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ABSTRACT -- The pronghorn (*Antilocapra americana*) was reintroduced into Wind Cave National Park (WCNP), South Dakota, in 1914, and thus, has inhabited the Park for nearly a century. During the 1990's, a decline in the population raised concern for the continued existence of pronghorn inside WCNP; an investigation into the observed decline was initiated. Primary objectives of our study were to evaluate diet composition and forage selection by pronghorn in WCNP. Microhistological analysis was conducted on 58 fecal samples collected opportunistically from pronghorn during 2002. Blue grama (*Bouteloua gracilis*), common juniper (*Juniperus communis*), and northern bedstraw (*Galium boreale*) were identified as major seasonal food items, representing 14.6, 10.6, and 6.5 % of the annual diet, respectively. Annual diets of pronghorn in WCNP included 41.5 % grasses, 31.1 % shrubs, and 27.4 % forbs. Total forage production in WCNP was 72 % grass, 4 % shrubs, and 23 % forbs. Results indicated strong dietary selection by pronghorn for shrubs.

Key words: *Antilocapra americana*, diet composition, fecal samples, food habits, pronghorn, South Dakota, Wind Cave National Park.

The pronghorn (*Antilocapra americana*) was reintroduced into Wind Cave National Park (WCNP), South Dakota, in 1914, and thus, has inhabited WCNP for nearly a century. Pronghorn numbers in WCNP exceeded 300 individuals in the

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1960's; however, a population decline during the 1990's raised concern for the continued existence of the species within WCNP. Maintaining a healthy pronghorn population in WCNP is of ecological concern. However, the pronghorn population was estimated at 30 individuals in 2002. Thus, an evaluation of potential factors contributing to the population decline within WCNP was warranted.

Sagebrush (*Artemisia* spp.) has been identified as a major food item in pronghorn diets (Mason 1952, Mitchell and Smoliak 1971, Messenger and Schitoskey 1980). Changes in sagebrush density can affect overall health and survival of pronghorn populations. For example, Bayless (1969) noted that a decrease in quality of sagebrush in pronghorn diets contributed to poor body condition and fawn mortality during winter months in Montana. Long-term pronghorn habitat studies in sagebrush/grassland communities in Montana and shrub steppe communities in Oregon and Nevada classified sagebrush as 'survival forage' because of its high availability and nutritional value (crude protein) to pronghorn during critical winter months (Pyrah 1987, Hansen and Anthony 1999, Hansen et al. 2001). O'Gara and Yoakum (2004) suggested that distribution of sagebrush throughout winter range was essential for achieving long-term carrying capacities and population levels throughout the geographic range of this species. Furthermore, they noted that availability of sagebrush during prolonged winters was likely a primary factor affecting pronghorn survival. There also is evidence to suggest that pronghorn meet daily water requirements through consumption of shrubs such as sagebrush (Beale and Smith 1970).

Another factor that might affect pronghorn population dynamics is resource competition with other species. However, interspecific competition between pronghorn and other ruminants for food resources might not significantly influence pronghorn diet selection. For example, O'Gara and Yoakum (2004) noted that American bison (*Bison bison*) and pronghorn lived commensally before the arrival of European settlers; both ungulates often occurred in mixed herds and shared forage and water resources on vast open plains. Chase (1977) and Danvir (2000) suggested that bison foraging strategies might have benefited pronghorn by grazing abundant grasses, which stimulated growth of low growing forbs and shrubs and increased forage availability to sympatric pronghorn populations. Schwartz and Nagy (1976) documented limited competition for food resources between pronghorn and bison in northwestern Colorado, while Krueger (1986) documented that pronghorn selected forbs in proportion to availability on prairie dog (*Cynomys* spp.) towns and that pronghorn preferentially selected prairie dog towns for foraging in WCNP. Furthermore, pronghorn had no effect on prairie dog responses to pronghorn foraging and associated changes in forage quality throughout prairie dog towns (Krueger 1986). Similarly, McCullough (1980) concluded that interspecific competition for food resources between elk (*Cervus elaphus*), mule deer (*Odocoileus hemionus*), white-tailed deer (*O. virginianus*), and

