AN ABSTRACT OF THE THESIS OF

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Title: HABITAT FACTORS AFFECTING PRONGHORN USE OF PLAYAS IN SOUTH CENTRAL OREGON

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Pronghorn (Antilocapra americana) use of four playas (intermittent lakebeds) on Hart Mountain National Antelope Refuge (NAR) in south central Oregon was studied during the summers of 1974 and 1975. Percent canopy cover of playa vegetation, plant phenology, percent desiccated vegetation, soil moisture, available surface water and pronghorn use of range sites adjacent to playas were measured for each study area; the relationship between these parameters and pronghorn use of each lakebed was determined. A total of 14,316 pronghorn observations was recorded on the four playas during the two summers. Pronghorn observations totalled 4510 on range sites adjacent to the playas. Desert Lake received significantly ($P < 0.01$) more pronghorn use than the other playas during 1974 and 1975. No significant differences in use existed among Dobyns, Long and Spanish Lakes during either study year. Pronghorns demonstrated a greater dependence on lakebeds during a dry year than during a wet year. The

importance of succulent vegetation to pronghorns was reflected in the relationship between soil moisture and pronghorn use. Pronghorns indicated a strong preference for leafy arnica (Arnica foliosa), particularly at Desert Lake. On Spanish Lake during the wet year, 1975, prostrate knotweed (Polygonum aviculare) was an important pronghorn food. Other forbs eaten by pronghorns were poverty sumpweed (Iva axillaris) and Oenothera flava. As soil moisture decreased, desiccation of vegetation increased, and pronghorn use on playas increased, primarily on Desert Lake where the lowest percent desiccated vegetation occurred. Early leaf growth and early flowering stages of forbs were the most important developmental stages causing a selective response by pronghorns. Pronghorns terminated use of a lakebed if drinking water was unavailable, but the mere presence of water on a playa did not insure use.

As upland range sites, dominated by low sagebrush (Artemisia arbuscula), dried, pronghorn use of playas intensified throughout summer and early fall. Patterns of use by pronghorns of range sites adjacent to playas were similar between years, but increased pronghorn use during the wet year on all sites except Desert Lake supported the idea that during the wet year pronghorns were less dependent on playa vegetation. At Desert Lake, pronghorns indicated a preference for the Intermittent Lake (fair condition) range site, dominated by

Bolander's silver sagebrush (*A. cana bolanderi*). At the other three lakebeds, pronghorns showed a preference for Rocky Terrace (poor condition) range site. Pronghorns appeared to prefer the Desert Lake study site because of the combination of habitat factors which the other three playa sites lacked.

Habitat Factors Affecting Pronghorn Use of Playas in South Central Oregon

by

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HABITAT FACTORS AFFECTING PRONGHORN USE OF PLAYAS IN SOUTH CENTRAL OREGON

INTRODUCTION

Pronghorns (Antilocapra americana) require a variety of habitats for their essential life activities (Einarsen 1948, Buechner 1950, Mace 1954, Cole 1954). Campbell (1970) observed that pronghorn distribution was not random in relation to habitat type. He thought pronghorn group distribution was influenced by conditions of vegetation, human activity, livestock use and grazing history of pastures. Bayless (1969) found that in Montana a sagebrush-grassland type received the heaviest use in summer and winter.

Buechner (1950), in Texas, felt that pronghorn movements were governed by food supply and water, and listed the essentials of pronghorn range as food, cover, water, juxtaposition and interspersion. He defined juxtaposition as all of the requirements of a species being distributed within the cruising radius of an animal. He stated that pronghorns were more flexible than many animals in their juxtaposition requirements, as they readily shift their range to meet their requirements. His study showed that pronghorns shifted their ranges periodically to areas of highest rainfall and best vegetation. He found that seasonal use of plants varied not only with availability of plants, but also with preference of the animals.

Herrig (1974) recorded use of range sites by pronghorns in south central Oregon and found that certain range sites were used more than others by pronghorns and that juxtaposition of other range sites and available surface water were important factors in influencing use.

For 4 years while working at the Hart Mountain National Antelope Refuge, I observed differential use of certain playas by pronghorns. No one had attempted to compare these differences quantitatively nor explain why these apparent differences in use occurred.

The objectives of this study were to determine if there were significant differences in use by pronghorns on four playas on Hart Mountain NAR, Oregon and to determine how certain environmental factors affected pronghorn use of these lakebeds.

STUDY AREA

The south central and southeastern portions of Hart Mountain NAR served as the study area (Figure 1). The refuge is located in the western portion of the Great Basin Region in south central Oregon and includes spring, summer and fall pronghorn ranges. Pronghorns migrate from these portions of the refuge by late November to wintering areas in southeastern Oregon. During spring migration, in April, pronghorns arrive on Hart Mountain NAR when most of the playas on the refuge are filling with water from snow melt. Water levels of playas start decreasing due to evaporation in early June with the advent of warming weather.

Four playas (sites) were selected for study because of their location within the area utilized by the pronghorn population on the southern portion of the refuge: Desert Lake 211 ha, 1715 m elevation; Dobyns Lake 29 ha, 1723 m elevation; Long Lake 245 ha, 1778 m elevation; and Spanish Lake 180 ha, 1790 m elevation (Figure 1).

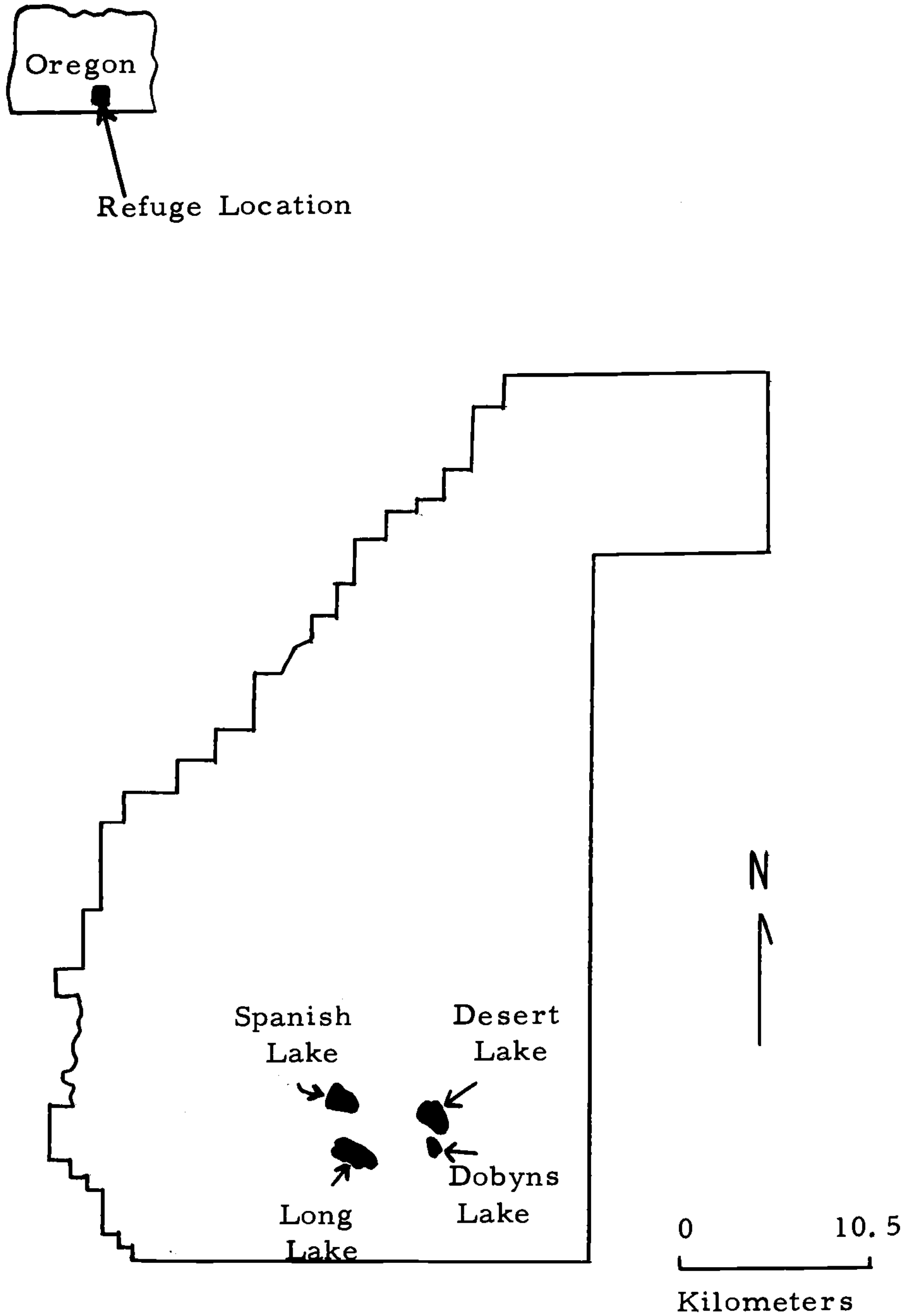


Figure 1. Location of study sites on Hart Mountain NAR.

SAMPLING METHODS

Two summers of field research were completed: 7 July through 21 September 1974, and 22 June through 13 September 1975.

