.9°W: 35.2°N), and is a portion of game management unit 8. The mean elevation of Garland Prairie is approximately 6,800 feet.

Figure 1. Location of the Anderson Mesa and Garland Prairie pronghorn antelope study areas in Northern Arizona.

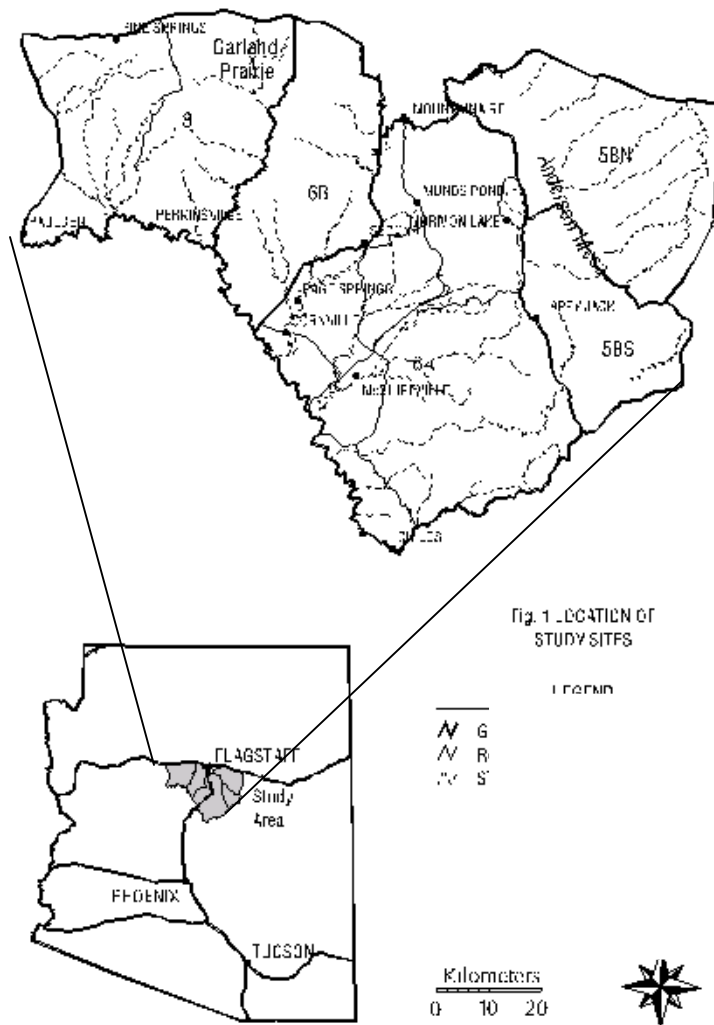


Fig. 1. LOCATION OF STUDY SITES

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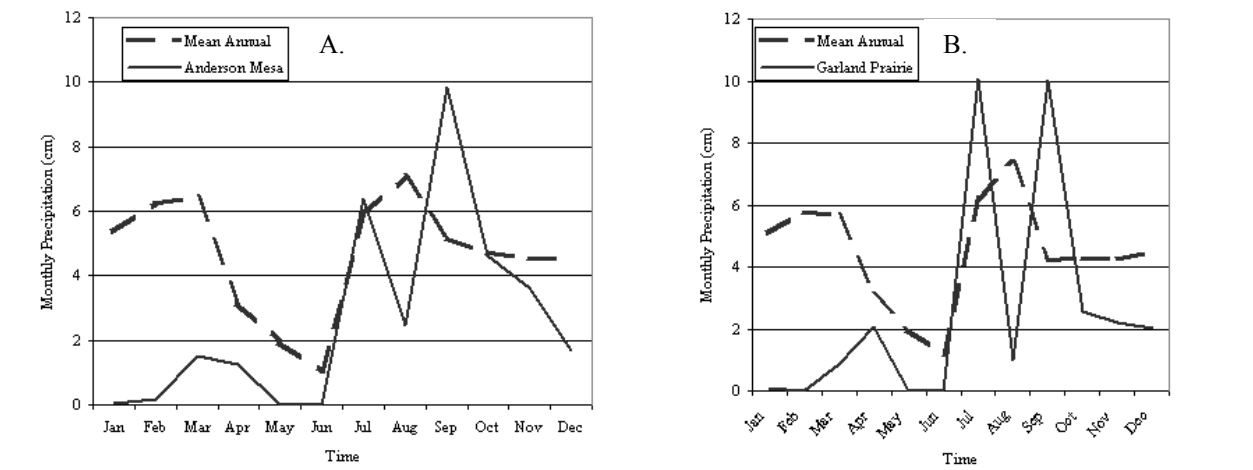
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The climatic pattern of the two study areas was similar, with mean summer temperatures (mid-July) of 21.1° C (71° F), and mean winter temperatures (mid-January) of 0.6° C (33° F). Mean annual precipitation for the two areas is 56.1 cm (23 in.) and 53.8 cm, (22 in.), for Anderson Mesa and Garland Prairie respectively. Precipitation pattern was bimodal with winter precipitation as a mixture of rain and snow, and the summer precipitation as monsoon thunderstorms. Precipitation amounts were significantly below the long-term average during this study (Figure 2.). While both study areas had near normal precipitation amounts during the summer months, their overall totals were 24.6 and 22.9 cm (10 and 9.3 in.) below their annual means, Anderson Mesa and Garland Prairie respectively( NOAA, 2002).

Figure 2. Actual and mean annual precipitation pattern for A.) Anderson Mesa, and B.) Garland Prairie in northern Arizona for 2002. NOAA 2002 Climatological Data Annual Summary Arizona..



Vegetation characteristics of the two areas were similar, consisting of Plains and Great Basin grassland communities located within Petran Montane coniferous forest. Anderson Mesa differed slightly in that there is a moderate amount of pinion-juniper scattered within the grassland community. The dominate vegetation on the Anderson Mesa study areas were forbs followed by grass and then shrubs, with 64, 28, and 8 percent forb, grass, and shrub respectively

(Appendix A). The dominant forb species included silver sage (*Artemisia ludoviciana*), aspen fleabane (*Erigeron macranthus*), common fleabane (*E. oreophilus*), red root eriogonum (*Eriogonum racemosum*), fleshy mullein (*Verbascum thapsus*), and goldeneyes (*Viguiera longifolia*). The dominant grasses included, western wheatgrass (*Agropyron smithii*), and blue grama (*Bouteloua gracilis*). The most common shrub species included green rabbitbrush (*Chrysothamnus nauseosus*), and broom snakeweed (*Gutierrezia sarothrae*).

On Garland Prairie the vegetative composition was more uniform with forbs more abundant at 35 %, followed by grasses at 33% and shrubs at 32%. Like Anderson Mesa, silver sage, aspen and common fleabane, and red root eriogonum were the most common forb species, with western wheatgrass, blue grama, bottlebrush squirreltail (*Sitanion hystrix*), and Arizona fescue (*Festuca arizonicus*) as the most common grass species. The most abundant shrub species on Garland Prairie were the same as those found on Anderson Mesa.

