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WINTER HABITAT SELECTION BY REINTRODUCED PRONGHORN ON ANTELOPE ISLAND, GREAT SALT LAKE, UTAH

Melissa J. Kilgore 1 and W. Sue Fairbanks 2

ABSTRACT.—The recent and future introduction of several ungulate species on Antelope Island necessitates knowledge of habitat use by each species. In this study habitat preferences of reintroduced pronghorn (Antilocapra americana) on Antelope Island were evaluated during February–March 1993 and January–March 1994. Elevation, slope, physiography, aspect, and habitat type of sites used by pronghorn were compared to similar data collected from random points. During the severe winter of 1993, pronghorn preferred terrain that was 1281–1380 m in elevation and was relatively flat or at the base of a hill. Slopes greater than 30% were avoided. South-facing slopes were preferred; west-facing slopes were avoided. Pronghorn preferred sagebrush habitats and avoided grasslands. During the mild winter of 1994, pronghorn showed preferences for slightly higher elevations, avoided slopes greater than 30%, but used other habitat features in proportion to their availability. Future winter studies of pronghorn should include considerations of snowfall patterns and the availability, versus the abundance, of sagebrush.

Key words: pronghorn, antelope, Antilocapra americana, habitat selection, winter habitat, habitat availability.

With the introduction of pronghorn into new areas, many questions must be answered concerning their winter habitat preferences. Factors such as vegetation availability and diversity, snow depth, and physiography may play an important role in their survival. Past habitat studies have considered these factors, but many neglected to examine a particular feature’s availability when results were interpreted (but see Amstrup 1978, Clary and Beale 1983, Ryder and Irwin 1987). Availability is important because observed habitat use by pronghorn may simply reflect the occurrence of habitat types in the area. Only when animals use certain features out of proportion to their availability can they be said to prefer or avoid those features (Marcum and Loftsgaarden 1980).

Optimal winter habitat with ample vegetation is critical for pronghorn survival. A severe winter with heavy snowfall and low temperatures can result in higher mortality from malnutrition (Martinka 1967, Van Wormer 1969) and may lead to a low production of young the following year (Martinka 1967). Additionally, deep snow can hinder winter movements by pronghorn (Van Wormer 1969, Mitchell 1980, Kindschy et al. 1982), affect vegetation availability (Hovey and Harestad 1992), and increase predation risk (Van Wormer 1969).

The reintroduction of pronghorn onto Antelope Island State Park in the Great Salt Lake, Utah, provided an excellent opportunity to study winter habitat selection of pronghorn. The recent and future introduction of other ungulates on the island necessitates knowledge of critical pronghorn winter habitat to minimize potential interspecific competition. Identification of these critical areas also can be used in planning construction of hiking and bike trails to avoid human use of prime winter habitat. The objective of this study was to determine which factors affect winter habitat preferences of pronghorn and thus to provide data for better management of pronghorn on Antelope Island.

STUDY AREA

Antelope Island State Park, in the south-eastern region of the Great Salt Lake, is about 16 km from Salt Lake City, Utah (Fig. 1). The island was closed to the public from 1983 to 1993 because of rising lake levels that flooded the 11.6-km causeway leading to the island.

The 10,409-ha island is topographically diverse, ranging in elevation from 1280 to 2011 m (Jones 1985, Utah Department of Natural Resources 1988). Average annual precipitation is 43 cm, with 10.8 cm falling January–March (National Weather Service Forecast Office [NWSFO], Salt Lake City International Airport, Salt Lake City, Utah). Most of the island

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MATERIALS AND METHODS

Fig. 1. Antelope Island State Park study area in the Great Salt Lake, Utah. Pronghorn moved from north to south through several open gates along the fence on the north side of the island.

is grassland with patches of sagebrush (Artemisia spp.) and a few small riparian and marsh areas. Intermittent streams run on the island in spring and summer seasons. Average temperatures for January, February, and March of 1993 were -3.9°C, -1.4°C, and 7.5°C, respectively; snowfall was 127.8 cm in January, 33.5 cm in February, and a trace in March. For winter 1994, temperatures averaged 2.7°C in January, 1.8°C in February, and 7.6°C in March; snowfall was 15.7 cm, 38.1 cm, and 7.9 cm, respectively (NWSFO).

