

AN ABSTRACT OF THE THESIS OF

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Title: USE OF RANGE SITES BY PRONGHORNS IN
SOUTH CENTRAL OREGON

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Relative use by pronghorns (Antilocapra americana) of 16 range sites was studied during summer and fall of 1971 and 1972 on Hart Mountain National Antelope Refuge, an area of high desert rangeland in south central Oregon. A Relative Use Index was developed based upon 1533 observations of pronghorns located on belts of known area to evaluate preference of pronghorns for range sites and condition class. A wide range in moisture conditions during the 2 years of the study affected soil moisture, succulence of vegetation, and availability of drinking water. In 1971, a year of above-average rainfall, pronghorns preferred upland xeric range sites, specifically Rocky Terrace that was dominated by Artemisia arbuscula. Below average rainfall occurred in 1972 and lowland mesic sites with succulent vegetation and water sources nearby were preferred by pronghorns during that year. Ninety-five percent of all

observations in 1972 were within 3200 meters of water. Juxtaposition of other sites appeared to be important in influencing use of specific range sites by pronghorns. Range sites with vegetation above 75 cm. in height and/or steep topography were not used as much as other sites by pronghorns. Average size of pronghorn groups increased from 4.2 in 1971 to 6.0 in 1972 when pronghorns concentrated on small lowland range sites near water. There was no apparent differential use of range sites by groups composed of different age and sex classes of pronghorns. A broad band of rough terrain and arid flat desert apparently acted as a natural barrier separating two populations of pronghorns on the refuge.

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In South Central Oregon

by

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USE OF RANGE SITES BY PRONGHORNS IN SOUTH CENTRAL OREGON

INTRODUCTION

The pronghorn (Antilocapra americana) is an important wildlife species of southeastern portion of Oregon and adjacent areas in Idaho, Nevada, and California. Much of the land utilized by pronghorn in Oregon is included in the High Desert Land Resource Area (Anderson and Greenfield, 1962). Range scientists have divided this resource area into a mosaic of range sites and classified the sites according to value for livestock management. The purpose of this study was to evaluate the range site concept for potential application for pronghorn management.

Utilization of various vegetation types by pronghorns has been studied in Montana by Cole (1956), Bayless (1969), and Campbell (1970) and in Wyoming by Sundstrom (1969) and Taylor (1971). However, the relationship between the pronghorn and the range site classification system has not been examined in the High Desert Area or in any other area, to my knowledge. Absence of knowledge concerning the range site-pronghorn relationship limits the appropriate consideration of pronghorns in grazing plans developed for the High Desert Area.

The specific objectives of the study were to describe observed

use of range sites within a portion of the High Desert Resource Area, determine if range sites were used uniformly with respect to group size and composition, and identify factors useful in characterizing pronghorn habitat.

DESCRIPTION OF THE STUDY AREA

Approximately 720 km² on Hart Mountain National Antelope Refuge, northeastern Lake County, south central Oregon, were selected for study for several reasons. Access and cooperation for the study had been assured under cooperative agreements with the Refuge Division, Bureau of Sport Fisheries and Wildlife. A variety of range sites occurring on the area had been identified and mapped, and records of past grazing and vegetation manipulation were available. Opportunities for additional research involving controlled manipulation of grazing and vegetation would be available through further cooperation.

Hart Mountain lies within the High Desert Resource Area (Anderson and Greenfield, 1962). Resource areas have been subdivided into a mosaic of rangeland classes called range sites (Anderson, 1956; Anderson and Greenfield, 1962). A range site is a distinctive rangeland that, in the absence of abnormal disturbance, has the potential to produce a unique association of plant species different from other range sites in kind and proportion of species and in total annual yield of usable forage for livestock (U. S. Department of Agriculture, 1967).

Each range site is classified more precisely on the basis of range condition (U. S. Department of Agriculture, 1967). Range

condition is defined as the present state of the vegetation on a range site relative to the climax plant community for that site. Condition classes are used to express the degree of departure from climax exhibited by the present composition of vegetation on each range site. Four condition classes or seral stages are recognized: excellent or climax, good, fair, and poor (U. S. Department of Agriculture, 1967). The four condition classes are defined in Appendix B, Table 1.

METHODS AND MATERIALS

Observations of pronghorns were recorded during the summer of 1971 and the summer and fall of 1972. Evaluations of range site preferences by pronghorns were based on these observations.

Sampling

The study area was divided into eight units to allow comparison of portions of the refuge that were ecologically different or spatially separated. This division also allowed comparison of use of a range site in all units where it occurred. Roads, fences, creeks, and canyons were used as identifiable boundaries separating units. Primitive roads transversing maximal numbers of range sites within units and passable with a 4-wheel drive jeep under normal weather conditions were selected as transect routes.

I determined 400 m to be the maximum distance allowing accurate location of a pronghorn under the conditions of the study. Thus the maximum width of a transect belt was 800 m, 400 m on each side of the road. Transect belts were plotted on mylar overlays of U. S. Geological Survey 7.5 minute quadrangle maps. When topographic features reduced visibility to less than 400 m, maximum distances were measured or estimated using contour lines on the map. Sampled areas of each range site in each

unit were measured from the overlays using a compensating polar planimeter. Total areas of each range site in each unit were obtained from the Soil Conservation Service range resource map of Hart Mountain National Antelope Refuge.

A variation of Hahn's (1949) cruise line method of counting observations within a known transect width was used to quantitate and compare use on sampled areas. Each observation of a pronghorn within the transect was considered one "unit of use." Transect routes were traversed during two 4-hour periods of the day. The first period began 10 to 20 minutes after sunrise and the second about 4 hours before sunset. Buechner (1950) observed that pronghorns were most active during these time periods. Einarsen (1948) and Prenzlou et al. (1968) noted feeding and traveling activities peaked during these periods.

Data recorded relative to each observation of pronghorn(s) included number in group, age (adult or kid), sex, activity (feeding, standing alert, or traveling), range site and condition class, and unit of the study area. The distance to the nearest known water source and the estimated height of vegetation in which the pronghorn was standing was recorded for each observation in 1972. Each group (one or more pronghorns) was classified as one of three types: type I--buck(s) only, type II--doe(s) in group without kids (bucks often present), and type III--kids(s) in group (bucks and does most

often present). Each observation of a group was plotted on mylar overlays of the topographic maps. Distance from the nearest known water source was determined from the topographic map after the observations had been plotted.

Two limitations were imposed upon data recorded from a transect to reduce variability of sighting, counting, and identifying pronghorns. Transects were traversed only on cloudy-bright or clear days, and only pronghorns standing within the limits of the transect when first sighted were counted.

Descriptions of vegetation were obtained from Soil Conservation Service publications (Cahoon, 1970) and from data compiled from field records made during the 1968-69 survey of range condition by personnel from the Soil Conservation Service. These data included species and percent canopy cover of vegetation based on ocular reconnaissance techniques (Appendix B Tables 2 through 5). Field sheets were obtained from the Lake County Soil Conservation Service District Office, Lakeview, Oregon.

Data on temperature and precipitation were obtained from the U. S. Department of Commerce weather station at Hart Mountain National Antelope Refuge headquarters.

Analysis

Analysis of data obtained using the belt-transect sampling

method required three assumptions: (1) flushing behavior of pronghorns was similar in all range sites; (2) ability of observer to locate and identify pronghorns along the sample routes was identical for all sites; and (3) sample routes were representative of the range site within the unit being sampled.

Acceptance of the first assumption required that pronghorns reacted in a similar manner to an approaching vehicle regardless of range site. Several sites typically associated with basins were invisible from a distance because of surrounding higher ground. This assumption warranted evaluation for these areas because of the possibility of early flight by pronghorns due to noise of the approaching vehicle. The simplest method to determine if premature flight was occurring in basin sites was to approach upwind on foot, observe, return to the vehicle, and proceed on the route noting if observations were the same. Five attempts at comparison were made. Pronghorns were observed on two occasions; their relative positions did not change. Based on these data and past observations of pronghorns in these basins, the first assumption appeared valid.

The narrow width of the transect belt (400 m on either side of the road) and absence of vegetation high enough to conceal a standing pronghorn allowed acceptance of the second assumption.

The third assumption was accepted because transect routes were unmaintained trails with minimal site disturbance and were

seldom used by humans. This assumption may not have been valid during the pronghorn and deer hunting seasons when hunter use of transect routes was common.

Statistical analysis of these data was not practical because of small sample size (10 completed samples in 1971, 25 completed samples in 1972). Instead, an index was developed to rank the range sites and units of the study area by their relative use.

Mean intensities of use by pronghorns (observations per km²) were calculated for each range site in each unit where the range site occurred and had been sampled using the following equation:

$$\bar{u}_{ij} = \frac{o_{ij}}{s_{ij}} \quad (1)$$

where \bar{u} = mean intensity of use,

o = observation of pronghorns,

s = sampled area,

i = range site,

j = unit of study area.

Intensities of use weighted by the total area of each range site in each unit where it occurred were calculated for all range sites and units using the following formula for each range site:

$$\bar{w}_i = \frac{\sum_{j=1}^n (\bar{u}_{ij}) (T_{ij})}{\sum_{j=1}^n T_{ij}} \quad (2)$$

and for each study unit:

$$\bar{w}_j = \frac{\sum_{i=1}^m (\bar{u}_{ij}) (T_{ij})}{\sum_{i=1}^m T_{ij}} \quad (3)$$

where \bar{w} = weighted mean intensity of use,

T = total area,

n = number of units,

m = number of range sites.

Weighted calculations were necessary because range sites were not equally represented in all units where they occurred.

An overall intensity of use was calculated for the entire study area for each sampling period with the following formula:

$$\bar{SA} = \frac{\sum_{i=1}^m \sum_{j=1}^n (\bar{u}_{ij}) (T_{ij})}{\sum_{i=1}^m \sum_{j=1}^n T_{ij}} \quad (4)$$

where \bar{SA} = overall intensity of use of the study area during a sampling period.

In order to compare the intensity of use of a range site in one unit to the use of the same range site in another unit, it would be necessary to assume that an equal number of pronghorns had the opportunity to use each site. Weighted mean intensities of use for units indicated, however, that some units had a greater density of pronghorns than others during a given sampling period. Therefore, it was necessary to calculate use by pronghorns of each range site relative to the weighted mean use of the study unit in which they occurred. The result of dividing the mean use of a range site by the weighted mean use of the unit in which it occurred was called the Relative Use Index. A similar calculation was also used to compare relative weighted use of range sites and units between sampling periods when the overall use was different.