While the land ownership of Anderson Mesa is solely public land managed by the U.S. Forest Service, Garland Prairie is a mixture of public and private ownership. The public lands of both areas are managed as part of an active grazing allotments, with Anderson Mesa also having a significant recreational activity in the vicinity of the Marshall Lake and Little Dry Lake.

## **METHODS**

### Field Data Collection

We analyzed fecal material to evaluate pronghorn diet composition and quality. We collected fecal material during four critical periods of pronghorn reproduction: late gestation, parturition, lactation, and conception. We consulted with wildlife biologists from the two study areas, to determined dates of these periods (Table 1).

Table 1. Collection dates corresponding to the critical biological periods for Anderson Mesa, and Garland Prairie.

Biological Period	Pronghorn Herd	
	Anderson Mesa	Garland Prairie
Late Gestation	April 10 – April 25	April 1 – April 15
Parturition	May 10 – May 30	May 5 – May 20
Lactation	June 20 - July 10	June 15 – June 30
Conception	August 20 – September 10	August 15 –August 30

Our protocol for fecal collection called for groups of pronghorn to be located and observed until the majority of the individuals had defecated. Once the group had moved on, we separately collected entire individual fecal pellet groups. We labeled each fecal sample with date, number of pronghorn in the group, gender composition of the group, GPS location, biological period, and study area. We kept all fecal samples frozen until laboratory analysis could be performed.

We determined the plant species composition of each study area using 200 random locations. At each location we collected data on species composition using four 0.5m circular plots placed 1m from the center of the point oriented on the cardinal directions. In each subplot, we estimated the biomass present by species using a double sampling technique. We further collected the vegetation by species from one of the subplots for every 10 locations. We dried all vegetation collections using the same protocol used for fecal material. We used the dried collected vegetation to adjust each observer's estimate to a dry weight basis and combined these values to calculate relative plant composition of each study area.

#### Laboratory Analysis

Upon arrival at the laboratory, we cleaned samples by removing any foreign materials and dried them at 50° C for 48 hr. After recording the dry weights of all individual pellet group, we combined the groups to create four individual replicates per study area by biological period. We took care to insure that multiple samples from the same group of pronghorn remained

together. We ground the replicates in a Wiley mill to a mean particle size of 1mm, and stored in an airtight bottle for subsequent analysis.

#### Microhistological Analysis:

We determined diet composition using microhistological analysis of each replicate by study area and biological period. We processed and analyzed fecal and reference materials using the procedures described by Holt et al. (1991), and performed all microhistological at the 90% (P=0.1) confidence level.

#### Fecal Indices:

We evaluated diet quality using two fecal indices: diaminopimelic acid (DAPA) content, and fecal nitrogen content. We estimated fecal DAPA concentrations of individual diets using the procedures described by Nelson et al. (1984). We adjusted each collection to total DAPA content using the equation:

$$T \text{ DAPA}_i = (C \text{ DAPA}_i * PG \text{ Wt} * 8)$$

Where,  $T \text{ DAPA}_i$  was the total DAPA in the diet,  $C \text{ DAPA}_i$  was the DAPA concentration of the fecal sample,  $PG \text{ Wt}$  was the weight of the pellet group, and 8 is the daily defecation rate of most wild ungulates.

To determine fecal nitrogen concentration of individual diets we used a Kjheltec Auto Nitrogen Analyzer model 1030™. Total fecal nitrogen content of individual diets were determined using the equation:

$$T \text{ FN}_i = (C \text{ FN}_i * PG \text{ Wt} * 8)$$

Where,  $T \text{ FN}_i$  was the total fecal nitrogen in the diet,  $C \text{ FN}_i$  was the fecal nitrogen concentration of the fecal sample,  $PG \text{ Wt}$  was the weight of the pellet group, and 8 was the daily defecation rate of most wild ungulates.



## Data Analysis

We designed this study to test two separate hypotheses. The first hypothesis is that there is a difference in specie composition in pronghorn diets between Anderson Mesa and Garland Prairie herds. We tested this hypothesis using a completely random three factor factorial design, with pronghorn herds (Anderson Mesa and Garland Prairie), biological period (late gestation, parturition, peak lactation, time of conception) and plant species as the factors. We analyzed these data using a one-way analysis of variance (ANOVA). There were a high number of zeros in the data due to differences in plant selection between study areas and biological periods. Therefore, we used a non-parametric ranked sum analysis to evaluate the individual species relationship of the diets. When significant differences were detected, we used a Tukey's ranked mean separation test to determine the nature of the difference (Zar, 1999).

We tested a second hypothesis that there was a difference in the diet quality between Anderson Mesa and Garland Prairie. We designed this portion of the study as a completely random two-factor factorial, where the two factors were study area and biological period. We performed this analysis on each fecal index using a one-way ANOVA, and further tested any significant differences using a Tukey's mean separation test (Zar, 1999). We performed all statistical tests at the 90 % confidence ( $P = 0.1$ ) level.

## RESULTS

### Diet Composition Analysis

The mean individual species composition of the 2002 pronghorn diets for Anderson Mesa and Garland Prairie are reported in Appendix B. We found significant difference in dietary plant species diversity between pronghorn herds, with the Garland Prairie having higher mean species diversity than Anderson Mesa (Table 2.). There were no differences between biological periods

or between pronghorn herds by biological time period. The greatest difference in species diversity was during gestation. Forage species diversity was relatively constant over time (Table 2).

Table 2. Mean species diversity of pronghorn diets from two herds in northern Arizona during selected biological periods in 2002.

Biological Period	Pronghorn Herd		Species in Common
	Anderson Mesa	Garland Prairie	
Gestation	33.75	46.50 <sup>a</sup>	25
Parturition	32.25	47.75 <sup>a</sup>	30
Lactation	33.25	47.75 <sup>a</sup>	33
Conception	37.50	47.00 <sup>a</sup>	34

<sup>a</sup> Means in rows with different letters are significantly different ( $P < .01$ ) EMS= 4.36, error df=20.

There were significant differences in forage class selection by pronghorn herd over time (Table 3). Pronghorn in the Anderson Mesa herd had consistently higher amounts of grass ranging from 22.5 to 8.6 %, while the grass component of the Garland Prairie herd never exceeded 7.1 %. Forb use on Garland Prairie remained high, ranging from 66.2 to 83.0 % throughout all biological periods, while forb use on Anderson Mesa sharply declined from a high of 61.7 % in gestation to a low of 25.4 % during conception. Shrub use by the two pronghorn herds showed a mixed response over time, with shrub use significantly increasing from gestation to conception on Anderson Mesa, while only mildly increasing on Garland Prairie.