pronghorn on the National Bison Range in Montana was minimal due to limited spatial overlap between these species throughout most of the year. Nevertheless, sympatric populations of pronghorn, bison, elk, white-tailed deer, mule deer, and black-tailed prairie dog (*Cynomys ludovicianus*) occurred throughout WCNP. Pronghorn throughout WCNP might occupy niches that minimize or reduce interspecific competition for food resources with potential competitors, particularly larger free-ranging ruminants. The relationship between nutritional health of pronghorn and forage availability has been documented previously throughout western states (reviewed by O'Gara and Yoakum 2004). Past investigations indicated that pronghorn production and survival was influenced by quality and quantity of forage consumed by pronghorn (Beale and Smith 1966, Hockley 1968, Ellis 1972, Hervert et al. 2000, Hansen et al. 2001). However, to our knowledge, the only previously documented investigation of pronghorn food habits in WCNP was by Krueger (1986). That study occurred prior to the population decline and examined interspecific relationships among bison, black-tailed prairie dog, and pronghorn. Our objectives were to evaluate diet composition and forage selection by pronghorn in WCNP.

STUDY AREA

Wind Cave National Park encompassed an area of 115 km^2, with an average elevation of 1,257 m above mean sea level, and was situated in Custer County, South Dakota in the southeastern region of the Black Hills. The Black Hills is an isolated mountain range located in southwestern South Dakota and northeastern Wyoming and encompasses approximately 8,400 km^2 (Fecske and Jenks 2002). WCNP was enclosed by a 2.5-m woven-wire fence, with cattle guards present at all road entrances to prevent movement by ungulates out of WCNP. Wind Cave National Park was characterized by a mosaic of mixed-grass prairie interspersed with a ponderosa pine (*Pinus ponderosa*) dominated forest. Plant species occurring in the mixed grass prairie within WCNP included Kentucky bluegrass (*Poa pratensis*), blue grama (*Bouteloua gracilis*), western wheatgrass (*Pascopyrum smithii*), western snowberry (*Symphoricarpos occidentalis*), common juniper (*Juniperus communis*), and northern bedstraw (*Galium boreale*). Plant nomenclature followed Larson and Johnson (1999) and Johnson and Larson (1999).

METHODS

Fecal samples were collected from January to December 2002 to examine food habits of pronghorn in WCNP. Pellets from fresh defecations were collected opportunistically each month during the study period where pronghorn groups

were visually observed. Microhistological fecal analysis was performed on samples to determine coverage within each sample. Preparation of plant pigments for quantification and classification of pronghorn diets followed procedures described by Davitt and Nelson (1980). Fecal samples were dried at 60° C for 48 hours, blended, and washed. Samples were placed in a 95 % ethyl-alcohol solution for 7 days to extract plant pigments and rinsed in a 40 % bleach solution. Extracted plant pigments were stored in a staining solution containing a lactophenol blue agent for 7 to 10 days. Slides of plant pigments were prepared and examined by using 100 fields of view (25 fields of view per slide) to measure area of the fragments contained within each sample (Stewart 1967). Percent coverage of each species or forage class was determined by summing the area occupied by each species and dividing by the total area contained within slides. Confidence intervals (95 %) were constructed for mean values of percent coverage for each forage class.

Total forage production (forage availability) in WCNP was estimated by using a double-sampling method developed and described by the National Resources Conservation Service (National Range and Pasture Handbook 1997). Due to extreme drought conditions throughout WCNP during 2000 to 2004, we assumed that changes in rangeland composition during our study (2002) and in 2004 were minimal. We also assumed that total forage production during our study and data obtained during 2004 were similar. Thus, 2004 forage availability data were used to describe availability of forage during our study. Forage use by pronghorn was compared to forage availability by evaluating overlap in confidence intervals.

RESULTS

Fifty-eight fecal samples were collected between 26 January and 5 December 2002. Eleven species of grasses, 13 species of shrubs, and 3 species of forbs were identified in fecal samples. Pronghorn diets contained 25 plant species in winter and 20 species in summer (Table 1). Sagebrush species, including big sagebrush (*Artemisia tridentata*), fringed sagewort (*A. frigida*), and silver sage (*A. cana*) comprised approximately 4.5 % of the annual diet (Table 1). Blue grama, common juniper, and northern bedstraw comprised 31.7 % of the annual diet (Table 1). Consumption of forbs ranged from 5 to 45 % and was greater than 40 % in June, August, and September (Fig. 1). Shrub consumption ranged from 17 to 49 % and was greater than 40 % in January, February, and December (Fig. 1). Grasses comprised greater than or equal to 39 % of food items during summer and winter months (Fig. 2). Grasses, shrubs, and forbs comprised 41 % (± 1.8, 95 % CI, SE = 0.9), 30 % (± 2.5, 95 % CI, SE = 1.3), and 27 % (± 2.8, 95 % CI, SE = 1.4), respectively, of annual diets during 2002 (Fig. 3). Field data collected during 2004 indicated that

Table 1. Percent composition of pronghorn diets in Wind Cave National Park, South Dakota, 2002.

