Seasonal use of agricultural lands by mule deer, white-tailed deer, and pronghorn antelope in Carter County, Montana
by Jamie Paul Selting

A thesis submitted in partial fulfillment of the requirements of the degree Masters of Science
Montana State University
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Abstract:
Mule deer (Odocoileus hemionus), white-tailed deer (Odocoileus virginianus), and pronghorn antelope (Antilocapra americana) that graze on agricultural lands can create conflicts. Forage consumed by deer arid antelope is often considered profit foregone. I observed 6 agricultural land use categories on 2 study areas in Carter County Montana to identify seasonal land use patterns of wild ungulates. A second objective was to identify potential conflicts created by wild ungulate use of local agricultural crops. Alfalfa, bottom rangeland, CRP (Conservation Reserve Program) lands, upland rangeland, wheat stubble, and growing wheat were observed during day and night hours for a period of 12 months. Mule deer densities on alfalfa peaked in fall and again in spring. CRP was selected in all seasons. Rangelands were most important in winter and summer. Whitetailed deer selected CRP lands in all seasons except fall. Alfalfa was selected in fall, spring, and summer. Antelope densities on alfalfa were highest in spring and fall, while growing wheat fields were used most in spring. Antelope in the northern study area selected CRP land in all seasons except fall. There were many significant correlations between wild ungulates and individual landscape variables, but I was unable to develop a multivariate model that explained a significant amount of the variation in numbers of wild ungulates occurring on individual sites. The agricultural crops that were potentially affected by wild ungulates were alfalfa and wheat. Estimated alfalfa consumption was highest for mule deer in August. Estimated alfalfa consumption by antelope peaked in May. The highest estimated alfalfa consumption was for white-tailed deer in April. Antelope densities peaked on growing wheat fields in April, but antelope abandoned wheat fields before yield reduction was likely.

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by

Jamie Paul Selting

A thesis submitted in partial fulfillment

of the requirements of the degree

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Bozeman, Montana

1994

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APPROVAL

of a thesis submitted by

Jamie Paul Selting

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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of
Master of Science
in
Fish and Wildlife Management

MONTANA STATE UNIVERSITY
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ABSTRACT

Mule deer (Odocoileus hemionus), white-tailed deer (Odocoileus virginianus), and pronghorn antelope (Antilocapra americana) that graze on agricultural lands can create conflicts. Forage consumed by deer and antelope is often considered profit foregone. I observed 6 agricultural land use categories on 2 study areas in Carter County Montana to identify seasonal land use patterns of wild ungulates. A second objective was to identify potential conflicts created by wild ungulate use of local agricultural crops. Alfalfa, bottom rangeland, CRP (Conservation Reserve Program) lands, upland rangeland, wheat stubble, and growing wheat were observed during day and night hours for a period of 12 months. Mule deer densities on alfalfa peaked in fall and again in spring. CRP was selected in all seasons. Rangelands were most important in winter and summer. White-tailed deer selected CRP lands in all seasons except fall. Alfalfa was selected in fall, spring, and summer. Antelope densities on alfalfa were highest in spring and fall, while growing wheat fields were used most in spring. Antelope in the northern study area selected CRP land in all seasons except fall. There were many significant correlations between wild ungulates and individual landscape variables, but I was unable to develop a multivariate model that explained a significant amount of the variation in numbers of wild ungulates occurring on individual sites. The agricultural crops that were potentially affected by wild ungulates were alfalfa and wheat. Estimated alfalfa consumption was highest for mule deer in August. Estimated alfalfa consumption by antelope peaked in May. The highest estimated alfalfa consumption was for white-tailed deer in April. Antelope densities peaked on growing wheat fields in April, but antelope abandoned wheat fields before yield reduction was likely.

INTRODUCTION

The drought of the 1930's marked a low for wildlife and agriculture on the Great Plains (Severson 1981). Since then, agricultural practices and wildlife management have changed, resulting in marked increases in agricultural productivity and wild ungulate populations in agricultural areas. Increased wildlife populations and demands for greater efficiency in agricultural production have produced conflicts. Today, damage by wildlife to crops is perceived as a widespread problem in the United States (Conover and Decker 1991). Perceptions of wildlife damage vary between individuals and can be influenced by geographic region (Conover 1994), agricultural economic conditions, wildlife population levels, and weather (Adkins 1992).

This project was initiated to provide quantitative information on wild ungulate use of agricultural lands in southeastern Montana. When Carter and Fallon County ranchers realized that their area was importing unusually large amounts of forage, they identified low local forage production as a potential cause (E. Williams, pers. commun.). Wild herbivores were identified as potential forage consumers. A local committee of ranchers proposed to study mule deer, white-tailed deer, and pronghorn antelope use of agricultural lands to determine if they could be

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In summer 1992, I initiated a study to identify annual land use patterns of wild ungulates and determine land characteristics that influenced wild ungulate abundance. Most recent studies in the area (Olenicki 1993, Griffiths 1990, Dusek 1987) focused mainly on ecology of wild ungulates with agricultural impacts of these species addressed as a secondary objective. Those studies emphasized individual animal movements using radio telemetry. I concentrated on animal use of specific sites through time.

My primary objectives were to identify wild ungulate land use patterns and to determine land characteristics that influence the abundance of wild ungulates. A secondary objective was to identify potential conflicts created by wild ungulate use of local agricultural crops.

DESCRIPTION OF STUDY AREAS

Two study areas approximately 50 km apart were used. Habitat types and topography were distinct for each area.

Ekalaka Area

The Ekalaka study area was in northern Carter county, Montana (Figure 1). The closest community was Ekalaka. Observation sites (areas observed in wild ungulate surveys) encompassed a land area of 1,213 ha located adjacent to the Plevna, Mill Iron, Prairiedale, Pershing, and Powderville county roads. Generally, these roads encircle the Ekalaka Hills division of Custer National Forest at distances of 0.5 km to 6.4 km from the forest. Forest areas were not sampled. Little Beaver Creek and Boxelder Creek angle northeasterly through the county.

The Ekalaka area is characterized by relatively resistant, forested, sandstone formations of the Ekalaka Hills, Chalk Buttes, and Long Pine Hills. Forested lands were limited to those hill formations and were composed primarily of ponderosa pine (Pinus ponderosa) communities with infrequent quaking aspen (Populus tremuloides) inclusions. Draws with hardwood/shrub communities frequently extended beyond the forested areas. Important tree and shrub species in these areas were green ash (Fraxinus

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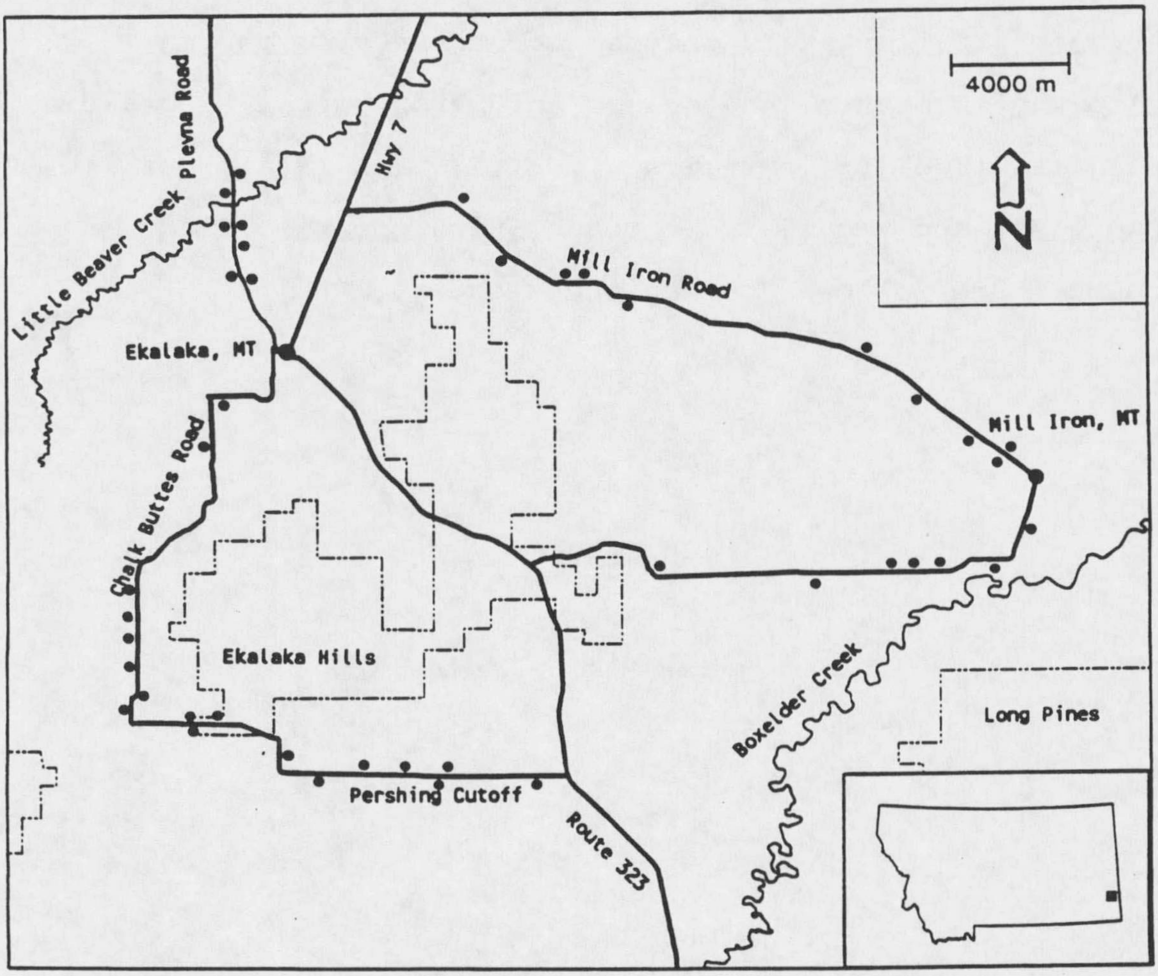