In addition to the differences in forage class consumption by herd and biological period, we found a significant difference in mean forage species composition by herd and biological period (appendix B). Within the Anderson Mesa herd, we found a total of 20 species to be significant; four grass species, nine forb species and seven shrub species. The significant grass species were western wheatgrass, blue grama, Arizona fescue, and junegrass (*Koeleria pyramidata*). These grass species accounted for 13.9 % of the 22.5 % of grasses consumed during gestation diet, 15 % of the 22.3 % grasses ingested during parturition, 10.9 % of the 13.6

% eaten during lactation, and 7.8 % of the 8.6 % of those consumed during conception diet. The significant forb species were yarrow (*Achillea millefolium*), silver sage, brickella (*Brickella* spp.), bull thistle (*Cirsium vulgare*), prairie clover (*Dalea albiflora*), common fleabane, red root eriogonum, globe mallow (*Sphaeralcea ambigua*), and dandelion (*Taraxacum officinale*). These forb species accounted for 34.4 % of the 61.7 % of forbs eaten during gestation, 32 % of the 50.8 % of those consumed during parturition, 12% of the 28.9 % ingested during lactation, and 11.3 % of the 25.4 % of the forbs present in conception diet. The seven significant shrub species were: serviceberry (*Amelanchier alnifolia*), hackberry (*Celtis pallida*), two species of rabbitbrush (*Chrysothamnus nauseosus* and *C. viscidiflorus*), juniper (*Juniperus deppeana*), Gamble oak (*Quercus gambelii*), and wax current (*Ribes cereum*). These shrub species accounted for 10.4 % of the 15.8 % of shrubs consumed during gestation, 21.5 % of the 26 % eaten during parturition, 47.2% of the 57.5 % ingested during lactation, and 51.9 % of the 66 % of shrubs in conception diet.

Table 3. Mean diet composition by forage class of pronghorn diets from two herds in northern Arizona during selected biological periods in 2002.

Biological Period Forage Class	Pronghorn Herd	
	Anderson Mesa	Garland Prairie
Gestation:		
Grass	22.5	7.1
Forb	61.7	70.2
Shrub	15.8	22.8
Parturition:		
Grass	22.3	4.3
Forb	51.1	83.0
Shrub	26.5	12.7
Lactation:		
Grass	13.6	3.8
Forb	28.9	66.2
Shrub	57.5	30.0
Conception:		
Grass	8.6	1.0
Forb	25.4	72.0
Shrub	66.0	27.0

EMS = 46, error df =60

Within Garland Prairie diets, we found a total of 23 species to be significant, two grass species, 17 forb species and four shrub species. The significant grass species were blue grama, and junegrass. These two species accounted for 3.5 % of the 7.1 % of grasses consumed gestation, 2.9 % of the 4.3 % eaten during parturition, 0.7 % of the 3.8 % ingested during lactation, and 0.3 % of the 1.04 % consumed during conception. The significant forb species were yarrow, silver sage, brickella, Indian paintbrush (*Castilla integra*), hairy golden aster (*Chrysopsis villosa*), field bindweed (*Convolvulus arvensis*), cryptantah (*Cryptantah angustifolia*), Dalmatian toadflax (*Linaria dalmatica*), fillarie (*Erodium cicutarium*), aspen fleabane, common fleabane, red root eriogonum, sunflower (*Helianthus annuus*), penstemon (*Penstemon* spp.), silverweed (*Potentilla anserina*), dandelion, and goldeneye (*Viguiera longifolia*). These forb species accounted for 36.5 % of the 70.2 % of forbs eaten during gestation, 49.8 % of the 83 % present in parturition diet, 43.5% of the 66.2 % ingested during lactation, and 42.8 % of the 72 % of forbs present in conception diet. The four significant shrub species were: serviceberry, juniper, Ponderosa pine (*Pinus ponderosa*), and wild rose (*Rosa* spp.). These shrub species accounted for 15 % of the 22.1 % of shrubs consumed during gestation, 9.2 % of the 12.7 % of the shrubs present in parturition diets, 16.9% of the 30 % of those eaten during lactation diet, and 17.9 % of the 27.1 % of the shrubs found in conception diets.

Forage preference/Avoidance has been defined as the ratio of relative consumption of individual plant species in proportion to the relative availability of that individual plant species.

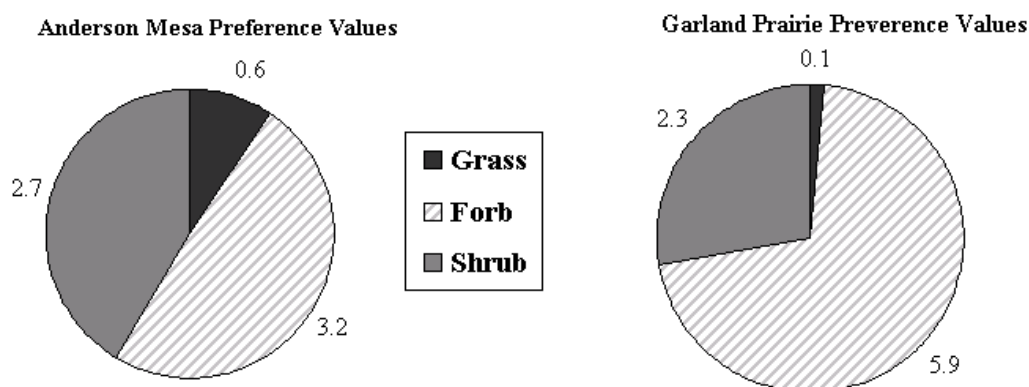
$$Pr_i = Di/Ai$$

Where  $Di$  is the proportion of plant species  $i$  in the diet,  $Ai$  is the proportion of plant species  $i$  available for consumption, and  $Pr$  is the preference value for plant species  $i$ . Generally, plants with  $Pr$  values  $> 1.5$  are considered plant species that animals are actively selecting for

(Selection), those with Pr values  $< 0.5$  are considered species that are being actively selected against (avoided), and plants with Pr values  $> 0.5$  but  $< 1.5$  are plants being consumed by chance (no active selection or avoidance).

As a whole, for both the Garland Prairie and Anderson Mesa pronghorn diets, forbs had the highest mean preference value of all forage classes (Figure 4.). The mean preference for shrubs also indicated an active selection for shrubs, while the preference for grasses showed an active avoidance of this forage class. Between the two pronghorn herds, preference for forbs on Garland Prairie was almost twice that of Anderson Mesa, with the avoidance of grasses on Garland Prairie far stronger than on Anderson Mesa (Figure 4.)

Figure 4. Forage class preference values for two pronghorn antelope herds in northern Arizona during selected biological periods in 2002.



If we examine the individual species preferences, we see further differences in forage selection patterns between the two pronghorn herds (Appendix C). The Anderson Mesa herd, selected for at least three grass species during every biological period and avoided five grass species. Conversely, the Garland Prairie herd selected for only one grass species and avoided at least 11 species. The most preferred grass species on Anderson Mesa was junegrass (Table 6.).

Table 6. Mean number of species by forage class by selection preferences category of two pronghorn antelope herds in northern Arizona during selected biological periods in 2002.

