Habitat Preferences of Feral Hogs, Deer, and Cattle on a Sierra Foothill Range

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Abstract

The relative habitat preferences of feral hogs (Sus scrofa), black-tailed deer (Odocoileus hemionus columbianus), and cattle were assessed for 17 habitat types by sampling the distribution and abundance of fecal sign on a northern California annual range. Hogs preferred oak thickets and irrigated pastures; deer preferred brushland and oak woodland; and cattle preferred level topography and sites with relatively high herbage production including irrigated pastures, upland plains, and oak savanna-woodland. Deer and cattle used the study area during winter only, whereas the hogs were permanent residents. An association analysis indicated the greatest potential for interspecific competition would be between cattle and deer on foothill ridge tops and between cattle and hogs on irrigated pastures.

As part of a study of the life history and ecology of the feral hog in California (Barrett 1978) a preliminary analysis was made of the habitat preferences of the three ungulates (hogs, deer, and cattle) living on the Dye Creek Ranch situated 15 km south of Red Bluff, Tehama County, California. The results were used to delineate those habitats (range sites) on which there is a potential for conflict between livestock and game preserve enterprises utilizing the same land. Information is available on the habitat preferences of deer and cattle on Sierra foothill rangelands (Leopold et al. 1951, Wagon 1968), but little is available for feral hogs (Pine and Gerdets 1973). No studies have considered all three species simultaneously.

Study Area and Methods

The study area included a portion of the eastern plains of the Sacramento Valley and stretched eastward 15 km into the lower foothills of Mt. Lassen. The climate is Mediterranean with annual rainfall averaging 450-650 mm (Barbour and Major 1977). The foothills rise to 400 m above the valley floor and are dissected by east-west drainages. Available habitats were subjectively classified on aerial photos using topographic and vegetation criteria. Topographic categories included: (1) plains of the Sacramento Valley floor, (2) flat ridge-tops between the river canyons with slopes under 10%, (3) north, and (4) south slopes of the canyons. Vegetation categories included: (1) irrigated pasture, (2) upland plain, (3) boulder wash, (4) rock-grass, (5) buckbrush, (6) oak savanna, (7) oak woodland, and (8) oak thicket (includes riparian forest). The first 3 vegetation categories (Fig. 1) are located exclusively in the Sacramento Valley below 100 m elevation on old floodplains and terraces (U.S. Department of Agriculture 1967). The remaining five vegetation categories (Fig. 2) are found only in the foothills (Barrett 1978). A total of 17 combinations of the topographic and vegetation categories were mapped as habitat types. Mapping units varied between 50 and 200 m in width, thus were small relative to ungulate home ranges.

Two resident feral hog sub-populations were recognized (Barrett 1978), and sampling was stratified accordingly into a valley edge area (2327 ha) and a foothill area (1562 ha). Deer and cattle utilized the study area as winter range and had free access to all habitats in both strata, with the exception that cattle were restricted by fences in irrigated pastures.

North-south belt transects were positioned systematically at intervals of 0.8 km. In 1968, 448 plots (1.5 X 92 m) were sampled (0.06% sample), but only 291 plots were sampled in 1969 (0.04% sample). The proportion of plots located in each habitat type was used as an indicator of the availability of each type.

Sampling of accumulated hog scats, deer pellet groups (1968 only), and cow pats in each plot was completed within 2 weeks during September each year just prior to the influx of deer and cattle. This season was selected after pilot samples indicated the density of hog scats was greatest at the end of the dry season. Most deer and cattle droppings from the previous winter also remained identifiable through the dry season. Thus the data are representative of the fecal deposition pattern for each species over a 2-year period.

Data were pooled for all plots within each habitat type and compared between years and between strata. The frequency of occurrence and density of sign of each animal were calculated for each habitat type. A Chi-square test of association indicated that the frequency distributions of all types of sign were not significantly different (P<0.05) between years, therefore, data for both years were pooled. There were minor but statistically significant differences between strata. However, since the rank order of preferences for the various types was, with a minor exception, the same in both strata, all data were pooled.