Robel et al. (1970) used a habitat preference index to evaluate relative usage of three range sites and three other vegetative types by greater prairie chickens (Tympanuchus cupido pinnatus) in Kansas. A habitat preference index greater than 1.0 indicated greater than "average" use and implied that there was a preference for that type. A value of less than 1.0 indicated avoidance or at least less than "average" use. In a similar manner the Relative Use Index (RUI) indicated relative preference for range sites within a given area (a specific unit or the study area) and allowed comparison

of the relative use of range sites in different areas and during different sample periods.

Observations of pronghorns were classified by their distance to water (400-m intervals) and by height of vegetation (15-cm intervals) in which they were standing. Percentages observed in each distance and height interval were calculated for each group type.

RESULTS

Categorization of the Study Area

Range Sites

Twenty-six range sites were identified on Hart Mountain National Antelope Refuge from data collected by the Soil Conservation Service during the range condition survey made in 1968 and 1969 (Cahoon, 1970). Nineteen of these range sites occurred on the study area. Three range sites, inaccessible by jeep, were not sampled. Condition classes for the remaining range sites varied from poor to good. No range sites were classed as excellent on the refuge.

The 16 range sites were classified into four categories based on their topography (percent slope), average annual precipitation, elevation, and location in the study area. These categories were: upland xeric, upland mesic, transition, and lowland mesic.

Three range sites were classified as upland xeric: Arid Loamy Terrace, Rocky Terrace, and Semi-Desert Terrace. These sites occurred throughout the flat, dry (20 to 30 cm of precipitation annually), lower elevations of the refuge, and occupied 61 percent of the study area (Figure 1).

Gravelly Ridgetop, High Rolling Hills, Rolling Hills, and Shrubby North Complex were classified as upland mesic. These

range sites occurred at higher elevations of the central and western portion of the study area and were characterized by steep terrain and by relatively high precipitation (38 cm annually). These range sites occupied 14.9 percent of the total study area (Figure 1). High Rolling Hills occupied all of the large plateau on the western edge of the study area. Most of this plateau had a slope gradient of less than 10 percent (U. S. Department of Agriculture, 1969).

Six range sites were classified as transition. These were Claypan Terrace, Droughty Bottomland Fan, Lakebed Terrace, Moist Bottomland Fan, Platy Terrace, and Shrubby Terrace Complex. Approximately 5 percent of Shrubby Terrace Complex was Claypan Terrace, 5 percent was Moist Bottomland Fan, 30 percent was Rocky Terrace, and 60 percent was Shrubby Terrace. Range sites in the transition category had intermediate annual precipitation (25 to 30 cm) and occupied 18.0 percent of the total study area (Figure 1).

Three range sites were placed in the lowland mesic category: Intermittent Lake, Semi-Wet Meadow, and Lakebed. These sites had little slope and low to intermediate rainfall. They were commonly intermixed among the upland xeric and transition sites (Figure 1). Clay surface layers and subsoil of these range sites allowed them to retain much of their annual precipitation (Cahoon, 1970). Semi-Wet Meadow was dissimilar from the other two lowland mesic sites in that it occurred along narrow bottomlands and drainageways

Figure 1. Range site categories and study units on the Hart Mountain study area.

LEGEND

RANGE SITE CATEGORIES:

UPLAND XERIC

UPLAND MESIC

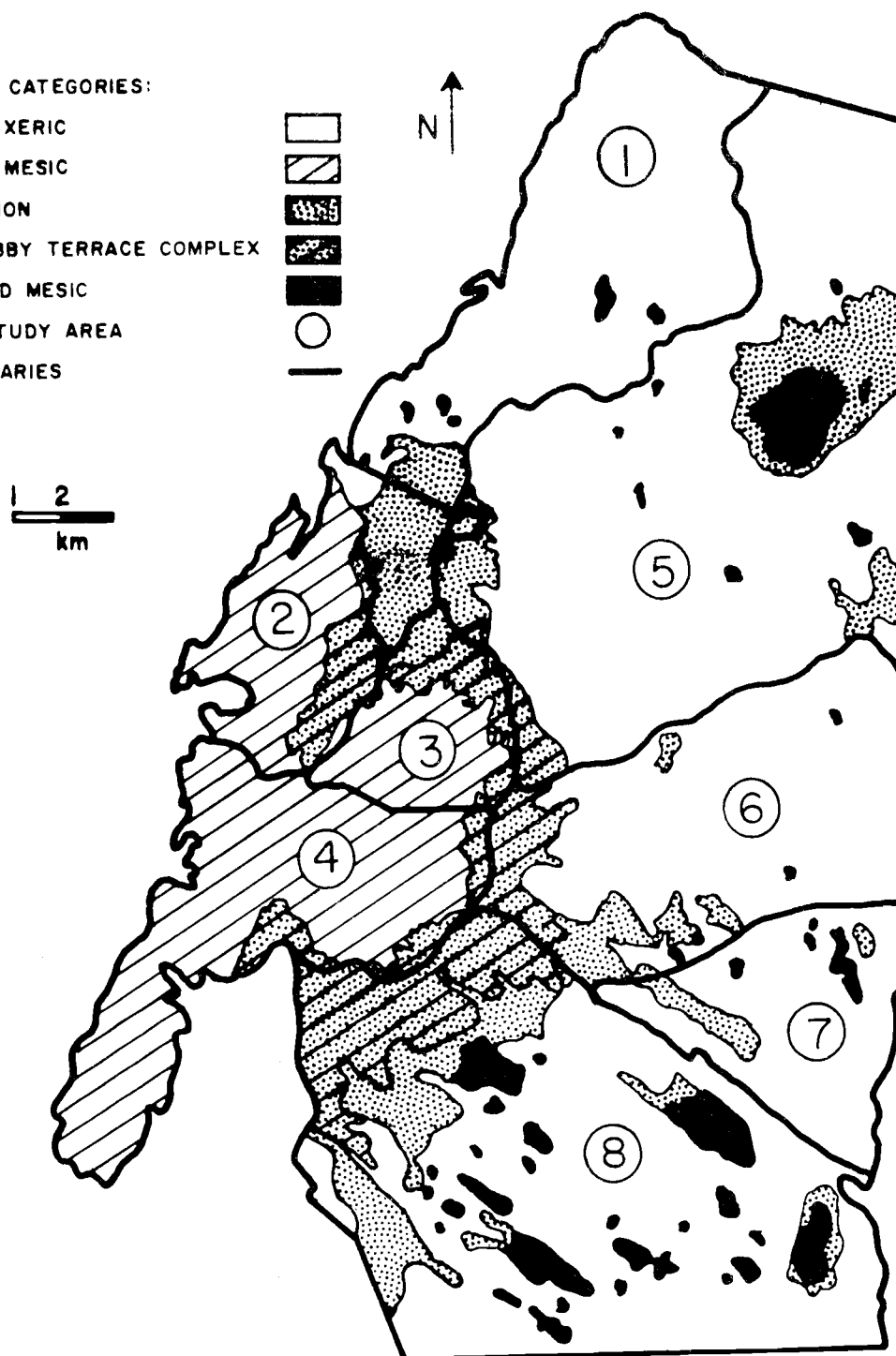
TRANSITION

SHRUBBY TERRACE COMPLEX

LOWLAND MESIC

UNITS OF STUDY AREA

UNIT BOUNDARIES



rather than in small basins as did Lakebed and Intermittent Lake sites (Cahoon, 1970). Lowland mesic types occupied 3.9 percent of the study area (Figure 1).

Geographical Units

The eight units of the study area (Figure 1) varied in the composition of range sites. Rangeland in Units 1, 5, 6, 7, and 8 consisted primarily of upland xeric range sites (Table 1). These units also contained a variety of transition and lowland mesic sites but lacked upland mesic sites.

Fifty-seven, 62 and 89 percent of the rangeland in Units 2, 3, and 4, respectively, were comprised of upland mesic range sites (Table 1). Unit 4 also contained transition sites. Unit 3 had all sites represented except upland xeric. All four site categories were represented in unit 2.

Known water sources included creeks, springs, lakebeds, and trench reservoirs. Availability of water varied from year to year and was dependent on the amount of winter and spring precipitation and on water carried over from the previous year. Several water sources were dry during a portion of the study (Figure 2).

Incidence of Fire and Spraying

On 10 September 1954, an accidental fire burned 50 percent

Table 1. Percentage composition by categories of range sites on the study area and in each unit of the study area. Number of range site-condition classes represented is in parenthesis.

Unit	Percent of Study Area	Categories of Range Sites			
		Upland Xeric	Upland Mesic	Transition	Lowland Mesic
		61	15	18	4
1 ^a	12	81 (5)		4 (2)	2 (2)
2	6	5 (2)	57 (3)	36 (6)	2 (1)
3	4		62 (3)	38 (4)	
4 ^b	10		89 (5)	10 (1)	
5	24	80 (6)		16 (7)	4 (1)
6	12	85 (2)		14 (5)	1 (1)
7	6	88 (2)		9 (3)	3 (2)
8	26	63 (4)		28 (7)	9 (3)