Forage Class Preference Value	Anderson Mesa				Garland Prairie			
	Gestation	Parturition	Lactation	Conception	Gestation	Parturition	Lactation	Conception
Grass:								
Selection	4	6	6	3	1	0	1	0
Avoidance	5	5	5	6	11	11	11	11
None	2	0	0	2	0	1	0	1
Not Available	1	1	1	1	0	0	0	0
Forb:								
Selection	15	11	11	13	19	19	17	17
Avoidance	19	22	21	21	12	18	16	15
None	2	3	3	2	9	3	7	8
Not Available	6	6	6	6	2	2	2	2
Shrub:								
Selection	4	7	7	7	7	8	8	8
Avoidance	4	2	2	4	4	4	4	4
None	3	2	2	0	1	0	0	0
Not Available	1	1	1	1	0	0	0	0
Totals								
Selection	23	24	24	23	27	27	26	25
Avoidance	28	29	28	31	27	33	31	30
None	7	5	5	4	10	4	7	9
Not Available	8	8	8	8	2	2	2	2

There were more forbs selected for by both herds than any other forage class. There were an average of 13 forb species selected for by the Anderson Mesa herd, and an average of 18 forb species selected for by the Garland Prairie herd (Table 6). As a whole, the forb species selected for by either herd each contributed to at least 1.5 % of the diet composition, with some species accounting for 3.5 % individually. There were also more forbs avoided by both herds than any other forage class. The Anderson Mesa herd avoided an average of 20 different forb species per biological period with at least 12 different forb species avoided by the Garland Prairie herd depending on the biological period. Those forbs avoided tended to be those least important to the diet, that is those species contributing less than 0.5 % of the diet in any one period. Those forbs most selected for on Anderson Mesa were yarrow, brickellia, bull thistle, and dandelion, with common fleabane and red root eriogonum being the most prominent forbs avoided. For Garland Prairie, brickellia, Dalmation toadflax, filleria, sunflower, and dandelion were the most

preferred, with tragopogon (*Tragopogon dubius*), locoweed (*Astragalus* spp.), and Arizona ragweed (*Ambrosia psilostachya*) showing the greatest avoidance.

Shrub species selection and avoidance was much less dramatic than forbs or grasses. The Anderson Mesa herd selected for four to six shrubs species while avoiding two to four shrub species. The shrub species most often selected for was serviceberry, followed by wax current and juniper. The shrubs with the lowest preference value were broom snakeweed and shrubby buckwheat (*Eriogonum fasciculatum*). On Garland Prairie the most often selected shrub species was also serviceberry, followed by hackberry (*Celtis pallida*), Gamble oak (*Quercus gambleii*), and wild rose (*Rosa* spp.). The least selected species were again broom snakeweed and shrubby buckwheat.

#### Diaminopimelic Acid Analysis

With the exception of lactation, DAPA content of the Garland Prairie pronghorn herd were at least 35 to 129 % greater than that found in the Anderson Mesa pronghorn herd during the same biological period (Table 4). This would suggest that there was a greater amount of rumen activity in the Garland Prairie pronghorn, most likely due to a higher quality diet.

Table 4. Mean daily DAPA output (mg/day) from two pronghorn herds in northern Arizona during selected biological periods in 2002.

Biological Period	Pronghorn Herd	
	Anderson Mesa	Garland Prairie
Gestation:	204.29	277.49 <sup>a</sup>
Parturition	87.87 <sup>a</sup>	199.41
Lactation	105.43 <sup>a</sup>	173.87
Conception	121.87 <sup>a</sup>	176.72

<sup>ab</sup> Means with the same letter are significantly different at  $P \leq 0.1$ .

## Fecal Nitrogen

There were no significant differences in fecal nitrogen content between pronghorn herds or between biological periods (Table 5.).

Table 5. Mean daily fecal nitrogen output (g/day) from two pronghorn herds in northern Arizona during selected biological periods in 2002.

Biological Period	Pronghorn Herd	
	Anderson Mesa	Garland Prairie
Gestation:	5.48	5.43
Parturition	5.20	6.79
Lactation	4.17	6.93
Conception	6.32	6.64

## **DISCUSSION**

Yoakum and O’Gara (2000), classified pronghorn as opportunistic foragers, with shifting forages class selection depending on forage availability and quality. Yoakum (1990) reviewed a number of pronghorn dietary studies and reported that forbs are the predominately preferred forage class followed by shrubs, with grasses as the least preferred species. Mitchell (1980) further supported these conclusions, indicating that, while grass and shrub species may be found in pronghorn diets, they normally indicate a scarcity of forb species resulting in higher grass and shrub consumption.

The pattern of high forb use and very low use of grass and shrub species by pronghorn on Garland Prairie is consistent with expected pronghorn food selection. Initially, forbs were the dominant component of the Anderson Mesa pronghorn diets, with grasses and shrubs occurring less frequently. As time progressed, the quantity of forbs in the diet steadily declined, while shrubs increased until they were the dominant component of the diet during lactation and conception. The most likely explanation for this trend is the limited availability of forb specie due to drought conditions on Anderson Mesa. Annuals are a major source of the forbs found on



Anderson Mesa. The growth and availability of these forbs are directly affected by precipitation. During the spring and summer of 2002, the Anderson Mesa area only received 11.6 cm of its normal 25.6 cm of precipitation. This would contribute to a below normal forb availability and explain the higher use of shrubs by Anderson Mesa pronghorn.

Diaminopimelic acid is a unique amino acid found in anaerobic bacteria such as those found in the rumen of ungulate species. Because of the amino acid specificity of pancreatic and intestinal mucosal enzymes, peptides containing DAPA cannot be broken down to individual amino acids for absorption. These DAPA containing tri-peptides pass out of the digestive tract in the feces, where they can be measured as an indirect indicator to the ruminant animal's diet quality. Nelson et al. (1984) established the value of Diaminopimelic acid (DAPA) as a fecal indicator of diet quality. The content of DAPA recovered from the Garland Prairie and Anderson Mesa pronghorn herds would indicate a significantly higher quality diet in the Garland Prairie herd, across all biological periods.

Diet quality can have particular significant impacts on reproductive function in wild ruminants depending on the particular stage of reproduction. The quality of the diet during late gestation is significant to the development of the fawn. While the majority of the cell development occurs during the first two trimesters of gestation, the vast majority of fetal growth takes place in the last trimester. Diets of low nutritional quality during the last trimester typically result in low birth weights of the fawn, which in turn has significant implications for initial fawn survival (Robbins, 1983).

