THESIS

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

Submitted by

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WE HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY MELISSA J. CHADWICK ENTITLED "WINTER HABITAT USE BY REINTRODUCED PRONGHORN ON ANTELOPE ISLAND, GREAT SALT LAKE" BE ACCEPTED AS FULFILLING PARTIAL REQUIREMENTS FOR THE THESIS IN ZOOLOGY.

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ABSTRACT: Preferences of pronghorn (Antilocapra americana) for elevation, slope, physiography, aspect, and habitat type were evaluated in February and March 1993. Characteristics of sites used by pronghorn were compared to data collected from random points. Pronghorn preferred terrain that was 1281-1380 m in elevation, was relatively flat or at the base of a hill, and had a slope of less than 30%. Aspects facing south were preferred; those facing west were avoided. Sagebrush habitats were used greater than in proportion to their availability; grasslands were used less. Since habitat studies rarely compare results to availability, this study makes an important contribution to the winter ecology and management of pronghorn.

With the introduction of pronghorn into new environments, many questions need to 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 have neglected to look at the feature's availability when interpreting results (Bayless 1967, Yoakum 1974, Courtney 1987). Availability is important because observed habitat use by pronghorn may simply reflect the percentage of habitat types in the area. Animals may not be preferentially using certain features of habitat and avoiding others.

Pronghorn habitat preferences can change with varying weather conditions (Ryder and Irwin 1987). Snow is the biggest factor in pronghorn movement (Van Wormer 1968:142, Mitchell 1980:112, Kindschy et al. 1982). Deep snow also affects vegetation availability (Hovey and Harestad 1992) and increases predatory risks (Van Wormer 1968:146).

The reintroduction of pronghorn onto Antelope Island in the Great Salt Lake, Utah, provided an excellent opportunity to study the winter habitat use of pronghorn when placed into a new situation. The objective of this study was to determine what factors influenced the winter habitat selections of the pronghorn.

STUDY AREA AND METHODS

Antelope Island State Park is located in the southeastern region of the Great Salt Lake, about 16 km from Salt Lake City, Utah. The 10,409-ha island is topographically diverse and ranges in elevation from 1280-2011 m (Utah Dept. of Natural Resources 1988, Jones 1985). Average annual precipitation is 43 cm, with 8 cm falling in February and March (Salt Lake International Airport Weather Station, pers. commun.). Most of the island is grassland with patches of sagebrush and a few small riparian and marsh areas. Intermittent streams run on the island in spring and summer seasons. The island was named by John C. Fremont in the 1840's for the herds of pronghorn inhabiting it. However, the last pronghorn was sighted in 1870 (M. A. Larsson, pers. commun.). The island 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.

Twenty-three pronghorn were net-gunned in Summit County, Utah, and reintroduced to Antelope Island at the end of January 1993. Before being released, each was fitted with a solar-powered radio transmitter (Advanced Telemetry Systems, Inc., Box 398, Isanti, MN 55040), mounted on a standard livestock ear tag.

The pronghorn were tracked during February and March 1993, using radio telemetry to locate groups. Data were collected 2-3 days a week between 0700 and 1800 h. No animal was included in more than one group on the same day, and groups were noted as separate only if there was ≥0.05 km of separation between them. Pronghorn observations stopped when winter groups began to disperse and bucks began selecting territories (31 March).