Environmental Factors

Each study site was divided into two portions: the playa and range sites adjacent to the playa.

Vegetation Analysis of Playas

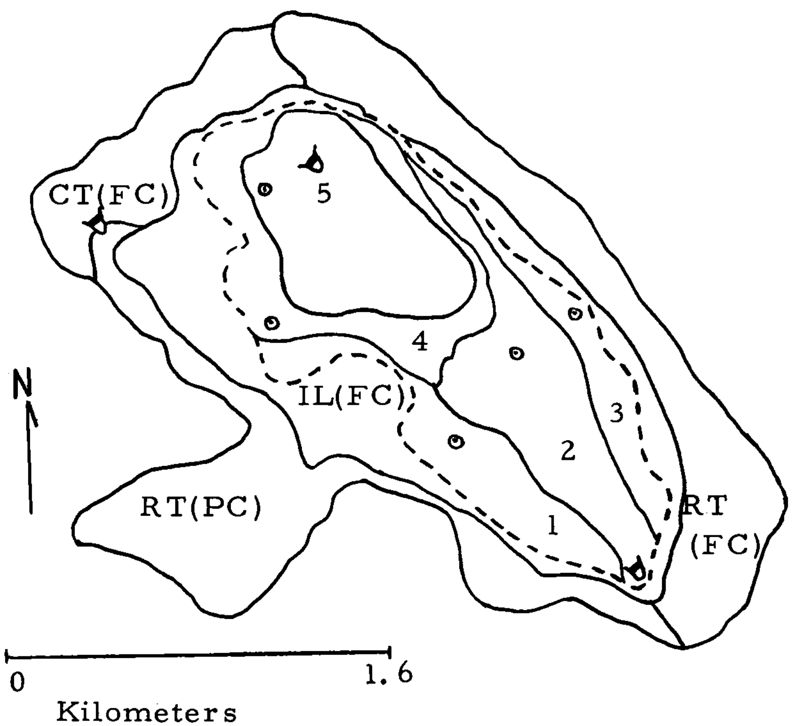
I defined playa as that portion of each lake bottom which in years of average precipitation was inundated by water in May and lacked Bolander silver sagebrush (*Artemisia cana bolanderi*), except for a few small, isolated plants. The lack of Bolander silver sagebrush gave these relatively flat surfaces their playa appearances as opposed to the surrounding sagebrush aspect.

Range sites, described by Cahoon (1970), were used for this study. Cahoon (1970) divided lake bottoms on Hart Mountain NAR into two range sites, 1) Intermittent Lake and 2) Lakebed. Condition classes for range sites were obtained from the U. S. Department of Agriculture (1967). Differences in species composition were not described for each playa, thus I sampled plant communities to detect differences which existed within range sites. I delineated a plant community as a spatial and temporal organization of plants exhibiting observable differences in floristic composition and/or cover from adjacent or surrounding organizations of plants (Figures 2, 3, 4, 5).

On each playa, plant communities were sampled within a stand of vegetation which characterized that community; selection of sampling locations was subjective and was based on an initial reconnaissance of each playa.

Canopy coverage of vegetation was estimated by methods of Daubenmire (1959) and Poulton and Tisdale (1961). Canopy coverage measurements were taken as soon as drying of soil permitted. Percent frequency of species was determined by the method of Daubenmire (1970). One macroplot (30.5 m X 25.3 m) was established within each representative stand. I defined representative stand as a group of plants, based on my reconnaissance of the given playa, which characterized and satisfied my delineation of plant community.

Five randomly spaced sampling transects were permanently marked within each macroplot. Ten microplots (20 cm X 50 cm) were sampled along each transect providing 50 samples ($5m^2$) per macroplot. Vegetation was sampled once during each field season. Five transects previously provided satisfactory results in the sagebrush-grassland communities of Oregon (Dr. William C. Krueger personal communication).



LEGEND

I. Playa vegetation
   A. Intermittent Lake range site communities:
      1. *Eleocharis-Arnica-Muhlenbergia*
      2. *Eleocharis-Muhlenbergia-Iva*
      3. *Muhlenbergia-Eleocharis*
   B. Lakebed range site communities:
      4. *Eleocharis-Arnica*
      5. *Arnica-Eleocharis*

II. Range sites adjacent to lakebed:
   RT(PC) = Rocky Terrace (poor condition)
   RT(FC) = Rocky Terrace (fair condition)
   IL(FC) = Intermittent Lake (fair condition)
   CT(FC) = Claypan Terrace (fair condition)

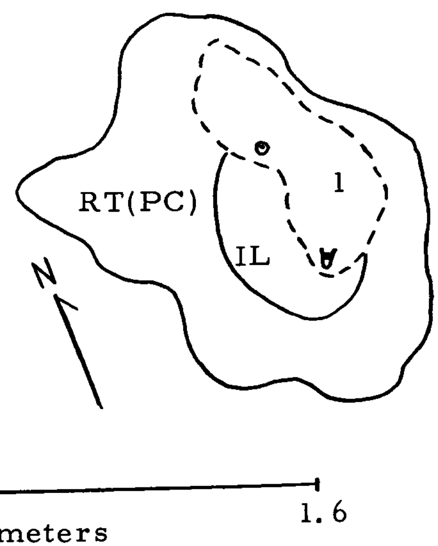
= Dugout (trench reservoir)

= Vegetation macroplot and soil moisture sampling locations

- - - = Playa boundary

—— = Communities and range site boundaries

Figure 2. Playa range site plant communities and adjacent range sites at Desert Lake.



LEGEND

I. Playa vegetation
   A. Lakebed range site community:
      1. Eleocharis-Iva

II. Range sites adjacent to Lakebed:
   IL = Intermittent Lake
   RT(PC) = Rocky Terrace (poor condition)

= Dugout (trench reservoir)

= Vegetation macroplot and soil moisture sampling location

- - - = Playa boundary

—— = Range site boundaries

Figure 3. Playa range site plant community and adjacent range sites at Dobyns Lake.

LEGEND

I. Playa vegetation
   A. Lakebed range site communities:
      1. Eleocharis-Arnica-Polygonum
      2. Arnica-Eleocharis-Scirpus
      3. Eleocharis-Arnica
      4. Eleocharis-Arnica-Rumex
      5. Eleocharis

II. Range sites adjacent to Lakebed:
    IL = Intermittent Lake
    RT(PC) = Rocky Terrace (poor condition)
    MBF(PC) = Moist Bottomland Fan (poor condition)

= Dugout (pit reservoir)

= Vegetation macroplot and soil moisture sampling locations

- - - = Playa boundary

—— = Communities and range site boundaries

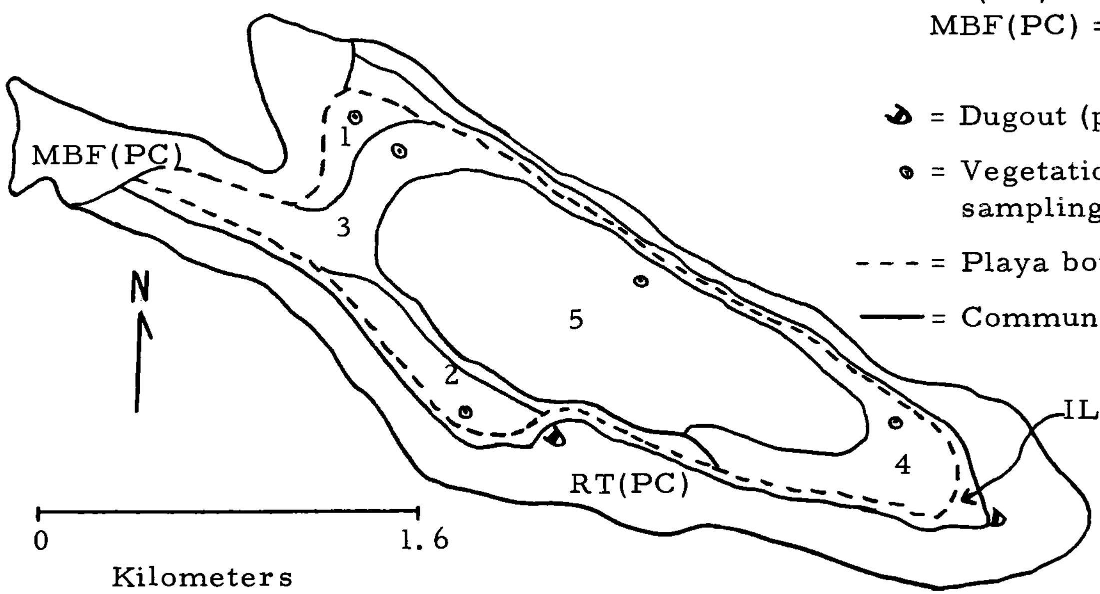
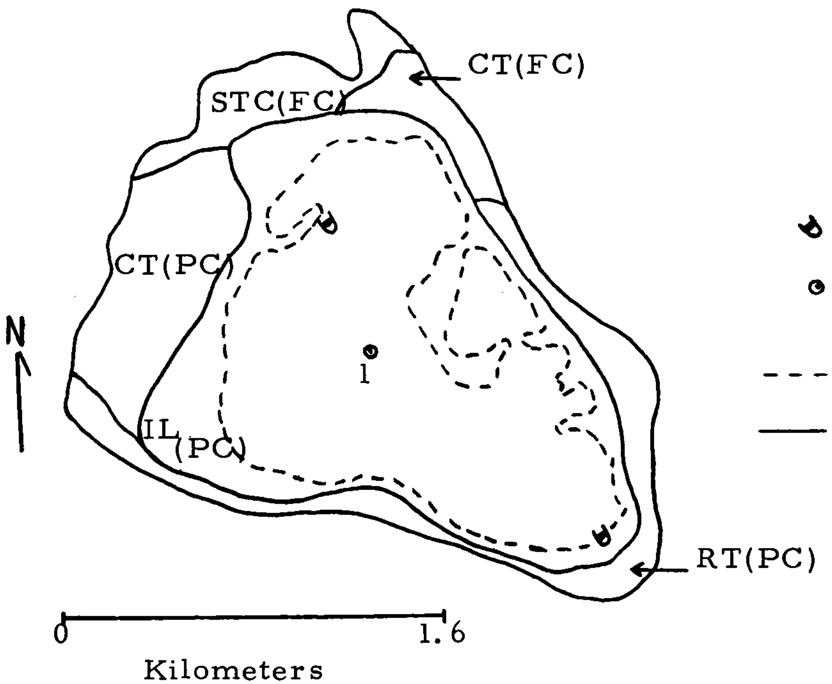