Diet quality during the parturition period may have more impact on the doe than the fawn. During the final days of gestation, there are a number of physiological changes that take place in the doe in preparation for parturition. The most important of these changes are the

hormonal variations related to parturition and the initiation of lactation. In most wild ruminants the protein requirement for parturition is equal to, or exceed the normal maintenance requirements (Moen, A. N.1973, Robbins, 1983). In order to meet these requirements the doe must increase her nutrient intake. Should she be on a limited quality diet, the only alternative she will have is to increase her dry matter intake. Normally wild ruminants have a daily dry matter intake of about 2.5% of their body weight (BW). The nature of the doe's nutrient needs are such that if the diet quality is not increased, she may have to increase her intake to 3.3 or 4 % BW in order to meet her nutrient demands. The problem with this scenario is that low quality forages not only do not provide the necessary nutrients, they have a low digestibility. This low digestibility results in a reduced microbial efficiency in the rumen, a slower passage rate of forage out of the rumen, and the accumulation of materials that prevent the doe from increasing her dry matter intake (Hungate 1966, Milligan et al. 1986, Grovum 1988,) The summation of these conditions is that the doe is not able to significantly increase her intake, thus limiting her ability to meet her needs for parturition and early lactation.

The period with the single highest nutrient demands on the doe is lactation (Robbins, 1983). Protein and energy requirements vary with time as a function of the body size and digestive development of the fawn. The amount of protein and energy required by the doe is a function of two conditions: 1) The nutrient demand of the fawn for growth, and 2) The amount of solid food the fawn can effectively consume to meet that demand. The doe will try to provide as much milk as she can to meet the needs of the fawn not met by the fawn's forage intake.

At birth, the rumen/reticular complex of the fawn is non-functional, and requires extensive development in size and capabilities. As the fawn grows the demand for nutrients for growth exceed the amount it can obtain from solid food, thus the demand on the doe to offset the

difference is increased (Robbins, 1983). This trend continues until the fawn is about 50 days of age, at which time the development of the rumen begins catching up with the fawn's demands for growth. If, however, the quality of the diet is such that the doe is not able to meet her own nutrient needs and those of the fawn, then two things will happen. First her ability to produce milk will decline, making it more difficult for the fawn to meet its nutrient requirements. Secondly the reduced nutrient intake of the fawn will retard its development, and increase its risk to mortality factors.

The importance of nutrition during the conception period is often overlooked when examining the reproductive performance of wild ungulates. A primary reason for this oversight is that the doe has just completed gestation, parturition and lactation. At this stage in the annual life cycle the fawn has been weaned and the only apparent nutrient demands for the doe is maintenance. This is where the misconception occurs. While there are no direct demands for production of a fawn, the doe has just completed a 335-day process that has placed significant demands on all of her body reserves. If she is to be able to breed and conceive in time for the next year, she has only 30 days in which to replenish her body conditions in order to cycle for breeding. During this period, protein levels in the diet are critical to the doe's potential for breeding in a timely manner (Shirley, 1986). The pattern of DAPA concentrations shown in Figure 5 would suggest that the does in the Anderson Mesa herd have as much as 20% less protein in their diet as the Garland Prairie herd. This would suggest that does in the Anderson Mesa herd may have more difficulty cycling their reproductive functions to be able to breed on an annual basis. This phenomenon alone may partially account for the lower fawn recruitment observed in the Anderson Mesa herd.

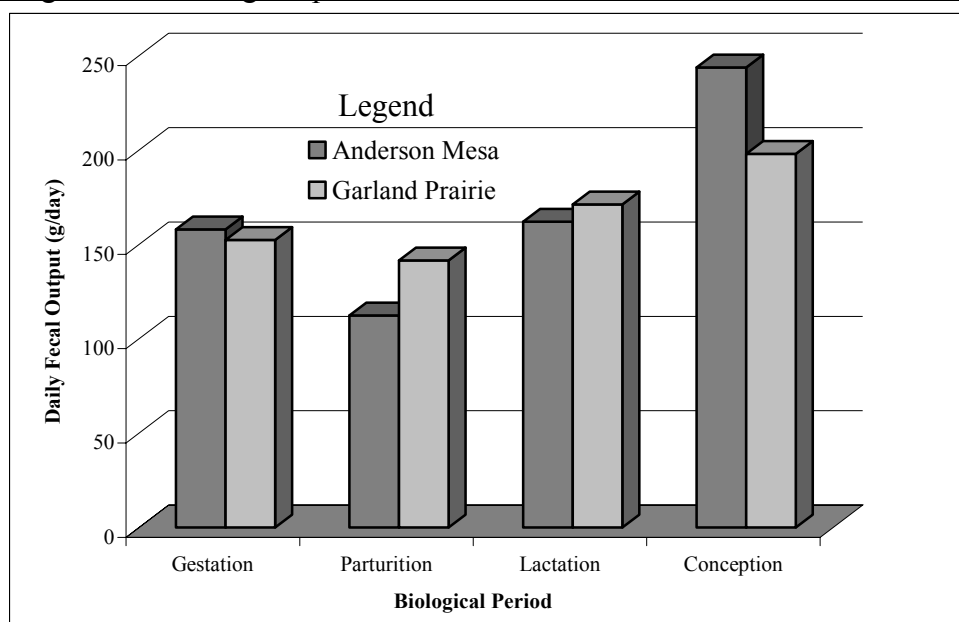
Fecal nitrogen is derived from a number of digestive and physiological sources. A component of fecal nitrogen is nitrogen contained in undigested foodstuffs. In most non-ruminant animals, undigested food provides a significant input to fecal nitrogen. However, in ruminant diets, this input is not as significant. The primary site of nitrogen in plant materials is in the cell soluble content. The rumen microbial population is highly efficient in digesting plant cell soluble contents. It has been estimated that cell soluble degradation by rumen bacteria is as high as 95% (Hungate, 1966). For this reason undigested food sources of nitrogen are small in ruminant animals. The second source is microbial residue, specifically undigested bacterial protein such as DAPA. The third source is non-recovered digestive enzymes. These are a combination of pancreatic and intestinal enzymes involved in the breakdown of food in the mid-gut. The final source of fecal nitrogen is epithelial tissue shed by the digestive tract. The quantity of GI tract tissue is a function of the physical characteristics of the diet. Foodstuffs that are highly succulent with low amounts of fiber are less effective in scouring the GI tract. Conversely, diets high in poorly digested fiber are highly effective in scouring epithelial tissue from the inside of the GI tract (Merchen, 1988).

The pattern of fecal nitrogen shown in Figure 6 indicates no difference in fecal nitrogen between pronghorn herds or over time. This may be misleading. As we reported, there are significant differences in the DAPA concentrations of the feces, however they are not apparent in the fecal nitrogen. One possible explanation is the effect of the quality of the diet. Those diet with higher amounts fiber are of lower quality, and have the potential of depositing higher amounts of nitrogen in the feces from GI tract tissue. Further, poorly digested foods tend to cause larger amounts of digestive enzymes to be excreted in the digestive tract, thus increasing nitrogen in the feces from non-recovered digestive enzymes. This lack of significant difference

may suggest something about the forage quality consumed by the two pronghorn herds. In as much as we know there are significant differences in the DAPA concentrations that are not manifested in the fecal nitrogen, it may be possible that a lower quality diet consumed by the Anderson Mesa herd would increase the nitrogen losses due to GI tissue and non-recovered digestive enzymes, thereby masking any differences in the fecal nitrogen between the two pronghorn herds.

