BED-SITE SELECTION BY DESERT MULE DEER IN SOUTHERN ARIZONA

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Abstract—We compared bed sites selected by desert mule deer (Odocoileus hemionus eremicus) to nearby random sites to assess bed site features. Thermal cover of bed sites (i.e., vegetation ≥75 cm high that provided shade for a deer) was highest in summer ($\bar{X} = 43.7\% \pm 4.1\% SE$) compared to spring (29.7% ± 4.4), winter (33.5% ± 3.1), and autumn (39.8% ± 4.0); however, selection for bed sites with thermal cover that differed most from that available randomly was highest in spring (X difference between bed and random sites = 14.8% ± 5.2) compared to summer (8.3% ± 4.1), winter (6.6% ± 3.5), and autumn (8.6% ± 3.5). Thermal cover is likely important as a contribution to thermoregulation, escape cover, protection of fawns, and fawn survival.

Resumen—Comparamos los echaderos seleccionados por el venado bura (Odocoileus hemionus eremicus) a sitios cercanos al azar para determinar las características de los echaderos. La cubierta termal de los echaderos (o sea, vegetación ≥75 cm de altura que proveyó sombra para el venado) fue más alta en el verano ($\bar{X} = 43.7\% \pm 4.1\% SE$), comparado con la primavera (27.9% ± 4.4), invierno (33.5% ± 3.1), y otoño (39.8% ± 4.0). Sin embargo, la selección de echaderos con cubierta termal que difirió más que lo disponible al azar fue más alta en la primavera (X diferencia entre echaderos y sitios al azar = 14.8% ± 5.2) comparada con el verano (8.3% ± 4.1), invierno (6.6% ± 3.5), y otoño (8.6% ± 3.5). La cubierta termal es quizás importante como una contribución a la termorregulación, cubierta de escape, protección de ciervos, y supervivencia de cier vos.

The scale at which biologists measure and assess the ways in which wildlife use landscapes influences the patterns of use observed (Kotliar and Wiens, 1990). Habitat use by ungulates, for example, is studied most often at the home range (macrohabitat) scale with radiocollared animals. Movements, forage, and cover selection by desert mule deer (Odocoileus hemionus eremicus) all have been studied at the home-range scale in the southwestern United States (Dickinson and Garner, 1979; Koerth et al., 1985; Ordway and Krausman, 1986; Bellantoni and Krausman, 1990; Albert and Krausman, 1993), but not at the smaller, microhabitat scale.

Studies on use of thermal cover by deer in northern climates suggest that dense cover of conifer forest canopies benefits deer most during winter (Cox, 1938; Verme and Ozoga, 1971; Ozoga and Gysel, 1972; Moen, 1976; DelGiudice and Riggs, 1996). Conversely, temperature extremes in southwest deserts occur during summer; therefore, thermal cover (i.e., vegetation ≥75 cm high that provided shade for a deer) can aid in thermoregulation (Anthony, 1972; Leopold and Krausman, 1987; Hayes and Krausman, 1993). Our objectives were to determine if deer selected (Hall et al., 1997) bed sites with different amounts of thermal cover compared to paired random sites (50–100 m from bed sites) and to understand vegetation characteristics of bed sites.

Materials and Methods—We studied deer in Avra Valley, Pima Co., Arizona, in an area bounded by the Tucson Mountains to the east and the Ruskuge Mountains to the west, 20 km west of Tucson. Elevations ranged between 610 and 1,429 m. Land ownership was patchy with municipal, state, federal, Tohono O'dham Nation, and private landholders (e.g., housing developments and ranches) represented.

<table>
<thead>
<tr>
<th>Season</th>
<th>Bed</th>
<th>Random</th>
<th>( \bar{X} ) difference (df = 1, n)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>( X )</td>
<td>SE</td>
<td>( X )</td>
</tr>
<tr>
<td>Spring</td>
<td>26</td>
<td>29.7</td>
<td>4.37</td>
<td>14.9</td>
</tr>
<tr>
<td>Summer</td>
<td>49</td>
<td>43.7</td>
<td>4.11</td>
<td>35.3</td>
</tr>
<tr>
<td>Autumn</td>
<td>38</td>
<td>39.8</td>
<td>4.00</td>
<td>31.2</td>
</tr>
<tr>
<td>Winter</td>
<td>45</td>
<td>33.5</td>
<td>3.06</td>
<td>26.9</td>
</tr>
</tbody>
</table>

Vegetation associations in the area were common to the Sonoran Desert and included: creosote (Larrea tridentata)-bursage (Ambrosia) in undisturbed flats; desert grassland along portions of major washes and associated flood plains; ironwood (Olneya tesota)-canyon ragweed (Ambrosia ambrosioides) in washes; mesquite (Prosopis velutina)-burroweed (Isocoma tenuisecta) in disturbed flats (i.e., abandoned agricultural lands); and palo verde (Cercidium)-mixed cacti on bajadas.

Precipitation is bimodal, occurring during the July to September monsoon and December to March winter showers (Reitan and Green, 1968). Mean precipitation was 28.3 cm for Tucson, Arizona, 1996 (National Climatic Data Center, 1996). Average normal seasonal temperatures for 1993 were 24.3, 30.2, 16.6, and 13.6°C for spring (April to June), summer (July to September), autumn (October to December), and winter (January to March), respectively (National Climatic Data Center, 1993). These seasons were defined based on weather patterns and biology of desert mule deer (Krausman and Etchberger, 1995).

We used net-guns to capture and collar desert mule deer (Krausman et al., 1985) in November 1995 and February 1996 to obtain a representative sample of the mule deer in Avra Valley. Each collar was color-coded to assist in visual identification of individuals.