Antelope Island was named by John C. Fremont in the 1840s for the herds of pronghorn inhabiting it. However, the last pronghorn on the island was sighted in 1870 (M. A. Larsson personal communication). The island also is inhabited by about 500 bison (Bison bison) and 70 mule deer (Odocoileus hemionus), with populations of coyotes (Canis latrans), bobcats (Lynx rufus), and Golden Eagles (Aquila chrysaetos) as potential predators of pronghorn.

PRONGHORN MIGRATION

Twenty-three pronghorn were captured with a net-gun in Summit County, Utah, and released on Antelope Island 30 January 1993. Three bucks from Morgan County, Utah, introduced to the island in May 1993, and 10 fawns born in May and June 1993 were included with the original 23 pronghorn in the 1994 field season. Prior to release onto the island, each animal was fitted with a solar-powered radio transmitter (Advanced Telemetry Systems, Inc., Box 398, Isanti, MN 55040) mounted on a standard livestock ear tag.

Pronghorn were tracked February–March 1993 and January–March 1994 in all weather conditions, using radiotelemetry to locate groups. Data were collected 2–3 d per week between 0700 and 1800 h. No animal was included in more than 1 group on the same day, and groups were noted as separate only if they were separated by ≥0.5 km. Pronghorn observations stopped when winter groups began to disperse and bucks began establishing territories (31 March 1993 and 20 March 1994).

The visual location of each group was marked on a topographic map. Dominant vegetation, physiography, and elevation were noted. Later the site was revisited to measure slope, using a clinometer, and aspect (north 315–44°, east 45–134°, south 135–224°, or west 225–314°). Slope was categorized into 2 groups (<30% and >30%) because slopes >30% were scarce; this also facilitated comparison with previous studies (Kindschy et al. 1978).

Categorization of physiography and vegetation type occupied was subjective but consistent. We categorized the physiography of each point as relatively flat (little or no slope), slope of hill, top of hill, base of hill, or terrace. Dominant vegetation was categorized as grassland (few or no sagebrush, bushes, or trees), sagebrush (some grass and forbs), sagebrush-dunes (sand dunes where sagebrush predominates), or shrub (woody vegetation other than sagebrush). We used only grassland and sagebrush habitats in the statistical analysis due to limited availability of other vegetation types, even when all other types were combined into a single group.

Air temperature at the time of the sighting of each pronghorn group was recorded. Snow depth at the site was recorded by relating the depth of snow to the length of the pronghorn's hind legs. Wind direction and velocity data were obtained from the closest weather station to the island, the Salt Lake International Airport (NWSFO), about 26 km southeast of Antelope Island. Wind conditions at the weather station and on the island were comparable as...
both occur on the valley floor equidistance from the mountain range. Readings are taken hourly at the station, and we used values closest to the times of pronghorn group sightings.

Sites used by pronghorn were compared to 76 randomly selected sites to determine habitat preferences. We determined the number of random sites by estimating that 20 sightings of pronghorn groups would be made per month over the 2-winter study period. When determining random-point distribution, we considered the whole island because it was impossible to define a priori the boundaries of available range.

Random points were chosen using a random-number table and a grid (60 x 60 m) superimposed onto a 7.5-minute series topographic map. Once the location in the field was approached as closely as possible with a topographic map, we selected the exact spot for data collection by releasing a rock on a string that had been swung overhead. At each of these random points, the elevation, slope, aspect, dominant vegetation, and physiography were recorded.