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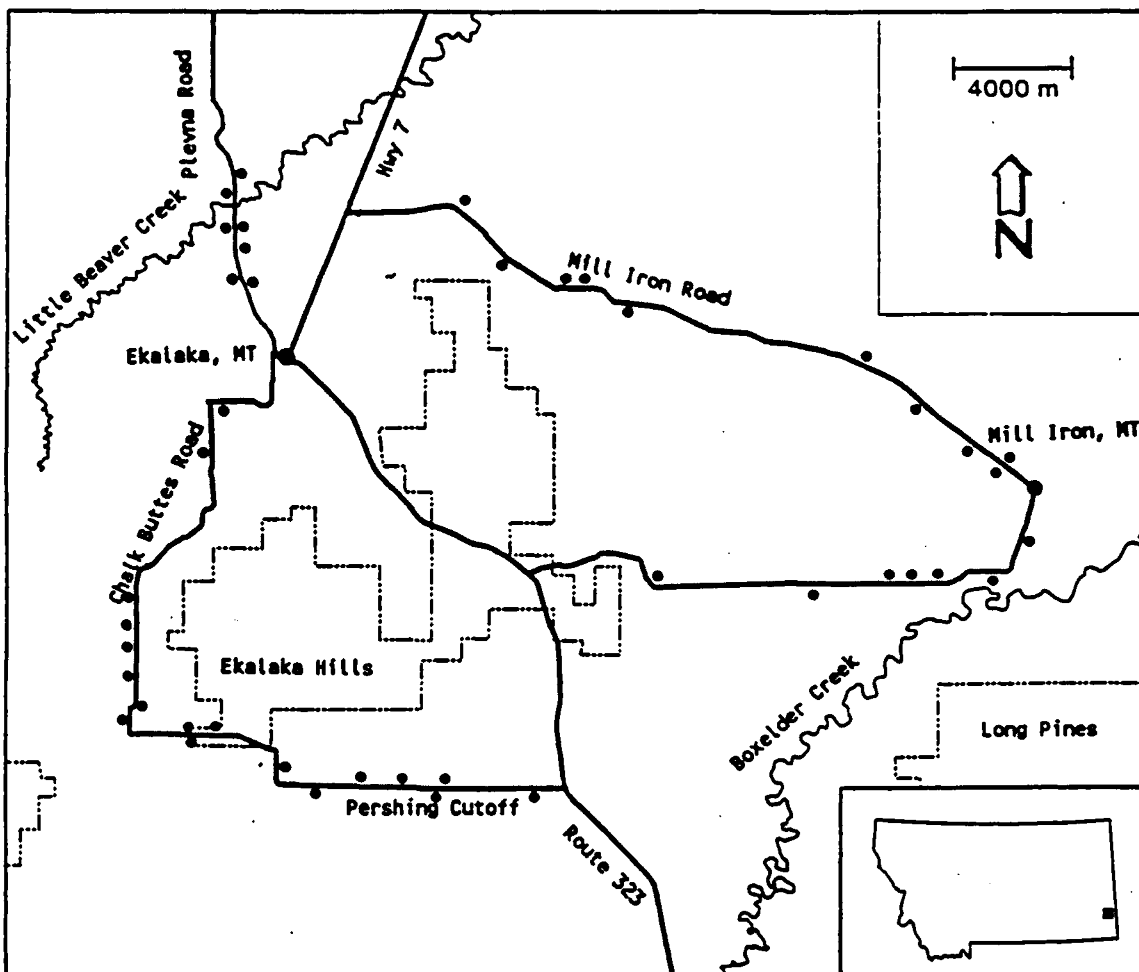
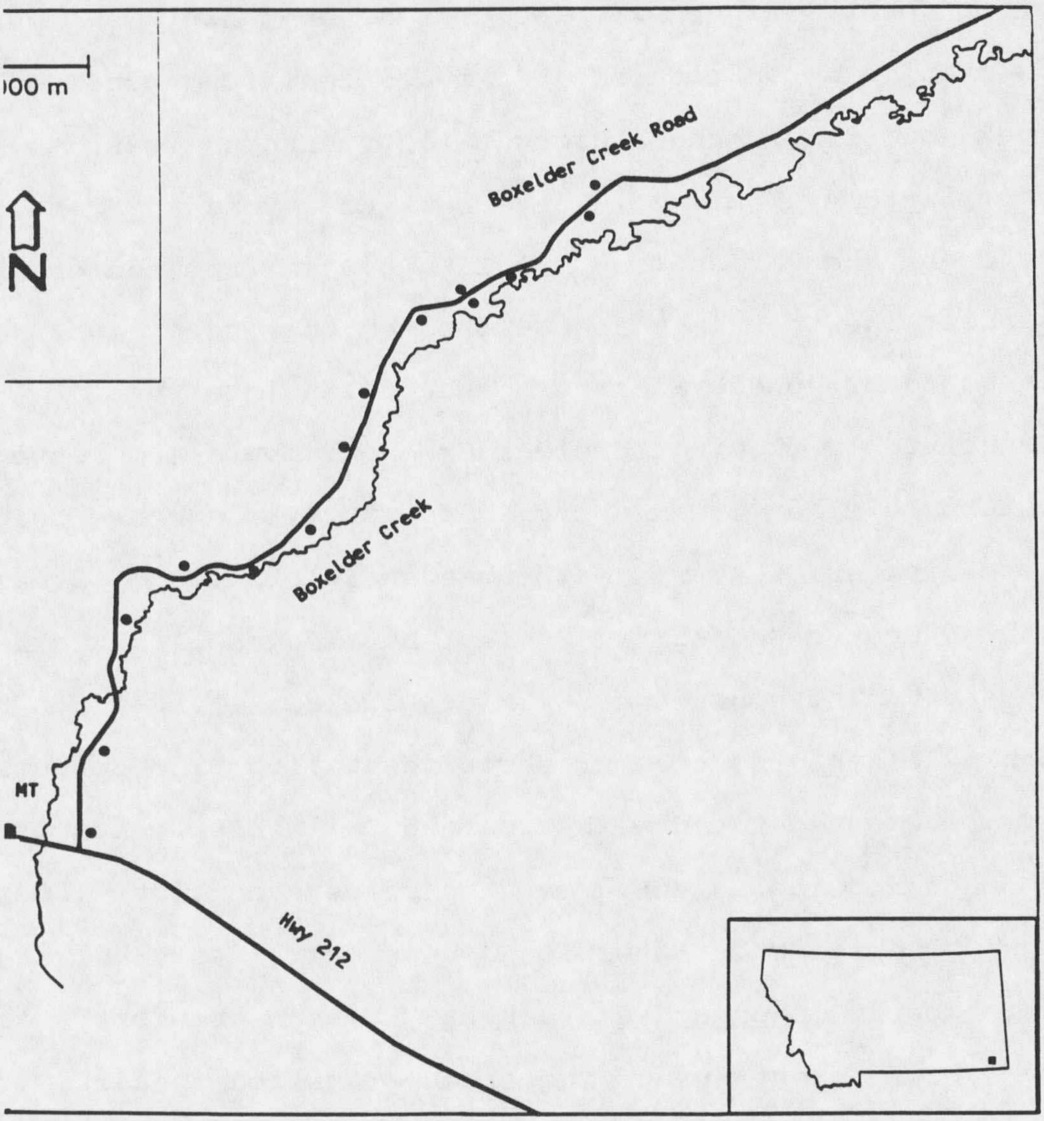


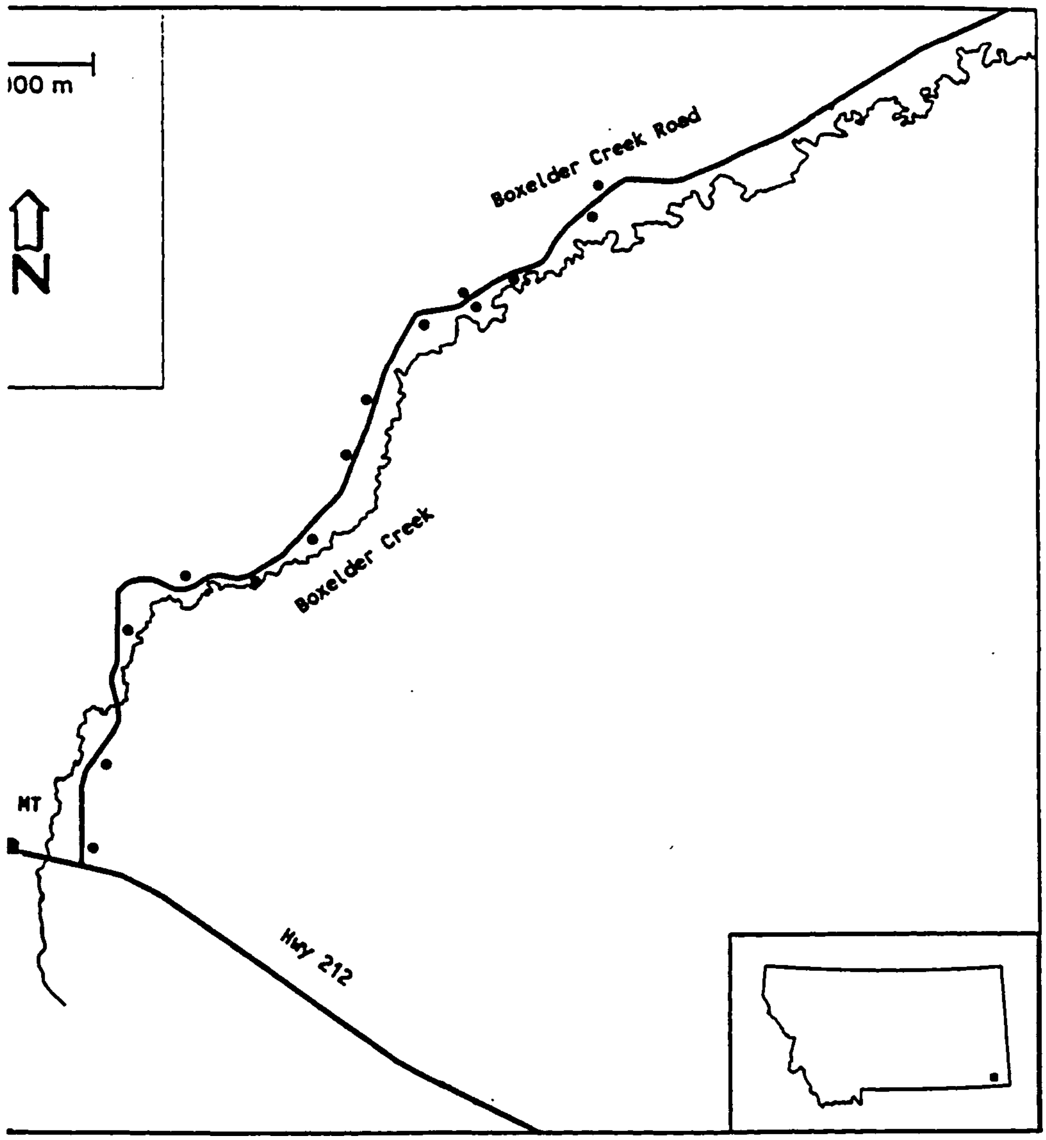
Figure 1. Map of the Ekalaka study area showing observation sites, main roads, creeks, and forest boundaries.

Boxelder Study Area

The Boxelder study area was in the southwest corner of Carter County (Figure 2). The closest community was Hammond. Observation sites totaled 462 ha located along Boxelder Creek Road from Montana Highway 212, north and east approximately 21 km. Boxelder Creek Road runs adjacent to the creek and varies from 0.001 to 0.8 km from the creek channel. The area is characterized by rolling plains dissected by ephemeral creeks that drain into the northeasterly flowing Boxelder Creek. Tributaries converge to form Boxelder Creek approximately 2.4 km south of Highway 212. Boxelder Creek was mapped as an intermittent stream (United States Geological Survey) but flowed all months of the study. The upstream 9.5 km of Boxelder Creek north of Highway 212 had no tree or shrub vegetation. The downstream 10.5 km was vegetated with tree and tall shrub communities. Dominant species in the area sampled were boxelder (Acer negundo), plains cottonwood (Populus deltoides), silver buffaloberry (Shepherdia argentea), common snowberry, green ash, and fragrant sumac. Sagebrush-grassland species were similar to the Ekalaka area but with increased presence of greasewood (Sarcobatus vermiculatus) in the bottomlands. Resistant sandstone forms buttes and outcroppings throughout the area.



2. Map of the Boxelder study area showing observation sites, main roads, and Boxelder Creek.



2. Map of the Boxelder study area showing observation sites, main roads, and Boxelder Creek.

Land Use

The first cattle were trailed into the area in 1882 and released near Boxelder Creek. Prior to 1900, nearly all land was used for livestock grazing. Most homesteading occurred from 1900 to 1914, when the first dryland farming operations started (Carter County Conservation District 1976). Sheep, cattle, and small grains were the major land enterprises at the time of my study. Land use in the county was approximately 90% rangeland, 1.7% crops, 1.9% CRP, 4.2% forest, and 2.2% other uses. Major agricultural crops, in order of abundance, were winter wheat (including fallow), alfalfa, barley, oats, millet, rye, and safflower. Sixty-five percent of the land is deeded, 7% is state land, and the remainder is federally owned. (U. S. Dep. Agric., Agricultural Stabilization and Conservation Service, unpubl. data). Small scale logging occurred in the Ekalaka Hills and Long Pine Hills areas during the study.

Climate

The climate of southeastern Montana is continental and semi-arid. Average annual precipitation is 39.2 cm in the Ekalaka area and 32.9 cm in the Boxelder area (NOAA 1993). Seventy-five percent of the precipitation occurs as rain during the agricultural growing season, April 1 to September 30 (Carter County Conservation District 1976). I used weather information from the Ekalaka station for the Ekalaka area and the Ridgeway station for the Boxelder study area. Since a dry period in 1988, the general precipitation trend has been upward (Figure 3). Precipitation for September 1992 to August 1993 was above normal for both study areas with significantly higher rainfall occurring in June and July (NOAA 1993) (Figures 4 and 5). Long term average temperature is 20°C for July and 7°C for January. The frost free period is from 110 to 130 days (Soil Conservation Service 1992).

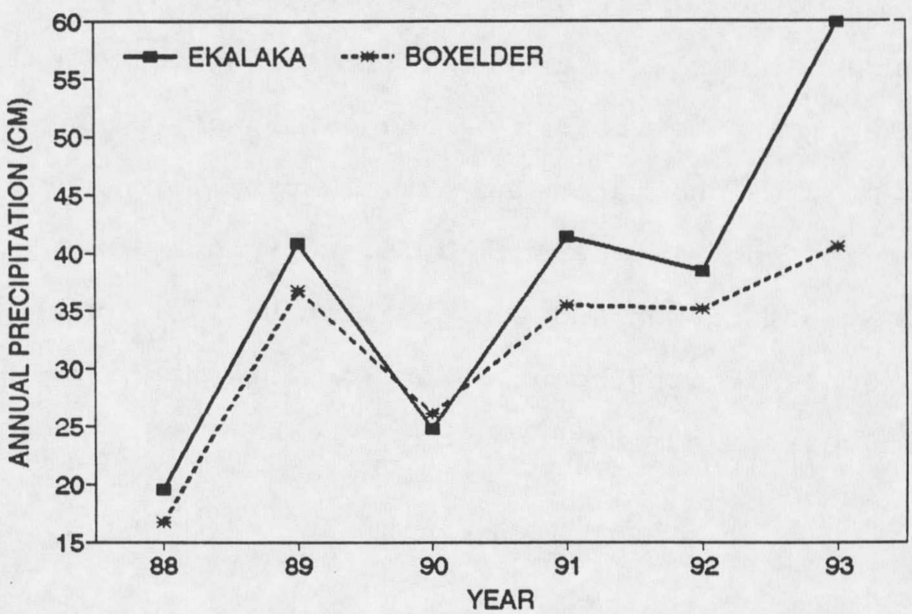


Figure 3. Annual precipitation trend in the Ekalaka and Boxelder study areas, 1988-1993.