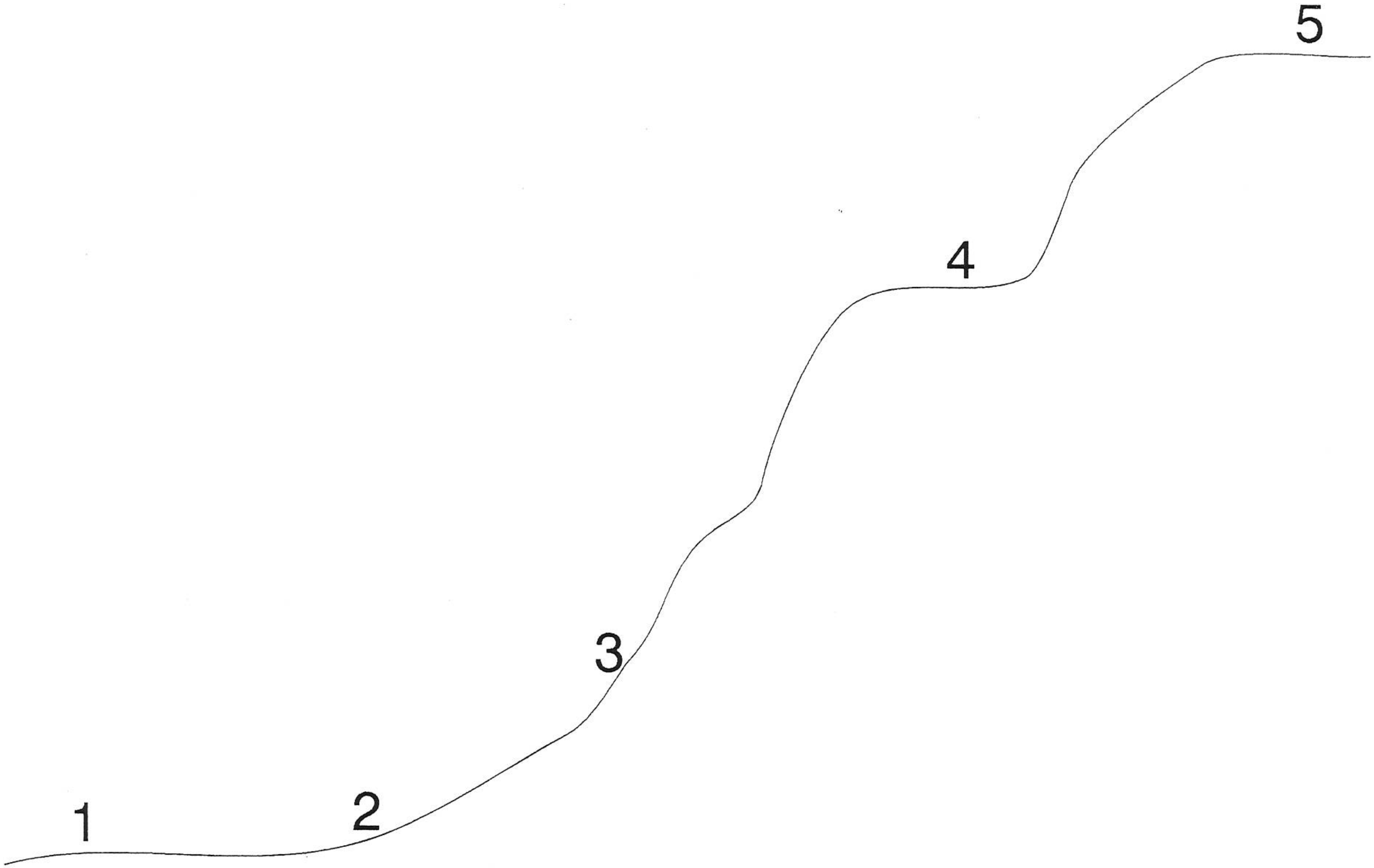
The location of each group was marked on a topographic map. Dominant vegetation, physiography, and elevation were noted. Temperature at the time of the sighting was recorded with an outdoor thermometer, and current weather conditions were recorded. Snow depth at the site was recorded by relating the depth of snow to the length of the pronghorn's hind legs. Later the site was revisited to measure slope, using a clinometer, (<30% or >30%) and aspect (north 315°-44°, east 45°-134°, south 135°-224°, or west 225°-314°).

Categorization of physiography and vegetation occupied was subjective but consistent. The physiography of each point was categorized as relatively flat (little or no slope), slope of hill, top of hill, base of hill, or terrace (Fig. 1). Dominant vegetation was categorized as grassland (few or no sagebrush (Artemisia sp.), bushes, or trees), sagebrush (some grass and forbs), sagebrush/dunes (sand dunes where sagebrush predominates), or shrub (woody vegetation other than sagebrush).

Wind direction and velocity were obtained from the weather station at the Salt Lake International Airport, about 26 km southeast of Antelope Island. Readings are taken hourly at the station, and I used values closest to the times of the pronghorn group sightings.

Sites actually used by pronghorn were compared to 76 randomly selected sites to determine habitat preferences.

Fig. 1. Categorization of physiography on Antelope Island. Numbers represent different features: 1 = relatively flat, 2 = base of hill, 3 = slope of hill, 4 = terrace, and 5 = top of hill.



5
4
3
2
1

The number of random sites was determined by approximating the number of pronghorn groups that I expected to see over a two-year period. When determining random point distribution, the whole island was considered 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. To avoid bias, the exact spot for data collection within a grid was chosen by randomly 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 the pronghorn were using a site in proportion to its availability (use = availability; $P > 0.05$) or less or more frequently than in proportion to availability (use < or > availability; $P \leq 0.05$). If the 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, elevation, physiography, slope, dominant vegetation, and aspect data were analyzed with Bonferroni Z tests to determine which categories were used significantly more or less than expected based on availability (Marcum and Loftsgaarden 1980). In all Bonferroni Z tests, 97% confidence intervals were used for individual categories, and simultaneous α varied with the number of categories in the analyzed feature.