Figure 4. Playa range site plant communities and adjacent range sites at Long Lake.



LEGEND

I. Playa vegetation
   A. Lakebed range site community:
      1. Eleocharis-Iva

II. Range sites adjacent to Lakebed
   IL(PC) = Intermittent Lake (poor condition)
   RT(PC) = Rocky Terrace (poor condition)
   CT(PC) = Claypan Terrace (poor condition)
   CT(FC) = Claypan Terrace (fair condition)
   STC(FC) = Shrubby Terrace Complex (fair condition)

= Dugout (trench reservoir)

= Vegetation macroplot and soil moisture sampling location

- - - = Playa boundary

—— = Range site boundaries

Figure 5. Playa range site plant community and adjacent range sites at Spanish Lake.

Range Sites Adjacent to Playas

I used the description of vegetation of Hart Mountain NAR (Cahoon 1970) to define adjacent range sites within 400 m of the edge of each playa. Using ocular reconnaissance to verify Cahoon's (1970) vegetation descriptions, I found them incomplete in two instances at Long and Desert Lakes.

At Long Lake a narrow band of vegetation, 26 ha, dominated by Richardson's muhly (*Muhlenbergia richardsonis*) and scattered Bolander silver sagebrush comprised the outer edge of the Lakebed range site. At Dobyns Lake, 16 ha of the 45 ha Lakebed range site were dominated by Bolander silver sagebrush. Cahoon (1970) did not distinguish these areas from Lakebed range sites. Neither Richardson's muhly nor Bolander silver sagebrush were recorded in the range plant list for Lakebed range site (U. S. Department of Agriculture 1969). I felt there were sufficient differences to warrant treating the 26 ha and 16 ha areas at Long and Dobyns Lakes respectively, as adjacent range sites. Following Cahoon's (1970) methodology I called these two areas Intermittent Lake range sites. Richardson's muhly and Bolander silver sagebrush were listed for the Intermittent Lake range site by the U. S. Department of Agriculture (1969).

Plant Phenology

Phenological stages were divided into the following classes by plant types:

A. forbs and grasslike species, 1) early leaf growth 2) flowering, 3) seed production, and 4) drying.

B. grasses, 1) growth initiation, 2) boot stage, 3) hard seed, 4) seed scatter, 5) summer dormancy, and 6) regreening leaves (West and Wein 1971).

Stages of development were observed and recorded for each stand of vegetation within 90 m of each macroplot. Phenological observations were made at the time vegetation measurements and soil moisture readings were taken. I checked at least 50 plants and recorded the development stage.

Desiccated Vegetation

I visually estimated the percent of the total vegetation which was dried on each playa at the end of every weekly sampling period to determine the percent of desiccated vegetation.

Soil Moisture

Delmhorst cylindrical gypsum blocks were used to determine soil moisture. Blocks were placed at depths of 17.8 cm (upper level) and 45.7 cm(lower level) at opposite ends of each vegetation macroplot (Figures 2, 3, 4, 5). The blocks were placed in the soil following the method of Shearer (1963). Weekly mean resistance measurements at the upper and lower depths were calculated and used for analysis.

Soil samples were collected during the summer of 1974 at depths of 17.8 cm and 45.7 cm; one sample was taken per macroplot. Salinity measurements were conducted at the Oregon State University Soil Testing Laboratory; the Solu Bridge Technique was used to determine total soluble salt content (Kauffman and Gardner 1976). Soil moisture tensions (percent moisture) were determined at 0.3, 2.0 and 15.0 atmospheres by the Pressure Membrane Extraction Technique at the Oregon State University Soil Physics Laboratory.

Available Surface Water

Water availability at each lake bottom was observed throughout both study periods. Size and location of dugouts (trench and pit reservoirs) were recorded for each lake, and available drinking water was recorded as either present or not present.

Pronghorn Use

Playas

Census routes for the lakebeds consisted of an existing dirt trail at each playa which was traversed by vehicle. Two playas were censused in the morning and two in the evening. For logistical reasons Desert and Dobyns Lakes, and Spanish and Long Lakes were censused together, respectively. During the next sampling day, the sequence was reversed. Morning censusing was completed no later than 5 h after sunrise and evening censusing began about 4 h before sunset.

Numbers and locations of pronghorns were recorded from observation points along the trail at each playa. Pronghorns on each playa were censused 6 times/week for 11 weeks from 7 July through 21 September 1974, and 22 June through 13 September 1975. One pronghorn observation constituted one "unit of use" (Herrig 1974).

An index to pronghorn use was derived by dividing the numbers of pronghorns observed per week on each playa by the number of hectares for that playa. This value, computed weekly, was used as the dependent variable for multiple regression analyses and for comparison of pronghorn use among study sites.

Adjacent Range Sites

Censusing of pronghorns within range sites adjacent to each playa was accomplished during the pronghorn census of that playa. Census routes, times and dates were the same as those described in the preceding playa section. Numbers and locations of pronghorns were recorded for each range site from observation points at each playa.

I found that 400 m from the edge of a playa was the maximum distance at which I could accurately locate a pronghorn in an adjacent range site. Locations of pronghorns in adjacent range sites were plotted on plastic overlays of U. S. Geological Survey aerial photographs. I used a dot grid calculator to determine acreages of adjacent range sites.

Numbers of pronghorns counted per week within each adjacent range site were divided by the number of hectares in that site and constituted pronghorn use of adjacent range sites. The weekly pronghorn use figures were used to detect differential use of range sites and as independent variables for multiple regression analyses.

Statistical Analysis

My basic assumption concerning pronghorn movements during this study was that all pronghorns utilizing the southern portion of the refuge had equal opportunity to freely roam and select any area for their use. There were no physical barriers impeding pronghorn movements between playas, and the greatest distance between any study sites was 7.2 km, a distance easily traversed by pronghorns.

Weekly totals of pronghorns/ha for each playa were analyzed by two-way analysis of variance (Snedecor and Cochran 1967) to determine if a significant difference in use existed between at least one of the playas and the other three. Each playa served as a treatment for comparison, and time was used as replications. The 5 percent significance level was selected for the F-test, but if the 1 percent significance level was found it was selected over the lower significance level.

Differences between specific pairs of means were tested with Least Significant Difference (LSD) (Snedecor and Cochran 1967).

Forward stepwise multiple regression analysis (Draper and Smith 1966) was used to evaluate the relative importance and interrelationships of the following selected factors affecting pronghorn use of playas: 1) percent of desiccated vegetation, 2) adjacent range site use and, 3) soil moisture at two levels. Variables entering the model at each stage were tested for significance at the 5 percent level.

To check for possible direct or indirect influences on pronghorn use of the playas simple linear correlations were calculated for each independent variable.

Differences in pronghorn use of the lakebeds and adjacent range sites between years were tested by paired *t*-tests at the 10 percent significance level.

Eleven weeks of data, 7 July - 21 September 1974 and 22 June - 13 September 1975, were analyzed for both study periods by analysis of variance and (LSD) techniques. Nine weeks of data, 21 July - 21 September 1974 and 6 July - 13 September 1975, were analyzed for both study periods by multiple and linear regression techniques. Inundation of all playas in 1974 precluded placement of soil moisture blocks and resulted in their subsequent delayed acclimation to moisture conditions.

RESULTS

Environmental Factors

Vegetation Analysis of Playas

Canopy cover estimates were greater for most species within each community during 1975 than in 1974 (Tables 1, 2). Measurements of Richardson's muhly indicated the greatest overall decrease in canopy cover between 1974 and 1975 (Tables 1, 2). Species showing some decrease in canopy coverage between years were poverty sumpweek (*Iva axillaris*) on Dobyns Lake, and *Rumex conglomeratus* and *Oenothera flava* on Desert Lake (Tables 1, 2).