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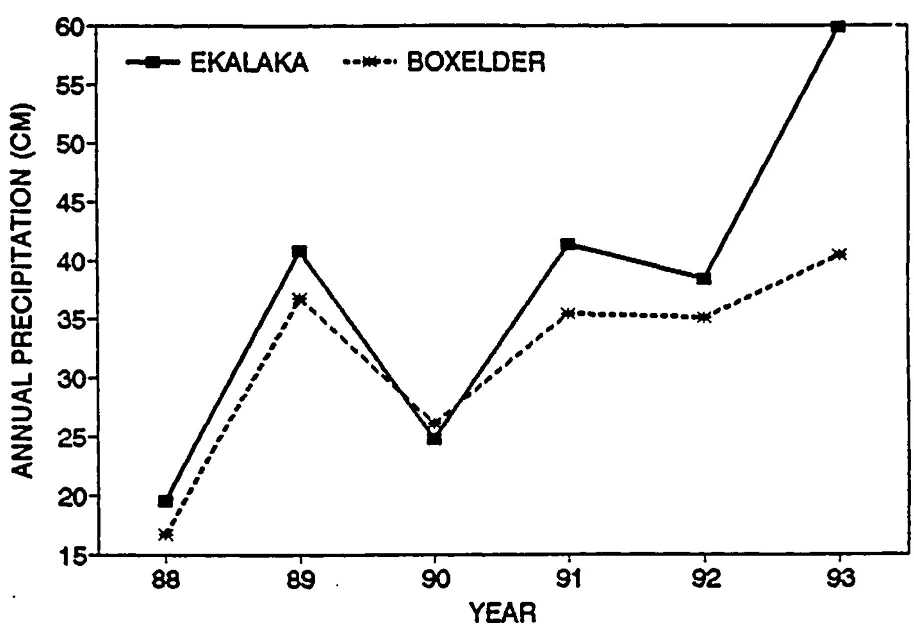

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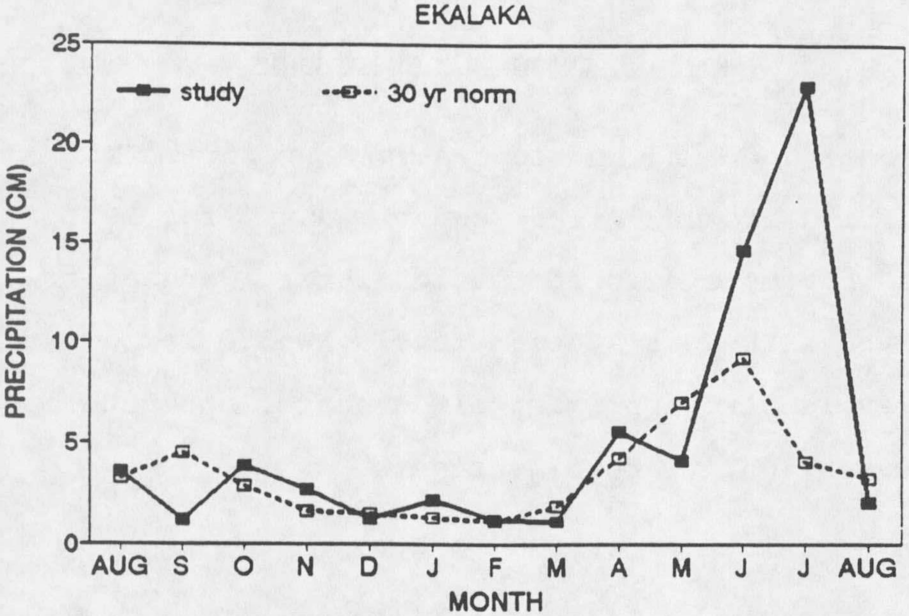

Figure 4. Monthly precipitation in the Ekalaka study area from August, 1992 to August, 1993.

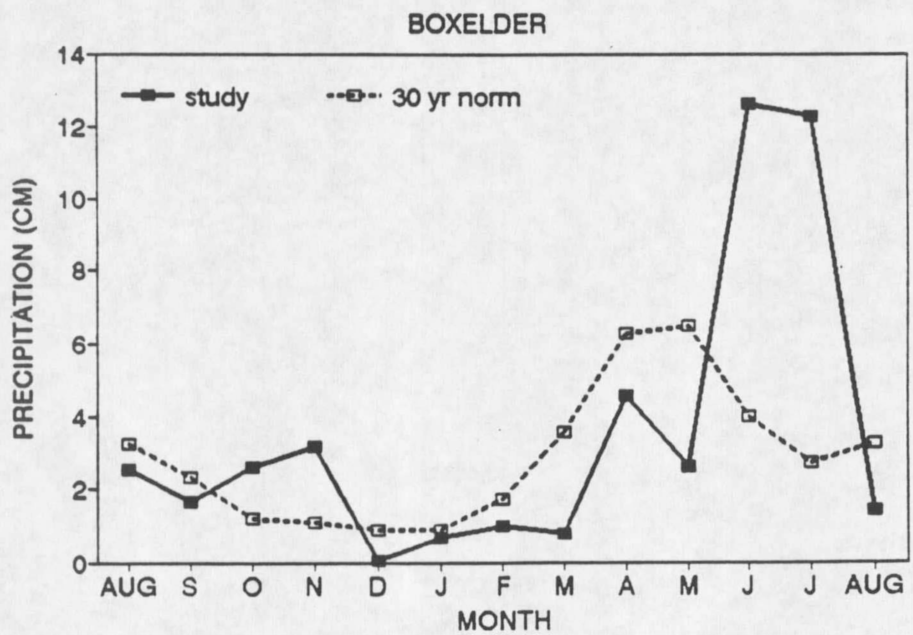

Figure 5. Monthly precipitation in the Boxelder study area from August, 1992 to August, 1993.

Wild Ungulate Populations

Region 7 deer and antelope harvest reports (Montana Dep. Fish Wildlife and Parks, unpubl. data) for 1992 suggested that mule deer population levels were at or slightly above 30-year average levels. White-tailed deer harvest levels were approximately average, and antelope harvest was slightly above average.

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METHODS

Ungulate Count Procedure

From September 1992 to August 1993, deer and antelope counts were conducted on 56 sites located within 6 major land use categories. These were alfalfa, bottom rangeland, Conservation Reserve Program lands (CRP), upland rangeland, wheat stubble, and growing wheat (Table 1). Approximately 10 observation sites were chosen in each land use category. Observation sites within categories were either whole fields, parts of fields, or pastures located adjacent to county roads that served as travel routes through each study area. Individual observation sites were selected based on landowner approval, ease of observation, and proximity to county roads. Location of sites adjacent to county roads allowed year-long travel, reduced interference with ranch operations, and allowed rapid observation of several sites within a given time period. Travel routes were designed so the direction of travel could be alternated.

At each observation site, presence of livestock, number and species of deer, and number of antelope were recorded (1 deer or 1 antelope = 1 observation). Activity and age (when possible) were also recorded. Extensive age and sex classification efforts were not possible due to time constraints set by the number of sites to be checked in each time period.

Table 1. Land use categories used in wild ungulate surveys.

Alfalfa	Fields with a grass-alfalfa mix containing at least 20% alfalfa canopy coverage prior to first harvest. Harvested for livestock feed (not seed production).
Bottom Rangeland	Native or reseeded rangeland used for livestock grazing in any season. Located in the lowest elevation in relation to surrounding topography. Usually adjacent to perennial or intermittent creeks.
CRP	Lands enrolled in the Conservation Reserve Program. Seedings older than three years containing an average mix of alfalfa (0.45 kg pls (pure live seeds)) and crested wheatgrass (1.8 kg pls). Pubescent and intermediate wheatgrass were often substituted and yellow sweetclover was included occasionally.
Upland Rangeland	Native or reseeded rangeland used principally for livestock grazing in any season. Low relief sites located in high elevations in relation to surrounding topography. Usually elevated 2 or more terrace levels above bottom rangeland sites.
Wheat stubble	Winter wheat that was seeded in the fall of 1991 and harvested in the early fall of 1992. Plants were mature when the study was initiated.
Growing wheat	Winter wheat that was seeded in the fall of 1992 to be harvested in the early fall of 1993. Winter wheat that was planted and matured during the study period.

Wild ungulate counts were conducted on each observation site at 4 time periods: dawn, day, dusk, and night. Dawn counts were from 1/2 hour before to 1/2 hour after sunrise.

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Table 1. Land use categories used in wild ungulate surveys.

Alfalfa	Fields with a grass-alfalfa mix containing at least 20% alfalfa canopy coverage prior to first harvest. Harvested for livestock feed (not seed production).
Bottom Rangeland	Native or reseeded rangeland used for livestock grazing in any season. Located in the lowest elevation in relation to surrounding topography. Usually adjacent to perennial or intermittent creeks.
CRP	Lands enrolled in the Conservation Reserve Program. Seedings older than three years containing an average mix of alfalfa (0.45 kg pls (pure live seeds)) and crested wheatgrass (1.8 kg pls). Pubescent and intermediate wheatgrass were often substituted and yellow sweetclover was included occasionally.
Upland Rangeland	Native or reseeded rangeland used principally for livestock grazing in any season. Low relief sites located in high elevations in relation to surrounding topography. Usually elevated 2 or more terrace levels above bottom rangeland sites.
Wheat stubble	Winter wheat that was seeded in the fall of 1991 and harvested in the early fall of 1992. Plants were mature when the study was initiated.
Growing wheat	Winter wheat that was seeded in the fall of 1992 to be harvested in the early fall of 1993. Winter wheat that was planted and matured during the study period.

Wild ungulate counts were conducted on each observation site at 4 time periods: dawn, day, dusk, and night. Dawn counts were from 1/2 hour before to 1/2 hour after sunrise.

Daytime ranged from 2 hours after sunrise to 2 hours before sunset. Dusk observations were between 15 minutes before sundown to 45 minutes after sundown. Night observations were made from 1 hour after sundown until the observation route was complete. Observations were not conducted when fog, snow, or rain impaired visibility. Binoculars (9x36) were employed to verify species sighted at dawn, day, and dusk. Night observations were aided by a 1.5 million candle power spotlight and binoculars.

To assess observation efficiency, I walked through a set of observation sites after making counts from the road. Another observer watched for animals that flushed. CRP lands were walked in winter and summer. Alfalfa, bottom rangeland, and upland rangeland were walked in summer.

Seasons were defined as fall (September - November), winter (December - February), spring (March - May), and summer (June - August). Counts were conducted 10 times per season at each time period giving 40 counts at each observation site per season.

To compensate for unequal observation site sizes, an average ungulate density was determined for each land use category in each month. Monthly data were combined to form seasonal estimates.

Wild Ungulate Use Patterns on Agricultural Lands

For each season, the total number of deer and antelope observed in each land use category were analyzed to determine if use of each land category was proportional to its availability. A technique developed by Neu et al. (1974) and the HABUSE computer program (Wood, unpublished) were used to determine if wild ungulates used agricultural lands in greater, less, or equal proportion to availability. The results are reported as use less than (-), greater than (+), or equal to (=) availability among all land use categories examined.

Wild Ungulate Associations with Agricultural Crop Production Capability

I used Soil Conservation Service (1992) land capability class (LCC) ratings to determine if wild ungulates were using lands in relation to their agricultural crop production capability. These ratings indicate limitations to crop production and are a general indicator of fertility (W. Yost, pers. commun.). On a scale from 1 to 8, smaller values indicate soils with the fewest limitations to agricultural crop production, and large values indicate the opposite. Dominant soil type at each observation site was determined from soils maps. The land capability rating associated with the dominant soil type was then assigned to each observation site. The HABUSE program was used to determine if wild ungulates used land capability classes in greater, less, or equal proportion to availability. Land capability classes observed in each land use category were analyzed to determine if use of each land category was proportional to its availability. A technique developed by Neu et al. (1974) and the HABUSE computer program (Wood, unpublished) were used to determine if wild ungulates used agricultural lands in greater, less, or equal proportion to availability. The results are reported as use less than (-), greater than (+), or equal to (=) availability among all land use categories examined.