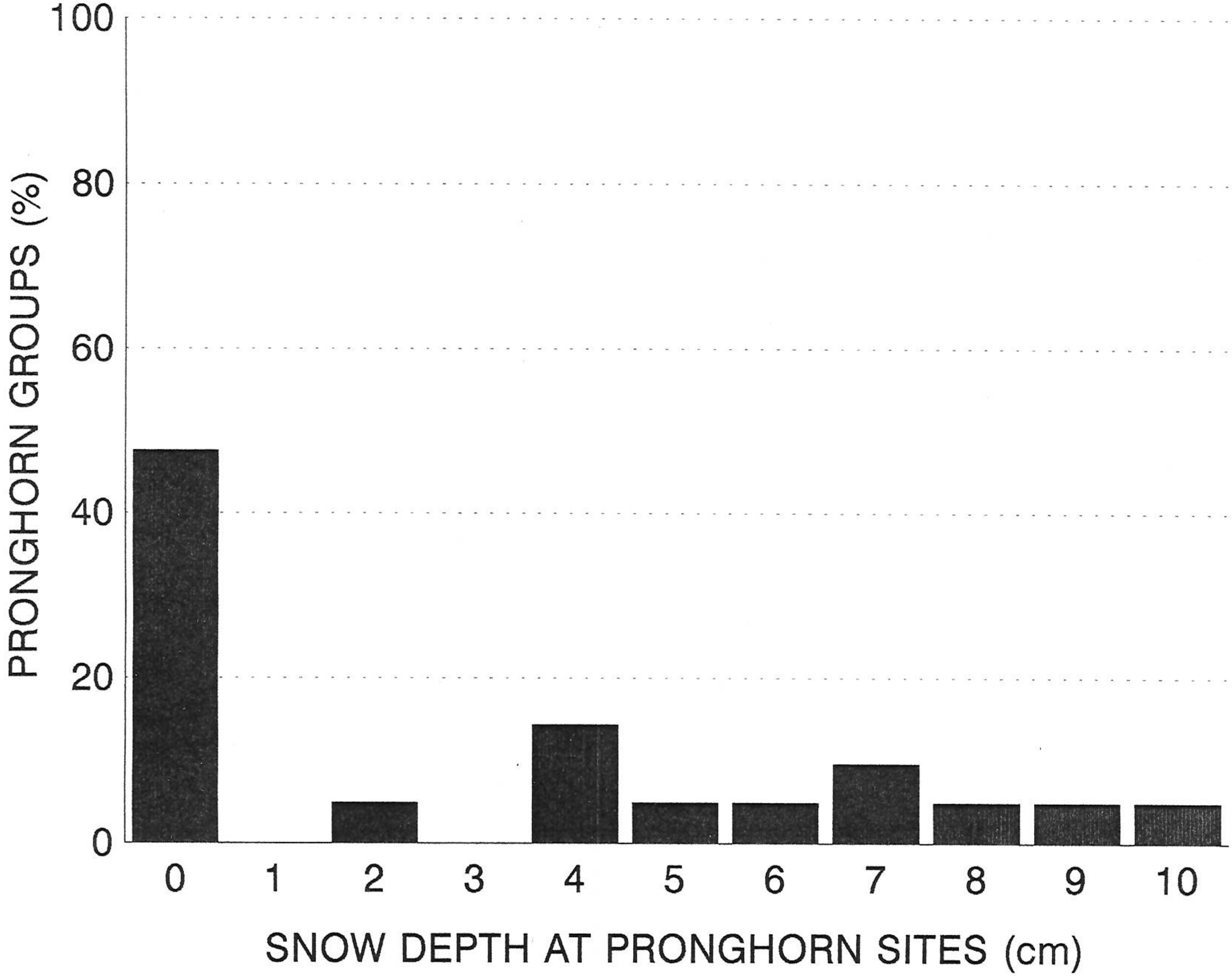
Wind velocity and current temperature were compared independently of physiography data and analyzed using the Kruskal-Wallis test to determine if pronghorn use of physiographic features was related to weather conditions. Aspect and wind velocity were compared and analyzed in a similar manner. Snow depth was summarized as descriptive data and was not analyzed statistically.

RESULTS

Observations of 47 pronghorn groups containing 679 individuals were made. Each group consisted of 2-23 pronghorn; mean group size was 14 ± 8 S.D. animals.

Snow was on the ground 6 February-15 March 1993. In general, snow depth on the island ranged from 0-60 cm. 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 0-10 cm. Pronghorn were found in areas free of snow 48% of the time and in areas with snow 52% of the time (Fig. 2; $\underline{n}$ = 21).

Fig. 2. Percentage of pronghorn groups found in differing amounts of snow ($\underline{n}$ = 21).


PRONGHORN GROUPS (%)
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
9
10
SNOW DEPTH AT PRONGHORN SITES (cm)

Only grassland and sagebrush habitats were used in the statistical analysis due to limited availability of other vegetation types, even when all other groups were combined into one group. Pronghorn exhibited preferences in the use of vegetation types (Fig. 3; $\chi^2 = 4.3$, df = 1, $P < 0.05$). Pronghorn occupied sagebrush habitats in greater proportion than their availability, and grasslands in less ($P \leq 0.03$ for each, simultaneous $\alpha = 0.06$).

Elevation use by pronghorn was different than expected based on availability (Fig. 4; $\chi^2 = 15.8$, df = 3, $P < 0.01$). Pronghorn preferred elevations ranging from 1281-1380 m and avoided those above that range ($P \leq 0.03$ for each). Pronghorn use of elevations ranging from 1381-1480 m equaled the availability of that elevation range ($P \geq 0.03$, simultaneous $\alpha = 0.12$).

Pronghorn exhibited preferences and avoidances in the use of physiographic features (Fig. 5; $\chi^2 = 22.4$, df = 4, $P < 0.01$). Relatively flat areas and bases of hills were used in greater proportion than their availability, and slopes of hills were avoided ($P \leq 0.03$ for each, simultaneous $\alpha = 0.15$). Pronghorn used terraces and tops of hills about equal to their availability ($P \geq 0.03$ for each).

Slope was categorized into two groups because slopes

Fig. 3. Vegetation occupied by pronghorn on Antelope Island compared to availability (Solid = pronghorn groups, N = 47; Hatched = random points, N = 70).