Species	% Diet		
	Overall	Winter[a]	Summer[b]
Crested wheatgrass (*Agropyron cristatum*)	1.5	tr[c]	2.2
Redtop (*Agrostis stolonifera*)	1.1	1.2	1.0
Sideoats grama (*Bouteloua curtipendula*)	tr	tr	0.0
Blue grama (*Bouteloua gracilis*)	14.6	16.0	13.3
Smooth brome (*Bromus inermis*)	1.7	1.7	1.7
Sedge (*Carex* spp.)	tr	tr	tr
Foxtail barley (*Hordeum jubatum*)	tr	0.0	tr
Indian ricegrass (*Oryzopsis hymenoides*)	4.3	5.1	3.6
Western wheatgrass (*Pascopyrum smithii*)	tr	tr	tr
Needleandthread (*Hesperostipa comata*)	4.8	3.9	5.7
Green needlegrass (*Nassella viridula*)	tr	tr	0.0
Unknown spp.	12.0	13.8	10.5
Total grasses	41.5	43.6	39.6
Serviceberry (*Amelanchier* spp.)	tr	tr	0.0
Silver sagebrush (*Artemisia cana*)	1.4	1.6	1.2
Fringed sagewort (*Artemisia frigida*)	2.0	3.1	1.0
Big sagebrush (*Artemisia tridentata*)	tr	tr	1.2
Bearberry (*Arctostaphylos uva-ursi*)	tr	tr	tr
Mountain mahogany (*Cercocarpus montanus*)	tr	tr	0.0
Ponderosa pine (*Pinus ponderosa*)	2.0	2.3	1.7
Wild plum, sand cherry, pin cherry chokecherry (*Prunus* spp.)	1.3	1.1	1.4
Currant (*Ribes* spp.)	2.8	1.5	3.8

Table 1, continued.

Species	% Diet		
	Overall	Winter[a]	Summer[b]
Wild rose (*Rosa* spp.)	3.6	4.2	3.0
Buffaloberry (*Shepherdia* spp.)	tr	tr	0.0
Western snowberry (*Symphoricarpos occidentalis*)	3.4	4.5	2.5
Unknown spp.	2.6	2.8	2.4
Total shrubs	31.1	33.4	29.1
Sageworts (*Artemisia* spp.)	tr	0.0	tr
Aster (*Aster* spp.)	1.9	1.4	2.3
Northern bedstraw (*Galium boreale*)	6.5	6.9	6.2
Unknown spp.	18.6	14.6	22.1
Total forbs	27.4	23.0	31.3

[a]Winter = October - March
[b]Summer = April - September
[c]tr = trace (< 1% of diet)

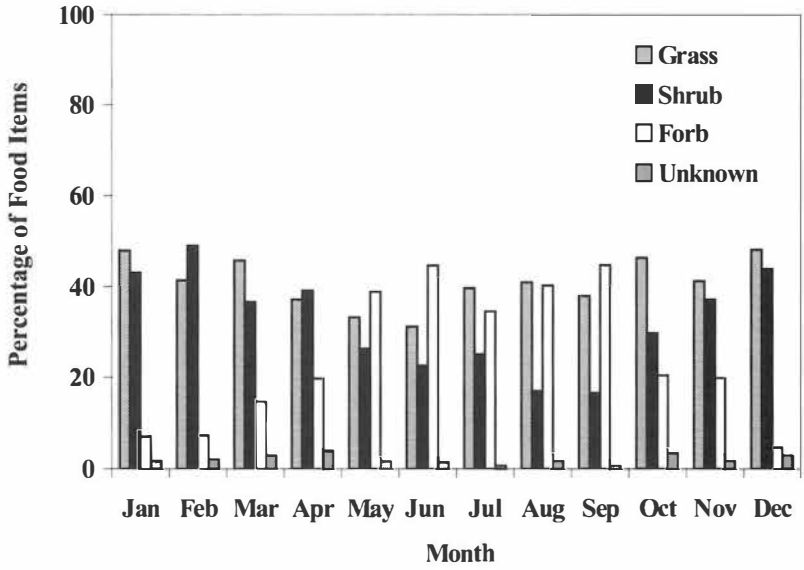

Figure 1. Diet composition of pronghorns (n = 58) by month in Wind Cave National Park, South Dakota, 2002.