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Wild Ungulate Associations with Landscape Variables

For all observation sites, distance to the nearest agricultural crop (alfalfa, CRP, and wheat) was measured from topographic maps. Slope and the distance from each observation site to the nearest perennial creek, intermittent creek, hiding cover, forest, and occupied homestead were also measured. Data from both study areas were combined to test for associations between landscape variables and deer and antelope abundance. Seasonal correlations and comparisons were determined by Spearman rank correlations (Rs) and Kruskal-Wallis tests as described in Conover (1980).

I tested interactions of landscape variables by using multiple linear regression (Neter et al. 1993) on all species in all seasons. Ungulate density was the dependent variable and the landscape variables were the independent variables. The independent variables used in the regression models were distance to the nearest CRP land, alfalfa field, wheat field, perennial creek, intermittent creek, hiding cover, forest, occupied homestead, and percent slope.

Wild Ungulate Associations with Vegetation

Vegetative composition was estimated for alfalfa, bottom rangeland, CRP, and upland rangeland in late June and early July. Vegetative cover was estimated by recording the percent of the ground covered by grasses, forbs, shrubs, and mosses found within 20x50 cm plots at 20 random points in each observation site. The vegetative cover classes were: Class 1 = 0-1 percent; Class 2 = 1-5 percent; Class 3 = 5-25 percent; Class 4 = 25-50 percent; Class 5 = 50-75 percent. Class 6 = 75-95 percent; Class 7 = 95-100 percent. The mid points of the coverage classes were used in the data analysis. I used Spearman rank (Rs) correlations to test for associations between wild ungulates and vegetative characteristics for alfalfa, CRP, upland rangeland and bottom rangeland.

Wild Ungulate Associations with Livestock

During wild ungulate counts, the presence and type of livestock present on observation sites were recorded. I tested for associations between the presence of wild ungulates and the presence of livestock on all lands using Spearman rank correlations (Rs).

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Potential for Wild Ungulate Impacts to Agricultural Crops

Alfalfa

An monthly estimate of growing alfalfa consumption from greenup to harvest (August) was calculated using an animal count method developed by Austin and Urness (1992). Estimated alfalfa consumption was based on the average animal count per month in the dusk period for antelope and night period for deer. The average number of animals was determined from 3 or 4 counts. The average number of animals was multiplied by the number of nights in each month to determine deer or antelope depredation days. The number of depredation days was then multiplied by a daily consumption value (0.90 kg for mule deer and white-tailed deer, 0.68 kg for antelope) (Austin and Urness 1992) yielding a monthly consumption value of alfalfa hay (13% moisture). The consumption estimates assume that the animals fed every night of the month. Consumption values were based on average adult animals in a typical range situation. Mule deer consumption rates were used for whitetail consumption estimates. Impacts to stacked hay were not assessed.

Wheat

I did not attempt to estimate consumption of wheat, but published information (Cole and Wilkins 1958, Sexon et al. 1981, Dunphy et al. 1982, Torbit et al. 1993) indicated that timing of use may be critical. I noted deer and antelope numbers in fallow and planted wheat fields through an annual cycle to determine wild ungulate use relative to the critical period of growing point emergence.

numbers in fallow and planted wheat fields through an annual cycle to determine wild ungulate use relative to the critical period of growing point emergence.

RESULTS

Wild Ungulate Counts

During the study period, a total of 4,687 mule deer, 1,322 white-tailed deer, and 2,767 antelope observations were recorded. Forty-two percent of all mule deer, 93% of all white-tailed deer, and 66% of all antelope observations were in the Ekalaka area (Appendix Table 6). The first deer and antelope fawns began accompanying does in late June and were included in total counts starting in July. The percentages of July observations as fawns were 4.2% for mule deer, 6.8% for whitetails, and 5.5% for antelope. In August, fawns made up 15.5%, 6.1%, and 9.9% of the observations of mule deer, white-tailed deer, and antelope, respectively.

Over all seasons, mule deer and antelope densities (animals/ha) were significantly higher (P=0.01 and P=0.04, respectively) on observation sites in the Boxelder study area. White-tailed deer densities on observation sites did not significantly differ between study areas (P=0.37). The dominant observed activity in all seasons was feeding, followed by bedding and traveling.

I did not find major differences in sightability among land use categories. In CRP lands, I observed an average of 85% (n=10 walks) of all animals present at night and 80% (n=

13 walks) of all animals present during the day. All other land use categories were checked only during the day (n=28 walks). I saw >90% of the animals present in those types.

Wild Ungulate Use of Agricultural Lands

Mule deer densities per land use type varied from 0.0 to 0.42/ha. White-tailed deer densities were lower and ranged from 0.0 to 0.11/ha. Antelope density peaked at 0.58/ha (Figures 6-8). For all 3 species, the number of observations in each land use category was not proportional (chi-square test, P<0.05) to availability in any season (Appendix Table 7).

Ekalaka Study Area

Mule Deer. In fall, CRP and alfalfa were selected (use > availability) while CRP was the only type selected in winter (Table 2). In spring, alfalfa was used in proportion to availability, and CRP was selected. In summer, upland and bottom rangeland use was proportional to availability and CRP was selected. In all seasons, all other land use categories were used less than expected.

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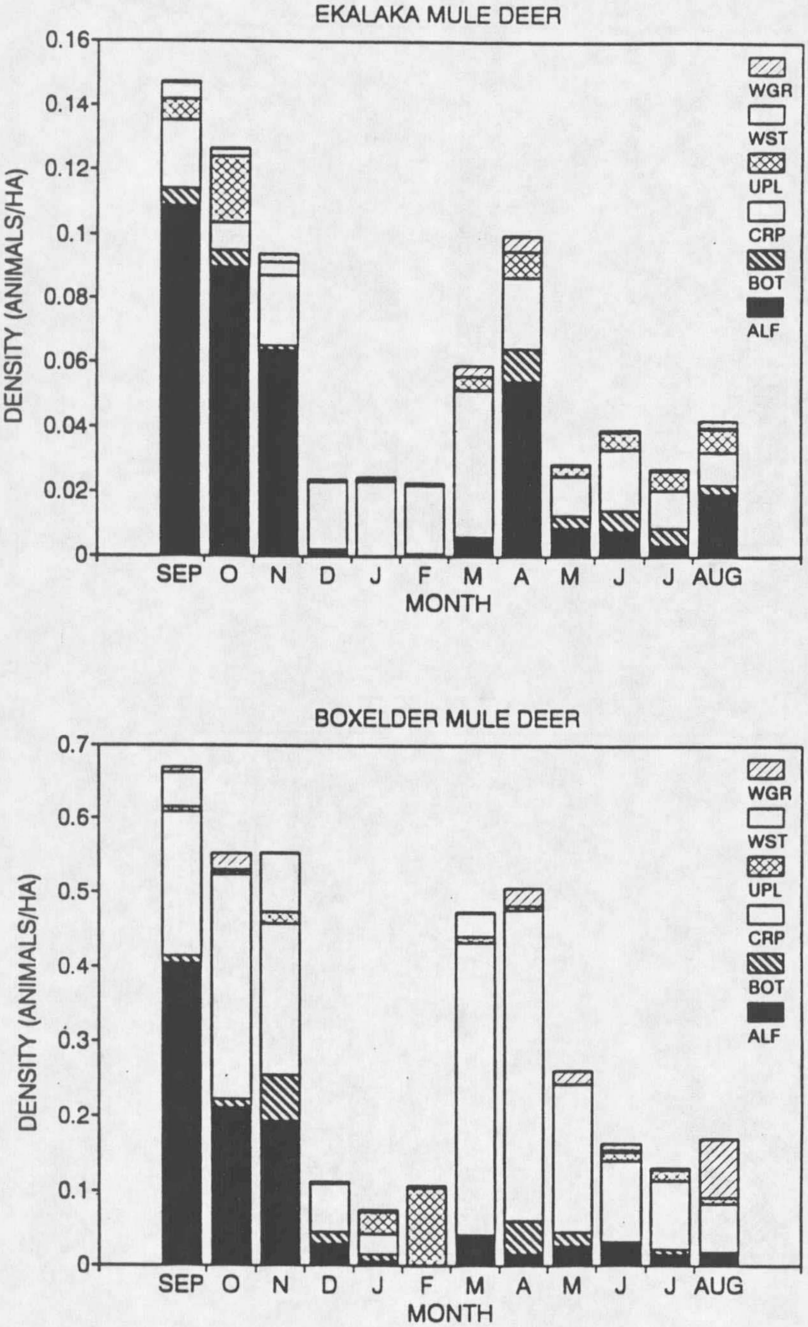

Figure 6. Average mule deer densities on alfalfa (ALF), bottom rangeland (BOT), Conservation Reserve Program (CRP), upland rangeland (UPL), wheat stubble (WST), and growing wheat (WGR) observation sites in the Ekalaka and Boxelder study areas from September 1992 to August 1993.

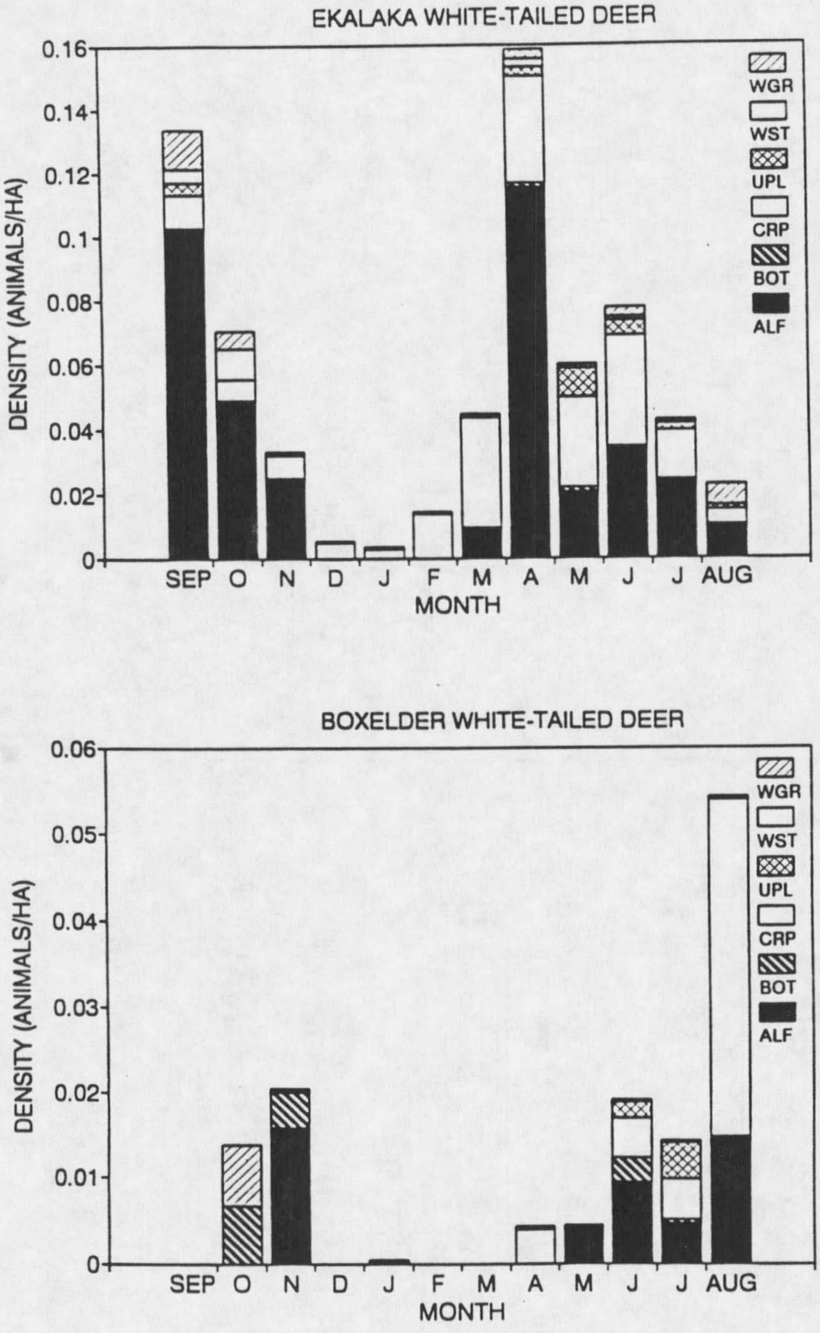

Figure 7. Average white-tailed deer densities on alfalfa (ALF), bottom rangeland (BOT), Conservation Reserve Program (CRP), upland rangeland (UPL), wheat stubble (WST), and growing wheat (WGR) observation sites in the Ekalaka and Boxelder study areas from September 1992 to August 1993.