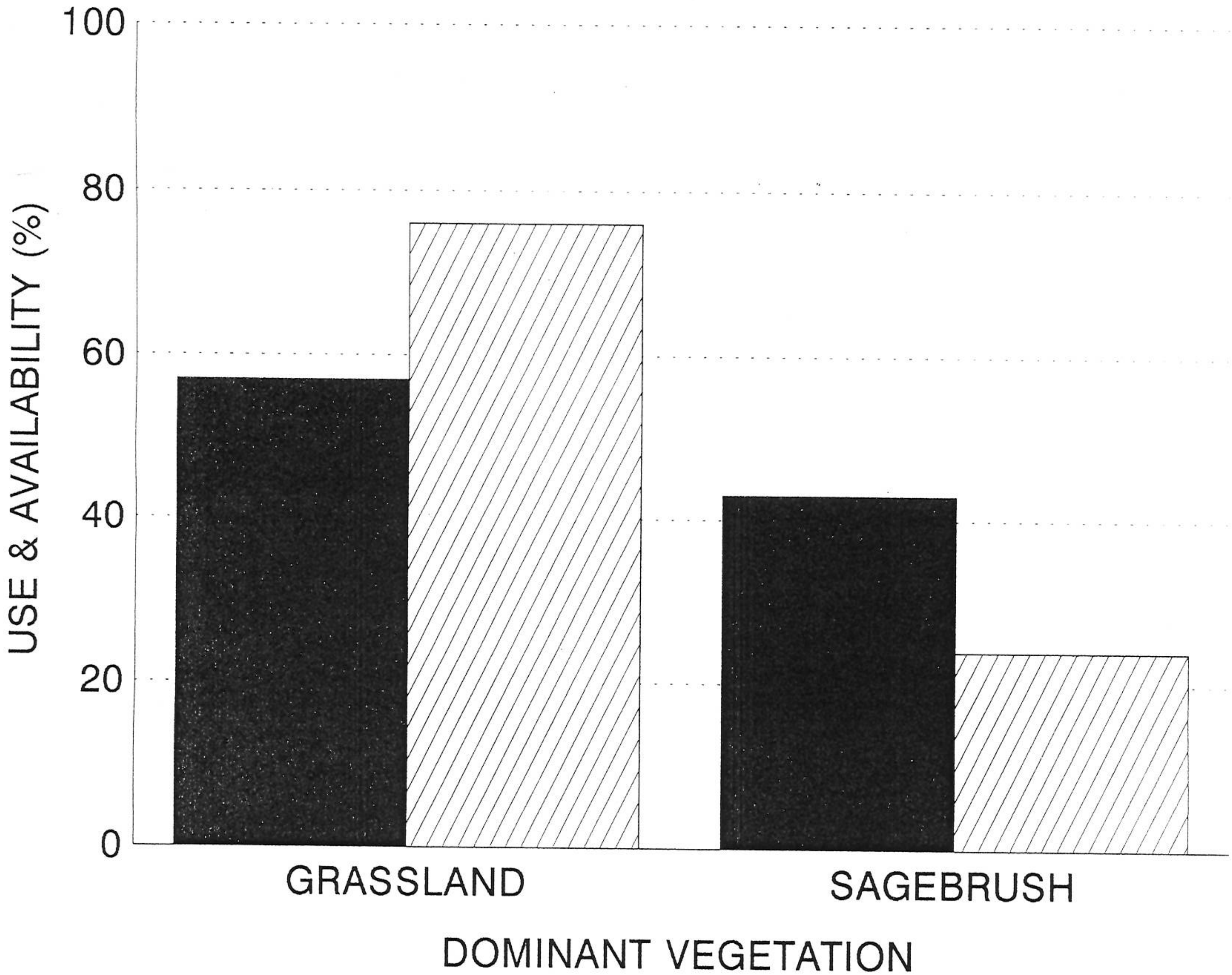
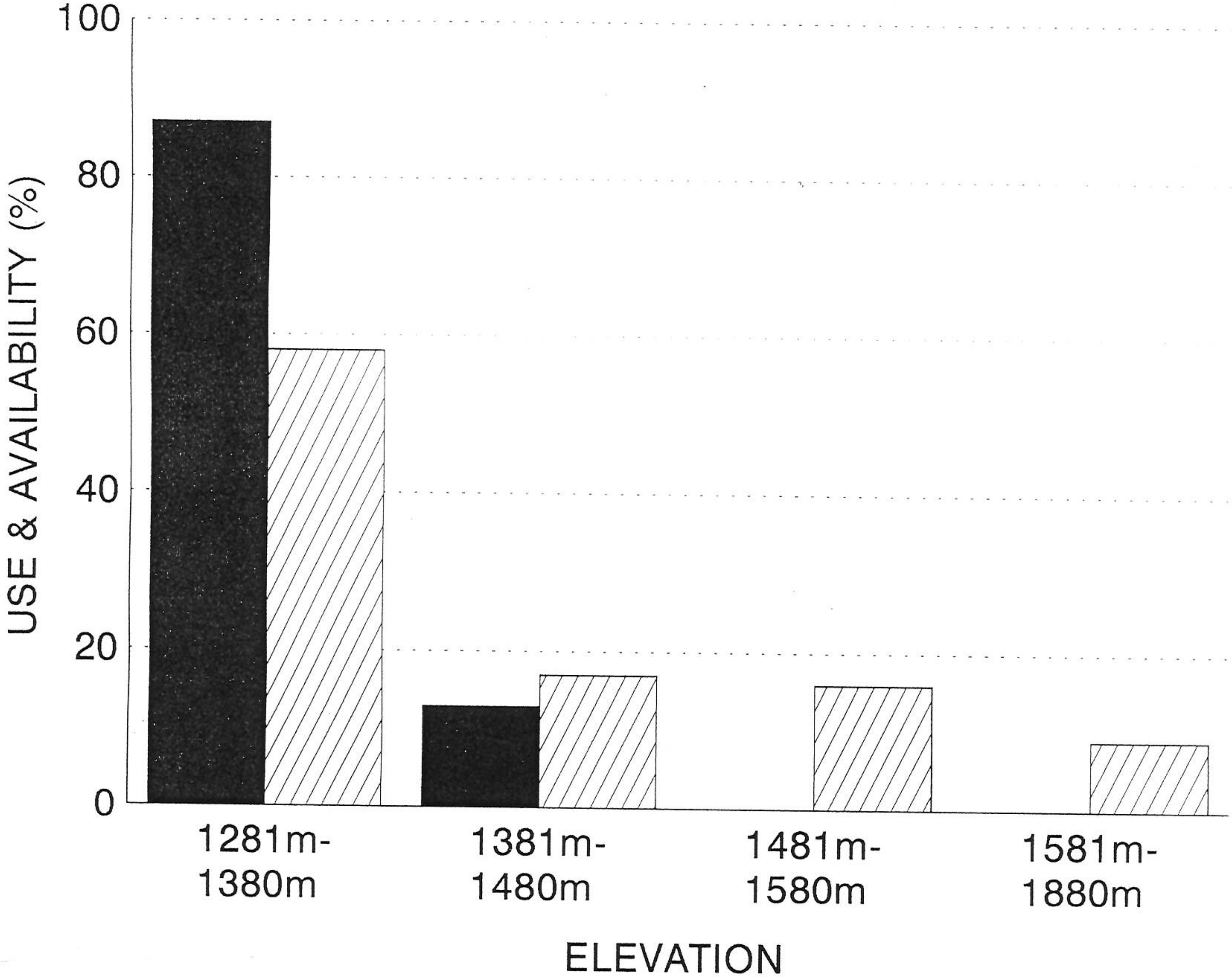