^aOne range site not sampled occupied 13 percent of the unit area

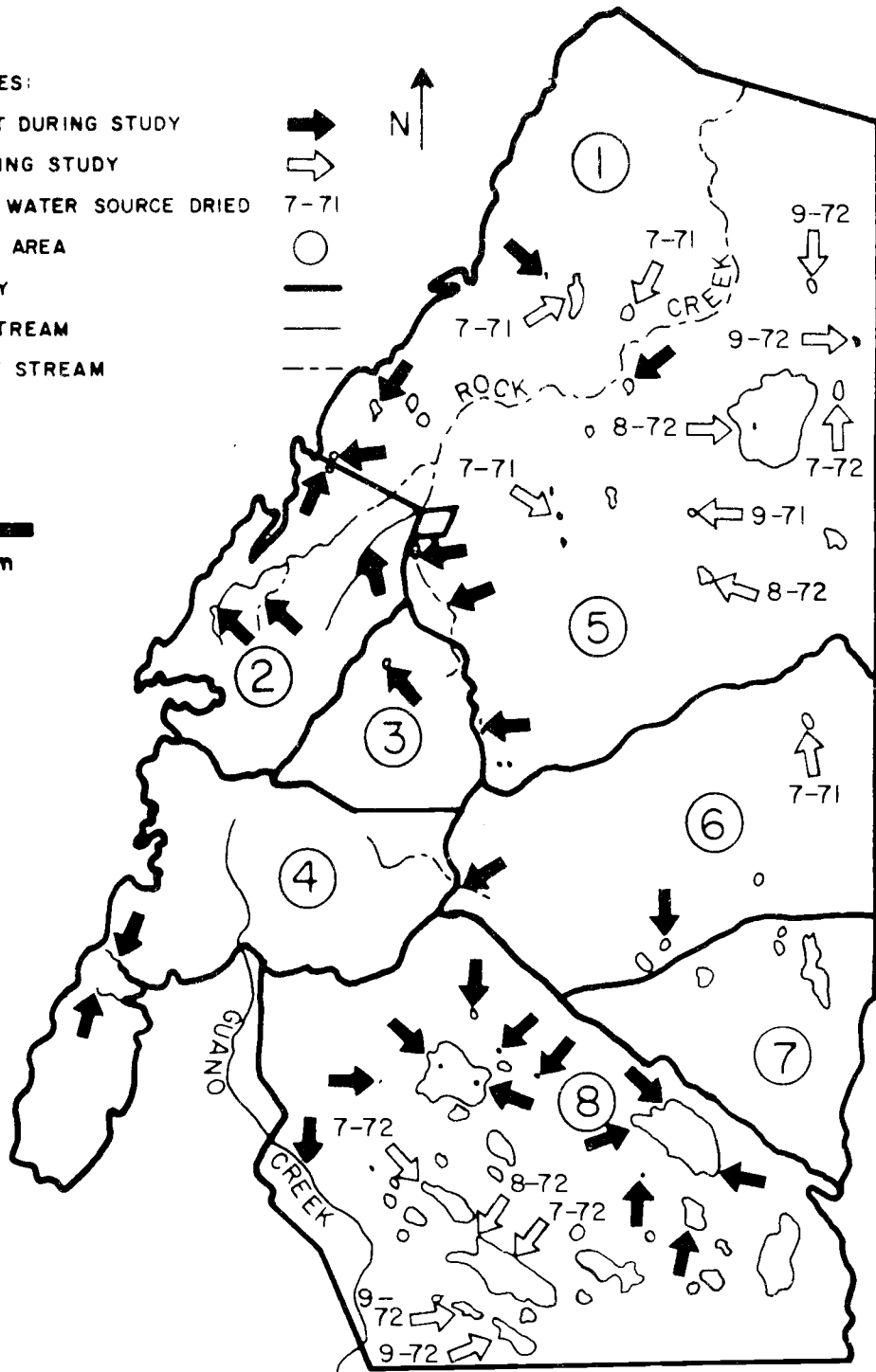
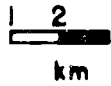
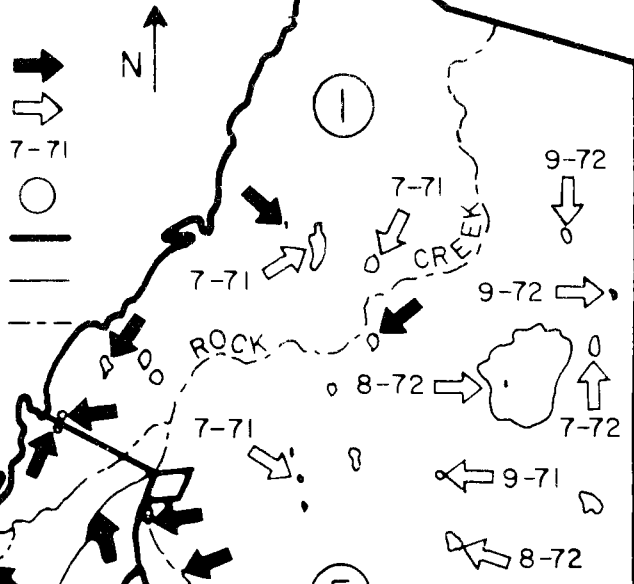
^bOne range site not sampled occupied 1 percent of the unit area.

Figure 2. Known water sources on the Hart Mountain study area.

LEGEND

WATER SOURCES:

- PERMANENT DURING STUDY
- DRIED DURING STUDY
- MONTH-YEAR WATER SOURCE DRIED
- UNIT OF STUDY AREA
- UNIT BOUNDARY
- PERMANENT STREAM
- INTERMITTENT STREAM



of the rangeland in Unit 2 currently classified as High Rolling Hills (Narrative Report, 1954). The portion of High Rolling Hills occurring in Unit 4 was not affected. Approximately 46 percent of the transect belt in Unit 2, High Rolling Hills, occurred in the 17-year-old burn.

Another fire occurred on the study area during the second summer of field work. Approximately 26.3 km² burned in late August and early September in Units 2 and 8. No observations of pronghorns were recorded on the burned area in 1971 or 1972, either before or after the fire. Therefore, this burn did not affect results of the study.

From 1962 to 1967 several sagebrush control spray projects were executed. Aerial applications of 2-4, D were made on 9.4 km² of the study area. The only results reported were those for the spraying conducted in June 1967. An apparent kill of 90 percent was reported for Artemisia spp. and Chrysothamnus spp. at the end of the 1967 growing season (Narrative Report, 1967). No further data were reported. Five range sites that had been sprayed and were sampled were: Claypan Terrace (fair condition), Moist Bottomland Fan (fair condition), and Platy Terrace (fair condition) in Unit 5; and Platy Terrace (good condition) and Semi-Wet Meadow (fair condition) in Units 1 and 2.

Use of Range Sites and Units

Use by pronghorns of sample belts was recorded from 14 July to 11 September 1971 and from 29 June to 10 November 1972. Each route was traveled 10 times in 1971 and 25 times in 1972. A total of 1533 observations of pronghorns was classified, 399 in 1971 and 1134 in 1972.

Each transect route was traversed once in the morning and once in the evening to constitute a sample. Samples were combined into five periods for analysis. Combinations were based on moisture, temperature, range condition, plant phenology, man-caused disturbance, and pronghorn behavior patterns. These factors may have affected pronghorn use of range sites and units of the study area and therefore were analyzed separately.

Two samples in 1971 and six samples in 1972 were taken during the summer period (late June to mid-August). This period was characterized in both years by low amounts of precipitation (1971--trace, 1972--0.1 cm) and average temperatures for that time of year. The mean temperatures for July and August 1971 and 1972, respectively, were 65^oF and 63^oF (U. S. Department of Commerce, 1971 and 1972).

Early fall observations in both years consisted of two samples obtained from late August to early October. Notable changes in

environmental factors and behavior occurred during this period. Average temperature dropped (16°F in 1971 and 13°F in 1972) and precipitation increased (4.34 cm in 1971 and 2.03 cm in 1972) from August to September both years. Flower development and bloom of Artemisia spp. occurred during this period. Onset of pronghorn rutting activities was also observed.

Three samples in 1972 were taken in late fall (October, November). Minimum temperatures for this period averaged 27°F , and a total of 3.3 cm of precipitation fell as rain and snow. New growth of cool season range plants was noted early in the sample period. Horn casting was recorded in mid-November.

One sample was taken each year during the mid-August 5-day hunting season for buck pronghorn. A sample was also obtained during the 1972 general deer season in the first half of October. Use of transect roads by hunters in vehicles was common throughout these sample periods. The lower number of observations during these periods (Table 2) suggested that hunter vehicle activity inhibited pronghorn use of transect belts. Based on this information, these data were analyzed separately from seasonal data.

Use of Range Site Categories

Yearly differences in relative use of categories were obvious only in the summer sample (Table 2). During the summer sample

Table 2. Relative use indices for pronghorns for four categories of range sites during five sample periods in 1971 and 1972 on the Hart Mountain study area.

Sample Period Year	Number of Observations	Categories of Range Sites			
		Upland Xeric	Upland Mesic	Transi- tion	Lowland Mesic
Summer					
1971	185	1.3	0.4	0.7	0.4
1972	661	0.6	1.2	1.8	4.7
Pronghorn Hunt					
1971	61	1.2	0.8	0.2	2.9
1972	26	1.5	-	0.3	-
Early Fall					
1971	153	1.2	0.2	0.1	5.5
1972	287	1.1	0.1	0.7	4.6
Deer Hunt					
1972	18	1.5	-	0.1	-
Late Fall					
1972	142	1.4	-	0.1	1.8

period, 1971, only upland xeric sites were preferred (RUI of 1.3). In 1972 all categories except upland xeric were preferred; strongest preference (RUI of 4.7) was shown for the lowland mesic category. Variations in use of categories were not apparent in early fall. Because hunter disturbance occurred during the Pronghorn Hunt period, early fall was the only other period where comparison was possible.

Relative use of range site categories on the study area varied between samples. The major changes in use occurred from summer to early fall in both years. Although preference for upland xeric sites was about the same in summer and early fall of 1971, relative use in 1972 more than doubled as sampling progressed. Conversely, relative use of range sites in the lowland mesic category increased 10 times from summer to early fall in 1971 and remained the same in both samples in 1972. Relative use of upland xeric and lowland mesic sites was almost identical in late fall. Range sites in the upland mesic and transition categories, as a group, were not preferred by pronghorns. Preference was indicated only in summer, 1972, when use of upland xeric sites was low. Relative use of these range sites was low again by early fall.

Use of Range Sites

Overall use indices of 16 range sites (by condition classes)

were calculated for five sample periods in 1971 and 1972. The RUI of each site in each unit where it was sampled was calculated for three sampling periods. Data showing the RUI of sites in each unit are not presented for the Pronghorn and Deer Hunt periods because of small sample size and disturbances during the sampling process.

Summer. Usage of range sites differed between summers of 1971 and 1972. Eleven of 25 sites received use in 1971, six of these were preferred by pronghorns. In 1972, 18 of 25 sites were used, and 11 were preferred. More sites were used in all categories in 1972 with notable increases in use of sites in transition and lowland mesic categories (Table 4). Strong preferences were apparent in 1971 for Rocky Terrace (poor condition), an upland xeric site; and for Lakebed Terrace (poor condition), Moist Bottomland Fan (poor condition), and Platy Terrace (good condition), all transition sites (Table 3). In 1972, pronghorns exhibited greatest preference for all lowland mesic sites and the following five transition sites: Claypan Terrace (fair condition), Lakebed Terrace (poor condition), Moist Bottomland Fan (poor and fair condition), Platy Terrace (good condition) (Table 4). No upland xeric site was preferred in 1972.

The relative usage of range sites varied between units. Indices of sites within units, however, reflected the same trends between 1971 and 1972 as indicated above in overall usage of range sites and in usage of categories of range sites. Exceptions occurred in Units

Table 3. Relative Use Indices for pronghorns for 25 range sites arranged by condition class and the Relative Use Index of each range site in each unit in which it occurred on the Hart Mountain study area in summer, 1971.