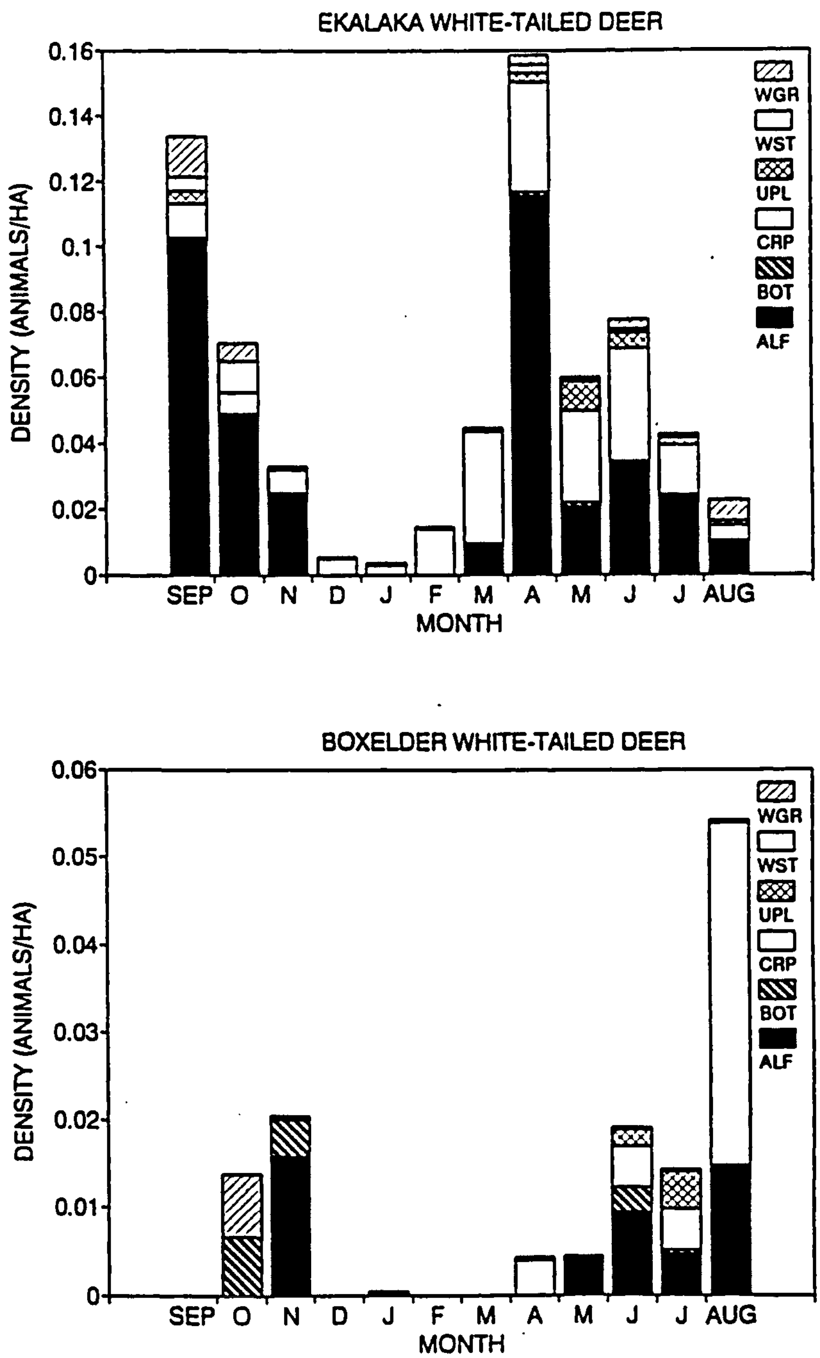

Figure 7. Average white-tailed deer densities on alfalfa (ALF), bottom rangeland (BOT), Conservation Reserve Program (CRP), upland rangeland (UPL), wheat stubble (WST), and growing wheat (WGR) observation sites in the Ekalaka and Boxelder study areas from September 1992 to August 1993.

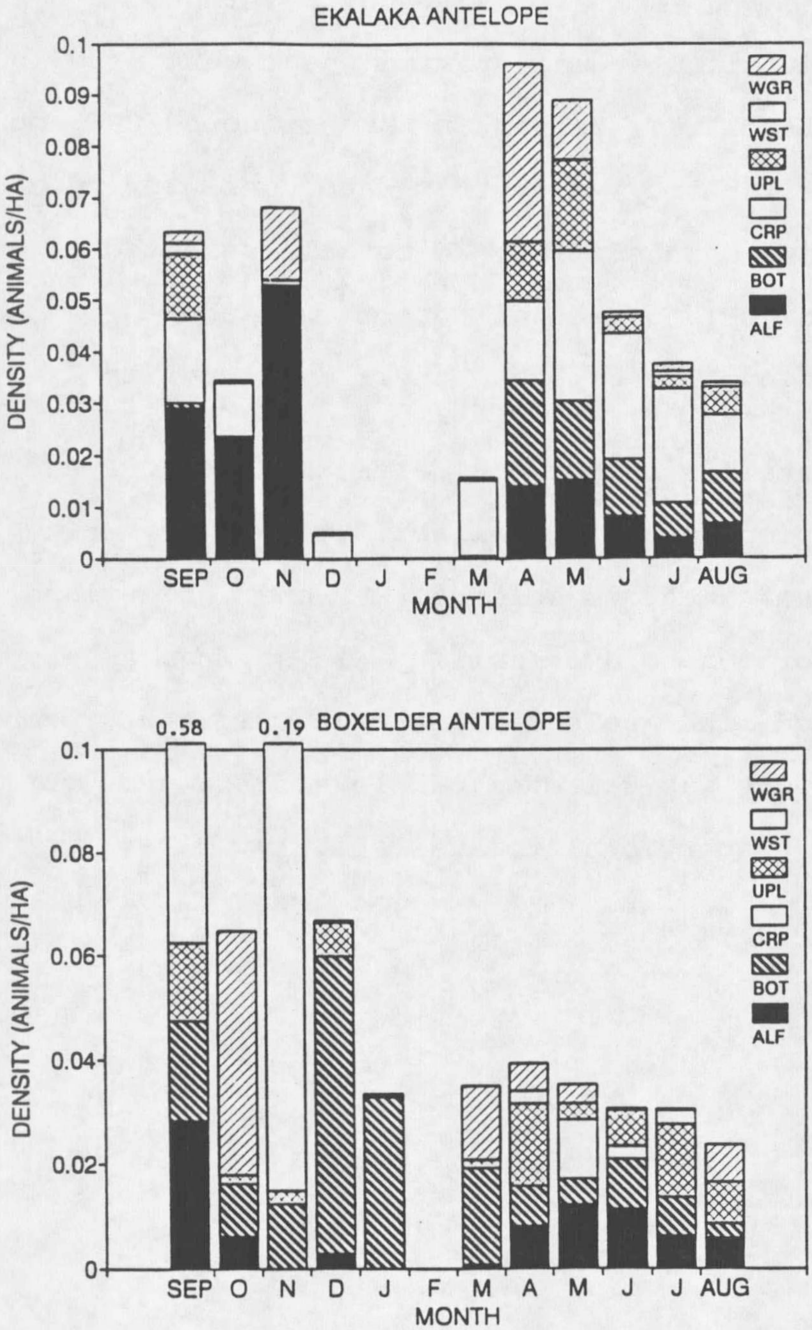

Figure 8. Average antelope densities on alfalfa (ALF), bottom rangeland (BOT), Conservation Reserve Program (CRP), upland rangeland (UPL), wheat stubble (WST), and growing wheat (WGR) observation sites in the Ekalaka and Boxelder study areas from September 1992 to August 1993.

White-tailed Deer. In fall, whitetails selected alfalfa. CRP, wheat stubble, and growing wheat were used in proportion to availability. In winter they selected CRP and avoided (use < availability) all other land uses. Spring and summer distributions were similar. Whitetails selected alfalfa fields and CRP and used all other land use categories proportionally less than their availability.

Antelope. Antelope selected alfalfa and used CRP and growing wheat in proportion to availability in fall. In winter, I found that antelope selected CRP and used upland rangeland in proportion to availability. In spring, antelope were more dispersed. They selected alfalfa, CRP, and growing wheat. In summer, CRP was selected, while alfalfa and bottom rangeland use was proportional to availability.

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Table 2. Mule deer, white-tailed deer, and antelope use of agricultural land use categories in the Ekalaka and Boxelder study areas.

		Season											
Area	Land Use	Fall			Winter			Spring			Summer		
		MUL[a]	WTD	ANT	MUL	WTD	ANT	MUL	WTD	ANT	MUL	WTD	ANT
Ekalaka	ALF[b]	+[c]	+	+	−	−	−	=	+	+	−	+	=
	BOT	−	−	−	−	−	−	−	−	−	=	−	=
	CRP	+	=	=	+	+	+	+	+	+	+	+	+
	UPL	−	−	−	−	−	=	−	−	−	=	−	−
	WST	−	=	−	−	−	−	−	−	−	−	−	−
	WGR	−	=	=	−	−	−	−	−	+	−	−	−
Boxelder	ALF	+	+	−	−	*	−	−	*	=	=	+	=
	BOT	−	=	=	−	*	+	−	*	=	−	−	=
	CRP	+	−	−	=	*	−	+	*	=	+	+	−
	UPL	−	−	−	+	*	−	−	*	=	−	−	=
	WST	−	−	+	−	*	−	−	*	−	−	−	−
	WGR	−	=	=	−	*	−	−	*	=	=	−	−

[a]MUL= mule deer; WTD= white-tailed deer; ANT= antelope.
[b]ALF= alfalfa; BOT= bottom rangeland; CRP= conservation reserve program; UPL= upland rangeland; WST= wheat stubble; WGR= growing wheat.
[c](+)= use greater than availability; (=)= use proportional to availability; (-)= use less than availability; (*)= no test

Boxelder Study Area

Mule Deer. In the fall, selection of alfalfa and CRP mirrored land use patterns in the Ekalaka area (Table 2). Upland rangeland was selected in winter while CRP use was proportional to availability. In spring, CRP was the only land use category selected. In summer, CRP was selected while alfalfa and growing wheat were used in proportion to availability.

White-tailed Deer. In fall, whitetails selected alfalfa while using bottom rangeland and growing wheat in proportion to availability. There were not enough observations in winter and spring to test land use. Whitetails selected CRP and alfalfa in summer.

Antelope. In fall, antelope selected wheat stubble and used growing wheat and bottom rangeland in proportion to availability. In winter, the only antelope observed were on bottom rangeland. Spring distribution was widest with proportionate use of all land use types except wheat stubble. In summer, no land use category was selected. Alfalfa, bottom rangeland, and upland rangeland were used in proportion to availability while CRP, growing wheat, and wheat stubble were avoided.

Boxelder Study Area

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White-tailed Deer. In fall, whitetails selected alfalfa while using bottom rangeland and growing wheat in proportion to availability. There were not enough observations in winter and spring to test land use. Whitetails selected CRP and alfalfa in summer.

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Wild Ungulate Associations with Agricultural Crop Production Capability

Three land capability classes (3, 4, and 6) were present. Land capability classes 3 and 4 were suited for cultivation, with the latter suited for growing fewer cultivated crops. Both classes were also suited for pasture, range, woodland, and wildlife. Land capability class 6 lands were suited generally for pasture, range, woodland and wildlife. Overall, the most agriculturally productive lands (LCC 3) were used for wheat. Moderately productive lands (LCC 4) were seeded to CRP and alfalfa, while the least productive lands (LCC 6) were used for grazing. For all three species, the number of observations in each land capability class was not proportional (chi-square test, $P<0.05$) to availability in any season (Appendix Table 8).

Mule Deer

The most agriculturally productive lands (LCC 3) were selected in fall and spring while the least productive lands (LCC 6) were selected in winter and summer (Table 3).

White-tailed Deer

Selection for the most agriculturally productive farmlands occurred in fall, spring, and summer. Moderately productive lands (LCC 4) were selected only in winter, while least productive lands were selected in fall and used in proportion to availability in spring.

Antelope

Antelope selected the most productive lands in fall and selected moderately productive lands in all seasons. Least productive lands were selected in summer and used in proportion to availability in spring.

Table 3. Mule deer, white-tailed deer, and antelope use of land capability classes (LCC) in the Ekalaka and Boxelder study areas combined.

Season	LCC	Species		
		MUL[a]	WTD	ANT
Fall	3	+[b]	+	+
	4	-	-	=
	6	-	+	-
Winter	3	-	-	-
	4	-	+	+
	6	+	-	-
Spring	3	+	+	-
	4	-	-	+
	6	-	=	=
Summer	3	=	+	-
	4	-	-	+
	6	+	-	+

[a]MUL= mule deer; WTD= white-tailed deer; ANT= antelope
[b](+)= use greater than availability; (=)= use proportional to availability; (-)= use less than availability.