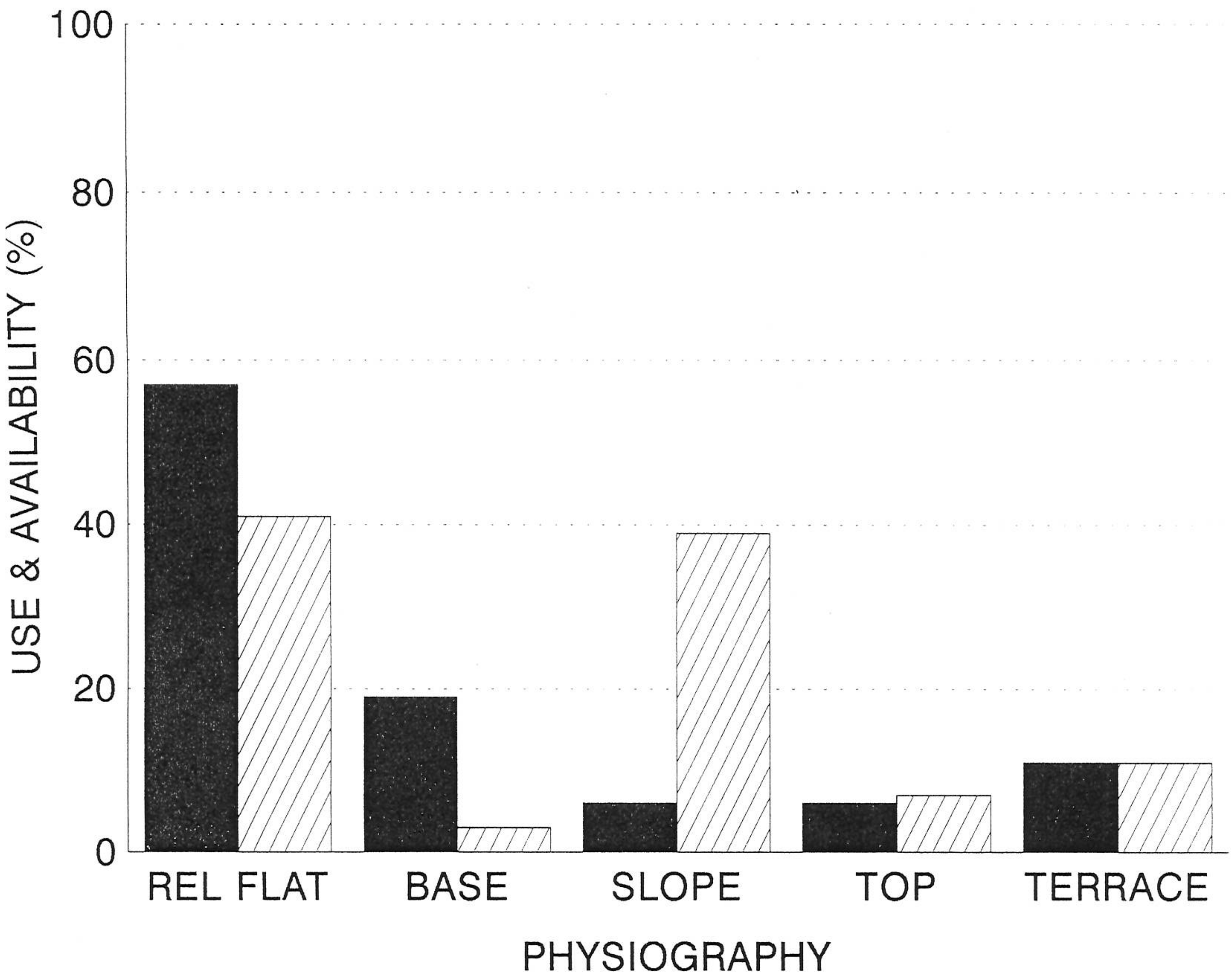