We hasten to point out that while fecal nitrogen can be an indicator of differences in dietary quality, there are a number of conditions that make it a much less sensitive indicator than what might be desired.

Figure 6. Comparison of mean daily fecal nitrogen output from two pronghorn herds in northern Arizona during selected biological periods in 2002.



## CONCLUSION

The purpose of this study was two fold. The first purpose was to determine if there were any differences in the diet composition that might account for the differences in fawn recruitment between the Garland Prairie and Anderson Mesa pronghorn herds. Our results confirm a definite

difference in the diet composition, with the Garland Prairie herd diets having significantly higher plant diversity across all biological periods. The Garland Prairie diets had a significantly higher proportion of forbs and lower quantities of grasses than the Anderson Mesa diets. Even though, the Anderson Mesa herd started out with relatively high forb content, there was a continual conversion from forb to shrub over time, until shrub species dominated their diet. Additionally, the Garland Prairie herd showed a dramatically higher preference for forb species than the Anderson Mesa herd.

The second purpose was to evaluate the quality of the diet using indirect indicators of diet quality. Diaminopimelic acid analysis of feces from both herds showed a significant difference between pronghorn herds. The Garland Prairie herds had significantly higher DAPA levels across all biological periods, indicating a higher rumen microbial activity most likely related to a higher diet quality. The use of fecal nitrogen as an indicator of diet quality was inconclusive. The lack of difference between pronghorn herds was most likely due to the sources of fecal nitrogen, and the possible impact low quality/high fiber forages have of metabolic fecal nitrogen level.

Even though the direct evaluation of the nutrient quality of the two herd's diet could not be performed due to insufficient plant material collection, there is sufficient indication that the Garland Prairie pronghorn herd was on a higher nutritional plane than the Anderson Mesa herd. This higher nutritional condition during critical periods of reproduction could account for the higher fawn recruitment on Garland Prairie.

We hasten to point out that this study was conducted in the fifth year of a drought, and that the impacts of that drought may be cumulative. It is highly possible that even though the

Garland Prairie herd is on a higher quality diet, the quality of that diet might not be sufficient to allow the Garland Prairie herd to sustain a strong pattern of fawn recruitment.

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## Appendix A

## Forage Species availability on Anderson Mesa and Garland Prairie during 2001.

Common Name	Scientific Name	Vegetative Composition	
		Anderson Mesa	Garland Prairie
Grass			
Western Wheatgrass	<i>Agropyron smithii</i>	19.8%	5.2%
Wild Oats	<i>Avena fatua</i>	1.1%	0.5%
Blue Grama	<i>Bouteloua gracilis</i>	5.2%	9.9%
Brome Grass species	Brome spp.	0.0%	0.1%
Red Brome	<i>Bromus rubens</i>	0.2%	1.3%
Sedge	<i>Carex</i> spp,	0.4%	0.0%
Arizona Fescue	<i>Festuca arizonicus</i>	0.2%	6.1%
June Grass	<i>Koeleria pyramidata</i>	0.0%	0.0%
Mountain Muhley	<i>Muhlenbergia montana</i>	0.0%	0.9%
Kentucky Bluegrass	<i>Poa pratensis</i>	0.1%	1.2%
Bottlebrush Squirreltail	<i>Sitanion hystrix</i>	0.0%	7.1%
Six-week Fescue	<i>Vulpia octaflora</i>	1.1%	0.1%
Other Grasses		0.0%	0.4%
Total Grass		28.2%	32.9%
Forb			
Yarrow	<i>Achillea millefolium</i>	0.0%	1.0%
Wild Onions	<i>Allium</i> spp.	0.0%	0.2%
Arizona Ragweed	<i>Ambrosia psilostachya</i>	0.1%	0.1%
Pussytoe	<i>Anteneria rosulata</i>	0.1%	2.1%
Silver sage	<i>Artemisia ludoviciana</i>	5.0%	3.8%
Common Aster	<i>Aster commutatus</i>	0.3%	0.0%
Wooly Locoweed	<i>Astragalus mollissimus</i>	0.1%	0.1%
Milkvetch	<i>Astragalus</i> spp.	0.1%	0.1%
Brickellia	<i>Brickellia</i> spp.	1.4%	0.9%
Shepard's Purse	<i>Capsella bursa-pastoris</i>	0.2%	0.0%
Indian Paintbrush	<i>Castilla integra</i>	0.5%	0.6%
Rattlesnake Weed	<i>Chamaesyce albomarginata</i>	0.5%	0.0%
Hairy Gold Aster	<i>Chrysopsis villosa</i>	0.0%	1.4%
Bull Thistle	<i>Cirsium vulgare</i>	2.2%	1.3%
Golden Tickseed	<i>Coreopsis tinctoria</i>	0.1%	0.7%
Cryptantah	<i>Cryptantah angustifolia</i>	0.2%	0.3%
Blue Dick	<i>Dichelostemma pulchellum</i>	0.2%	1.1%
Fillarie	<i>Erodium cicutarium</i>	3.7%	0.5%
Aspen Fleabane	<i>Erigeron macranthus</i>	13.8%	2.7%
Common Fleabane	<i>Erigeron oreophilus</i>	5.5%	4.5%
Red Root Eriogonum	<i>Eriogonum racemosum</i>	0.0%	3.6%
Scarlet guara	<i>Gaura coccinea</i>	0.0%	0.3%
Geranium	<i>Geranium caespitosum</i>	0.0%	0.2%
Sunflower	<i>Helianthus annuus</i>	0.2%	0.4%
Iris	<i>Iris missouriensis</i>	0.1%	1.2%

Table (continued)