Desert and Long Lakes exhibited the greatest number of species (Tables 1, 2). The least number of taxa grew on Spanish and Dobyns Lakes. Common spike-rush (*Eleocharis palustris*) and *Dowingia yina* exhibited the greatest and least frequency respectively (Tables 1, 2). No poverty sumpweed was found on Long Lake, and Richardson's muhly grew only on Desert Lake. Leafy arnica (*Arnica foliosa*) grew only on Desert and Long Lakes (Tables 1, 2).

Range Sites Adjacent to Playas

Rocky Terrace (poor condition) was the most common adjacent range site on all playas except Spanish Lake (Table 3). Intermittent

Table 1. Percent canopy coverage and percent frequency by plant community, Hart Mountain NAR, 1974.

Taxa[a]	Dobyns Lake	Desert Lake				
	Eleocharis-Iva	*Eleocharis-Arnica-Muhlenbergia*	*Eleocharis-Muhlenbergia-Iva*	*Muhlenbergia-Eleocharis*	*Eleocharis-Arnica*	*Arnica-Eleocharis*
Arnica foliosa		18.70			28.96	56.100
Iva axillaris	16[b].96[c]		11.88	2.28		
Rumex conglomeratus		6.76	+.4		3.36	
Oenothera flava		1.4		+.8		
Psilocarphus brevissumus		1.46		1.36		
Polygonum kelloggii		+.2				
Phlox spp.						
Boraginaceae						
Muhlenbergia richardsonis		13.54	19.84	36.94		
Eleocharis palustris	39.100	27.100	24.100	25.98	30.100	2.34
Scirpus cernuus		+.2		+.8		

[a] Taxa follow Garrison et al. (1976)

[b] Number to the left of the dot is percent coverage where value was > 0.5%. The + to left of dot indicates coverage < 0.5%.

[c] Number to right of dot is percent frequency.

Table 1. Continued.

Taxa	Spanish Lake	Long Lake				
	Eleocharis Iva	*Eleocharis- Arnica- Polygonum*	*Arnica- Eleocharis- Scirpus*	*Eleocharis- Arnica*	*Eleocharis- Arnica- Rumex*	*Eleocharis*
Arnica foliosa		11.80	39.98	20.94	17.96	
Iva axillaris	2.20					
Rumex conglomeratus		1.20		+.2	1.12	2.20
Oenothera flava		+.8	+.2		1.2	
Psilocarphus brevissumus		+.18	+.2			
Polygonum kelloggii		1.26	1.16			
Phlox spp.		+.4				
Boraginaceae		+.4				
Muhlenbergia richardsonis						
Eleocharis palustris	39.100	31.96	31.80	42.100	37.100	64.100
Scirpus cernuus		+.14	7.68		1.10	

Table 2. Percent canopy coverage and percent frequency by plant community, Hart Mountain NAR, 1975.

Taxa[a]	Dobyns Lake	Desert Lake				
	Eleocharis Iva	Eleocharis-Arnica-Muhlenbergia	Eleocharis-Muhlenbergia-Iva	Muhlenbergia-Eleocharis	Eleocharis-Arnica	Arnica-Eleocharis
Arnica foliosa		19. 76			30. 100	65. 100
Iva axillaris	14[b]. 92[c]		9. 96	2. 30		
Rumex conglomeratus		3. 54	+. 4		2. 28	
Oenothera flava		+. 4		1. 12		
Psilocarphus brevissumus		2. 60	+. 12	2. 82		
Polygonum kelloggii		2. 74				
Dowingia yina						
Boraginaceae		+. 6	+. 8	2. 72		
Muhlenbergia richardsonis		8. 48	10. 78	18. 92		
Eleocharis palustris	35. 100	42. 100	39. 100	28. 100	42. 100	5. 82
Scirpus cernuus		+. 10	+. 14	+. 6	+. 2	

[a] Taxa follow Garrison et al. (1976)

[b] Number to the left of the dot is percent coverage where value was > 0. 5%. The + to left of dot indicates coverage < 0. 5%.

[c] Number to right of dot is percent frequency.

Table 2. Continued.

Taxa	Spanish Lake	Long Lake				
	Eleocharis-Iva	*Eleocharis-Arnica-Polygonum*	*Arnica-Eleocharis-Scirpus*	*Eleocharis-Arnica*	*Eleocharis-Arnica-Rumex*	*Eleocharis*
Arnica foliosa		15.82	39.100	26.100	21.100	
Iva axillaris	2.26					
Rumex conglomeratus		2.26		+.4	1.12	3.38
Oenothera flava		+.6				
Psilocarphus brevissimus		4.100	+.2		1.30	
Polygonum kelloggii		4.48				
Dowingia yina		+.2				
Boraginaceae		4.48	+.18	+.8	1.26	
Muhlenbergia richardsonis						
Eleocharis palustris	53.100	61.96	57.92	72.100	78.100	79.100
Scirpus cernuus	+.6	12.80	20.84	1.18	7.80	

Table 3. Hectares and relative percent of range sites adjacent to playas, Hart Mountain NAR, 1974-75.

Playa and Range Site	ha	Relative Percent
Desert Lake		
Intermittent Lake[b]	76	26
Rocky Terrace[a]	96	32
Rocky Terrace[b]	87	29
Claypan Terrace[b]	38	13
Dobyns Lake		
Intermittent Lake	16	16
Rocky Terrace[a]	82	84
Spanish Lake		
Intermittent Lake[a]	86	39
Rocky Terrace[a]	44	20
Claypan Terrace[a]	47	22
Claypan Terrace[b]	16	7
Shrubby Terrace Complex[b]	25	12
Long Lake		
Intermittent Lake	26	12
Rocky Terrace[a]	137	66
Moist Bottomland Fan[a]	45	22

a = Poor condition

b = Fair condition

Lake (poor condition) comprised the largest adjacent range site on Spanish Lake. Spanish Lake possessed the greatest variety of adjacent range sites, five; and Dobyns Lake had the least, two.

Plant Phenology

The 1975 portion of the study began 3 weeks earlier than during 1974. Phenological stages of all species occurred earlier through 10 July 1974, than during the same period in 1975. After 14 July of both years, all vegetative stages were similar. On Desert Lake from 25 August through the end of the study periods for both years, leafy arnica was in the early leaf growth stage which usually consisted of two leaves growing to a length of 7. 5 cm.

On Dobyns Lake during 1975, all developmental stages were about 2 weeks later than 1974. On Spanish Lake vegetative stages were similar to Dobyns Lake, except in 1974 when poverty sumpweed did not reach class 4 (drying). Between 9-13 September 1975 poverty sumpweed on Spanish Lake reached class 4.

Phenological stages occurred 2 weeks earlier in 1974 than in 1975 on Long Lake. All forbs reached class 4 by 11-17 August 1974, but not until 24-30 August 1975. Leafy arnica and R. conglomeratus showed some new leaf growth 31 August - 13 September 1975, as did O. flava, but not until 7-13 September at Long Lake.

Common spike-rush exhibited much drying on all playas, starting in late June, even when the plants were in standing water.

Desiccated Vegetation

Vegetation at Desert Lake showed the lowest percent desiccation during both years in September; vegetation on Long Lake showed the greatest percent desiccation in 1974, and Long and Spanish Lakes exhibited the highest percent desiccation (99) during 1975 (Tables 4, 5).

Lowest mean percent desiccation during both years was recorded at Desert Lake (Tables 4, 5). Highest mean percent desiccation (Tables 4, 5) was at Spanish Lake.

Between 4-10 August 1974 percent desiccation increased rapidly on Long, Desert and Dobyns Lakes (Table 4). From 11 August - 21 September 1974 percent desiccation on all 4 playas was gradual (Table 4). Desiccated vegetation was 50 percent between 21-27 July 1974 on Spanish Lake. Between 27 July - 3 August 1974 estimated desiccation increased rapidly to 80 percent at Spanish Lake then increased gradually through 21 September. Percent desiccation trends were more gradual during 1975 (Table 5). The most rapid increases in desiccation of vegetation in 1975 occurred at Long Lake during 10 August - 6 September and at Desert Lake from 24 August - 13 September.

Table 4. Estimated percent desiccation of playa vegetation, Hart Mountain NAR, 1974.

Date	Spanish Lake	Dobyns Lake	Desert Lake	Long Lake
21-27 July	50	5	10	15
28 July-3 August	80	20	15	18
4-10 August	87	27	17	20
11-15 August	88	70	60	75
22-24 August	90	75	65	80
25-31 August	95	85	70	88
1-7 September	97	90	75	92
8-14 September	98	95	78	95
15-21 September	99	98	80	99
Mean	87.1	62.7	52.2	64.6

Table 5. Estimated percent desiccation of playa vegetation, Hart Mountain NAR, 1975.