100
80
60
40
20
0
USE & AVAILABILITY (%)
GRASSLAND
SAGEBRUSH
DOMINANT VEGETATION

Fig. 4. Elevation used by pronghorn on Antelope Island compared to availability (Solid = pronghorn groups, N = 47; Hatched = random points, N = 76).



100
80
60
40
20
0
USE & AVAILABILITY (%)
1281m-
1380m
1381m-
1480m
1481m-
1580m
1581m-
1880m
ELEVATION

Fig. 5. Physiographic features used by pronghorn on Antelope Island compared to availability (Solid = pronghorn groups, N = 47; Hatched = random points, N = 76).


USE & AVAILABILITY (%)
100
80
60
40
20
0
REL FLAT
BASE
SLOPE
TOP
TERRACE
PHYSIOGRAPHY

>30% were scarce, and for comparison to previous studies (Kindschy et al. 1978). Use of slope by pronghorn was different than expected (Fig. 6; $\chi^2 = 6.6$, df = 1, $\underline{P} < 0.02$). Pronghorn preferred slopes <30% and avoided those >30% ($\underline{P} \leq 0.03$ for each, simultaneous $\alpha = 0.06$).

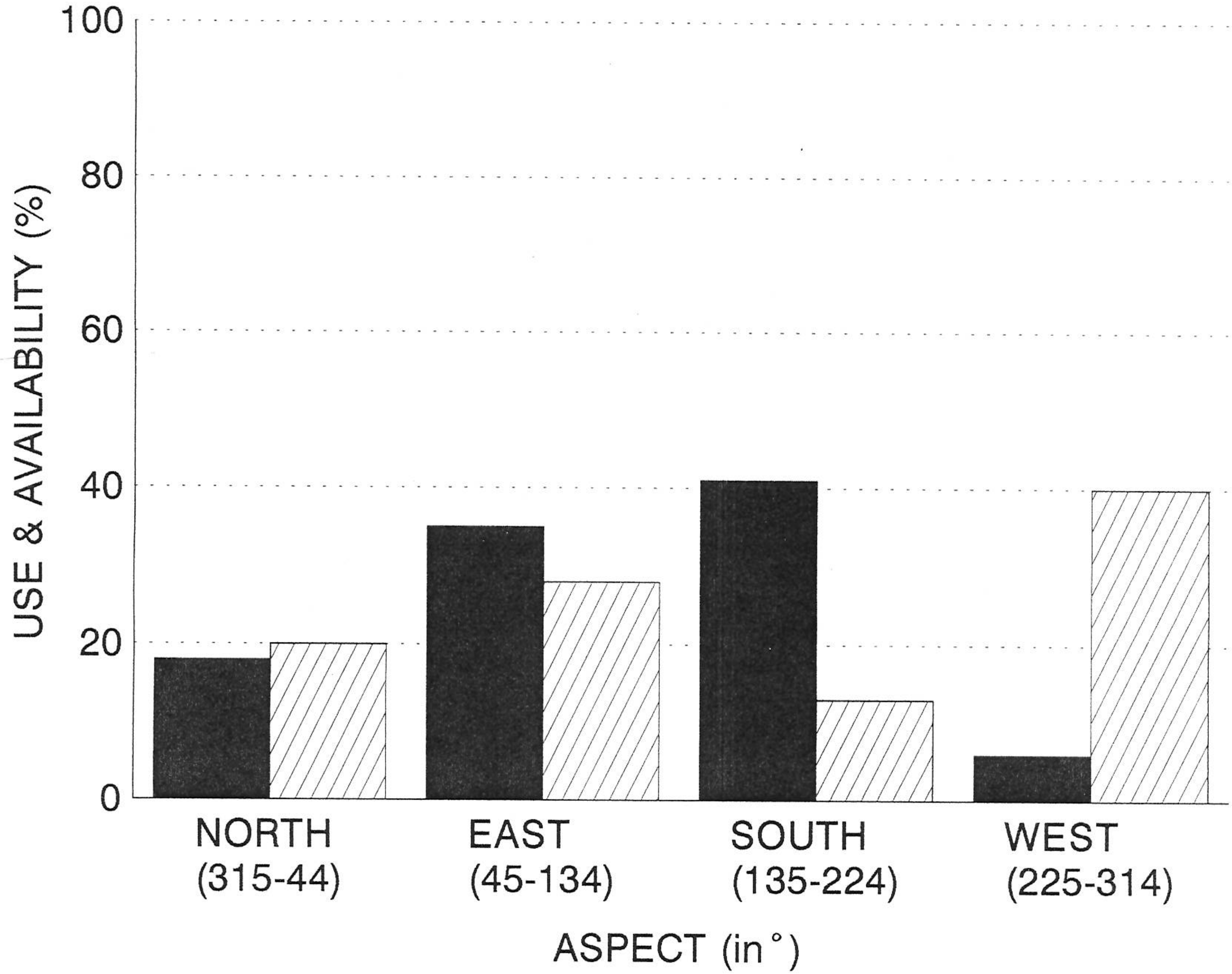
Aspect use differed from availability (Fig. 7; $\chi^2 = 9.6$, df = 3, $\underline{P} < 0.05$). South-facing aspects were used in greater proportion than their availability, and west-facing aspects were used less ($\underline{P} \leq 0.03$ for each, simultaneous $\alpha = 0.12$). No difference between use and availability was noted for north- or east-facing aspects ($\underline{P} \geq 0.03$ for each).