Range Site Category Range Site	(Condition)	RUI ^a	Units of the Study Area							
			1	2	3	4	5	6	7	8
Upland Xeric										
Arid Loamy Terrace	(Poor)	0.0								0.0
	(Fair)	0.0					0.0			
Rocky Terrace	(Poor)	7.0	8.5							2.7
	(Fair)	0.6	0.4	3.5			1.2	2.4	0.0	0.4
	(Good)	0.0	0.0							
Semi-Desert Terrace	(Fair)	0.3				0.8	0.0	0.0	0.0	
Upland Mesic										
Gravelly Ridgetop	(Good)	0.0			0.0	0.0				
High Rolling Hills	(Fair)	0.0		0.0		0.0				
	(Good)	0.6		1.5		0.0				
Rolling Hills	(Good)	0.8			2.2	0.0				
Shrubby North Complex	(Good)	0.0		0.0		0.0				
Transition										
Claypan Terrace	(Poor)	0.0		0.0						0.0
	(Fair)	1.3		0.0			0.9		0.0	1.1
Droughty Bottomland Fan	(Poor)	0.0					0.0			
Lakebed Terrace	(Poor)	2.4					3.2			
Moist Bottomland Fan	(Poor)	2.5								1.1
	(Fair)	1.0					12.7	0.0	0.0	
Platy Terrace	(Fair)	0.0		0.0	0.0		0.0	0.0		
	(Good)	4.3	4.1	4.5						
Shrubby Terrace Complex	(Fair)	0.0		0.0		0.0				0.0
	(Good)	0.0		0.0	0.0			0.0		0.0
Lowland Mesic										
Intermittent Lake	(Poor)	0.0								0.0
	(Fair)	0.0								0.0
Semi-Wet Meadow	(Fair)	0.0	0.0	0.0						
Lakebed		0.8	2.9				0.2			0.4

^aOverall Relative Use Index for each range site - condition class.

Table 4. Relative Use Indices for pronghorns for 25 range sites arranged by condition class and the Relative Use Index of each range site in each unit in which it occurred on the Hart Mountain study area in summer, 1972.

Range Site Category Range Site	(Condition)	RUI ^a	Units of the Study Area							
			1	2	3	4	5	6	7	8
Upland Xeric										
Arid Loamy Terrace	(Poor)	0.0								0.0
	(Fair)	0.0					0.0			
Rocky Terrace	(Poor)	0.8	0.0							0.8
	(Fair)	0.5	0.5	0.0			0.1	3.0	0.0	1.5
	(Good)	0.4	0.6							
Semi-Desert Terrace	(Fair)	0.3				0.6	0.0	0.0	0.0	
Upland Mesic										
Gravelly Ridgetop	(Good)	0.2			0.3	0.0				
High Rolling Hills	(Fair)	2.5		8.8		0.0				
	(Good)	1.6		0.8		0.0				
Rolling Hills	(Good)	0.0			0.0	0.0				
Shrubby North Complex	(Good)	0.0		0.0		0.0				
Transition										
Claypan Terrace	(Poor)	0.3		0.0						0.2
	(Fair)	3.5		0.0			8.3		0.0	1.0
Droughty Bottomland Fan	(Poor)	0.0					0.0			
Lakebed Terrace	(Poor)	3.2					2.6			
Moist Bottomland Fan	(Poor)	4.9								3.8
	(Fair)	4.9					36.8	0.0	28.3	
Platy Terrace	(Fair)	0.0		0.0	0.0		0.0	0.0		
	(Good)	7.6	9.9	2.5						
Shrubby Terrace Complex	(Fair)	0.0		0.0		0.0				0.0
	(Good)	1.3		0.1	2.8			0.0		0.0
Lowland Mesic										
Intermittent Lake	(Poor)	4.8								3.8
	(Fair)	2.7								2.2
Semi-Wet Meadow	(Fair)	5.5	2.4	2.5						
Lakebed		5.1	0.0				7.1			2.6

^aOverall Relative Use Index for each range site - condition class.

1, 6, and 8. In Unit 1, the RUI (2.9) indicated preference for Lakebed in 1971, whereas no use (RUI of 0.0) occurred in 1972. Increased usage was noted in 1972 for Rocky Terrace (fair condition) in Units 6 and 8 (Table 4). Both of these instances conflicted with use patterns of upland xeric and lowland mesic categories between summers, 1971 and 1972 (Table 2).

Early Fall. Although relative use of range site categories was similar in early fall of 1971 and 1972 (Table 2), relative usage of individual range sites differed between years (Tables 5 and 6). Eleven sites were used in 1971 with six preferred, and 14 were used in 1972 with seven preferred. Of the six preferred sites in 1971, only two--Rocky Terrace (poor condition) and Lakebed--were preferred in 1972. Six of 14 sites used in 1972 had not been used in 1971. Most obvious changes in intensity of use occurred in Arid Loamy Terrace (fair condition), an upland xeric site, and in several sites of the transition and lowland mesic categories. Intermittent Lake (poor and fair condition) and Moist Bottomland Fan (poor condition) were most preferred in early fall, 1971 (Table 5). In 1972, pronghorns exhibited greatest preference for Semi-Wet Meadow (fair condition) and Arid Loamy Terrace (fair condition) (Table 6). No upland mesic site was preferred either year.

Relative Use Indices of sites within units reflected overall differences in use of range sites between years. Two exceptions

Table 5. Relative Use Indices for pronghorns for 25 range sites arranged by condition class and the Relative Use Index of each range site in each unit in which it occurred on the Hart Mountain study area in early fall, 1971.

Range Site Category Range Site	(Condition)	RUI ^a	Units of the Study Area							
			1	2	3	4	5	6	7	8
Upland Xeric										
Arid Loamy Terrace	(Poor)	0.0								0.0
	(Fair)	0.0					0.0			
Rocky Terrace	(Poor)	1.7	0.0							0.7
	(Fair)	0.5	0.4	0.0			0.0	1.2	0.0	0.6
	(Good)	0.0	0.0							
Semi-Desert Terrace	(Fair)	2.2					2.6	1.1	0.0	7.0
Upland Mesic										
Gravelly Ridgetop	(Good)	0.0			0.0	0.0				
High Rolling Hills	(Fair)	0.3		8.9		0.0				
	(Good)	0.4		1.5		0.0				
Rolling Hills	(Good)	0.0			0.0	0.0				
Shrubby North Complex	(Good)	0.0		0.0		0.0				
Transition										
Claypan Terrace	(Poor)	0.0		0.0						0.0
	(Fair)	0.2		0.0			0.0		0.0	0.2
Droughty Bottomland Fan	(Poor)	0.0					0.0			
Lakebed Terrace	(Poor)	0.0					0.0			
Moist Bottomland Fan	(Poor)	3.8								1.3
	(Fair)	0.1					0.0	0.0	19.0	
Platy Terrace	(Fair)	0.0		0.0	0.0		0.0	0.0		
	(Good)	0.0	0.0	0.0						
Shrubby Terrace Complex	(Fair)	0.0		0.0		0.0				0.0
	(Good)	0.0		0.0	0.0			0.0		0.0
Lowland Mesic										
Intermittent Lake	(Poor)	14.9								5.0
	(Fair)	10.7								3.6
Semi-Wet Meadow	(Fair)	0.0	0.0	0.0						
Lakebed		2.3	46.2				0.7			0.3

^a Overall Relative Use Index for each range site - condition class.

Table 6. Relative Use Indices for pronghorns for 25 range sites arranged by condition class and the Relative Use Index of each range site in each unit in which it occurred on the Hart Mountain study area in early fall, 1972.

Range Site Category Range Site	(Condition)	RUI ^a	Units of the Study Area							
			1	2	3	4	5	6	7	8
Upland Xeric										
Arid Loamy Terrace	(Poor)	0.0								0.0
	(Fair)	6.8					5.1			
Rocky Terrace	(Poor)	1.0	0.0							1.4
	(Fair)	0.9	1.5	2.1			0.3	2.5	0.6	1.4
	(Good)	0.7	0.6							
Semi-Desert Terrace	(Fair)	0.6					1.0	0.0	0.0	0.0
Upland Mesic										
Gravelly Ridgetop	(Good)	0.0			0.0	0.0				
High Rolling Hills	(Fair)	0.0		0.0		0.0				
	(Good)	0.2		0.1		0.0				
Rolling Hills	(Good)	0.0			0.0	0.0				
Shrubby North Complex	(Good)	0.0		0.0		0.0				
Transition										
Claypan Terrace	(Poor)	1.0		2.6						0.5
	(Fair)	1.5		0.0			0.0		8.9	2.6
Droughty Bottomland Fan	(Poor)	0.0					0.0			
Lakebed Terrace	(Poor)	0.0					0.0			
Moist Bottomland Fan	(Poor)	0.0								0.0
	(Fair)	0.8					0.0	0.0	8.6	
Platy Terrace	(Fair)	0.0		0.0	0.0		0.0	0.0		
	(Good)	2.5	0.0	1.9						
Shrubby Terrace Complex	(Fair)	0.0		0.0		0.0				0.0
	(Good)	0.9		0.0	2.9			0.0		0.0
Lowland Mesic										
Intermittent Lake	(Poor)	0.6								0.7
	(Fair)	0.0								0.0
Semi-Wet Meadow	(Fair)	70.5	0.0	37.9						
Lakebed		1.4	0.0					0.2		2.6

^a Overall Relative Use Index for each range site - condition class.

occurred: relative usages of Rocky Terrace (poor condition) and Lakebed in Unit 8 were greater in 1972 although the overall RUI of each range site was less (Table 6).

Late Fall. Fewer range sites were used in late fall, 1972, than in any previous sampling periods. Six of 25 sites received use; four of these were preferred by pronghorns (Table 7). Use was recorded on one or more sites of all categories except upland mesic. Only Rocky Terrace (fair condition) was used in more than one unit; pronghorns exhibited strong preference for it in five of six units in which it occurred. Three other sites received strong preference in one unit: Lakebed in Unit 1, Rocky Terrace (fair condition) in Unit 2, and Moist Bottomland Fan (fair condition) in Unit 7.

Pronghorn and Deer Hunts. Relative use of individual range sites during hunting season, as depicted by relative use indices, differed from one another and from those periods before and after the seasons (Table 8). Even though the same number of buck pronghorn tags (15) were issued in 1971 and 1972 and hunter vehicle use was similar, relative use of range sites by pronghorns was different each year. Relative use was greatest in Arid Loamy Terrace (fair condition) and Intermittent Lake (poor condition) during the Pronghorn Hunt period, 1971 (Table 8). No range sites in the transition category were preferred during that period. Three upland xeric and two transition range sites received similar use during the 1972

Table 7. Relative Use Indices for pronghorns for 25 range sites arranged by condition class and the Relative Use Index of each range site in each unit in which it occurred on the Hart Mountain study area in late fall, 1972.