Date	Spanish Lake	Dobyns Lake	Desert Lake	Long Lake
6-12 July	8	5	5	10
13-19 July	10	7	8	10
20-26 July	12	10	10	10
27 July-2 August	30	12	14	18
3-9 August	35	20	15	20
10-16 August	40	30	20	30
24-30 August	55	40	30	50
31 August-6 September	65	55	45	70
7-13 September	80	75	70	85
Mean	37.2	28.2	24.1	33.6

Soil Moisture and pH

Soil moisture trends decreased during both years as the season progressed (Tables 6, 7). Lower soil moisture values were recorded in 1974 than 1975 (Tables 6, 7). From 1 January through 31 August 1974 and 1975, 11.2 cm and 31.0 cm of precipitation were measured respectively (Refuge records). During June 1975, an unusual amount of precipitation for Hart Mountain, 11.5 cm was recorded. Hart Mountain received 19.8 cm more precipitation through 13 September 1975 than through 21 September 1974. Dobyns Lake apparently retained the least amount of soil moisture and Spanish Lake held the greatest amoung through the end of each study period (Table 6, 7).

Moisture tensions at upper and lower soil levels were highest at Dobyns Lake during both summers (Tables 6, 7). Moisture tensions were lower at Spanish, Desert and Long Lakes. Pressures other than 0.3, 2.0 and 15.0 atmospheres (Tables 6, 7) were determined by direct conversion of resistance meter readings (Dr. Charles H. Ullery personal communication).

The highest percent soil moisture at 0.3 atmospheres was determined for Dobyns Lake at upper and lower levels (Table 8). The lowest percent moisture at 15.0 atmospheres was within the Long Lake *Arnica-Eleocharis-Scirpus* community (Table 9) at upper and lower soil levels. At Desert Lake, at 0.3 atmospheres, the greatest

Table 6. Weekly average soil moisture[a] and moisture tension (atmosphere) trends per playa, Hart Mountain NAR, 1974.

	Spanish Lake				Dobyns Lake			
Week	Up[b]	Atm[d]	Lo[c]	Atm	Up	Atm	Lo	Atm
21-27 Jul	109	0.84	150	0.50	68	1.40	3	22.50
28 Jul-3 Aug	60	1.50	142	0.54	10	9.80	2	23.60
4-10 Aug	41	2.60	137	0.58	3	22.50	2	23.60
11-15 Aug	15	6.00	118	0.74	1	25.00	1	25.00
22-24 Aug	11	8.65	112	0.82	0	>25.00	0	>25.00
25-31 Aug	7	16.90	105	0.89	0	>25.00	0	>25.00
1-7 Sept	5	19.70	99	0.95	0	>25.00	0	>25.00
8-14 Sept	3	22.50	84	1.11	0	>25.00	0	>25.00
15-21 Sept	2	23.60	74	1.32	0	>25.00	0	>25.00

[a] Average of resistance meter readings.
[b] Up = Upper level.
[c] Lo = Lower level.
[d] Atm = Atmospheres (atm. > 9.7 interpolated).

Table 6. Continued.

Week	Desert Lake				Long Lake			
	Up	Atm	Lo	Atm	Up	Atm	Lo	Atm
21-27 Jul	83	1.17	125	0.68	70	1.40	87	1.10
28 Jul-3 Aug	58	1.54	95	1.00	25	3.30	45	1.90
4-10 Aug	48	1.82	79	1.22	18	4.80	30	2.80
11-15 Aug	22	3.84	48	1.82	4	21.10	15	6.00
22-24 Aug	13	7.05	43	1.98	2	23.60	10	9.70
25-31 Aug	8	15.50	28	3.00	1	25.00	6	18.30
1-7 Sept	4	21.10	22	3.84	0	>25.00	4	21.10
8-14 Sept	2	23.60	10	9.70	0	>25.00	3	22.50
15-21 Sept	1	25.00	8	15.50	0	>25.00	2	23.60

Table 7. Weekly average soil moisture[a] and moisture tension (atmospheres) trends per playa, Hart Mountain NAR, 1975

	Spanish Lake				Dobyns Lake			
Week	Up[b]	Atm[d]	Lo[c]	Atm	Up	Atm	Lo	Atm
6-12 Jul	--[e]	--	--	--	--	--	--	--
13-19 Jul	--	--	--	--	--	--	--	--
20-26 Jul	--	--	--	--	--	--	--	--
27 Jul-2 Aug	--	--	--	--	--	--	--	--
3-9 Aug	--	--	--	--	24	3.48	1	25.00
10-16 Aug	--	--	--	--	17	5.64	1	25.00
24-30 Aug	81	1.18	97	0.97	4	21.10	1	25.00
31 Aug-6 Sept	65	1.40	85	1.12	1	25.00	1	25.00
7-13 Sept	47	1.82	85	1.12	11	25.00	1	25.00

[a] Average of resistance meter readings.
[b] Up = Upper level.
[c] Lo = Lower level.
[d] Atm = Atmospheres (atm. ≻9.7 interpolated).
[e] Playa inundated, no readings taken.

Table 7. Continued.

Week	Desert Lake				Long Lake			
	Up	Atm	Lo	Atm	Up	Atm	Lo	Atm
6-12 Jul	157	0.45	190	0.30	--	--	--	--
13-19 Jul	153	0.52	189	0.30	--	--	--	--
20-26 Jul	164	0.42	189	0.30	101	0.95	102	0.92
27 Jul-2 Aug	130	0.62	147	0.52	120	0.72	126	0.67
3-9 Aug	101	0.95	144	0.51	77	1.34	104	0.90
10-16 Aug	84	1.13	111	0.82	35	2.40	73	1.36
24-30 Aug	31	2.88	63	1.46	36	2.46	34	2.48
31 Aug-6 Sept	43	2.11	78	1.36	11	8.65	50	1.70
7-13 Sept	27	3.50	64	1.42	7	16.90	41	2.14

Table 8. Percent soil moisture at predetermined tensions within plant communities at Spanish and Dobyns Lakes, Hart Mountain NAR, 1974

	Percent Moisture		
Playa	0.3 (atm)	2.0 (atm)	15.0 (atm)
Spanish Lake			
Upper level	65.30	55.62	37.31
Lower Level	55.20	47.41	31.74
Dobyns Lake			
Upper level	81.55	79.12	44.02
Lower level	75.42	72.74	47.18

Table 9. Percent soil moisture at predetermined tensions within plant communities at Long Lake, Hart Mountain NAR, 1974.

Communities		Percent Moisture 0.3 (atm)	5.0 (atm)	15.0 (atm)
Eleocharis-Arnica-Polygonum				
	Upper level	57.63	55.06	34.93
	Lower level	63.68	58.36	34.66
Arnica-Eleocharis-Scirpus				
	Upper level	50.32	42.07	27.96
	Lower level	53.48	46.43	29.60
Eleocharis-Arnica				
	Upper level	56.74	47.64	31.34
	Lower level	60.15	50.53	33.00
Eleocharis-Arnica-Rumex				
	Upper level	57.92	49.80	31.46
	Lower level	58.22	48.34	32.10
Eleocharis				
	Upper level	53.22	44.21	29.57
	Lower level	59.86	49.94	33.27

percent soil moisture was determined for the lower level within the *Eleocharis-Arnica-Muhlenbergia* community (Table 10). The lowest percent soil moisture at 15.0 atmospheres for Desert Lake was within the *Muhlenbergia-Eleocharis* community (Table 10).

O. flava a shallow rooted annual exhibited new leaf growth in September of both years on Desert and Long Lakes when the calculated tension was 22.0 atmospheres at the upper soil level. Leafy arnica grew through the end of both study periods on Desert and Long Lakes in plant communities where calculated tension was greater than 25.0 atmospheres at the lower soil level. Leafy arnica also grew where the calculated tension was less than 0.5 atmospheres at the lower level within the *Arnica-Eleocharis* community after 5 September 1975 at Desert Lake. Since leafy arnica is a deeply rooted plant the lower soil moisture values above may not be directly related to leafy arnica growth.

Poverty sumpweed remained green during August on Dobyns Lake when calculated soil moisture tensions at upper and lower soil levels were greater than 25.0 atmospheres. Prostrate knotweed, a shallow rooted annual, was growing when calculated upper soil level tension between 24 August - 13 September 1975 were 1.18 and 1.82 atmospheres respectively at Spanish Lake. During 1974, a drier year, the upper soil moisture tensions between 24 August - 14

Table 10. Percent soil moisture at predetermined tensions within plant communities at Desert Lake, Hart Mountain NAR, 1974

Communities		Percent Moisture 0.3 (atm)	5.0 (atm)	15.0 (atm)
Eleocharis-Arnica-Muhlenbergia				
	Upper level	64.36	54.34	36.49
	Lower level	68.17	56.75	37.13
Eleocharis-Muhlenbergia-Iva				
	Upper level	59.24	48.31	32.92
	Lower level	61.74	50.89	32.92
Muhlenbergia-Eleocharis				
	Upper level	55.88	45.10	29.80
	Lower level	57.49	46.10	30.57
Eleocharis-Arnica				
	Upper level	63.26	51.24	34.65
	Lower level	63.66	51.65	34.72
Arnica-Eleocharis				
	Upper level	65.51	62.50	37.81
	Lower level	66.63	59.94	38.58

September were 16.9 and 22.5 respectively (Table 6). During 1974, only a few, stunted prostrate knotweed plants were observed.

Soil pH measurements indicated that Spanish and Dobyns Lakes exhibited higher alkalinity than Desert and Long Lakes (Table 11). Spanish and Desert Lake soils had the highest and lowest pH values respectively. All playa soils exhibited low salinity (Table 12).