Pronghorn use of aspect was not based on wind velocity ($\underline{H} = 2.40$, df = 3, $\underline{P} = 0.493$), nor was pronghorn use of a particular physiographic feature related to the current wind velocity ($\underline{H} = 4.33$, df = 4, $\underline{P} = 0.363$). Current temperature and pronghorn use of physiographic features were not related ($\underline{H} = 5.93$, df = 4, $\underline{P} = 0.205$). Therefore, pronghorn were not choosing an aspect or physiographic feature based on the temperature or wind velocity in the area.

DISCUSSION

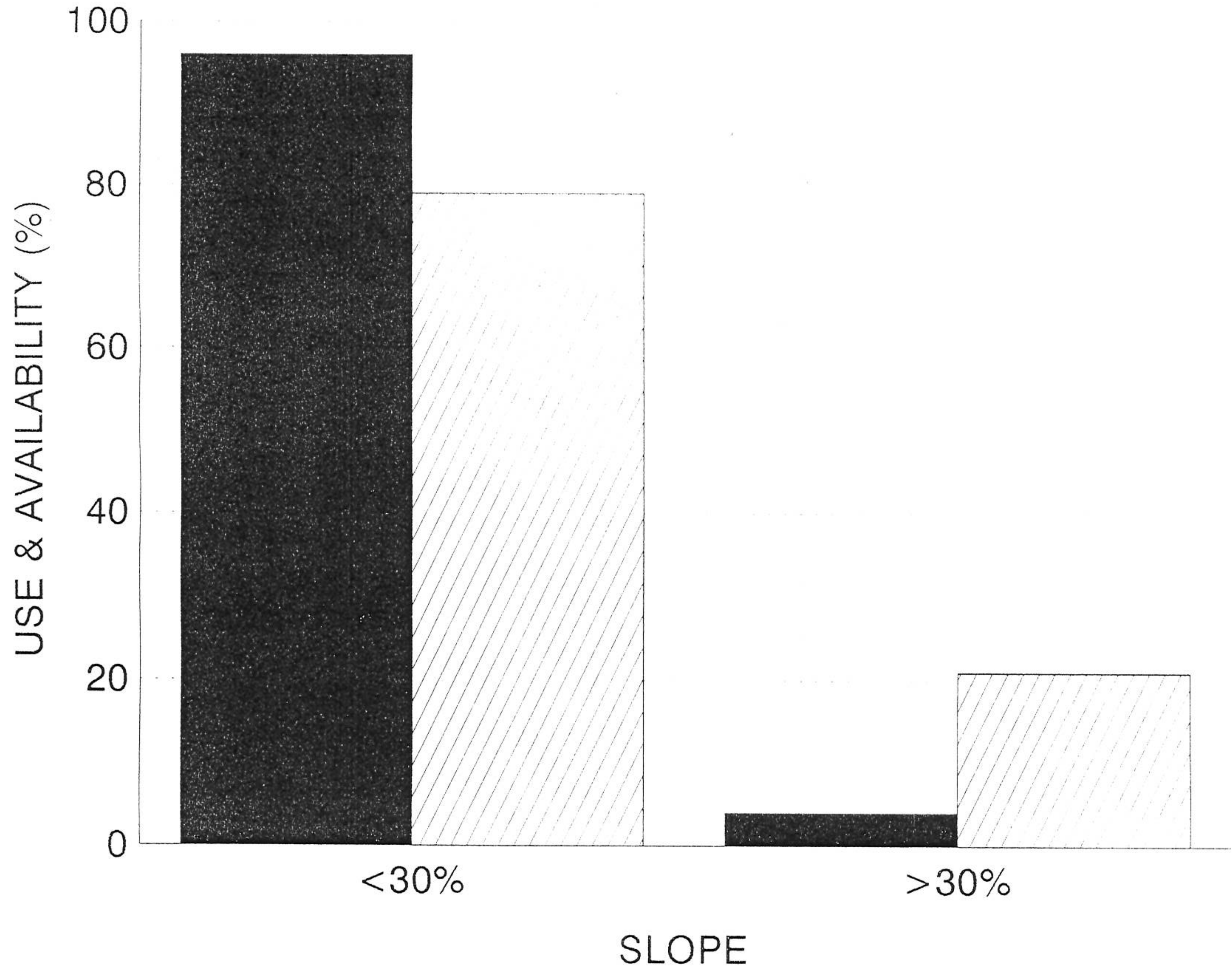
The winter of 1993 was especially harsh and weather probably played a stronger than normal role in habitat use by pronghorn. January had record-breaking snowfall with below normal temperatures. When this study began in February, the

Fig. 6. Slope used by pronghorn on Antelope Island compared to availability (Solid = pronghorn groups, N = 47; Hatched = random points, N = 76).