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	6	+	-	-
Spring	3	+	+	-
	4	-	-	+
	6	-	=	=
Summer	3	=	+	-
	4	-	-	+
	6	+	-	+

[a]MUL= mule deer; WTD= white-tailed deer; ANT= antelope
[b](+)= use greater than availability; (=)= use proportional to availability; (-)= use less than availability.

Wild Ungulate Associations with Landscape Variables

Seasonal Correlations

Mule Deer. Of the landscape variables I measured, mule deer observations were significantly associated with perennial creeks, intermittent creeks, homesteads, CRP lands, and forest in one or more seasons (Appendix Table 9). In the fall, more mule deer were observed on observation sites closer to intermittent creeks and homesteads. The number of mule deer using alfalfa fields in fall was significantly lower (P=0.09) on fields farther from perennial creeks. In winter, mule deer observations were lower on sites near the forest and higher on sites closest to CRP lands. In spring, mule deer observations were significantly lower on observation sites farther from CRP and homesteads. In summer, mule deer observations were significantly lower on sites farther from perennial creeks and homesteads. The number of mule deer using upland rangeland sites in summer decreased as the distance to an alfalfa field increased (P=0.07).

White-tailed Deer. White-tailed deer observations were significantly associated with land slope, CRP lands, forest, intermittent creeks, and homesteads in one or more seasons. Observation sites with less slope were used significantly more in fall and spring. There were no significant associations in winter. In spring, sites farther away from forest and CRP lands yielded significantly fewer whitetail observations. In summer, there were significantly more whitetails observed on sites closer to intermittent creeks. Growing wheat fields close to intermittent creeks were used significantly more ($P=0.02$) than fields at greater distances.

Antelope. In one or more seasons, antelope observations were significantly associated with alfalfa fields, intermittent creeks, forest, and homesteads. In fall, there were no significant associations between antelope and any land variable that I measured. In winter, there were significantly more antelope on lands located at greater distances from alfalfa fields, intermittent creeks, and forest lands. In spring, and summer, antelope numbers were higher on sites located farthest from the forest and occupied homesteads.

Multiple Regression Models

Twelve multiple regression models, 3 species in 4 seasons, were tested. The independent variables used in the regression models were distances to the nearest CRP land, alfalfa field, wheat field, perennial creek, intermittent more in fall and spring. There were no significant associations in winter. In spring, sites farther away from forest and CRP lands yielded significantly fewer whitetail observations. In summer, there were significantly more whitetails observed on sites closer to intermittent creeks. Growing wheat fields close to intermittent creeks were used significantly more ($P=0.02$) than fields at greater distances.

Antelope. In one or more seasons, antelope observations were significantly associated with alfalfa fields, intermittent creeks, forest, and homesteads. In fall, there were no significant associations between antelope and any land variable that I measured. In winter, there were significantly more antelope on lands located at greater distances from alfalfa fields, intermittent creeks, and forest lands. In spring, and summer, antelope numbers were higher on sites located farthest from the forest and occupied homesteads.

Multiple Regression Models

Twelve multiple regression models, 3 species in 4 seasons, were tested. The independent variables used in the regression models were distances to the nearest CRP land, alfalfa field, wheat field, perennial creek, intermittent creek, hiding cover, forest, and occupied homestead. Percent slope was also included. Only 2 of the 12 models detected significant relationships ($P<0.10$) between wild ungulates and landscape variables. The two models did not explain a substantial amount of the variability ($R^2<0.50$) in ungulate observations (Table 4).

Table 4. R-squared and P-values from multiple regression models for mule deer, white-tailed deer, and antelope using ungulate density as the dependent variable and landscape variables as independent variables.

Season	Mule deer	White-tailed deer	Antelope
Fall	0.30[a]	0.23	0.09
	(0.08)[b]	(0.30)	(0.25)
Winter	0.18	0.50	0.17
	(0.75)	(0.00)	(0.85)
Spring	0.17	0.24	0.17
	(0.90)	(0.30)	(0.83)
Summer	0.19	0.20	0.15
	(0.61)	(0.51)	(0.91)

[a]=R-squared value
[b]=P-value

Wild Ungulate Associations with Livestock

Cattle were observed on upland range sites as frequently as on bottom rangeland sites in the fall ($P=0.92$) and spring ($P=0.82$). In winter and summer, cattle tended to use bottom rangeland significantly more than other sites (P=0.07 and P=0.09 respectively). In winter and early spring, grazing also occurred on alfalfa and wheat fields. Sheep used upland rangeland sites as frequently as bottom rangeland sites in fall (P=0.92), winter (P=0.40), spring (P=0.47), and summer (P=0.12). Horses were observed on one observation site and were not included in the analysis.

White-tailed deer observations were negatively correlated with cattle presence in fall (P=0.09), spring (P<0.01), and summer (P=0.01). In winter, antelope observations were negatively correlated with cattle presence (P=0.09). There were no associations evident between sheep and any wild ungulate or between mule deer and any type of livestock.

Wild Ungulate Associations with Vegetation

The average bottom rangeland vegetative coverage was 55% grass, 33% forb, and 8% shrub. Vegetative coverage for upland observation sites averaged 49% grass, 28% forb, and 11% shrub. Dominant species in order of abundance are listed in Appendix Table 10.

Alfalfa vegetative cover in alfalfa fields was similar for both areas. Average alfalfa cover prior to first cutting was 29% for all alfalfa fields. Remaining cover categories in descending order of abundance were perennial (seeded) use bottom rangeland significantly more than other sites ($P=0.07$ and $P=0.09$ respectively). In winter and early spring, grazing also occurred on alfalfa and wheat fields. Sheep used upland rangeland sites as frequently as bottom rangeland sites in fall ($P=0.92$), winter ($P=0.40$), spring ($P=0.47$), and summer ($P=0.12$). Horses were observed on one observation site and were not included in the analysis.

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The average bottom rangeland vegetative coverage was 55% grass, 33% forb, and 8% shrub. Vegetative coverage for upland observation sites averaged 49% grass, 28% forb, and 11% shrub. Dominant species in order of abundance are listed in Appendix Table 10.

Alfalfa vegetative cover in alfalfa fields was similar for both areas. Average alfalfa cover prior to first cutting was 29% for all alfalfa fields. Remaining cover categories in descending order of abundance were perennial (seeded) grass, annual forbs, annual grass, and bare ground. Average wheatgrass vegetative cover in CRP sites was 43% while cheatgrass was 6% and other grasses 1%. CRP fields in the Ekalaka area that contained alfalfa had an average alfalfa vegetative cover of 8%. The CRP field in the Boxelder area had 31% alfalfa vegetative cover. The vegetative cover of other forbs found in CRP fields did not significantly differ between study areas. These accounted for 7%. The most common forbs in CRP in order of abundance were western salsify (_Tragopogon dubius_), common dandelion (_Taraxacum officinale_), kochia (_Kochia scoparia_), and field bindweed (_Convolvulus arvensis_).

In summer, 2 significant relationships between wild ungulates and vegetative cover were discovered. Antelope using alfalfa fields appeared on fields with lower alfalfa vegetative cover ($P \leq 0.01$), and antelope observations were highest on CRP with lowest forb vegetative cover ($P=0.07$). No other significant relationships were discovered.

Potential Impacts to Agricultural Crops

Alfalfa

Estimated average alfalfa consumption varied from 0.0 kg/ha to 5.5 kg/ha. The highest average consumption estimate (5.5 kg/ha) was for white-tailed deer in the Ekalaka area in April. The lowest values (0 kg/ha) varied for each species.

Generally, lowest estimated consumption occurred in early spring (Table 5).

Wheat

Growing winter wheat was grazed by all species, but received heaviest use by antelope in spring. Antelope grazing on spring wheat peaked in April (0.035 antelope/ha). Use decreased in May (0.012 antelope/ha) and was slight in June (0.001 antelope/ha). Peak whitetail densities on growing wheat occurred in August (0.006 white-tailed deer/ha) and peak mule deer densities occurred in April (0.005 mule deer/ha).

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Table 5. Average ($\bar{X}$), and range (minimum and maximum) of estimated alfalfa consumption (kg/ha) from April 1993 to August 1993. Estimates for the Ekalaka area were based on 7 fields (size range 5 ha to 47 ha). Estimates for the Boxelder area were based on 4 fields (size range 12 to 31 ha).

		Mule deer			White-tailed deer			Antelope		
Area		$\bar{X}$	Min	Max	$\bar{X}$	Min	Max	$\bar{X}$	Min	Max
Ekalaka	Apr	0.1	0.0	0.8	5.5	0.0	35.1	0.0	0.0	0.1
	May	0.1	0.0	0.9	1.4	0.0	7.0	0.5	0.0	2.3
	Jun	0.4	0.0	2.8	1.4	0.0	7.0	0.2	0.0	0.9
	Jul	0.4	0.0	2.6	1.7	0.0	7.7	0.0	0.0	0.0
	Aug	2.2	0.0	15.5	0.3	0.0	1.9	0.0	0.0	0.0
Boxelder	Apr	0.5	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0
	May	1.4	0.0	5.1	0.2	0.0	0.8	0.1	0.0	0.5
	Jun	1.5	0.0	4.5	0.5	0.0	1.7	0.4	0.0	1.4
	Jul	0.7	0.0	1.6	0.3	0.0	1.2	0.0	0.0	0.0
	Aug	0.4	0.0	1.6	1.1	0.0	2.1	0.0	0.0	0.0

DISCUSSION

Use of Agricultural Lands by Mule Deer

Mule deer were the most abundant wild ungulate observed in both study areas and were often visible during the day. The highest densities of mule deer on observation sites occurred in the fall when most observations were in alfalfa fields and CRP land. In eastern Montana, increased use of alfalfa fields by mule deer during autumn was also documented by Egan (1957), Wood et al. (1989), and Griffiths (1990). Most alfalfa fields remained green longer than native forages due to their location in bottomland areas where they benefit from runoff and subirrigation. Olenicki (1993) documented the decrease in forage succulence on uplands adjacent to alfalfa bottoms on Boxelder Creek as summer progressed. Cutting (harvest) the hay extended the vegetative stage of alfalfa plants into late summer and may have provided forage that was nutritionally superior to native vegetation.

In addition to extended succulence, ungulates may benefit from relatively high crude protein, low acid detergent fiber, and low neutral detergent fiber levels in alfalfa in autumn (R. Ditterline, pers. commun.). Ditterline (unpubl. data) found alfalfa that yielded 25% crude protein

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Conservation Reserve Program lands also stayed greener than surrounding rangelands. Dense vegetation in CRP catches snow and helps retain and absorb moisture. The combination of increased moisture and absence of grazing provides optimum growing conditions for forbs and for early growth and fall regrowth of cool season grasses. Because they were neither grazed nor mowed, they provided lateral cover as well as forage.

In fall, use of sites near intermittent creeks and homesteads by mule deer was linked to the placement of alfalfa and CRP fields. Most CRP fields (retired cropland) were located away from the bottoms and were often bounded by intermittent creeks. The correlation of mule deer abundance to farmsteads may be explained by the location of many farmsteads in bottomland and creek areas. As mule deer used succulent alfalfa bottoms along perennial and intermittent creeks in the fall, they were drawn closer to homesteads. Homesteads in both areas were often associated with topographic cover which could provide shelter for deer in fall. Areas close to homesteads may also provide protection from hunters. The majority of homesteads were not posted, but hunting in the immediate vicinity of the house was probably not allowed.

In fall, mule deer used the most agriculturally productive lands more than expected. Crawford (1950) noted that cultivation was an indicator of fertility and documented positive associations between soil fertility and rabbit, raccoon, fox squirrel and opossum. Use of more fertile areas providing high quality crop forage in fall could be advantageous for animals attempting to build or delay utilization of energy reserves.

Hunting did not seem to affect mule deer use of agricultural habitats. Observations were reduced only about 10% in the month after the season opened. Kufeld et al. (1988) found that hunting pressure did not cause female mule deer to increase home ranges or distances traveled, but they did increase use of more effective cover. Swenson (1982) found that mule deer in a mixed-grass prairie used timbered and juniper breaks significantly more during hunting seasons. Mule deer with home ranges in and adjacent to the forest areas probably used those areas for cover, but deer on the plains apparently found adequate hiding cover in CRP, creek bottoms, and rolling topography. Hunting pressure was not estimated, so the extent of movement due to hunters is not known.