Range Site Category Range Site	(Condition)	RUI ^a	Units of the Study Area							
			1	2	3	4	5	6	7	8
Upland Xeric										
Arid Loamy Terrace	(Poor)	0.0								0.0
	(Fair)	1.1					0.5			
Rocky Terrace	(Poor)	0.1	0.0							0.4
	(Fair)	3.1	1.5	22.5			2.7	3.0	0.0	2.9
	(Good)	0.0	0.0							
Semi-Desert Terrace	(Fair)	0.0				0.0	0.0	0.0	0.0	
Upland Mesic										
Gravelly Ridgetop	(Good)	0.0			0.0	0.0				
High Rolling Hills	(Fair)	0.0		0.0		0.0				
	(Good)	0.0		0.0		0.0				
Rolling Hills	(Good)	0.0			0.0	0.0				
Shrubby North Complex	(Good)	0.0		0.0		0.0				
Transition										
Claypan Terrace	(Poor)	0.0		0.0						0.0
	(Fair)	0.9		0.0			0.0		0.0	7.0
Droughty Bottomland Fan	(Poor)	0.0					0.0			
Lakebed Terrace	(Poor)	0.0					0.0			
Moist Bottomland Fan	(Poor)	0.0								0.0
	(Fair)	1.4					0.0	0.0	32.1	
Platy Terrace	(Fair)	0.0		0.0	0.0		0.0	0.0		
	(Good)	0.0	0.0	0.0						
Shrubby Terrace Complex	(Fair)	0.0		0.0		0.0				0.0
	(Good)	0.0		0.0	0.0			0.0		0.0
Lowland Mesic										
Intermittent Lake	(Poor)	0.0								0.0
	(Fair)	0.0								0.0
Semi-Wet Meadow	(Fair)	0.0	0.0	0.0						
Lakebed		3.0	10.2				0.0			0.0

^a Overall Relative Use Index for each range site - condition class.

Table 8. Relative Use Indices for pronghorns for 25 range sites arranged by condition class on the Hart Mountain study area during the Pronghorn and Deer Hunt sample periods.

Range Site Category Range Site	(Condition)	Sample Period		
		Pronghorn Hunt		Deer Hunt
		1971	1972	1972
Upland Xeric				
Arid Loamy Terrace	(Poor)	0.0	0.0	0.0
	(Fair)	15.5	0.0	0.0
Rocky Terrace	(Poor)	2.9	1.8	0.0
	(Fair)	0.1	2.0	3.1
	(Good)	0.0	0.0	0.0
Semi-Desert Terrace	(Fair)	0.0	1.0	0.0
Upland Mesic				
Gravelly Ridgetop	(Good)	0.0	0.0	0.0
High Rolling Hills	(Fair)	2.0	0.0	0.0
	(Good)	0.9	0.0	0.0
Rolling Hills	(Good)	0.0	0.0	0.0
Shrubby North Complex	(Good)	0.0	0.0	0.0
Transition				
Claypan Terrace	(Poor)	0.0	0.0	0.0
	(Fair)	0.3	2.0	1.6
Droughty Bottomland Fan	(Poor)	0.0	0.0	0.0
Lakebed Terrace	(Poor)	0.8	1.5	0.0
Moist Bottomland Fan	(Poor)	0.7	0.0	0.0
	(Fair)	0.3	0.0	0.0
Platy Terrace	(Fair)	0.7	0.0	0.0
	(Good)	0.5	0.0	0.0
Shrubby Terrace Complex	(Fair)	0.0	0.0	0.0
	(Good)	0.0	0.0	0.0
Lowland Mesic				
Intermittent Lake	(Poor)	7.7	0.0	0.0
	(Fair)	0.0	0.0	0.0
Semi-Wet Meadow	(Fair)	0.0	0.0	0.0
Lakebed		2.3	0.0	0.0

Pronghorn Hunt; only one, Rocky Terrace (poor condition) had been preferred in 1971. In spite of more deer hunters and probably greater disturbance in the study area during the Deer Hunt period, 1972, preferences for range sites by pronghorns resembled those shown during the 1972 Pronghorn Hunt. Two range sites, Rocky Terrace (poor condition) and Claypan Terrace (fair condition) were preferred in both of these sample periods in 1972.

Use of Units

Pronghorn preferences for units of the study area varied from sample to sample and between years (Table 9). Units 1, 2, 3, 4, and 8 were used most consistently and received higher preference ratings than other units during all undisturbed samples. Units 6 and 7 received indices above 0.5 only during the 1972 pronghorn season, whereas Unit 4 received almost no use. Relative usage of Unit 1 decreased from summer to early fall in 1971 and increased from summer to late fall in 1972. Units 2, 3, and 5 were preferred in summer and early fall in 1972 but not in 1971. Pronghorns preferred Unit 8 during all samples in 1971 but only during summer and Pronghorn Hunt periods in 1972.

Use Patterns of Pronghorn Groups

Pronghorn groups observed ranged in size from 1 to 55

Table 9. Relative Use Indices of eight units of the Hart Mountain study area during five sampling periods in 1971 and 1972.

Sample Period Year	Units of the Study Area							
	1	2	3	4	5	6	7	8
Summer								
1971	1.2	0.8	0.6	0.1	0.7	0.1	0.0	2.3
1972	0.7	3.8	1.5	0.0	1.2	Tr ^a	Tr	1.3
Pronghorn Hunt								
1971	0.5	2.2	0.0	0.0	1.8	0.1	Tr	1.5
1972	0.0	0.1	0.0	0.0	0.1	3.0	1.8	1.8
Early Fall								
1971	0.5	0.5	0.0	0.0	0.2	0.5	Tr	3.0
1972	1.1	3.6	1.0	0.0	1.3	0.3	0.3	0.9
Deer Hunt								
1972	9.5	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Late Fall								
1972	4.1	Tr	0.0	0.0	2.0	Tr	0.1	0.2

^aTrace (Tr) = less than 0.05.

animals in 1971 and 1972. Groups averaged smaller in size in 1971 than in 1972 (Table 10). Average sizes were smaller in summer and early fall than during the late fall period. Deviations from the mean group size were most common in the summer period. Smaller than average groups were recorded in upland mesic and lowland mesic sites in summer, 1971, and in upland xeric sites in summer, 1972. Larger than average groups were recorded in upland mesic sites in summer, 1972.

Use of range sites by pronghorn group types, based on percentage of observations, varied between years in summer more than any other sample period (Table 11). The most obvious changes were increased use by Type III groups in upland mesic and lowland mesic sites in 1972. In summer, 1971, many pronghorns were in Type I and II groups while most were in Type III groups in 1972. A high percentage of observations of Type III groups occurred in early and late fall of both years.

Relationship to Water

Relative percentages of observations at various distances from water during summer indicated that use of rangeland by pronghorns decreased sharply at distances of 2000 meters or more from water (Table 12). The mean distance to water for all observed pronghorns during summer was 725.6 m. Distribution of groups of Types I

Table 10. Mean group size for pronghorns observed in four categories of range sites during three sampling periods in 1971 and 1972 on the Hart Mountain study area. Numbers of pronghorn groups in parentheses.

Sample Period Year	Average Size	Categories of Range Sites			
		Upland Xeric	Upland Mesic	Transi- tion	Lowland Mesic
Summer					
1971	4.2	4.8 (21)	1.6 (8) ^a	6.0 (11)	1.3 (4) ^a
1972	6.2	2.8 (31)	11.6 (11)	7.5 (32)	4.6 (33)
Early Fall					
1971	4.0	4.2 (17)	2.5 (4) ^a	2.5 (8)	5.8 (9)
1972	6.4	6.3 (22)	1.3 (3) ^a	8.6 (11)	5.4 (9)
Late Fall					
1972	10.9	9.0 (9)	--	10.0 (3)	31.0 (1)

^aBased on 15 or fewer observations of pronghorns.

Table 11. Percentages of observations of pronghorns that occurred in three group types in four categories of range sites during three sampling periods in 1971 and 1972 on the Hart Mountain study area.

Sample Period Year	Categories of Range Sites											
	Upland Xeric			Upland Mesic			Transition			Lowland Mesic		
	I ^a	II ^b	III ^c	I	II	III	I	II	III	I	II	III
Summer												
1971	16	19	65	69	31	0 ^d	5	52	43	80	20	0 ^d
1972	35	6	59	4	0	96	5	3	92	12	9	79
Early Fall												
1971	10	25	65	70	30	0 ^d	30	0	70	7	12	81
1972	3	9	88	50	50	0 ^d	1	4	95	6	5	89
Late Fall												
1972	4	16	80	--	--	--	0	44	56	0	0	100

^a Groups of bucks only.

^b Groups with does but no kids.

^c Groups with kids.

^d Percentages based on 15 or fewer observations.

Table 12. Percentages of pronghorns observed by group type at 400-m intervals from known water sources during three sampling periods in 1971 and 1972 on the Hart Mountain study area.

Sample Period Pronghorn Group	Distance Class (m)										
	0- 400	401- 800	801- 1200	1201- 1600	1601- 2000	2001- 2400	2401- 2800	2801- 3200	3201- 3600	3601- 4000	4001+
Summer											
I	30	27	13	14	11	3	1	--	--	--	1
II	80	12	--	--	8	--	--	--	--	--	--
III	53	12	12	6	13	1	3	--	--	--	--
Early Fall											
I	40	--	20	20	20	--	--	--	--	--	--
II	13	--	14	10	24	10	--	10	--	19	--
III	38	14	5	14	2	--	13	--	4	9	1
Late Fall											
I	67	--	--	--	--	--	--	--	--	--	33
II	--	--	47	24	--	--	29	--	--	--	--
III	--	--	37	--	19	17	--	24	--	3	--

and III were similar whereas Type II groups averaged much closer to a water source.

Observations of pronghorns were distributed up to 4000 m from water during early fall, 1972 (Table 12). The average distance from water for all observations was 1311.3 m. All groups of Type I were observed less than 2000 m from water whereas only 71 and 73 percent of observations of groups of Types II and III, respectively, were within 2000 m of water.

Most observations of pronghorns in late fall, 1972 occurred between 800 m and 3200 m from water (Table 12). Mean distance to water for all observations was 1850.0 m. There appeared to be no difference in distribution of observations between groups of Types II and III. Only three observations of Type I groups were recorded.