Available Surface Water Within the Playa Study Sites

Water was available to pronghorns throughout the 1974 field season at Desert, Dobyns and Spanish Lakes, and through 1 September at Long Lake. During 1975 water was available to pronghorns at all playas.

Large dugouts averaged 61.4 m long X 13.7 m wide X 2.1 m deep at Desert and Dobyns Lakes and 16.8 m long X 4.9 m wide X 1.5 m deep at Spanish Lake (Figures 2, 3, 5). Two small dugouts averaging 6.7 m long X 4.6 m wide X 0.9 m deep were at Long Lake (Figure 4).

Open water existed on Desert Lake through 8 September 1974, on Dobyns Lake through 14 July, on Spanish Lake through 9 July and on Long Lake through 31 August. Amounts of standing water were not recorded for 1974. Surface water was available to pronghorns in dugouts at Desert Lake after 8 September 1974, at Dobyns Lake after

Table 11. Soil pH measured within playa plant communities, Hart Mountain NAR, 1975.

	Depth	
	17.8 cm	45.7 cm
Spanish Lake		
Eleocharis-Iva	8.5[a,b]	8.8[a,b]
Dobyns Lake		
Eleocharis-Iva	8.4[a,b]	8.6[a,b]
Desert Lake		
Eleocharis-Arnica-Muhlenbergia	8.2[a]	8.2[a]
Eleocharis-Muhlenbergia-Iva	8.2[2]	8.2[a]
Muhlenbergia-Eleocharis	8.2[a]	8.2[a]
Eleocharis-Arnica	8.2[a]	8.2[a]
Arnica-Eleocharis	8.2[a]	8.4[a,b]
Long Lake		
Eleocharis-Arnica-Polygonum	8.2[a]	8.4[a,b]
Arnica-Eleocharis-Scirpus	8.2[a]	8.4[a]
Eleocharis-Arnica	8.2[a]	8.4[a]
Eleocharis-Arnica-Rumex	8.2[a]	8.4[a]
Eleocharis	8.2[a]	8.2[a,b]

a = Thymol blue

b = Cresol red

Table 12. Soil salinity measurements from plant communities, Hart Mountain NAR, 1975.

Playa and community	Depth 17.8 cm	45.7 cm
Spanish Lake		
Eleocharis-Iva	1.65[a]	3.40[a]
Dobyns Lake		
Eleocharis-Iva	0.55	1.20
Desert Lake		
Eleocharis-Arnica-Muhlenbergia	0.35	0.30
Muhlenbergia-Eleocharis	0.25	0.20
Eleocharis-Arnica	0.20	0.20
Arnica-Eleocharis	0.10	0.10
Long Lake		
Eleocharis-Arnica-Polygonum	0.30	0.70
Eleocharis-Arnica	0.35	2.50
Eleocharis-Arnica-Rumex	0.30	0.20
Eleocharis	0.30	0.10

a = Salts (mmhos/cm) tested by Oregon State University Soil Testing Laboratory.

14 July and at Spanish Lake after 9 July in the north dugout. No surface water was available to pronghorns at Long Lake after 1 September 1974.

During 1975 an estimated 19.4 ha of open water remained on Desert Lake and 28.3 ha on Long Lake through 13 September. Open water remained through 7 August on Dobyns Lake and 8 September on Spanish Lake during 1975.

Pronghorn Use of Playas and Adjacent Range Sites

A total of 14,316 pronghorn observations were recorded on the four playas, 9,854 in 1974 and 4,462 in 1975. Pronghorn observations totalled 4,510 on range sites adjacent to the four playas, 2,165 and 2,345 during 1974 and 1975 respectively.

During 1974 and 1975 Desert Lake received more pronghorn use than other playas (Tables 13, 14). Total numbers of pronghorns/ha were calculated in the following decreasing order per playa during 1974 and 1975; Dobyns, Long and Spanish (Tables 13, 14). The pronghorn population at Hart Mountain NAR was similar during 1974 and 1975 (Refuge records).

During 1974 the numbers of pronghorns increased as the season progressed on Desert Lake, and decreased on other playas (Table 13). The number of pronghorns increased as the season progressed at Desert Lake during 1975, but in contrast to 1974 pronghorn numbers

Table 13. Weekly observations of pronghorns/ha at Desert, Dobyns, Long and Spanish Lakes, Hart Mountain NAR, 1974.

Sampling week	Weekly observations of pronghorns/ha by playa			
	Desert	Dobyns	Long	Spanish
7-13 Jul	0.03	0	0.11	0
14-20 Jul	3.52	0	1.42	0
21-27 Jul	1.02	0.04	0.16	0
28 Jul-3 Aug	2.74	0	0.09	0.01
4-10 Aug	2.31	3.41	0.08	0
11-15 Aug	3.48	0.07	0	0
22-24 Aug	2.85	3.44	0.01	0.01
25-31 Aug	3.96	0.22	0.01	0.04
1-7 Sept	7.08	0.33	0	0.02
8-14 Sept	8.64	0	0	0.02
15-21 Sept	7.82	0	0	0.01
Total	43.45	7.51	1.88	0.11

Table 14. Weekly observations of pronghorns/ha at Desert, Dobyns, Long and Spanish Lakes, Hart Mountain NAR, 1975.

Sampling week	Weekly observations of pronghorns/ha by playa			
	Desert	Dobyns	Long	Spanish
22-28 Jun	0	0	0	0
29 Jun-5 Jul	0.28	0	0	0
6-12 Jul	0.27	0	0	0
13-19 Jul	0.04	0	0	0
20-26 Jul	0.17	0.11	0.07	0
27 Jul-2 Aug	0.57	0.04	0.23	0.02
3-9 Aug	0.93	0.22	0.02	0
10-16 Aug	2.79	0	0.29	0.09
24-30 Aug	4.02	0.33	0.47	0.39
31 Aug-6 Sept	4.43	5.07	0.16	0.41
7-13 Sept	4.45	0.37	0.05	0.21
Total	17.95	6.14	1.29	1.12

did not decrease as much at Dobyns, Long and Spanish Lakes (Tables 13, 14). The greatest number of pronghorns/ha, 8.64, occurred on Desert Lake during 8-14 September 1974, and on Dobyns Lake from 31 August to 6 September 1975 when 5.07/ha were calculated.

Increased pronghorn use on Desert Lake began during the week of 14 July 1974 and 10 August 1975. Pronghorn use on Dobyns Lake was sporadic for both years. Most use occurred early in the 1974 sampling period on Long Lake, while the reverse occurred during 1975 (Tables 13, 14). Pronghorns used Spanish Lake during the latter portions of both sampling periods (Tables 13, 14).

No pronghorns were observed on Dobyns Lake during the first two sampling weeks, nor on Spanish Lake for the first three sampling weeks of 1974. Pronghorns were not seen on Dobyns Lake after 7 September, nor after 31 August on Long Lake during 1974. No pronghorns were seen during the first sampling week on Desert Lake, through the fourth sampling week on Dobyns or Long Lakes, nor through the fifth sampling week on Spanish Lake during 1975 (Table 14).

A significant difference ($P < 0.01$) in pronghorn use occurred on Desert Lake between the two study periods (Table 15). No significant differences in pronghorn use occurred between the two years on Dobyns, Long or Spanish Lakes (Table 15).

Most pronghorns, 113.6/ha, were recorded within the *Arnica-Eleocharis* community on Desert Lake in 1974 and within the

Table 15. Total observations of pronghorns/ha on lakebeds and adjacent range sites, Hart Mountain NAR, 1974-75.

Lakebed[a]	1974		1975
Desert	43.75	**	17.95
Dobyns	7.51		6.14
Long	1.88		1.29
Spanish	0.11		1.12
Mean (all lakebeds)	14.82		6.71
Adjacent Range Sites[b]			
Desert	6.47[c]		3.14
Dobyns	0.56		2.57
Long	0.78*		3.45
Spanish	0.12*		2.04
Mean (all range sites)	2.63		2.86

[a] N = 11

[b] N = 9

[c] $P \leq 0.10$

** $P \leq 0.01$

* $P \leq 0.05$

Eleocharis-Arnica community 34.8/ha, during 1975 (Table 16). The least number of pronghorns, 9.4/ha during 1974 and 5.9/ha in 1975, occurred within the Muhlenbergia-Eleocharis and Eleocharis-Muhlenbergia-Iva communities respectively (Table 16). During both study periods the Eleocharis-Arnica-Muhlenbergia community received greater pronghorn use than the Eleocharis-Muhlenbergia-Iva community (Table 16). During the last three weeks of the study in 1974, up to 84 percent of the pronghorns observed on the southern half of Hart Mountain NAR (Refuge census data) stayed within the 57 ha Arnica-Eleocharis community at Desert Lake.

During 1974 and 1975 at Desert Lake most pronghorn use was recorded in the Eleocharis-Arnica-Muhlenbergia, Eleocharis-Muhlenbergia-Iva and Muhlenbergia-Eleocharis communities through the end of both study periods.

More pronghorn use was observed at Dobyns Lake within the Eleocharis-Iva community during 1974 compared to 1975 (Table 16). When feeding on Dobyns Lake pronghorns were always observed eating poverty sumpweed. Pronghorns/ha within the Eleocharis-Iva community on Spanish Lake varied from 0.1 in 1974 to 1.1 during 1975 (Table 16).