Locations of individual deer were obtained \( \geq 24 \) h apart during daylight hours. We hiked to collared deer and attempted to obtain a visual location to determine if the deer was bedded or not. If the deer was bedded, we marked the location for vegetation measurements.

When we saw bedded deer, we recorded their location. We used the line-intercept method (Canfield, 1941) to measure percent dominant vegetation of each species and percent thermal cover in and 20 m around the bed site. We measured percent cover of all plant species; grouped percent-cover values for trees, shrubs, forbs (i.e., annual herbaceous plants), succulents (i.e., fleshy plants with water-storing leaves or stems), vines, and grasses; total percent cover for all plant species; and percent thermal cover. We measured vegetation along a 20-m line, the direction of which we determined randomly. We then selected randomly a paired location 50 to 100 m from the bed-site and repeated vegetation measurements.

We used logistic regression for matched case-control studies to compare vegetation characteristics of beds to random sites for males and females combined (Hosmer and Lemeshow, 1989). We used stepwise selection \((P = 0.25 \) to enter; \( P = 0.15 \) to remove\) to determine those characteristics that best differentiated bed from paired-random sites.

RESULTS—We captured 17 desert mule deer, 3 males and 14 females, a ratio similar to all deer observed in the study area between July 1996 and March 1997 (39 males and 154 females). Thermal cover of bed sites used by deer was highest in summer compared to other seasons (Table 1). Deer showed evidence of selection for bed sites in areas of relatively high thermal cover in all seasons \((\chi^2 \geq 3.60, P < 0.06)\). However, deer selected bed sites with thermal cover that differed most from that available in spring when available thermal cover was lowest \((14.9\%)\) compared to other seasons when available thermal cover was much higher \((26.9–35.3\%); \) Table 1). Characteristics that distinguished bed sites from random sites also varied seasonally (Table 2).

DISCUSSION—Given the high temperatures in the desert Southwest, we expected amount of thermal cover to be an important determinant of bed-site selection by desert mule deer during spring and summer. Consequently, selection for thermal cover was strongest in spring, when available thermal cover was lowest (Table 1). In summer, bed sites used had the highest cover of all seasons but because available thermal cover was higher, selection was less strong than for spring (Table 1). Amount of available thermal cover was highest in summer because foliage growth is increased because of mon-
soon rains. Selection also occurred during winter and autumn, but to a lesser degree, which suggests thermoregulation is less of a factor during these mild seasons. Further, selection of thermal cover in winter may be confounded by deer seeking escape cover during winter and autumn.

We observed female mule deer fawning as early as 8 August 1996 (Fox and Krausman, 1994). Female deer may have selected vegetation with high cover to protect fawns and to gain access to forage with greater nutritional benefits. Because the first 45 days of a fawn’s life are most crucial to survival (Trainer, 1975), female nutritional benefits from rains may improve lactation quality or quantity and improve fawn survival (Smith and LeCount, 1979; Urness, 1981). Additionally, increased thermal cover, which implies increased escape cover, may improve fawn survival during summer. Dense stands of mesquite made it difficult to approach deer while remaining undetected, suggesting that success for non-ambush predators may be reduced in areas of dense cover.

Selection for bed sites was stronger in spring, summer, and autumn compared to winter (Table 1). We expected bed site selection in winter to be weaker than other seasons because deer are not thermally stressed. In winter, however, deer selected bed sites with characteristics that indicated high thermal cover (Table 2). Escape and thermal cover were indistinguishable by our measures, therefore selection for thermal cover may, in part, reflect a selection for protective cover.

Our view of thermal cover at bed sites reflects our scale of measurement and the paired design we used. It is clear, however, that deer are able to locate and use areas with high thermal cover despite seasonal periods of low available cover. Additional research is needed to determine the ecological significance thermal cover has on deer condition, survival, productivity, and recruitment (Parker and Gillingham, 1990; Cook et al., 1998).

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**LITERATURE CITED**


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**Table 2**—Vegetation parameters selected by stepwise procedures, their standard errors, Wald Chi-square, P-value, and odds ratios for the probability of bed versus random sites for desert mule deer in Avra Valley, Arizona, 1996-1997. Estimates represent the difference in % cover of parameters between bed and random sites as measured along a 20-m line transect.

<table>
<thead>
<tr>
<th>Season</th>
<th>Parameter</th>
<th>Estimate</th>
<th>SE</th>
<th>Wald $x^2$</th>
<th>P</th>
<th>Odds ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring</td>
<td>Tree</td>
<td>0.07</td>
<td>0.027</td>
<td>6.72</td>
<td>0.0096</td>
<td>1.073</td>
</tr>
<tr>
<td>Summer</td>
<td>Total</td>
<td>0.04</td>
<td>0.016</td>
<td>7.38</td>
<td>0.0066</td>
<td>1.046</td>
</tr>
<tr>
<td></td>
<td>Grass</td>
<td>0.08</td>
<td>0.054</td>
<td>2.31</td>
<td>0.1282</td>
<td>1.046</td>
</tr>
<tr>
<td></td>
<td>Vine</td>
<td>-0.13</td>
<td>0.071</td>
<td>3.59</td>
<td>0.0582</td>
<td>0.874</td>
</tr>
<tr>
<td>Autumn</td>
<td>Total</td>
<td>0.08</td>
<td>0.050</td>
<td>2.48</td>
<td>0.1152</td>
<td>1.046</td>
</tr>
<tr>
<td></td>
<td>Mesquite</td>
<td>0.08</td>
<td>0.035</td>
<td>5.82</td>
<td>0.0158</td>
<td>1.088</td>
</tr>
<tr>
<td>Winter</td>
<td>Thermal</td>
<td>0.02</td>
<td>0.014</td>
<td>3.18</td>
<td>0.0746</td>
<td>1.026</td>
</tr>
</tbody>
</table>


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