The number of mule deer observed in winter dropped to about 40% of fall numbers. Conservation Reserve Program lands were the preferred land use category. In winter, Thomas and Irby (1991) saw a similar peak in use of lands managed in a manner similar to CRP in an intermountain environment. Parker and Gillingham (1990) demonstrated that

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The crested wheatgrass complex including (Agropyron cristatum) and (Agropyron desertorum) was common on CRP lands and rangelands in both study areas. Urness et al. (1983) illustrated the nutritional value of Agropyron desertorum for wintering mule deer in Utah. This species tended to produce greater amounts of fall regrowth and earlier spring growth than native grasses. This favorably affected the nutritional plane of wintering mule deer due to relatively superior protein levels compared to native browse species (Urness et al. 1983).

Wood et al. (1989) noted the importance of bunchgrass prairies, shrublands, and hardwood draws for mule deer wintering in a breaks area 200 km north and west of Ekalaka. The general absence of topographic relief, draws, and dense shrub cover on my observation sites probably made them less efficient as winter cover than other upland types closer to the forest and breaks. Mule deer used upland shrublands, hardwood draws, and forest areas in Carter County, but these areas were located away from the county roads that I used to access my observation sites.

In spring, mule deer used alfalfa in proportion to availability and selected CRP. The early greenup of both provided nutritious forage at this critical time. In spring, emerging alfalfa and grass plants have high leaf to stem ratios thus providing high protein. Twenty-eight percent crude protein was documented for alfalfa in Beaverhead County in the spring of 1993 (R. Ditterline, unpubl. data). At this time of year, relative feed value (a rating based on digestibility and protein) of alfalfa is at its highest. Consumption of protein-rich foods in spring may aid in nourishment of fetal tissues and in recovery of body tissues lost over winter.

Conservation Reserve Program lands also provided residual cover for mule deer in the spring. Heavy grazing on upland range typically left little residual vegetative cover by spring when residual forage height in CRP fields was ≥0.5 m. In spring, more animals were observed on agricultural lands (wheat and alfalfa) that were close to CRP fields. Cover close to agricultural feeding sites enhances mule deer habitat (Thomas and Irby 1991).

Although mule deer did not select the most agriculturally productive land use categories in spring, they were observed using the most fertile areas within each category. This suggests that deer may seek agriculturally productive land in early spring when energy reserves are access my observation sites.

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The widest distribution of mule deer among land use types occurred in summer when deer are normally most widely distributed. At this time, productive does isolate themselves for fawning and fawn rearing. Conservation Reserve Program lands were selected and alfalfa, growing wheat, upland range, and bottom rangeland were used in proportion to availability. This pattern might not occur in a drier summer or a summer with low sweetclover growth. The rains that occurred in 1992 and 1993 provided early forage that remained green throughout the summer. Aerial observations of both study areas revealed an abundance of sweetclover in upland rangeland areas throughout summer. In the Missouri River breaks, Hamlin and Mackie (1989) found that yellow sweetclover, when available, comprised 36-59% of mule deer summer diets.

In the Boxelder area, favorable vegetative conditions in uplands probably delayed migration to bottom lands in late summer (Doug Gardner, pers. commun., Griffiths 1990). This late summer migration was less pronounced in the Ekalaka area, but more mule deer were observed on upland rangeland in summer than in any other season.

The positive correlation between mule deer numbers and perennial creeks and homesteads in summer was probably a result of some animals migrating to bottom lands in late summer. Dispersal before fawning and the increased use of bottom rangeland would also place deer closer to perennial creeks. The shading cover lacking in intermittent creeks may have caused deer to seek shading cover associated with perennial creeks. In summer, Olenicki (1993) observed a dramatic difference in temperature between the bottom of a perennial creek and an adjacent sunlit bank.

I did not identify any significant associations between mule deer and livestock in any season. Wood (1986) reported that cattle had little effect on mule deer populations due to habitat partitioning in rough terrain. Olenicki (1993) reported that wintering of livestock along Boxelder Creek may have caused deer to move into upland zones in late fall. Mule deer selection of ungrazed lands (alfalfa, CRP) in some seasons suggests that mule deer avoided lands with livestock, but interactions on my study areas were not common enough to form statistically significant associations.

Use of Agricultural Lands by White-tailed Deer

White-tailed deer were the least frequently observed wild ungulate on the study areas. In fall, whitetails selected alfalfa, while using CRP and wheat in proportion to availability. Compton (1986) and Dusek (1987) noted similar increases in alfalfa use in the fall. Gould and Jenkins (1993) reported high use of CRP in fall, especially for bedding. In this season, whitetail numbers observed on the 6 bottom rangeland would also place deer closer to perennial creeks. The shading cover lacking in intermittent creeks may have caused deer to seek shading cover associated with perennial creeks. In summer, Olenicki (1993) observed a dramatic difference in temperature between the bottom of a perennial creek and an adjacent sunlit bank.

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In fall, I observed whitetails grazing on wheat stubble fields on and adjacent to my observation sites in the Ekalaka area. Studies in eastern Montana woodland and prairie habitats also indicated utilization of wheat in fall and winter (Dusek 1987, Wood et.al. 1989), but plant parts or the growth stage of plants used was not clear. My observations indicated that white-tailed deer valued both wheat stubble (grain and volunteer shoots) and growing wheat (10-15 cm emergent wheat) for short periods in the fall and winter.

Greater use of flatter lands (less slope) in fall was an artifact of their selection for agricultural fields. Alfalfa, CRP, and wheat fields were generally located on flat or moderately rolling land to facilitate cultivation. Conservation Reserve Program lands were cultivated prior to enrollment in the program. The alfalfa field that received heaviest use by whitetails was located in a flat creek bottom.

In winter, most whitetails observed were on CRP lands, though some were on forest lands and uplands adjacent to my study area. Swenson et al. (1983) reported that approximately 46% of all whitetails observed wintered in upland prairie areas associated creek/riparian and agricultural lands. In many years, bottom and riparian areas drift in with snow. Conservation Reserve Program lands were generally located 2.2 times further from perennial creeks than intermittent creeks, giving them more of an upland characteristic. Whitetails in South Dakota used CRP in proportion to its availability (Gould and Jenkins 1993) but selected wetlands and woodlands in winter. In the absence of these riparian and woodland elements, tall ungrazed grass stands may substitute for physical structure in providing thermal and hiding cover.

In spring, alfalfa and CRP fields were selected, and sites adjacent to CRP had significantly more deer than those at greater distances. This hints at the importance and attraction of early greenup to winter-stressed deer. The preference for flatter land was an artifact of cultivation requirements, as in the fall. More whitetails were observed on sites close to forest land in spring than other seasons. Dusek (1987) observed white-tailed deer using lower parts of hardwood draws associated with the pine forest in Long Pine habitat near the Ekalaka study area. Draws were used for bedding and as routes of travel between pine communities and agricultural fields.

In summer, whitetails selected CRP land and alfalfa on both study areas. Gould and Jenkins (1993) noted the same selection for CRP land but detected avoidance of agricultural fields. They speculated that increasing use of agricultural lands. In many years, bottom and riparian areas drift in with snow. Conservation Reserve Program lands were generally located 2.2 times further from perennial creeks than intermittent creeks, giving them more of an upland characteristic. Whitetails in South Dakota used CRP in proportion to its availability (Gould and Jenkins 1993) but selected wetlands and woodlands in winter. In the absence of these riparian and woodland elements, tall ungrazed grass stands may substitute for physical structure in providing thermal and hiding cover.

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CRP fields between spring and summer reflected foraging on sweetclover and alfalfa. I compared whitetail densities on CRP fields with alfalfa and sweetclover to fields without alfalfa and sweetclover and found no significant difference in use for any species (mule deer, white-tailed deer, and antelope) during spring and summer. This suggests that CRP land provided habitat that was valuable for reasons other than occurrence of dominant forage species.

Conservation Reserve Program lands provided excellent hiding cover for fawns in summer. The large tracts of thick grass probably decreased the potential for interactions with predators. On several occasions I flushed fawns from their beds when females were not present. Gould and Jenkins (1993) indicated that CRP land was important to females during fawn rearing, and Luttschwager (1991, cited in Gould and Jenkins 1993) noted an increase of fawns in CRP land after June 1.

Intermittent creeks were also important to white-tailed deer in summer. These creeks varied in vegetation and canopy so overhead thermal cover provided in these areas was not a consistent factor in selection. However, the associated cool, sheltered, cut banks and abundant vegetative growth could have provided some overhead thermal cover as well as green, succulent forage. Dispersion of females prior to fawning may have distributed deer into upland areas where territories included cropland as well as intermittent creek habitat. The great abundance of intermittent creeks in the areas would also make association with them more common.

Significantly more white-tailed deer were observed in areas without cattle than in grazed areas during fall, spring, and summer. In these seasons, whitetails were mainly using alfalfa and CRP where no grazing occurred. Dusek (1989) reported that whitetails that did not have easy access to ungrazed areas tolerated the presence of cattle through subtle movements and changes in distribution. Alfalfa and CRP stands offered whitetails in my study areas alternative ungrazed habitats.

Use of Agricultural Lands by Pronghorn Antelope

Antelope ranked second to mule deer in total observations. Their abundance relative to mule deer and white-tailed deer may be high due to their greater occurrence in day counts.

Antelope concentrated on the most agriculturally productive lands in fall. This may indicate that these lands are desirable territories for dominant bucks and doe bands. Decreased use of these areas in spring and summer suggests that productivity may be less important in other seasons or when social conditions change.

In the Ekalaka area, alfalfa was the only land use type that received greater than expected use by antelope during fall. Cole (1956) noted that alfalfa use increased through early fall. In his studies, forbs (mostly alfalfa) areas would also make association with them more common.

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Antelope in the Boxelder area selected wheat stubble in fall and used growing wheat in proportion to availability. Sexon et al. (1981) showed that pronghorns in Kansas made winter wheat a substantial part of their diet in late autumn. They suggested that pronghorns were able to live and reproduce successfully on their study area partly because of their use of cultivated crops when native foods were scarce.

Hunting may also have influenced use of habitat. Observations in the month after the season began were only 27% of the numbers recorded the month prior to the season. Hunting apparently moved antelope away from the county roads that I used to access my observation sites.

Pronghorns wintering in the Boxelder area selected bottom rangeland. One small area was used most of the winter. This area had a sagebrush component uncommon to bottomlands close to the creek. Although cattle were wintered in the same area, they were fed and remained closer to the creek than the antelope. Antelope in the Ekalaka area moved to winter range away from my survey routes during January. The upland and bottom rangeland sites that I observed were generally lacking in the sagebrush shrub cover that many studies in the Northern Great Plains indicated was important to antelope on winter range (Bayless 1969, Freeman 1971, Pyrah 1987).

In spring in the Ekalaka area, antelope selected alfalfa, CRP, and growing wheat. The heavy use and benefits of alfalfa and CRP were similar to those noted for deer. Selection of growing wheat was also observed by Torbit et al. (1993) who found that crude protein levels of winter wheat increased gradually from November to January, then increased rapidly from January through March. When crude protein dropped in late April, antelope abandoned wheat fields. In my study area, selection of green wheat fields and decreased use of these fields in May agrees with this trend. Antelope were observed on rangelands adjacent to wheat fields in June, but did not appear to use the wheat fields as in early spring. One growing wheat field was cut for hay before maturity extending the period of use by antelope and deer.

During spring in the Boxelder area, antelope used all land use categories except wheat stubble. Growing wheat was less available to antelope in the Boxelder area, and the wintered in the same area, they were fed and remained closer to the creek than the antelope. Antelope in the Ekalaka area moved to winter range away from my survey routes during January. The upland and bottom rangeland sites that I observed were generally lacking in the sagebrush shrub cover that many studies in the Northern Great Plains indicated was important to antelope on winter range (Bayless 1969, Freeman 1971, Pyrah 1987).

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In summer, antelope in the Ekalaka area continued to select CRP sites. Antelope, however, chose CRP lands with lower forb coverage. This probably resulted from antelope choosing more open, somewhat drier, and less fertile CRP stands. Alfalfa and sweetclover, major components of the forb forage class, were less abundant in these areas.

In the Boxelder area, the combination of alfalfa, bottom range, and upland range met the needs of antelope in summer. Widespread distribution of antelope probably reflected the wide distribution of sweetclover and succulent forbs across all land types. Cole (1956), Campbell (1970), and Pyrah (1987) noted the importance of sweetclover in summer diets.

Cole (1956) found that fences may have influenced antelope use of alfalfa fields. Most fences on my study areas had 5 wires without woven wire and did not appear to deter antelope access to any of my observation sites. Campbell (1970) also found that distribution and movements were not significantly influenced by fence type in southeastern Montana.

There was a significant negative correlation between antelope and cattle in winter in the Boxelder study area. Most ranchers in the Boxelder area wintered cattle and sheep on bottom rangeland areas close to creeks and homesteads. Livestock were fed on a daily basis. High human activity, high stock density, and the location of livestock wintering areas close to the creek and homesteads made these areas undesirable to antelope. Campbell (1970) found little competition for forage between cattle and antelope on rangelands in southern Carter county. Conditions on Boxelder creek in the winter were not typical of the open rangelands in Carter County.