Relationship to Height of Vegetation

Percentages of observations of pronghorns in relation to height of vegetation indicated similar use of all height classes less than 75 cm in summer, 1972 (Table 13). The average height of vegetation for all observations was 37 cm. Use of vegetation heights by groups of Types I and III was similar. Type II groups were recorded in somewhat lower vegetation.

Observations of pronghorns were distributed equally in all

Table 13. Percentages of pronghorns observed by group type in 15-cm intervals of vegetation heights during three sampling periods in 1971 and 1972 on the Hart Mountain study area.

Sample Period Pronghorn Group	High Class (cm)					
	0- 15	16- 30	31- 45	46- 60	61- 75	76- 90
Summer						
I	5	25	50	11	8	1
II	52	--	12	12	24	--
III	17	15	26	19	21	2
Early Fall						
I	30	20	20	--	10	20
II	10	14	57	10	--	9
III	16	25	18	28	--	13
Late Fall						
I	--	--	33	67	--	--
II	--	--	47	53	--	--
III	28	2	70	--	--	--

height classes except 60 to 75 cm during early fall, 1972 (Table 13). Seventy-five percent of the observations occurred in vegetation between 16 and 60 cm in height. The mean height of vegetation in which observations were recorded during early fall was 40.7 cm. Distribution of all types of groups was similar.

Percentages of observations of pronghorns in the height classes indicated no use of vegetation higher than 50 cm in late fall, 1972 (Table 13). Approximately 69 percent of all observations occurred between 30 and 45 cm with the average height of vegetation 32.7 cm. Use of height classes by types of groups was similar except that 30 percent of all observations of groups of Type III occurred in vegetation less than 30 cm high.

DISCUSSION

Annual variation in moisture conditions appeared to be the important factor influencing range site and unit selection and intensity of use of range sites by pronghorns on the study area. Although precipitation during summer sample periods was similar in 1971 and 1972, 439 percent more rain fell during the growing season in 1971 than in 1972 (Table 14). No soil moisture data were collected during this study, but it was assumed that range moisture conditions were below normal and that range vegetation would reflect these conditions (Laycock and Price, 1970). Dirschl (1961, cited by Prenzlów, 1965) reported that droughty conditions influenced pronghorn habitat selection; bottomlands, intermittent streams, and slough borders were used more during dry conditions. Similar patterns of use were apparent on the Hart Mountain study area in summer, 1972, and in early fall, 1971 and 1972.

Table 14. Precipitation in centimeters in the Hart Mountain study area from April through July, 1971 and 1972 (U. S. Department of Commerce, 1956-72).

Month	15-Year Mean	1971	1972
April	2.54	4.45	1.50
May	4.39	5.49	0.69
June	4.22	3.07	0.48
July	1.12	1.80	0.08

Relative Use Indices showed pronghorns preferred range sites of the lowland mesic category during the dry periods noted above. Lowland mesic sites may have received more use in droughty condition because they retained moisture and had succulent vegetation (primarily forbs in Lakebed) later in the season and/or because they were often associated with water sources. Sundstrom (1969) stated that the presence of water sources and succulent vegetation increased use of vegetative types.

Lakebed was the most consistently used lowland mesic range site during droughty periods both years. Lakebed most often maintained some succulent vegetation through summer and early fall and, if a large trench reservoir was present, retained water through driest periods. Indices of use and general observations indicated lakebeds with succulent vegetation such as Arnica foliosa, Oenothera spp., and Iva axillaris received most use. Low and no use of Lakebed was recorded in units when nearby water sources were no longer available to the animals. The large RUI value recorded for Lakebed in Unit 1 in early fall, 1971, was a result of several observations of a herd feeding on one small lakebed after rains induced growth of cool season plants.

Intermittent Lake sites occurred only in Unit 8 and were located adjacent to or near Lakebed sites. Usage of the two range sites was probably interrelated. Use of Intermittent Lake (poor and

fair condition) was similar to Lakebed in summer of 1971 and 1972 and varied inversely with Lakebed in early fall of both years. There was no apparent difference in use of poor and fair condition classes of Intermittent Lake. Artemisia cana was the dominant species on Intermittent Lake sites. Use of A. cana by pronghorns was documented by Dirschl (1963) and Mitchell and Smoliak (1971) in Canada during all seasons of the year. A notable lack of use of both Lakebed and Intermittent Lake (poor condition) occurred in Spanish Lake basin in Unit 8. Two water sources were available, but no use of the area was recorded in the transect belt nor from general observation. Vegetation in this lakebed consisted only of Eleocharis spp., which was dry and desiccated by early summer both years.

Semi-Wet Meadow sites occurred only in Units 1 and 2 along Rock Creek. Use of this site occurred only during the driest droughty periods (summer and early fall, 1972) when range vegetation was desiccated and water sources were drying. No use was recorded in transect belts in 1971 although general observations indicated pronghorns used this range site irregularly. Intensity of use by pronghorns was heavy in summer and greatest in early fall, 1972. The large RUI value in Unit 2 in early fall was a result of several observations of a group in the small area occupied by this site. It was not apparent whether pronghorns were using the vegetation on this site, the available water, or both.

The upland xeric category of range sites had the highest relative use indices in summer, 1971. In addition, this category was preferred by pronghorns in all samples except summer, 1972. Consistent use may have been shown for upland xeric sites because they occupied 61 percent of the study area and because approximately 75 percent of all known water sources were located within 400 m of upland xeric sites. All range sites in this category were dominated by sagebrush species. Rock Terrace, an Artemisia arbuscula dominated site, occupied 39 percent of the study area. Arid Loamy Terrace and Semi-Desert Terrace, dominated by Artemisia tridentata, respectively occupied 4 and 18 percent of the study area. Stoddart and Smith (1955) indicated that shrubs may provide forage of higher nutritive value than grasses or forbs during droughty periods. The importance of Artemisia spp. in food habits of pronghorns has been documented by numerous workers. Mason (1952) reported that Artemisia spp., especially Artemisia arbuscula, made up 61 percent by volume of all pronghorn rumen contents in a year-round study on Hart Mountain and that Artemisia spp. were used in every month. A variety of forbs also occurred in upland sites, particularly Rocky Terrace and Semi-Desert Terrace. Hoover et al. (1959), Ferrel and Leach (1950), and Buechner (1950) documented the importance of forbs in the summer diet of pronghorns. Beale and Smith (1970) and Taylor (1972) attributed significant differences in summer forb use in 2

years to differences in total precipitation during April and May. Although quantitative food habits data are not available for this study, pronghorns probably exhibited a similar preference for succulent forbs when available. After the wet spring of 1971, upland xeric sites probably provided pronghorns with succulent vegetation (both forbs and shrubs). In summer, 1972, this may not have been true, and subsequently pronghorns spent more time in mesic range sites where forbs were available. Increased use of upland xeric sites in early fall, 1972, may have been a result of shifts from other range sites due to increased palatability of vegetation, or possibly as a response to rutting activities. Pronghorns appeared to move about more during rutting season, thereby increasing use of the widespread upland xeric sites.

Rocky Terrace was the most widespread and most consistently used upland xeric site. Pronghorns may have preferred Rocky Terrace because it was dominated by Artemisia arbuscula, a preferred food item (Mason, 1952), and because it contained a greater variety and amount of herbaceous species than other upland xeric sites. Relative usages of condition classes of Rocky Terrace varied between sample periods and years. This variation in use may have been a result of the difference in vegetation between condition classes and/or the position of the site relative to water or another range site. There was no obvious association between use of Rocky

Terrace and use of any other individual range site or category of range sites. Measurements from observation locations plotted on maps, however, indicated that 98 percent of all use of Rocky Terrace was 1000 m or less from other range sites and that juxtaposition of sites was important.

Semi-Desert Terrace and Arid Loamy Terrace receive less average annual rainfall than other range sites on the study area. Consequently vegetation on these sites is probably succulent only during very moist periods. Relative usage of Semi-Desert Terrace (fair condition) was most consistent in Unit 5, and its use appeared to be associated with a small lakebed. When it dried, observations were no longer recorded in the area. Arid Loamy Terrace (fair condition) did not receive any use until a trench reservoir on Flook Lake dried, and two small trenches within the site contained the only water in the eastern portion of Unit 5. These occurrences indicated Arid Loamy Terrace and Semi-Desert Terrace were not preferred pronghorn habitat.

Relative use of upland mesic and transition range sites was highly variable between units. The overall RUI of a range site was often low even though it may have been greatly preferred in one or two units.

High Rolling Hills was the only upland mesic site that received considerable use. Relative Use Indices of Rolling Hills and Gravelly

Ridgetop resulted from five observations of one male pronghorn. Gravelly Ridgetop, Rolling Hills, and Shrubby North Complex were dominated by steep slopes whereas High Rolling Hills was a gently rolling range site. Topography may have been the major factor affecting their use. Usage of High Rolling Hills in Units 2 and 4 was probably independent of other range sites in either unit due to the location of this range site on a plateau. Preference was greater for fair condition High Rolling Hills in drier periods of early fall, 1971, and summer, 1972. This may have been due to presence of moist meadows within the area classified as fair. Moisture conditions by early fall, 1972, apparently were so dry that pronghorns moved off the plateau. No use was recorded in transect belts of High Rolling Hills in Unit 4. Unit 4 rangeland had not burned in 1954. Use of burned and unburned areas of Unit 2 was similar. Shrub species on burned portions, however, did not appear to be as high or dense as on unburned areas. This more diverse condition of Unit 2 may have influenced pronghorn use.

Seven of 10 transition sites were preferred during one or more sampling periods. Due to the small size and scattered nature of transition sites, the primary factor affecting their use appeared to be their position relative to other sites. In addition, moisture conditions on these sites were intermediate to upland xeric and lowland mesic sites, making them favorable in droughty periods. Height and

density of vegetation were probably primary factors affecting use of Droughty Bottomland Fan, Platy Terrace in fair condition (unsprayed), and Shrubby Terrace Complex in both fair and good condition.

Hoover et al (1959) indicated high, dense vegetation that restricted pronghorn movement and vision was not preferred habitat.

Seven transition sites received increased use from summer, 1971, to summer, 1972. Changes coincided with similar increases in relative usage of lowland mesic sites in the same unit or in an adjacent unit. Use during other sampling periods was highly variable and followed no apparent pattern. The only use of Shrubby Terrace Complex (good condition) in summer and early fall, 1972, occurred on the edge of the site approximately 1000 m from water.

Purshia tridentata available in the complex was utilized. Yoakum (1957) reported high use of this species in summer where it was available. Effects of spraying vegetation on transition range sites were not clear-cut. Use was recorded on all sprayed range sites except Platy Terrace in fair condition. Due to different juxtapositioning of range sites in each unit, comparison of sprayed and unsprayed area was not possible.