Common Name	Scientific Name	Vegetative Composition	
		Anderson Mesa	Garland Prairie
Dalmatian Toadflax	<i>Linaria dalmatica</i>	0.0%	0.4%
Blue Flax	<i>Linum lewisii</i>	0.1%	0.3%
Lupine	<i>Lupinus arizonicus</i>	2.1%	0.9%
Machaeranthera	<i>Machaeranthera asteroides</i>	0.3%	1.8%
Bur clover	<i>Medicago hispida</i>	0.4%	0.0%
Penstemon species	<i>Penstemon</i> spp.	0.0%	1.8%
Silverweed	<i>Potentilla anserina</i>	0.0%	0.4%
Mountain Parsley	<i>Pseudocymopterus montanus</i>	0.0%	0.2%
Wild Potato	<i>Solanum jamesii</i>	0.8%	0.0%
Globe Mallow	<i>Sphaeralcea ambigua</i>	1.4%	0.0%
Dandelion	<i>Taraxacum officinale</i>	1.0%	0.1%
Tragopogon	<i>Tragopogon dubius</i>	0.3%	1.0%
Verbena	<i>Verbena bracteata</i>	0.0%	0.0%
Fleshy Mullen	<i>Verbascum thapsus</i>	0.0%	0.4%
Goldeneyes	<i>Viguiera longifolia</i>	22.6%	0.6%
Other Forbs		0.4%	0.0%
Total Forbs		64.2%	35.0%
Shrub			
Serviceberry	<i>Amelanchier alnifolia</i>	0.3%	0.0%
Hackberry	<i>Celtis pallida</i>	0.0%	0.0%
Green Rabbitbrush	<i>Chrysothamnus nauseosus</i>	4.1%	6.4%
Sticky Rabbitbrush	<i>Chrysothamnus viscidiflorus</i>	0.0%	0.0%
Blackbrush	<i>Coleogyne ramosissima</i>	0.1%	1.0%
Broom Snakeweed	<i>Gutierrezia sarothrae</i>	1.4%	23.2%
Juniper	<i>Juniperus deppeana</i>	1.1%	0.0%
Ponderosa Pine	<i>Pinus ponderosa</i>	0.0%	0.2%
Gamble Oak	<i>Quercus gambelii</i>	0.0%	0.0%
Wax Current	<i>Ribes cereum</i>	0.0%	0.1%
Other Shrubs		0.6%	0.0%
Total Shrubs		7.6%	30.8%

## Appendix B

Mean percent diet composition by species of pronghorn diets from two herds in northern Arizona during selected biological periods in 2002.

Forage Species	Diet Composition (%)							
	Anderson Mesa				Garland Prairie			
	Gestation	Parturition	Lactation	Conception	Gestation	Parturition	Lactation	Conception
<b>Grass</b>								
Western Wheatgrass	2.90	1.33	0.95	1.18	0.00	0.22	0.16	0.00
Wild Oats	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.00
Blue Grama	4.23	1.13	0.55	1.11	2.19	1.59	0.39	0.08
Brome Grass species	0.00	0.00	0.00	0.00	0.00	0.00	0.77	0.11
Red Brome	0.17	0.00	0.63	0.22	0.00	0.00	0.30	0.03
Arizona Fescue	2.77	6.15	2.73	2.19	0.00	0.00	0.00	0.00
June Grass	4.00	6.39	6.66	3.31	1.33	1.34	0.33	0.17
Bull Muhey	0.00	2.49	0.08	0.00	0.00	0.00	0.00	0.00
Mountain Muhley	1.64	0.00	0.75	0.04	0.00	0.00	0.00	0.20
Kentucky Bluegrass	0.08	0.78	0.28	0.04	0.28	0.41	0.51	0.14
Little Bluestem	0.10	0.00	0.00	0.14	0.00	0.02	0.67	0.00
Bottlebrush Squirreltail	1.91	0.06	0.03	0.00	1.70	0.00	0.00	0.00
Other Grasses	4.70	3.91	0.94	0.40	1.51	0.24	0.61	0.62
<b>Total Grass</b>	<b>22.51</b>	<b>22.33</b>	<b>13.60</b>	<b>8.58</b>	<b>7.07</b>	<b>4.34</b>	<b>3.76</b>	<b>1.04</b>
<b>Forb</b>								
Yarrow	1.46	3.24	1.57	2.18	4.03	3.19	0.88	1.18
Wild Onions	0.00	0.02	0.00	0.00	0.21	0.62	0.15	0.17
Arizona Ragweed	0.45	0.16	0.04	0.03	0.00	0.00	0.00	0.00
Pussytoe	0.42	0.64	0.00	1.24	1.02	0.29	0.00	0.00
Silver sage	2.57	6.32	3.85	0.97	0.98	1.47	1.06	0.77
Common Aster	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46
Woolly Locoweed	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00
Milkvetch	0.00	0.00	0.00	0.00	2.47	0.96	0.13	1.36
Brickellia	5.81	10.10	3.67	2.31	6.29	5.22	2.93	6.71
Indian Paintbrush	0.00	1.05	0.00	0.00	0.30	0.62	2.33	0.47
Rattlesnake Weed	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hairy Gold Aster	0.00	0.00	0.00	0.25	3.30	5.78	6.87	12.18
Bull Thistle	1.85	1.60	0.82	0.66	0.47	0.26	0.06	2.53
Field Bindweed	0.00	0.64	0.15	0.22	0.12	9.86	2.91	1.71
Domestic Corn	0.00	0.00	0.00	0.00	0.06	0.12	0.02	0.00
Golden Tickseed	0.00	0.00	0.03	0.38	1.05	0.42	0.06	0.05
Cryptantah	0.00	0.00	0.00	0.00	1.90	5.16	1.18	2.22
Prairie Clover	1.58	0.44	0.17	0.31	1.30	0.00	0.00	1.11
Dalmatian Toadflax	0.00	0.00	0.00	0.00	0.01	3.26	3.63	1.63
Blue Dick	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00
Fillarie	0.00	0.00	0.00	0.00	3.50	3.67	3.36	2.16
Aspen Fleabane	0.00	0.00	0.00	0.00	3.30	0.60	0.98	1.78
Common Fleabane	5.22	1.82	0.21	1.29	2.00	4.48	3.37	4.56
Red Root Eriogonum	6.92	2.51	0.38	1.53	4.54	0.29	0.88	0.06
Scarlet guara	0.00	0.00	0.00	0.19	0.44	1.67	0.57	0.87
Geranium	0.53	0.38	1.87	0.30	0.75	0.38	0.75	0.42

Table (Continued)