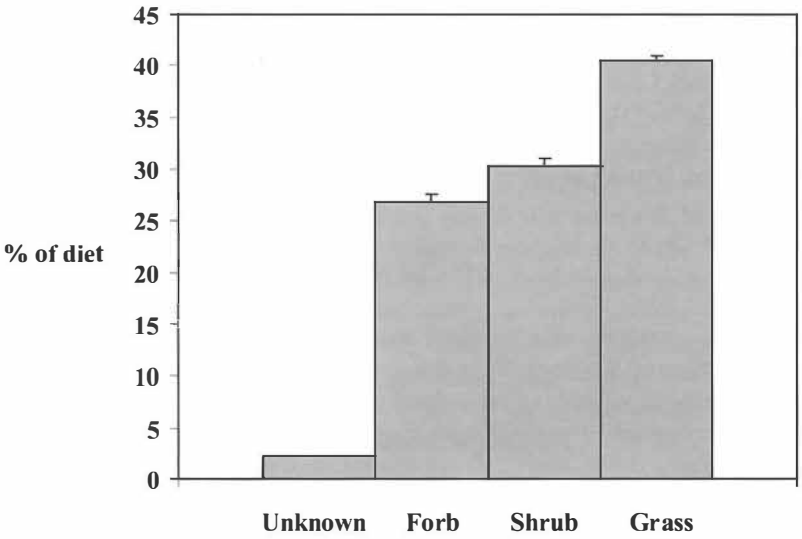

Figure 2. Diet composition of pronghorns (n = 58) in Wind Cave National Park, South Dakota, 2002.

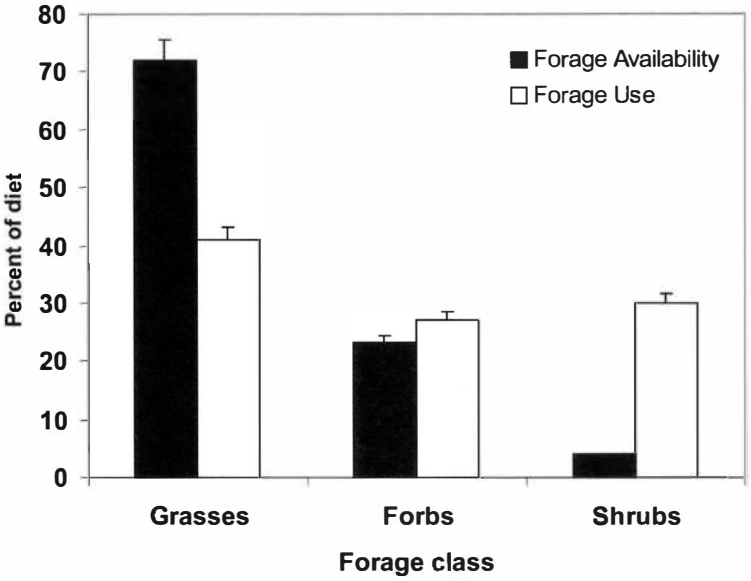

Figure 3. Availability and utilization of forage classes by pronghorns (n = 58) in Wind Cave National Park, South Dakota, 2002.

72 % (± 3.7, 95 % CI, SE = 1.9) of total forage production consisted of grasses, 4 % (± 0.2, 95 % CI, SE = 0.1) shrubs, and 23 % (± 1.2, 95 % CI, SE = 0.6) forbs (Fig. 3). Comparison of use and availability data suggested that pronghorn in WCNP avoided grasses, weakly selected forbs, and strongly selected shrubs.

DISCUSSION

Foraging strategies of pronghorn are selective compared to larger North American herbivores, however, little is known about food selection by pronghorn in habitats similar to WCNP (i.e., grassland-dominated habitats), where distribution of sagebrush is limited. The three most consumed plants by pronghorns in WCNP represented grass, shrub, and forb categories, respectively. Blue grama was observed in pronghorn diets in high quantities throughout the year. Common juniper was a major winter forage item while northern bedstraw was a major summer forage item. Pronghorn frequently consumed shrubs during winter months, but used forbs during summer months. Seasonal shifts in dietary content likely were influenced by increased availability of forbs during the growing season. High

digestibility of forbs likely benefited adult females that relied on energy reserves during lactation. Shrub species, including common juniper, were used by pronghorn during winter months, when forbs were less abundant.