Data collected during the pronghorn and deer seasons indicated use of roads by hunters in vehicles adversely affected pronghorn use of transect belts. The large size of the refuge and small numbers of

hunters probably did not affect overall use of range sites.

The most probable factor affecting use of units of the study area were the kinds of range sites present and availability of water. Units 1, 2, 5, and 8 were probably the most consistently used because of the number of water sources available and the variety of range sites of different categories.

Overall use of units of the study area by pronghorns appeared to have a definite pattern. Pronghorn observations were concentrated in the northern and southern portions of the refuge. Units 4, 6, and 7 occurred between the two more heavily used portions and received little or no use. Steep topography in Unit 4 and lack of water in Units 6 and 7 appeared to preclude use by pronghorns and to form a natural boundary between the more heavily used areas. Northern and southern portions may have supported separate and distinct groups of pronghorns. In a Montana study, Pyrah (1970) reported that herds occupying separate winter ranges also occupied different summer areas. On a summer range, winter herds separated into "summer herds," and summer herds from different winter ranges rarely mixed. A similar situation may have occurred on my study area. If groups of pronghorns in northern and southern portions of the study area were separate and distinct, use of range sites by northern and southern "herds" were independent. The independence of the two would allow preferences to be identified among units and

range sites available to each herd in further studies and may allow future management plans to be more easily developed.

Changes in group sizes and in percentage use of range sites by group types reflected changes in weather between years. An increase in mean group size from 1971 to 1972 coincided with an increase in percentage observations of Type III groups and with concentration of pronghorns near mesic range sites where succulent vegetation and water were available. Fichter (1972) suggested that all pronghorns within sight of one another in a given area belonged to a single "group" with "subgroups" continually forming and separating. If Fichter's theory is correct, these data indicate that cohesiveness of groups may have been affected by environmental factors. The large increase of mean group size in late fall was probably due to the approaching winter migration off the study area by a portion of the northern population and all of the southern population. Buechner (1950) and Campbell (1970) reported similar increases in group size following the breeding season.

Distribution of pronghorns was closely associated with distribution of water sources. Observations of pronghorns were most concentrated around water in summer, 1972. As sampling progressed through the summer, observations of pronghorns were distributed further from water. Distribution of various group types from water was similar in all sample periods although Type I groups ranged

closer to water, Sundstrom (1969) reported in Wyoming that 95 percent of all observations in July were within 4800 m of a water source.

There was little difference in distribution of observations of pronghorns between the first five height classes (up to 75 cm). The greatest frequency of observations occurred in the 30 to 45 cm category. Vegetation above 75 cm was available in several range sites but apparently was avoided by pronghorns.

Although data collected during this study were not conclusive, the apparent selection and consistent use of certain range site-condition classes and lack of use of others by pronghorns indicated that the range site classification system does have potential application in pronghorn management.

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APPENDICES

APPENDIX A

Introduction

Analysis of data obtained in this study revealed several management possibilities and research needs. Because acquiring recommendations was not a specific objective of this study, this information is presented here.

Management Considerations

Pronghorn selection of range sites appeared to be strongly influenced by the availability of preferred vegetation and the proximity of water. Management suggestions resulting from this study deal with these two factors.

Range sites in the lowland mesic category appeared to be key areas for pronghorns during droughty periods. Consideration should be given to adjusting stocking rates of livestock during dry years if water and/or succulent vegetation are limited. Fencing critical areas may also be considered.

Enlarging and deepening existing trench reservoirs which do not retain water through long, dry periods may be beneficial in maintaining pronghorn populations in some areas. Digging new trench reservoirs in areas with a suitable composition of range sites based

on this study would probably expand the area presently occupied by pronghorns and may increase the size of the herd.

Brush control may be beneficial in range sites where height and density of vegetation appear to be factors limiting use by pronghorns. In addition to controlling height and density of vegetation, brush control may allow native grasses and forbs to increase.

Management designed to enhance pronghorn use is not recommended for all range sites. Range sites such as those in the upland mesic category with steep slope gradients are probably not suitable pronghorn habitat because of topography and should not be managed for pronghorns.

Research Considerations

The following are suggestions for further research:

1. A seasonal study of vegetation is needed to identify specific differences between range sites and their condition classes. Inclusions of dissimilar vegetation types within range sites should be identified and mapped. Moisture and protein content of plants and soil moisture could also be monitored through the seasons.
2. A study of pronghorn use (including use of various group types) of range sites on a smaller portion of the refuge

- should be initiated to determine exactly how pronghorns are using the range sites (feeding, watering, etc.) and if use is restricted to a specific portion of the range site.
3. Control and treatment plots should be set up on range sites with low or no use to determine effects of various vegetative manipulation practices on vegetation composition and on utilization of the range sites by pronghorns. Characteristics of preferred pronghorn habitat could then be identified under controlled conditions.
 4. Importance of water sources should be determined. Water sources utilized by pronghorns could be fenced to prevent use, thereby assessing their influence on pronghorn rangeland use. New trench reservoirs should be dug or old ones improved while utilization of the surrounding range sites is monitored.
 5. Effects of range sites on home range of pronghorns should be determined. The home range of several groups in different areas on the refuge should be plotted and percentage utilization of range sites should be determined. These data may allow juxtapositioning of range sites and water sources to be evaluated.
 6. Pronghorns of both sexes and in various age classes should be permanently and visibly marked. Marking would

be necessary for home range determination, and migration studies. It would also allow assessment of the affects of habitat manipulation on home range and territory fidelity of pronghorns.

APPENDIX B

Table 1. Definitions of Range Conditions Classes (U. S. Depart. of Agric., Soil Conserv. Serv., 1967).

Class	Characteristics
Excellent	75 percent or more of the makeup of the present plant community mirrors the original for the range site. No current erosion is occurring. There is a full stand of the original forage plants for the site.
Good	50 percent to 75 percent of the makeup of the present plant community resembles the climax for the range site. Current erosion is no more than slightly active. The stand of original major forage plant may be 1/2 for the site.
Fair	25 percent to 50 percent of the makeup of the present plant community is still like the original for the range site. Current erosion is no more than moderately active. The stand of original major forage plants may be less than 1/4 for the site.
Poor	Less than 25 percent of the makeup of the present plant community is still like the original for the range site. Current erosion may be severely active. The stand of original major forage plants is generally less than 1/4 for the site.

Table 2. Maximum percentage canopy cover and percentage frequency of occurrence of shrubs, grasses, and forbs on six upland xeric sites on the Hart Mountain study area. Information was compiled from Soil Conservation Service data, Lakeview, Oregon and Feck (1951). Trace (Tr) amounts are less than 1 percent. Species listed are those with frequencies greater than 50 percent.

Taxa (Common name)	Arid Loamy Terrace		Semi-Desert Terrace	Rocky Terrace		
	P ^a	F ^b	F	P	F	G ^c
SHRUBS:						
<u>Artemisia tridentata</u> (Big sagebrush)	<u>35</u> ^d 100	<u>35</u> 100	<u>35</u> 75			
<u>A. arbuscula</u> (Low sagebrush)				<u>40</u> 100	<u>30</u> 100	<u>35</u> 100
<u>Tetradymia glabrata</u> (Littleleaf horsebrush)	<u>5</u> 75			<u>1</u> 100		
<u>Grayia spinosa</u> (Spiny hopsage)			<u>20</u> 67	<u>1</u> 80	<u>1</u> 50	
GRASSES:						
<u>Poa secunda</u> (Sandburgs bluegrass)	<u>5</u> 88	<u>4</u> 100	<u>5</u> 75	<u>10</u> 100	<u>20</u> 100	<u>15</u> 100
<u>Sitanion hystrix</u> (Squirreltail)	<u>10</u> 100	<u>8</u> 100	<u>20</u> 75	<u>12</u> 100	<u>20</u> 100	<u>10</u> 100
<u>Stipa thurberiana</u> (Thurber's needlegrass)		<u>8</u> 75	<u>10</u> 50			<u>5</u> 100
<u>Bromus tectorum</u> (Cheatgrass)			<u>2</u> 50	<u>5</u> 65		
<u>Oryzopsis hymenoides</u> (Indian ricegrass)		<u>3</u> 100				
<u>Agropyron spicatum</u> (Bluebunch wheatgrass)					<u>10</u> 67	<u>45</u> 100
FORBS:						
<u>Phlox longifolia</u> (Longleaf phlox)	<u>5</u> 75	<u>1</u> 75		<u>3</u> 100	<u>Tr</u> 60	<u>Tr</u> 67
<u>Eriogonum spp.</u> (Buckwheat)		<u>Tr</u> 75	<u>Tr</u> 75	<u>1</u> 80	<u>Tr</u> 50	<u>1</u> 60
<u>Crepis acuminata</u> (Tapertip hawksbeard)		<u>1</u> 75	<u>Tr</u> 50	<u>Tr</u> 60		

Table 2. Continued.

Taxa (Common name)	Arid Loamy Terrace		Semi-Desert Terrace			
	P ^a	F ^b	F	P	F	G ^c
<u>Balsamorhiza serrata</u> (Serrated balsamroot)				<u>Tr</u> 60	<u>Tr</u> 78	<u>Tr</u> 50
<u>Phlox diffusa</u> (Spreading phlox)				<u>Tr</u> 60		
<u>Arenaria</u> spp. (Sandwort)				<u>Tr</u> 60		
<u>Astragalus</u> spp. (Loco)				<u>Tr</u> 60		
<u>Erigeron</u> spp. (Feabane)						<u>2</u> 50

^a Poor condition class.

^b Fair condition class.

^c Good condition class.

^d Percentage canopy cover
Percentage frequency of occurrence

Table 3. Maximum percentage canopy cover and percentage frequency of occurrence of shrubs, grasses, and forbs on five upland mesic sites on the Hart Mountain study area. Information was compiled from Soil Conservation Service data, Lakeview, Oregon and Peck (1961). Trace (Tr) amounts are less than 1 percent. Species listed are those with frequencies greater than 50 percent.