At Long Lake during both study periods, pronghorns preferred the Eleocharis-Arnica community (Table 16). The heaviest pronghorn use, 7.2/ha, was recorded within the Eleocharis-Arnica community

Table 16. Total observations of pronghorns/ha within plant communities on four playas, Hart Mountain NAR, 1974-75.

Playa	Plant Community	Pronghorns/ha	
		1974	1975
Desert Lake			
	Eleocharis-Arnica-Muhlenbergia	25.3	19.1
	Eleocharis-Muhlenbergia-Iva	9.5	5.9
	Muhlenbergia-Eleocharis	9.4	7.2
	Eleocharis-Arnica	25.8	34.8
	Arnica-Eleocharis	113.6	21.2
Long Lake			
	Eleocharis-Arnica-Polygonum	2.9	2.1
	Arnica-Eleocharis-Scirpus	0.7	0.3
	Eleocharis-Arnica	7.7	4.5
	Eleocharis-Arnica-Rumex	2.6	2.6
	Eleocharis	0.2	0.1
Spanish Lake			
	Eleocharis-Iva	0.1	1.1
Dobyns Lake			
	Eleocharis-Iva	7.0	5.7

between 14-20 July 1974. During both sampling periods, 2.6 pronghorns/ha, were recorded in the Eleocharis-Arnica-Rumex community. Pronghorn use indicated least preference for the Eleocharis community at Long Lake for both years (Table 16). Within the Arnica-Eleocharis-Scirpus community at Long Lake, over twice as many pronghorns/ha were calculated during 1974 compared to 1975.

On range sites adjacent to Desert Lake, 6.47 pronghorns/ha were calculated during 1974 and 3.14 during 1975. Intermittent Lake (fair condition) range site received most pronghorn use during 1974 and 1975, accounting for 12.8 and 8.4 pronghorns/ha respectively (Table 17). Rockly Terrace (fair condition) received more pronghorn use during both years than Rocky Terrace (poor condition), while Claypan Terrace (fair condition) received the least pronghorn use in both years (Table 17). The largest number of pronghorns/ha were calculated within the Intermittent Lake (fair condition) site; 3.9, 22-28 August 1974 and 2.3, 3-9 August 1975. A significant ($P \leq 0.10$) difference in pronghorn use on adjacent range sites occurred between 1974 and 1975 at Desert Lake (Table 15).

During 1974, pronghorns indicated a preference for the Rocky Terrace (poor condition) range site over Intermittent Lake site at Dobyns Lake (Table 17). During the 1975 sampling period, 12.5 pronghorns/ha were recorded within the Intermittent Lake range site

Table 17. Total observations of pronghorns/ha on range sites, adjacent to playas, Hart Mountain NAR, 1974-75.

Playa	Range Site	Pronghorns/ha 1974	1975
Desert Lake	Intermittent Lake (fair condition)	12.8	8.4
	Rocky Terrace (fair condition)	6.9	2.5
	Rocky Terrace (poor condition)	3.5	0.6
	Claypan Terrace (fair condition)	0.2	0.5
Spanish Lake	Rocky Terrace (poor condition)	0.4	3.1
	Intermittent Lake (poor condition)	0.1	2.9
	Claypan Terrace (fair condition)	0.1	0.1
	Claypan Terrace (poor condition)	0	1.1
	Shrubby Terrace Complex (fair condition)	0	0.4
Long Lake	Rocky Terrace (poor condition)	1.0	4.1
	Moist Bottomland Fan (poor condition)	0.1	1.3
	Intermittent Lake	0.9	3.5
Dobyns Lake	Rocky Terrace (poor condition)	0.6	0.6
	Intermittent Lake	0.3	12.5

(Table 17). A large increase in pronghorn use of the Intermittent Lake range site between 31 August and 6 September 1975 resulted in 10.8 pronghorns/ha, the largest weekly count of pronghorns/ha on an adjacent range site at Dobyns Lake. No significant difference in pronghorn use on adjacent range sites occurred between 1974 and 1975 at Dobyns Lake (Table 15).

Use of the Dobyns Lake area by pronghorns apparently was related to their use of Desert Lake. There was a well traveled game trail leading from the Long Lake area to Dobyns Lake, then north to Desert Lake. Also, Dobyns and Desert Lakes were only about 0.6 km apart at one point.

In 1974 only 0.12 pronghorns/ha were calculated on range sites adjacent to Spanish Lake (Table 15). Adjacent range site use at Spanish Lake increased to 2.04 pronghorns/ha during 1975 (Table 15). Pronghorns apparently preferred the Rocky Terrace (poor condition) range site over other adjacent range sites at Spanish Lake with 0.4 and 3.1 pronghorns/ha calculated during 1974 and 1975 respectively (Table 17). Pronghorns/ha increased from 0.1 to 2.9 on the Intermittent Lake (poor condition) range site between 1974 and 1975 respectively (Table 17). No pronghorn observations were recorded within either the Claypan Terrace (poor condition) or Shrubby Terrace Complex (fair condition) range sites during 1974. During 1975, 1.1 and 0.4 pronghorns/ha were calculated within the Claypan Terrace (poor condition) and Shrubby Terrace Complex (fair condition) range sites respectively (Table 17). Pronghorn use was identical within the Claypan Terrace (fair condition) range site during both sampling periods (Table 17). A significant ($P < 0.05$) difference in pronghorn use on adjacent range sites occurred between 1974 and 1975 at Spanish Lake (Table 15).

At Long Lake pronghorns showed a preference for the Rocky Terrace (poor condition) range site as 1.0 and 4.1 pronghorns/ha were calculated during 1974 and 1975 respectively (Table 17). Only 0.1 pronghorn/ha was figured for the Moist Bottomland Fan (poor condition) range site, but pronghorns/ha increased to 1.3 in 1975 (Table 17). The majority of the pronghorn use on the Moist Bottomland Fan (poor condition) site occurred between 24-30 August 1975, when 1.1 pronghorns/ha were calculated. Pronghorns/ha increased from 0.9 to 3.5 on the Intermittent Lake Range site between 1974 and 1975 respectively (Table 17). A significant ($P < 0.05$) difference in pronghorn use on adjacent range sites occurred between 1974 and 1975 at Long Lake (Table 15).

Analysis of Variance and Least Significant Difference Analyses of Data

Analysis of variance of weekly pronghorn use figures showed a significant difference ($P < 0.01$) for both 1974 and 1975 among study areas.

In 1974 there was a significant difference at the 1 percent level (LSD) for pronghorn use between Desert Lake and the other three playas, but no significant difference among Dobyns, Spanish and Long Lakes. During 1975, there was a significant difference at the 5 percent level (LSD) between Desert Lake and the other Playas, but no significant difference among Dobyns, Spanish and Long Lakes.

Regression Analysis of Data

Desert Lake

Percent desiccated vegetation, soil moisture at two levels and weekly estimates of pronghorn use for each of the following adjacent range sites, Intermittent Lake (fair condition), Rocky Terrace (fair condition), Rocky Terrace (poor condition) and Claypan Terrace (fair condition), were used in the regression analysis as independent variables. All independent variables were regressed on weekly pronghorn use for Desert Lake.

A significant ($P < 0.05$) regression coefficient ($R^2 = 0.887$) was calculated during 1974 between pronghorn use (Y), upper soil moisture (X_2) and lower soil moisture (X_3). The regression equation by the method of least squares was $\hat{Y} = 5.035 + 0.175X_2 - 0.154X_3$. For 1975, variables showing a significant ($P < 0.05$) regression coefficient ($R^2 = 0.942$) were pronghorn use (Y) and lower soil moisture. The regression equation was $\hat{Y} = 2.649 - 0.014X_2$. All other variables entering the model at each stage were not significant. However, a close relationship between upper and lower soil moisture existed during both study periods. In 1975 this relationship led to the selection of lower soil moisture as the only independent variable showing a significant ($P < 0.05$) relationship with pronghorn use; however upper soil moisture also was closely related to pronghorn use.

Simple correlations between upper and lower soil moisture and pronghorn density during 1974 showed significant ($P < 0.05$) negative relationships ($r = -0.711$ and $r = -0.791$ respectively). During 1975, correlations between upper and lower soil moisture and pronghorn use showed significant ($P < 0.01$) negative relationships ($r = -0.969$ and $r = -0.970$ respectively). Desiccated vegetation showed significant correlations ($P < 0.05$; $r = 0.748$ and $P < 0.01$; $r = 0.872$) in 1974 and 1975 respectively with pronghorn use.

The simple correlation coefficient for Claypan Terrace (fair condition) and pronghorn use of the playa was not significant in 1974 but was significant ($P < 0.05$; $r = -0.713$) in 1975. Simple correlations for the other adjacent range sites both years were not significant.

Dobyns Lake

Percent desiccated vegetation, soil moisture at two levels and weekly pronghorn use for Rocky Terrace (poor condition) and

Intermittent Lake, were used in the regression analysis as independent variables. The independent variables were regressed on weekly pronghorn densities for Dobyns Lake.

None of the variables entering the model were significant during 1974. Multiple regression was not used during 1975 because Dobyns Lake was inundated during the first 4 weeks of the study period which precluded soil moisture readings.