Although Campbell (1970) and Freeman (1971) reported overlaps in diet and space between sheep and antelope in Carter County, I did not find any significant associations. Sheep were not as common as cattle on most of the observation sites that I observed so associations between antelope and sheep were difficult to detect.

Potential Impacts to Agricultural Crops

The agricultural crops exposed to game damage in my study areas were alfalfa and wheat. All 3 wild ungulate species were observed grazing on each type.

Alfalfa

The critical time for financial loss of growing alfalfa is between green-up and harvest. Overall impacts to alfalfa production generally appeared minimal (<2.0 kg/ha) in this time period, although the range (0.0 kg/ha to 35.1 kg/ha) of consumption estimates suggested that certain alfalfa fields on bottom rangeland areas close to creeks and homesteads. Livestock were fed on a daily basis. High human activity, high stock density, and the location of livestock wintering areas close to the creek and homesteads made these areas undesirable to antelope. Campbell (1970) found little competition for forage between cattle and antelope on rangelands in southern Carter county. Conditions on Boxelder creek in the winter were not typical of the open rangelands in Carter County.

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After the last cutting, forage production is lost if it is not grazed. Highest wild ungulate densities on alfalfa generally occurred after harvest (September-November). Wild ungulates could compete with livestock for winter forage only if alfalfa is grazed by livestock after harvest. This practice was common only on a few of the alfalfa fields that I observed.

Another potential impact is grazing stress to plants. Possible damage could occur if alfalfa plants are grazed before root reserves are replenished in fall. Townsend et al. (1993) found that any harvest within 6 weeks before a killing frost can reduce alfalfa stands, however, the grazing intensity needed to produce this effect is not known.

Wheat

Grazing winter wheat in the fall and winter generally does not reduce yield since the growing point is below the ground (Dunphy 1982). Spring grazing is generally not detrimental until the growing point is above ground. Wheat plants can have 20 to 30 cm of leafy growth above ground before the growing point emerges.

In Carter County, wheat growing point emergence occurs around May 15 at the earliest (Bauer et al. 1992, Schafer et al. 1985). In June, antelope use of wheat fields in my study areas was almost nonexistent. Torbit et al. (1993) tested for winter wheat yield reduction due to pronghorn grazing in eastern Colorado. They concluded that although pronghorns removed measurable amounts of green wheat, a reduction in grain yields could not be detected. In their study area, pronghorns shifted from wheat fields to native pastures before winter wheat became vulnerable to grazing damage. Cole and Wilkins (1958) also observed similar abandonment of wheat fields before the critical period of growing point emergence. Antelope damage to wheat in the Ekalaka and Boxelder study areas was probably limited to trampling and light grazing by a small number of animals.

Conclusions

Season and land use affected wild ungulate abundance on agricultural lands. Significant correlations between wild ungulate numbers and landscape variables suggested that distribution might be further explained by multivariate analysis of the landscape variables; however, the linear regression models that I used generally had poor predictive ability. The land use variables entered into the regression were not correlated strongly enough with deer numbers to before the growing point emerges.

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Conclusions

Season and land use affected wild ungulate abundance on agricultural lands. Significant correlations between wild ungulate numbers and landscape variables suggested that distribution might be further explained by multivariate analysis of the landscape variables; however, the linear regression models that I used generally had poor predictive ability. The land use variables entered into the regression were not correlated strongly enough with deer numbers to produce a model with good predictive ability. A relatively small number of observation sites in each land use category ($\leq$11) and uniqueness among them also increased overall variability in the models.

Although I frequently observed animals using specific sites, the pattern of use was not consistent on similar land use types in different locations. The balanced study design featuring systematic counts detected low predictability in ungulate use of agricultural lands. Wild ungulates do use agricultural lands, but individual animals use them differently within small spatial scales. My study was conducted when environmental conditions and wild ungulate populations were average or slightly above average. Use of agricultural sites could become less variable if animals were forced into a narrower range of habitats under drought or severe winter weather conditions. My study also suggests that a global approach to wild ungulate damage control may not be as effective as a local approach that addresses the specific agricultural sites and individual ungulates.

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APPENDIX

Table 6. Total observations and percent of total observations (%) per season for mule deer (MUL), white-tailed deer (WTD), and antelope (ANT) in the Ekalaka and Boxelder study areas.

Area	Season	MUL	%	WTD	%	ANT	%
Ekalaka	Fall	596	32	263	22	516	32
	Winter	359	19	103	9	24	2
	Spring	571	31	513	44	620	39
	Summer	324	18	294	25	427	27
Boxelder	Fall	1270	50	18	19	399	49
	Winter	320	13	1	1	115	14
	Spring	631	25	7	58	143	17
	Summer	291	12	68	72	162	20

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Table 7. HABUSE results for wild ungulate use of agricultural land use categories showing chi-square statistics and total number of animals observed by season in the Ekalaka and Boxelder study areas.

Area	Season	MUL[a]	WTD	ANT
Ekalaka	Fall	480.73[b] (596)[c]	187.52 (263)	948.73 (516)
	Winter	919.69 (359)	271.16 (103)	57.93 (24)
	Spring	562.39 (571)	557.76 (513)	278.74 (620)
	Summer	250.71 (324)	235.78 (294)	354.24 (427)
Boxelder	Fall	1824.06 (1270)	19.11 (18)	1808.95 (399)
	Winter	219.97 (320)	*[d]	287.23 (115)
	Spring	3652.83 (631)	*	13.63 (143)
	Summer	526.05 (291)	95.75 (68)	27.73 (162)

[a]MUL= mule deer; WTD= white-tailed deer; ANT= antelope
[b]chi-square statistic
[c]total observations
[d]= no test

Table 8. HABUSE results for wild ungulate use of land capability classes (LCC) showing chi-square statistics and total number of animals observed by season.

Season	MUL[a]	WTD	ANT
Fall	369.50[b] (1866)[c]	56.73 (281)	95.97 (915)
Winter	810.00 (679)	70.60 (104)	165.97 (139)
Spring	433.76 (1202)	151.58 (520)	25.47 (763)
Summer	105.61 (615)	75.07 (364)	253.38 (593)

[a]MUL= mule deer, WTD= white-tailed deer, ANT= antelope
[b]chi-square statistic
[c]total observations

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[b]chi-square statistic
[c]total observations

Table 9. Seasonal spearman rank (Rs) correlation coefficients for wild ungulates and landscape variables in all seasons.

		MUL[a]		WTD		ANT	
		Rs[b]	P	Rs	P	Rs	P
				Fall			
Dist[c]	ALF	-0.12	0.45	0.10	0.51	-0.01	0.94
	CRP	-0.17	0.27	-0.19	0.21	0.04	0.82
	WHT	0.09	0.57	0.02	0.90	0.12	0.46
	PCK	-0.16	0.23	0.10	0.45	-0.20	0.15
	ICK	-0.22	0.10	-0.08	0.54	0.18	0.19
	COV	-0.18	0.19	0.04	0.78	0.05	0.72
	FOR	-0.08	0.58	-0.20	0.15	0.14	0.31
	HMSD	-0.27	0.05	-0.03	0.82	-0.01	0.97
	SLOPE	-0.02	0.88	-0.35	0.01	0.01	0.93
				Winter			
Dist	ALF	-0.07	0.67	0.13	0.40	0.28	0.07
	CRP	-0.30	0.04	0.09	0.54	0.01	0.94
	WHT	0.15	0.36	0.06	0.74	0.18	0.26
	PCK	-0.19	0.17	0.01	0.96	0.06	0.68
	ICK	0.16	0.24	0.18	0.18	0.27	0.05
	COV	-0.20	0.14	-0.06	0.67	0.08	0.58
	FOR	0.26	0.05	0.11	0.44	0.26	0.06
	HMSD	0.05	0.72	0.18	0.19	0.09	0.50
	SLOPE	0.12	0.38	-0.13	0.34	0.16	0.26

Table 9. Continued.

		MUL[a]		WTD		ANT	
		Rs[b]	P	Rs	P	Rs	P
				Spring			
Dist[c]	ALF	−0.18	0.25	0.12	0.43	0.00	0.98
	CRP	−0.31	0.03	−0.40	0.01	−0.02	0.91
	WHT	0.02	0.90	−0.05	0.77	0.03	0.85
	PCK	−0.20	0.14	0.21	0.11	0.08	0.57
	ICK	0.07	0.59	−0.19	0.16	0.11	0.41
	COV	−0.12	0.38	−0.13	0.33	0.11	0.43
	FOR	0.14	0.31	−0.33	0.01	0.30	0.02
	HMSD	−0.24	0.08	0.12	0.40	0.30	0.03
	SLOPE	−0.04	0.78	−0.28	0.04	−0.12	0.40
				Summer			
Dist	ALF	−0.10	0.53	0.06	0.68	0.10	0.51
	CRP	−0.14	0.37	−0.17	0.27	−0.02	0.91
	WHT	−0.07	0.69	−0.04	0.80	−0.07	0.69
	PCK	−0.23	0.10	0.14	0.30	0.05	0.70
	ICK	0.04	0.75	−0.26	0.06	0.18	0.18
	COV	−0.07	0.64	−0.04	0.76	0.22	0.11
	FOR	0.30	0.03	−0.06	0.65	0.27	0.04
	HMSD	−0.26	0.06	−0.11	0.43	0.34	0.01
	SLOPE	0.15	0.28	−0.17	0.21	−0.12	0.39

[a]MUL= mule deer; WTD= white-tailed deer; ANT= antelope.
[b]Rs= spearman rank correlation coefficient; P= p-value.
[c]Dist= distance from observation site to nearest: ALF= alfalfa; CRP= conservation reserve program land; WHT= wheat; PCK= perennial creek; ICK= intermittent creek; COV= hiding cover; FOR= forest; HMSD= occupied homestead; SLOPE= land slope (%).

Table 9. Continued.

		MUL[a]		WTD		ANT	
		Rs[b]	P	Rs	P	Rs	P
				Spring			
Dist[c]	ALF	-0.18	0.25	0.12	0.43	0.00	0.98
	CRP	-0.31	0.03	-0.40	0.01	-0.02	0.91
	WHT	0.02	0.90	-0.05	0.77	0.03	0.85
	PCK	-0.20	0.14	0.21	0.11	0.08	0.57
	ICK	0.07	0.59	-0.19	0.16	0.11	0.41
	COV	-0.12	0.38	-0.13	0.33	0.11	0.43
	FOR	0.14	0.31	-0.33	0.01	0.30	0.02
	HMSD	-0.24	0.08	0.12	0.40	0.30	0.03
	SLOPE	-0.04	0.78	-0.28	0.04	-0.12	0.40
				Summer			
Dist	ALF	-0.10	0.53	0.06	0.68	0.10	0.51
	CRP	-0.14	0.37	-0.17	0.27	-0.02	0.91
	WHT	-0.07	0.69	-0.04	0.80	-0.07	0.69
	PCK	-0.23	0.10	0.14	0.30	0.05	0.70
	ICK	0.04	0.75	-0.26	0.06	0.18	0.18
	COV	-0.07	0.64	-0.04	0.76	0.22	0.11
	FOR	0.30	0.03	-0.06	0.65	0.27	0.04
	HMSD	-0.26	0.06	-0.11	0.43	0.34	0.01
	SLOPE	0.15	0.28	-0.17	0.21	-0.12	0.39

[a]MUL= mule deer; WTD= white-tailed deer; ANT= antelope.
[b]Rs= spearman rank correlation coefficient; P= p-value.
[c]Dist= distance from observation site to nearest: ALF= alfalfa; CRP= conservation reserve program land; WHT= wheat; PCK= perennial creek; ICK= intermittent creek; COV= hiding cover; FOR= forest; HMSD= occupied homestead; SLOPE= land slope (%).

Table 10. Dominant plant species in order of abundance for upland and bottom rangeland observation sites.

Grasses and Grasslike	<u>Upland Rangeland</u>
	Agropyron spp.
	Buchole dactyloides
	Bouteloua gracilis
	Stipa comata
	Poa spp.
	Bromus tectorum
	<u>Bottom Rangeland</u>
	Agropyron spp.
	Poa spp.
	Bromus tectorum
	Buchole dactyloides
	Distichlis stricta
	Carex filifolia
Forbs	<u>Upland and Bottom Rangeland</u>
	Salaginella densa
	Tragopogon dubius
	Melilotus officinalis
	Phlox hoodii
	Achillea lanulosa
	Taraxacum officinale
Shrubs	<u>Upland and Bottom Rangeland</u>
	Artemisia tridentata
	Artemisia frigida
	Artemisia cana

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