Availability of habitat features, as determined by random-point data, was compared to actual pronghorn sightings with chi-square analysis to determine if pronghorn were using a site in proportion to its availability (use = availability; \( \alpha \) of 0.05) or not in proportion to availability (use < or > availability). If pronghorn used a habitat less than expected, they were avoiding the feature; if the habitat was used more than expected, the pronghorn were choosing the feature. Following a significant difference as indicated by chi-square, we analyzed elevation, physiography, slope, dominant vegetation, and aspect data with Bonferroni Z tests to determine which categories of each feature were used significantly more or less than expected based on availability (Marcum and Loftsgarden 1980). In all Bonferroni Z tests, 97% confidence intervals were used for individual categories, and simultaneous \( \alpha \) varied with the number of categories in the analyzed feature.

Wind velocity and current temperature each were compared to physiography data and analyzed using the Kruskal-Wallis test to determine if pronghorn use of physiographic features was related to weather conditions. To test whether pronghorn were likely to use certain aspects more than others when wind velocities were high, we calculated median wind velocities for pronghorn observations at different aspects using Kruskal-Wallis. Aspect groups were combined into north- and east-facing and south- and west-facing due to small numbers of pronghorn observations at each aspect; north- and east-facing aspects were grouped because these slopes are usually colder than south- and west-facing aspects, on which snow melts more quickly. Snow depth in areas used by pronghorn was summarized but not analyzed statistically because availability data were collected in the summer.

**RESULTS**

In winter 1993, 47 observations of pronghorn groups were made; each group consisted of 2-23 pronghorn (mean \( \pm s = 14 \pm 8 \) animals). Forty pronghorn groups were observed in winter 1994; groups consisted of 1-36 pronghorn (mean \( \pm s = 11 \pm 11 \) animals).

Snowfall was heavy during 1993, totaling 161.3 cm in January and February (NWSFO). By 6 March snow was patchy, and by 15 March it remained only at higher elevations. Snow depth at the sites where pronghorn were observed ranged from 0 to 10 cm. Pronghorn were found in areas free of snow 48% of the time and in areas with snow 52% of the time (\( n = 21 \) observations of groups). Snowfall on the island was minimal during winter 1994, a total of 61.7 cm in January, February, and March (NWSFO). When snow did fall, it melted within 1-2 d. Consequently, pronghorn were observed in snow only 4 times.

During 1993 pronghorn groups occupied sagebrush habitats in greater proportion than their availability, and grasslands less than their availability (Fig. 2A; \( \chi^2 = 4.3, df = 1, P < 0.05 \)). In contrast, no preferences were observed in pronghorn use of vegetation types during 1994 (\( \chi^2 = 2.1, df = 1, P > 0.05 \)).

During winter 1993 pronghorn preferred elevations of 1281-1380 m and avoided those from 1481 to 1880 m (Fig. 2B; \( \chi^2 = 15.8, df = 3, P < 0.01 \)). During 1994 pronghorn preferred elevations of 1381-1480 m and avoided all higher elevations (\( \chi^2 = 9.8, df = 3, P < 0.05 \)). During 1993 pronghorn groups used south-facing aspects in greater proportion than their availability and west-facing aspects less than their availability (Fig. 2C; \( \chi^2 = 9.6, df = 3, P < 0.05 \)). Pronghorn groups showed no preferences or avoidances in use of aspect during
Fig. 2. Use versus availability of habitat characteristics by pronghorn on Antelope Island, Great Salt Lake, Utah, during the winters of 1993 and 1994. Use refers to pronghorn observations. Availability refers to collected random-point data; 1993: n = 47 observations, 1994: n = 40 observations.

the winter of 1994 ($\chi^2 = 1.1$, df = 3, $P > 0.05$).