Simple correlations for 1974 between independent variables and pronghorn use were low and not significant. During 1975, Intermittent Lake showed a significant ($P < 0.01$; $r = 0.996$) correlation with pronghorn use. All other correlations were non-significant in 1975.

Spanish Lake

Percent desiccated vegetation, soil moisture at two levels and weekly pronghorn use for Rocky Terrace (poor condition), Claypan Terrace (poor condition), Claypan Terrace (fair condition), Intermittent Lake (poor condition) and Shrubby Terrace Complex (fair condition) were used in the regression analysis as independent variables. The independent variables were regressed on weekly pronghorn use for Spanish Lake.

None of the variables entering the model was significant during 1974. None of the simple correlation coefficients was significant in 1974.

Multiple regression was not used during 1975 because Spanish Lake was inundated during the first 6 weeks of the study period which precluded soil moisture readings.

Simple correlation coefficients exhibiting significant ($P < 0.01$ and $P < 0.05$) relationships with pronghorn use were desiccated vegetation and Intermittent Lake (poor condition) respectively during 1975.

Long Lake

Soil moisture at two levels, percent desiccated vegetation and weekly pronghorn use for the following adjacent range sites, Rocky Terrace (poor condition), Moist Bottomland Fan (poor condition) and Intermittent Lake were used in the regression analysis as independent variables. All independent variables were regressed on weekly pronghorn use for Long Lake.

Results for 1974 showed a significant ($P < 0.05$) regression coefficient ($R^2 = 0.999$) between pronghorn use (Y) and desiccated vegetation (X_2), Moist Bottomland Fan (X_3), upper soil moisture (X_4) and lower soil moisture (X_5). The calculated regression equation was $\hat{Y} = -0.253 + 0.002X_2 - 1.746X_3 + 0.005X_4 + 0.004X_5$.

Multiple regression was not used during 1975 because Long Lake was inundated for the first 2 weeks of the study period which precluded soil moisture readings.

Simple correlation coefficients which indicated significant ($P < 0.01$) relationships with pronghorn use of the playa during 1974 were Rocky Terrace (poor condition) ($r = 0.865$), upper soil moisture ($r = 0.956$) and lower soil moisture ($r = 0.865$). Intermittent Lake showed a significant ($P < 0.05$) correlation ($r = 0.771$) with pronghorn use in 1974. Simple correlations for the other variables during 1974 were not significant. The only significant ($P < 0.01$) correlation coefficient ($r = 0.845$) during 1975 was between pronghorn use of the playa and Moist Bottomland Fan (poor condition).

DISCUSSION

Desert Lake received significantly more pronghorn use than other study areas during 1974 and 1975. No significant differences in use existed among Dobyns, Long and Spanish Lakes during either year of the study.

Pronghorns demonstrated a greater dependence on lakebeds during a dry year than during a wet year. Herrig (1974) found pronghorns preferred range sites of the lowland mesic category during dry periods on Hart Mountain. Although pronghorns terminated use of a lakebed if drinking water was unavailable, the mere presence of water on a playa did not insure use. The most important relationship between precipitation and pronghorn use was in regard to the availability of succulent vegetation. Beale and Smith (1970) in Utah listed succulence as apparently the major characteristic of forage sought by pronghorns. Pronghorns indicated a strong preference for leafy arnica, particularly at Desert Lake. Leafy arnica exhibited new, green growth throughout both summers. During the dry year, 1974, leafy arnica was one of the few green plants available for pronghorns during summer.

As soil moisture decreased, desiccation of vegetation increased, and pronghorn use intensified on Desert Lake where the least amount of desiccation occurred. Within the more xeric portions of Desert Lake, the Eleocharis-Arnica-Muhlenbergia, Eleocharis-Muhlenbergia-

Iva, and *Muhlenbergia-Eleocharis* plant communities, soil moisture was more quickly depleted than from the more mesic sites, *Eleocharis-Arnica* and *Arnica-Eleocharis*. The xeric communities exhibited the greatest amount of desiccation. In response to this drying, pronghorns used xeric sites during early summer and concentrated on mesic sites from July through the end of each study period. A similar relationship occurred at Long Lake; however, soil moisture was more quickly depleted on all sites at Long Lake, and when drinking water became available, pronghorn use ceased. At Dobyns Lake as soil moisture decreased and desiccation of vegetation increased pronghorn use decreased. During the dry year, pronghorns ceased using Dobyns Lake by the last two weeks of the study as vegetation became very desiccated although drinking water was available. Pronghorns at Spanish Lake responded directly to available succulent forage when soil moisture was available for plant growth. During the wet year, 1975, pronghorns showed a strong preference for prostrate knotweed at Spanish Lake. Other authors also found that prostrate knotweed was a pronghorn food (Ferrel and Leach 1950, Tsukamoto and Deibert 1968).

Various studies demonstrated the importance of forbs during summer for pronghorns (Dawson 1950, Ferrel and Leach 1952, Hoover et al. 1959). Pronghorn use of playas during my study apparently was in response to available green forbs and to a lesser extent water, which the low sagebrush (A. arbuscula)-dominated xeric upland range sites surrounding the playas lacked as summer progressed. Leafy arnica, a preferred forb by pronghorns on Desert Lake, had a 7.7 percent crude protein level (Deming 1958). Pronghorns in Saskatchewan preferred range plants with highest protein levels (Dirschl 1963). In an unpublished refuge report (1972) of pronghorn stomach analyses collected during Hart Mountain pronghorn hunting seasons, 1968-70, leafy arnica had a frequency of 11 percent.

Prostrate knotweed, a preferred forb by pronghorns at Spanish Lake, had a crude protein level of 11 percent (Deming 1958). During 1974), a dry year, prostrate knotweed was hardly noticeable growing at the northern edge of Spanish Lake playa.

Poverty sumpweed grew on all playas except Long Lake. Pronghorns were observed feeding on poverty sumpweed at Desert and Dobyns Lakes, and they undoubtedly fed on it at Spanish Lake. The unpublished refuge report indicated that 33 percent of the pronghorn stomach samples contained poverty sumpweed. Pronghorns apparently fed upon succulent poverty sumpweed at all playas except Long Lake during both study periods. Pronghorns ate poverty sumpweed in northeastern California (Ferrel and Leach 1950).

Pronghorns were observed drinking from dugouts and open surface water as long as it was present on all playas.

The increased use by pronghorns during 1975 compared to 1974 at Spanish Lake was partly due to available drinking water in a shallow spring fed dugout in the Claypan Terrace (poor condition) range site 0.8 km west of the playa and to the available succulent prostrate knotweed on the playa. Water was not available in the shallow dugout after mid July 1974. During 1975 pronghorns were observed within 1.6 km of the shallow dugout.

Pronghorns within the Desert Lake study site were always within 1200 m of water. Herrig (1974) reported mean distances to water for all pronghorn observations during summer was 725.6 m.

Early leaf growth and early flowering stages of forbs were apparently the most important developmental stages causing a selective response by pronghorns on all playas except at Dobyns Lake. Phenological stages did not seem to affect pronghorn use of Dobyns Lake.

As upland range sites, dominated by low sagebrush, dried, pronghorn use was concentrated on the playas throughout the summer and early fall.

Patterns of use by pronghorns of range sites adjacent to playas were similar between years. However, the number of observations per ha increased on all study sites except Desert Lake during the wet year. Patterns of use of the adjacent range sites supported the concept that during wet years, pronghorns were less dependent on playa vegetation.

At Desert Lake, pronghorns indicated a preference for the Intermittent Lake (fair condition) range site. Pronghorns were observed feeding on Bolander's silver sagebrush within this site; silver sagebrush was documented as a pronghorn food (Baker 1953, Mitchell and Smoliak 1971, Sundstrom et al. 1973). Because of the proximity of the Intermittent Lake (fair condition) site surrounding Desert Lake playa and the relative heavy use of this adjacent range site by pronghorns throughout both sampling periods, pronghorn use of these two areas was related. Rocky Terrace (fair condition) was preferred by pronghorns over Rocky Terrace (poor condition) at Desert Lake; all Rocky Terrace range sites were dominated by low sagebrush. Mason (1952) documented the importance of low sagebrush in the diet of pronghorns on Hart Mountain. Herrig (1974) reported that Rocky Terrace was the most widespread and most consistently used upland xeric site by pronghorns on Hart Mountain.

Although I did not test the relationship of range condition to pronghorn use, it is noteworthy that the range sites adjacent to Desert Lake were in better condition than sites adjacent to the other playas (see Table 3).

Pronghorns were not observed within heavy stands of Mountain big sagebrush (*A. t. vaseyana*) adjacent to Desert Lake and Spanish Lake within the Rocky Terrace (poor condition) range site.

Observations indicated pronghorns preferred the Intermittent Lake (fair condition) site at Desert Lake more than the Intermittent Lake (poor condition) site at Spanish Lake.

Because of the availability of succulent vegetation on all playas and adjacent range sites during the wet year, pronghorns did not concentrate on Desert Lake as they had during the dry year. Use of adjacent range sites was more evenly distributed during the wet year, than during the dry year when pronghorns concentrated on Desert Lake.

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