USE & AVAILABILITY (%)
100
80
60
40
20
0
NORTH
(315-44)
EAST
(45-134)
SOUTH
(135-224)
WEST
(225-314)
ASPECT (in °)

Fig. 7. Aspect used by pronghorn on Antelope Island compared to availability (Solid = pronghorn groups, N = 17; Hatched = random points, N = 40).


USE & AVAILABILITY (%)
100
80
60
40
20
0
<30%
>30%
SLOPE

above average snowfall and below normal temperatures continued (Salt Lake International Airport Weather Station, pers. commun.). Consequently, snow remained on the ground much longer than usual and influenced the availability of some resources, such as vegetation.

Snow depth can particularly affect forage availability for ungulates. The burial of shrubs by snow affected the availability of winter forage to black-tailed deer (Odocoileus hemionus columbianus) in British Columbia (Hovey and Harestad 1992). Most of the sagebrush on Antelope Island was 1-2 m high and was, at times, the only food source for the pronghorn. Because of deep snow on Antelope Island, grassland habitats were frequently covered. In Alberta, pronghorn had been seen pawing through snow to reach food, even when other vegetation was available (O'Gara 1978), but I did not observe the pronghorn in this study exhibiting that behavior.

Pronghorn may depend heavily on sagebrush during a severe winter (Bernt 1976). In winter, sagebrush has higher amounts of fat and protein compared to grasses and is therefore an excellent energy and maintenance resource for the pronghorn (Sundstrom et al. 1973). In Montana, pronghorn that fed on grasslands had a higher rate of mortality due to malnutrition than those that fed on sagebrush

(Martinka 1967).

Snow depth was important in the use and avoidance of elevation categories by pronghorn. Lower elevations, where there was less snow, may have been critical in predator avoidance. In general, most mortality in the winter comes from coyotes and bobcats which chase pronghorn into deep snow and have an easier time killing them (Van Wormer 1969:146, Bruns 1977). With less snow at the lower elevations, food also becomes more available and may have played a role in use of these areas.

Use of physiographic features by pronghorn was primarily based on the groups' winter location and food availability. The pronghorn were released onto the island facing into an area known as Buffalo Point. The region is located at the northern-most part of the island and is characterized by a ridge that runs in an east-west direction. The south slope and base of this ridge are dominated by sagebrush, which extends to the edge of the lake. The severe winter, deep snow, and the uncertainty of being in a new habitat, could of caused the pronghorn to remain in this general location where food was available. While in Buffalo Point, the pronghorn utilized the relatively flat areas and bases of hill regions where sagebrush was readily available. As the snow melted at the beginning of March, the pronghorn began to expand their range and leave the Buffalo Point area.

Pronghorn use of slopes in this study agreed with previous studies (Amstrup 1978, Kindschy et al. 1986) and may reflect predator avoidance behaviors. Use of steep slopes may pose a problem in detection of predators since the pronghorn would have an obstructed view in the distances they can observe relative to flatter areas. Outrunning predators on steep slopes would be more difficult than on flatter areas (Vaughan 1986:324).

Pronghorn use of aspect was primarily due to their location in February. Since the pronghorn remained in Buffalo Point throughout the month, all of the aspect readings came from the same direction, south-facing. Clary and Beale (1983) found that pronghorn preferred warmer aspects. One possible explanation is that snow melts more quickly on south-facing slopes and thus food availability would increase for the pronghorn and their ability to escape predators would be facilitated.

The pronghorn were under duress when they were released, and with the deep snow, did not have a chance to explore the island. The release location of the pronghorn and the severe winter probably affected the results of this study. With their release near Buffalo Point, the pronghorn had access to food and could easily observe predators in the area. Without knowledge of the rest of the island, they may have remained where their immediate needs could be met. Even though the pronghorn remained in the same general area for a month, I could not redefine my random point distribution because no physical barriers existed for the pronghorn, and thus no smaller area could be definitively determined as available.

Subsequent years of study are likely to yield different results with pronghorn's use of aspect and physiography. After a year of island exploration, the pronghorn may choose a different winter range that suits their needs better. The development of the island and its opening to the public July 1993 may influence their choice of habitat and their movement patterns on the island.

Habitat studies should be conducted over an extended period of time since weather conditions can affect the movement and location of the pronghorn groups (Ryder and Irwin 1987). The needs of the pronghorn should be considered in management of the island, especially concerning sagebrush and its availability in severe winters.

Future studies of winter habitat use by pronghorn on Antelope Island would be of great value. The recent reintroduction of pronghorn gives researchers an opportunity to study the growing population over an extended length of time to determine how pronghorn habitat use changes with population density. Such information should be useful in adjusting existing guidelines on the management of pronghorn. Continued study will also offer an opportunity to educate park visitors in the relationships among wildlife, habitat, and human recreational impact.

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