Forage Species	Diet Composition (%)							
	Anderson Mesa				Garland Prairie			
	Gestation	Parturition	Lactation	Conception	Gestation	Parturition	Lactation	Conception
Sunflower	0.00	0.00	0.34	0.24	3.59	1.43	1.46	1.09
Iris	1.06	0.00	0.00	0.11	0.00	0.26	0.85	0.03
Blue Flax	0.39	0.00	0.00	0.00	0.21	0.03	0.12	0.32
Lupine	0.00	0.00	0.00	0.00	0.96	2.03	0.62	1.10
Machaeranthera	0.90	0.87	0.58	0.44	1.36	3.67	1.10	0.85
Bur clover	0.26	0.24	0.25	0.30	0.09	0.00	0.00	0.00
Penstemon species	1.08	0.04	0.51	1.25	1.93	2.70	3.94	1.32
Water Smartweed	0.00	0.43	0.00	0.00	0.09	0.00	0.00	1.28
Silverweed	0.00	0.00	0.00	0.00	0.87	1.63	8.73	3.53
Mountain Parsley	0.00	0.00	0.00	0.00	2.82	0.55	1.03	1.02
Shepard's Purse	0.00	0.00	0.00	0.00	1.88	0.75	0.37	0.60
Wild Potato	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
Globe Mallow	0.00	2.71	1.30	0.49	0.00	0.00	0.00	0.00
Dandelion	8.97	3.23	0.06	1.53	1.88	1.30	0.89	1.13
Tragopogon	0.00	0.00	0.00	0.00	0.11	0.11	0.00	0.00
Sweet Clover	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00
Verbena	2.00	0.45	0.24	0.10	0.30	1.00	1.11	0.53
Fleshy Mullen	0.01	0.00	0.02	0.40	0.13	0.04	0.11	0.41
Goldeneyes	1.56	0.91	0.04	0.00	1.46	2.77	1.72	2.45
Other Forbs	18.63	13.01	12.73	8.68	14.62	12.54	11.74	13.68
<b>Total Forbs</b>	<b>61.66</b>	<b>51.14</b>	<b>28.89</b>	<b>25.39</b>	<b>70.15</b>	<b>83.00</b>	<b>66.22</b>	<b>71.95</b>
Shrub								
Serviceberry	0.40	6.76	15.73	15.06	4.33	1.30	3.26	1.30
Buckbrush	0.81	0.99	1.31	1.52	0.58	0.00	0.00	0.00
Hackberry	0.00	3.02	6.94	5.51	1.89	1.28	2.25	0.55
Green Rabbitbrush	3.65	4.05	6.12	2.39	1.23	1.42	1.77	2.13
Sticky Rabbitbrush	1.33	1.51	3.05	3.12	0.17	1.51	1.82	1.73
Shrubby Buckwheat	0.00	0.00	0.94	2.38	0.00	0.00	0.00	0.00
Broom Snakeweed	1.02	0.59	0.22	0.07	0.01	0.83	0.42	0.25
Juniper	1.05	0.58	1.36	13.60	4.08	4.65	7.04	6.53
Ponderosa Pine	0.00	0.00	0.16	0.00	1.90	1.05	3.57	4.96
Gamble Oak	1.48	1.99	4.21	2.87	0.43	1.10	2.22	2.86
Skunkbush	0.00	0.00	0.00	0.00	1.96	1.14	2.92	0.56
Wax Current	2.53	3.62	9.81	9.31	0.00	0.40	0.13	0.25
Wild Rose	0.00	0.00	0.00	0.00	4.22	1.10	0.84	2.24
Other Shrubs	3.57	3.84	7.65	10.16	1.30	0.32	1.39	3.54
<b>Total Shrubs</b>	<b>15.83</b>	<b>26.53</b>	<b>57.51</b>	<b>66.03</b>	<b>22.77</b>	<b>12.67</b>	<b>30.02</b>	<b>27.01</b>

## Appendix C

Selection preference by plant species of pronghorn diets from two herds in northern\_Arizona during selected biological periods in 2002.

Legend: S = Selection For, A = Avoidance, N = No Preference, NA = Not Available

Species	Preference Values							
	Anderson Mesa				Garland Prairie			
	Gestation	Parturition	Lactation	Conception	Gestation	Parturition	Lactation	Conception
Grass								
Western Wheatgrass	A	A	A	A	A	A	A	A
Wild Oats	A	A	A	A	A	N	A	A
Blue Grama	N	A	A	A	A	A	A	A
Brome Grass species	NA	NA	NA	NA	A	A	S	N
Red Brome	A	S	S	N	A	A	A	A
Sedge	S	S	S	S	A	A	A	A
Arizona Fescue	S	S	S	S	A	A	A	A
June Grass	A	A	A	A	A	A	A	A
Mountain Muhley	S	S	S	S	A	A	A	A
Kentucky Bluegrass	N	S	S	A	A	A	A	A
Squirrel-tail	A	A	A	A	A	A	A	A
Six-week Fescue	S	S	S	N	S	A	A	A
Forb								
Yarrow	S	S	S	S	S	S	N	A
Wild Onions	NA	NA	NA	NA	N	S	N	N
Arizona Ragweed	S	A	A	A	A	A	A	A
Pussytoe	S	A	A	S	A	A	A	A
Silver sage	N	N	N	A	N	N	N	N
Common Aster	A	A	A	A	A	A	A	S
Wooly Locoweed	A	A	A	A	A	A	S	A
Milkvetch	A	A	A	A	S	S	S	S
Brickellia	S	S	S	S	S	S	S	S
Indian Paintbrush	A	A	A	A	A	N	S	N
Rattlesnake Weed	A	A	A	A	NA	NA	NA	NA
Hairy Gold Aster	A	A	A	S	S	S	S	S
Bull Thistle	S	S	S	N	A	A	A	S
Field Bindweed	A	S	S	S	S	S	S	S
Domestic Corn	NA	NA	NA	NA	S	S	S	A
Golden Tickseed	A	A	A	A	S	A	A	A
Cryptantah	A	A	A	A	S	S	S	S
Prairie Clover	S	S	S	S	S	A	A	S
Dalmation Toadflax	NA	NA	NA	NA	A	S	S	S
Blue Dick	A	A	A	A	A	A	A	A
Fillarie	A	A	A	A	S	S	S	S
Aspen Fleabane	A	A	A	A	N	A	A	N
Common Fleabane	A	A	A	A	A	N	N	A
Red Root Eriogonum	S	A	A	A	N	A	A	A
Scarlet guara	A	A	A	S	N	S	S	S
Geranium	S	S	S	S	S	S	S	S
Sunflower	A	S	S	S	S	S	S	S

Table (Continued)

Species	<u>Preference Values</u>							N
	Anderson Mesa				Garland Prairie			
	Gestation	Parturition	Lactation	Conception	Gestation	Parturition	Lactation	N
Iris	S	A	A	N	A	A	N	A
Machaeranthera	N	A	A	A	N	S	N	A
Burclover	S	S	S	S	S	A	A	A
Penstemon species	S	N	N	S	N	S	S	N
Water Smartweed	NA	NA	NA	NA	S	A	A	S
Wild Potato	A	A	A	A	S	A	A	A
Globe Mallow	A	N	N	A	NA	NA	NA	NA
Dandelion	S	S	S	S	S	S	S	S
Tragopogon	NA	NA	NA	NA	A	A	A	A
Sweet Clover	NA	NA	NA	NA	S	A	A	A
Verbena	S	S	S	S	S	S	S	S
Fleshy Mullen	A	A	A	A	A	A	A	N
Goldeneyes	S	S	S	A	S	S	S	S
Shrub								
Serviceberry	N	S	S	S	S	S	S	S
Blackbrush	S	S	S	S	N	A	A	A
Hackberry	A	S	S	S	S	S	S	S
Green Rabbitbrush	N	N	N	A	A	A	A	A
Sticky Rabbitbrush	S	S	S	S	S	S	S	S
Shrubby Buckwheat	A	A	A	A	A	A	A	A
Broom Snakeweed	A	A	A	A	A	A	A	A
Juniper	N	N	N	S	S	S	S	S
Ponderosa Pine	A	S	S	A	S	S	S	S
Gambel Oak	S	S	S	S	S	S	S	S
Wax Current	S	S	S	S	A	S	S	S
Wild Rose	NA	NA	NA	NA	S	S	S	S