Relatively flat areas and bases of hills were used during 1993 in greater proportion than their availability; slopes of hills were avoided (Fig. 2D; $\chi^2 = 22.4$, df = 4, $P < 0.01$). In contrast, pronghorn groups exhibited no preferences or avoidances of physiographic features during the winter of 1994 ($\chi^2 = 4.0$, df = 4, $P > 0.05$). Pronghorn groups avoided slopes >30% during the winters of 1993 (Fig. 2E; $\chi^2 = 6.6$, df = 1, $P < 0.02$) and 1994 ($\chi^2 = 5.1$, df = 1, $P < 0.05$). During both 1993 and 1994, current temperature and pronghorn use of physiographic features were not related (1993: $H = 5.93$, df = 4, $P > 0.05$; 1994: $H = 3.84$, df = 4, $P > 0.05$), nor was the use of physiographic features related to wind velocity (1993: $H = 4.33$, df = 4, $P > 0.05$; 1994: $H = 4.57$, df = 4, $P > 0.05$). Wind velocity during 1993 was not correlated with aspects of terrain used by pronghorn ($H = 0.59$, df = 1, $P > 0.05$); however, during the winter of 1994 pronghorn use of north and east aspects was associated with higher wind velocities ($H = 4.17$, df = 1, $P < 0.05$). The median and modal wind direction
was 150° (i.e., from the southeast); therefore, use of north and east aspects was probably not due to thermoregulatory constraints.

**DISCUSSION**

Pronghorn exhibited more habitat preferences and avoidances during winter 1993 than 1994 due to heavy snowfall that limited vegetation availability. Use of the lowest elevations and relatively flat areas during 1993 may have aided pronghorn in predator avoidance and detection (Van Wormer 1969, Bruns 1977, Vaughan 1986). Pronghorn use of slopes <30% was consistent both years and with previous studies (Amstrup 1978, Kindschy et al. 1978) and also may reflect predator-avoidance behaviors; however, we have no direct evidence to support or refute this explanation, as there was no winter mortality despite frequent sightings of coyotes in the area.

Particularly during a severe winter, snow depth can affect the amount of forage available for ungulate consumption (Hovey and Harestad 1992). Pronghorn apparently preferred sagebrush habitats in 1993 because grassland areas were buried in deep snow. Pronghorn in Alberta were seen pawing through snow to reach food, even when other vegetation was available above the snow (O’Gara 1978), but we did not observe that behavior in this study. Additionally, higher concentrations of fats and proteins in sagebrush than in cured grasses may make sagebrush a preferred winter forage (Martinka 1967, Sundstrom et al. 1973); but the absence of habitat preferences in 1994, when there was little snow, suggests accessibility was the main preference factor.

Pronghorn preference for south-facing aspects may be related to their release near an east-west ridge known as Buffalo Point (Fig. 1). The severe winter, deep snow, and uncertainty of being in a new habitat could have caused the animals to remain in this location where sagebrush was readily available on a south-facing slope. However, their preference for south-facing aspects during winter 1993 was consistent with previous studies (Clary and Beale 1983); the warmer aspects provide faster snowmelt, thus increasing food availability.

On 4 August 1994 most of Buffalo Point burned, including almost all of the sagebrush. Few other areas on Antelope Island have south-facing aspects and sagebrush for pronghorn survival during a severe winter (Moss and Vaughn 1996). Future plans for the island should include habitat restoration with the planting of sagebrush on south-facing aspects. Additionally, studies that incorporate the Geographic Information System (GIS) with habitat preferences of all park ungulates would be beneficial in planning the development of trail systems and other human uses on the island (e.g., Koeln et al. 1994, Lachowski et al. 1994, Bosakowski et al. 1995, Moss and Vaughn in press).

As many as 15 mule deer and 100 bison were seen in the vicinity of pronghorn during winter. In addition, bighorn sheep (Ovis canadensis) are to be introduced to the state park in January–March 1997. Thus, competition for food and space may be an important consideration, especially during severe winters. Pronghorn appear to graze compatibly with bison, deer, and bighorn sheep (Yoakum 1980), and in some areas, mule deer and pronghorn have little overlap in habitat use during winter (Wood 1989). However, with few sagebrush areas, limited space, and increasing ungulate populations on the island, it is critical to continue to monitor habitat use to examine future competition for food and space.

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**LITERATURE CITED**


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