Taxa (Common name)	Gravelly Ridgetop	High Rolling Hills		Rolling Hills	Shrubby North Complex
	G	F	G	G	G
SHRUBS					
<u>Artemisia arbuscula</u> (Low sagebrush)	<u>35</u> ^a 100				
<u>Leptodactylon pungens</u> (Granite gillia)	<u>5</u> 73				
<u>Chrysothamnus viscidiflorus</u> (Green rabbitbrush)	<u>5</u> 64	<u>6</u> 88	<u>8</u> 43	<u>10</u> 60	
<u>Artemisia tridentata</u> (Big sagebrush)		<u>50</u> 75	<u>35</u> 71	<u>20</u> 80	<u>20</u> 67
<u>Purshia tridentata</u> (Bitterbrush)				<u>1</u> 60	
<u>Symphoricarpos rotundifolius oreophilus</u> (Mountain snowberry)					<u>6</u> 67
<u>Ceanothus velutinus</u> (Snow brush)					<u>65</u> 67
GRASSES:					
<u>Sitanion hystrix</u> (Squirreltail)	<u>6</u> 100	<u>10</u> 100	<u>10</u> 86	<u>2</u> 80	<u>8</u> 100
<u>Poa secunda</u> (Sandburg's bluegrass)	<u>12</u> 100	<u>10</u> 100	<u>20</u> 100	<u>8</u> 100	
<u>Festuca idahoensis</u> (Idaho fescue)	<u>30</u> 91	<u>30</u> 88	<u>30</u> 100	<u>25</u> 100	
<u>Poa cusickii</u> (Cusick bluegrass)		<u>15</u> 75	<u>7</u> 71	<u>7</u> 60	
<u>Festuca scabrella</u> (Rough fescue)			<u>25</u> 71		
<u>Stipa occidentalis</u> (Western needlegrass)				<u>3</u> 60	<u>30</u> 67
<u>Koeleria cristata</u> (Prairie Junegrass)				<u>5</u> 100	
<u>Elymus cinereus</u> (Giant wildrye)					<u>Tr</u> 100

Table 3. Continued.

Taxa (Common name)	Gravelly Ridgetop	High rolling Hills		Rolling Hills	Shrubby North Complex
	G	F	G	G	G
<u>Bromus marginatus</u> (Mountain brome)					<u>10</u> 67
FORBS:					
<u>Astragalus</u> spp. (Loco)	<u>1</u> 82	<u>2</u> 100			
<u>Phlox</u> spp. (Phlox)	<u>4</u> 91	<u>1</u> 75	<u>Tr</u> 57		
<u>Eriogonum</u> spp. (Buckwheat)	<u>1</u> 73	<u>1</u> 75	<u>Tr</u> 57	<u>1</u> 100	
<u>Lupinus</u> spp. (Lupine)	<u>10</u> 50	<u>20</u> 88	<u>1</u> 71	<u>Tr</u> 80	
<u>Trifolium</u> spp. (Clover)		<u>Tr</u> 50			
<u>Senecio</u> spp. (Senecio)		<u>1</u> 63			
<u>Crepis acuminata</u> (Tapertip hawksbeard)		<u>1</u> 75	<u>Tr</u> 57		
<u>Castilleja</u> spp. (Paintbrush)				<u>Tr</u> 60	
<u>Phlox diffusa</u> (Spreading phlox)				<u>Tr</u> 60	
<u>Phacelia</u> spp. (Phacelia)					<u>Tr</u> 100
<u>Monardella</u> spp. (Monardella)					<u>Tr</u> 100

^a Percentage canopy cover
Percentage frequency of occurrence

Table 4. Maximum percentage canopy cover and percentage frequency of occurrence of shrubs, grasses, and forbs on 10 transition sites on the Hart Mountain study area. Information was compiled from Soil Conservation Service, Lakeview, Oregon and Peck (1961). Trace (Tr) amounts are less than 1 percent. Species listed are those with frequencies greater than 50 percent.

Taxa (Common names)	Claypan Terrace		Droughty Bottom-land Fan		Moist Bottom-land Fan		Lakebed Terrace	Platy Terrace			Shrubby Terrace Complex	
	P	F	P		P	F	P	F	G	F	G	
SHRUBS:												
<u>Artemisia arbuscula</u> (Low sagebrush)	<u>35</u> ^a 100	<u>35</u> 100										
<u>A. tridentata</u> (Big sagebrush)			<u>40</u> 100		<u>25</u> 67	<u>25</u> 80	<u>40</u> 100	<u>25</u> 80	<u>16</u> 100	<u>35</u> 89	<u>25</u> 100	
<u>Chrysothamnus viscidiflorus</u> (Green rabbitbrush)		<u>2</u> 43			<u>50</u> 67	<u>10</u> 60		<u>11</u> 100		<u>15</u> 89	<u>15</u> 71	
<u>Eurotia lanata</u> (Winterfat)							<u>15</u> 80					
<u>Tetradymia glabrata</u> (Littleleaf horsebrush)							<u>15</u> 100	<u>6</u> 40				<u>3</u> 86
<u>Purshia tridentata</u> (Bitterbrush)								<u>10</u> 60		<u>20</u> 89	<u>20</u> 100	
<u>Symphoricarpos rotundifolius</u> <u>creophilus</u> (Mountain snowberry)												<u>3</u> 71
GRASSES:												
<u>Sitanion hystrix</u> (Squirreltail)	<u>10</u> 100	<u>6</u> 100	<u>10</u> 89		<u>20</u> 67	<u>2</u> 80	<u>20</u> 100	<u>11</u> 80		<u>10</u> 100	<u>11</u> 100	
<u>Poa secunda</u> (Sandburg's bluegrass)	<u>10</u> 100	<u>10</u> 86	<u>7</u> 67				<u>3</u> 80	<u>6</u> 80	<u>9</u> 100	<u>6</u> 100	<u>15</u> 100	

Table 4. Continued.

Taxa (Common names)	Claypan Terrace		Droughty Bottom- land Fan	Moist Bottom- land Fan		Lakebed Terrace	Platy Terrace		Shrubby Terrace Complex	
	P	F	P	P	F	P	F	G	F	G
<u>Stipa thurberiana</u> (Thurber needlegrass)		<u>7</u> 100	<u>10</u> 56				<u>10</u> 80		<u>10</u> 89	<u>5</u> 100
<u>Agropyron spicatum</u> (Bluebunch wheatgrass)		<u>12</u> 86					<u>10</u> 100	<u>12</u> 100	<u>20</u> 100	<u>10</u> 100
<u>Poa nevadensis</u> (Nevada bluegrass)				<u>5</u> 67						<u>1</u> 86
<u>Elymus cinereus</u> (Giant wildrye)				<u>5</u> 67	<u>18</u> 100					
<u>Bromus tectorum</u> (Cheatgrass)			<u>7</u> 56				<u>3</u> 80			
<u>Poa cusickii</u> (Cusick bluegrass)					<u>35</u> 80				<u>12</u> 75	
<u>Koeleria cristata</u> (Prairie junegrass)		<u>3</u> 71					<u>7</u> 80	<u>4</u> 100	<u>5</u> 89	
FORBS:										
<u>Trifolium macrocephalum</u> (Bighead clover)		<u>6</u> 80								
<u>Lomatium</u> spp. (Lomatium)		<u>1</u> 80								
<u>Balsamorhiza serrata</u> (Serrated balsamroot)		<u>Tr</u> 60								
<u>Phlox longifolia</u> (Longleaf phlox)		<u>2</u> 57			<u>Tr</u> 60		<u>Tr</u> b		<u>Tr</u> 63	

Table 4. Continued.

Taxa (Common names)	Claypan Terrace		Droughty Bottom-land Fan	Moist Bottom-land Fan		Lakebed Terrace	Platy Terrace		Shrubby Terrace Complex	
	P	F	P	P	F	P	F	G	F	G
<u>Phlox diffusa</u> (Spreading phlox)		<u>4</u> 57					<u>1</u> 60	<u>Tr</u> b	<u>Tr</u> 63	<u>Tr</u> 57
<u>Astragalus</u> spp. (Loco)		<u>1</u> 86						<u>Tr</u> b		<u>Tr</u> 57
<u>Trifolium beckwithii</u> (Beckwith clover)					<u>1</u> 60					
<u>Eriogonum</u> spp. (Buckwheat)					<u>1</u> 80					<u>Tr</u> 57
<u>Crepis acuminata</u> (Tapertip hawksbeard)							<u>3</u> 60	<u>Tr</u> b	<u>1</u> 80	
<u>Balsamorhiza sagittata</u> (Arrowleaf balsamroot)									<u>Tr</u> 50	
<u>Erigeron divergens</u> (Spreading fleabane)									<u>Tr</u> 50	<u>Tr</u>
<u>Epilobium</u> spp. (Epilobium)										<u>Tr</u> 71
<u>Lupinus</u> spp. (Lupine)										<u>Tr</u> 86

^a Percentage canopy cover
Percentage frequency of occurrence

^b Percentage frequency not calculated because only one sample was obtained.

Table 5. Maximum percentage canopy cover and percentage frequency of occurrence of shrubs, grasses, and forbs on four lowland mesic sites on the Hart Mountain study area. Information was compiled from Soil Conservation Service data, Lakeview, Oregon and Peck (1961). Trace (Tr) amounts are less than 1 percent. Species listed are those with frequencies greater than 50 percent.

Taxa (Common name)	Intermittent Lake		Semi-Wet Meadow	Lakebed
	P	F	F	
SHRUBS:				
<u>Artemisia cana</u> (Silver sagebrush)	<u>50</u> ^a 100	<u>35</u> 67		<u>1</u> 22
GRASSES:				
<u>Poa nevadensis</u> (Nevada bluegrass)	<u>5</u> 33	<u>2</u> 50	<u>35</u> 100	
<u>Muhlenbergia richardsonis</u> (Mat muhly)	<u>1</u> 33	<u>50</u> 100		<u>5</u> 56
<u>Sitanion hystrix</u> (Squirreltail)		<u>3</u> 50		
<u>Elymus triticoides</u> (Bluejoint wildrye)			<u>20</u> 100	
<u>Hordeum nodosum</u> (Meadow barley)			<u>5</u> 100	
<u>Eleocharis</u> spp. (Spikesedge)				<u>95</u> 67
FORBS:				
<u>Trifolium beckwithii</u> (Beckwith clover)			<u>15</u> 100	
<u>Achillea</u> spp. (Yarrow)			<u>3</u> 100	
<u>Iris</u> spp. (Iris)			<u>10</u> 67	
<u>Aster</u> spp. (Aster)			<u>5</u> 67	
<u>Sidalcea</u> spp. (Checkermallow)			<u>6</u> 67	
<u>Iva axillaris</u> (Povertyweed)				<u>43</u> 67

Table 5. Continued.

Taxa (Common name)	Intermittent Lake		Semi-Wet Meadow	Lakebed
	P	F	F	
<u>Arnica foliosa</u> (Leafy arnica)				<u>25</u> 50
<u>Oenothera sp.</u> (Primrose)				<u>12</u> 67
<u>Rumex crispus</u> (Curly dock)				<u>10</u> 56

^a Percentage canopy cover
Percentage frequency of occurrence