Percentage of grasses, shrubs, and forbs in annual diets of pronghorn in WCNP differed from that of other pronghorn populations across western North America. Diet composition of pronghorn in western South Dakota (Messenger and Schitoskey 1980), north-central New Mexico (Stephenson et al. 1985), and Saskatchewan, Canada (Dirschl 1963) contained less than 17 % grasses and greater than 45 % shrubs annually. Knick et al. (2003) noted that although geographic distribution of sagebrush in South Dakota was limited, pronghorn consumed large amounts of sagebrush during all seasons. Messenger and Schitoskey (1980) also found that sagebrush species, including big sagebrush, fringed sagewort, white sage (*A. ludoviciana*), and silver sage, represented greater than 5 % of pronghorn diets during every month of the year in northwestern South Dakota. Yoakum (1990) found that pronghorn consumed sagebrush during all seasons, but most often during autumn and winter because of increased availability and high protein content relative to grasses and forbs. Furthermore, he noted that sagebrush also influenced pronghorn survival on snow covered and drought-stricken rangelands where grasses and forbs were scarce. These studies confirmed the need for sagebrush for overall health and survival of pronghorn. However, only 4 % of total forage production (by weight) in WCNP consisted of shrubs, of which less than 1 % consisted of sagebrush (M. M. Curtin, Wind Cave National Park, Hot Springs, South Dakota, unpublished data). In addition, pronghorn diets contained less than 5 % big sagebrush, fringed sagewort, and silver sage during winter and summer months (Table 1). Thus, our results indicated that distribution and availability of shrubs, particularly sagebrush, to pronghorn throughout WCNP was limited.

The role of grasses in pronghorn diets has been documented poorly in the literature. Yoakum and O'Gara (2000) found that pronghorn grazed grasses heavily during spring and fall "green-up" when new growth was nutritious, however, total use of grasses in annual diets was 10 % throughout all pronghorn habitats. Yoakum (1990) reported that graminoids represented a minor portion of pronghorn annual diets in all biomes throughout western states and that total grass consumption averaged no more than 15 % of annual use throughout North America. However, grasses occurred most frequently in annual and seasonal pronghorn diets during our study. High consumption of grass by pronghorn in WCNP indicated that availability of preferred food items was limited in distribution throughout the year.

Seasonal variation in forage consumption by pronghorn previously has been documented in the literature. Yoakum (1990) suggested that forage preference by pronghorn consisted of a diversity of forb species and that consumption of forbs substantially exceeded consumption of grasses and shrubs in all biomes and for all seasons across western rangelands. Furthermore, he noted that some rangelands contained more than 150 forb species, of which 80 to 90 were consumed by pronghorn.

During our study, pronghorn consumed only three species of forbs and percentage of forbs consumed was less than 32 % during summer months, when forbs would likely be more readily available. Because WCNP was enclosed by a woven-wire fence with cattle guards present at all road entrances to prevent movement by ungulates out of WCNP, pronghorn were dependent on optimal forage within WCNP for survival. However, our data indicated that pronghorn consumed low amounts of optimal forage (e.g., digestible forbs and shrubs) throughout the year, suggesting that habitat quality was a factor that contributed, in part, to the pronghorn population decline in WCNP.

Long-term drought conditions during our study possibly reduced production of optimal forage and consequently, habitat quality. However, influence of drought on forage selection by pronghorn and the observed population decline in WCNP remains uncertain. Nevertheless, we hypothesize that the population decline was associated with reduced distribution and diversity of optimal forage (i.e., habitat quality) and that reduced habitat quality was influenced by long-term drought conditions throughout western South Dakota. Direct measurements of quality of forage consumed by pronghorn within WCNP were not obtained during our study. The population decline in WCNP increases the need for better information on quality of forage consumed both seasonally and annually by pronghorn throughout WCNP. Future investigations should further quantify forage availability and assess quality of forage consumed by pronghorn during years of normal precipitation. This information would enable managers to compare forage quality and quantity during drought conditions and years of normal precipitation, and effects of temporal changes in habitat quality on pronghorn productivity. Future research also should investigate relationships among availability and distribution of sagebrush and spatial distribution of pronghorns throughout WCNP.

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