Results and Discussion

Hogs

Topography was apparently not an important environmental variable to hogs except through its correlation with vegetation and water availability (Table 1). Of the 3 habitat types in the Sacramento Valley, hogs preferred pasture as evidenced by both scats and rooting. In summer I commonly saw 50 to 100 hogs in a pasture of only 160 ha. Most of the hog scats in the upland plain type were dropped along trails as the hogs crossed this type to reach the pastures and the washes. As scats were difficult to observe in the pastures because they were hidden by tall grass or were trampled into the soft ground by cattle, preference for irrigated pasture is likely underestimated. Boulder washes were intensively rooted for brodiaea (Brodiaea sp.) bulbs particularly in years of low acorn production.
In the foothills the hogs strongly preferred oak thicket vegetation. Other than caves, live oaks (*Quercus wislizenii*) and associated vegetation provided the major bedding cover for hogs. This was particularly true during the winter when blue oaks (*Quercus douglasii*) were leafless. Live oak thickets, found mainly on north slopes, and riparian forests were the coolest locations during the hot summer months, and the live oaks were a major source of acorns during the autumn. The oak thicket was heavily rooted because of the availability of acorns and invertebrates in the deep, moist soils. Preference for the remaining habitats decreased in proportion to the amount of vegetation present.

**Deer**

Black-tailed deer showed little response to topographic variation in the foothills, but they are strongly averse to venturing onto the open plains of the valley, even at night (Table I). In the foothills deer clearly preferred buckbrush habitats and secondarily oak woodland. Their use of the oak savanna and oak woodland types was not significantly different and both these types were preferred to the oak thicket and rock-grass habitats. Preference for sites dominated by buckbrush (*Ceanothus cuneatus*) is consistent with previous studies of deer in the Sierras (Leopold et al. 1951).

**Cattle**

Cattle preferred the Sacramento Valley to the foothills (Table I). Within the foothills they preferred ridge tops and other level topography, undoubtedly because they have difficulty traveling on steep, rocky slopes (Wagnon 1968). In the valley cattle strongly preferred irrigated pastures. The sample would have shown an even greater preference for irrigated pastures if cow pats remained longer and were more visible in the pastures. Cattle made relatively little use of the oak savanna or oak woodland types; it is difficult for them to traverse, plus there is less forage in the washes, due in part to rooting by the hogs. In the foothills cattle preferred the oak savanna and oak woodland types which provide the greatest amount of high-quality cattle forage (Barrett 1971).

**Potential for Interspecific Competition**

The potential for resource competition within each habitat type is illustrated for all species combinations by 3-dimensional plots of an association index and the respective habitat preference indices (Fig. 3). Habitat preference indices were calculated using Ivlev's (1961) method. Significance of results was tested by Chi square goodness of fit tests; a Chi square value with 1 degree of freedom was used to obtain an approximate test if the observed index for each case was different from zero (Wensel 1977). Association indices based on the same sign density data were calculated according to Southwood (1966:332). All indices are scaled on a -1 to +1 basis such that 0 indicates no preference or association, +1 means absolute positive preference or association, and conversely -1 indicates absolute negative preference or avoidance. Thus, points falling within the top quadrant in Figure 3 indicate positive association and joint habitat preference. If interspecific competition for a scarce resource (food or cover) is occurring, it is most likely in habitat types falling in this top quadrant (Schoener 1974, Pianka 1976).

Considering the study area as a whole, only cattle and deer showed significant positive association (mean association index, Fig. 3C). However, considering each of the 17 habitat types individually, hogs and cattle are most likely to be competing in the irrigated pastures; hogs and deer overlap most importantly in the buckbrush, north slope type, and cattle and deer are most likely to be competing on ridge tops in buckbrush, oak savanna and oak woodland types.

It should be emphasized that joint preference and positive association as indicated by the distribution of sign is a necessary but insufficient condition for documenting resource competition. Moreover, interference competition may exist to the degree that there is no apparent overlap in habitat use as a result of interspecific competition (Colwell and Futuyma 1971). Thus any inferences regarding competition based on these results must be considered as hypotheses to be tested experimentally.

Finally, these analyses of habitat overlap provide insight as to the suitability of the present habitat classification (emphasizing patterns on aerial photos) for assessing the relative habitat preferences of the three ungulates. For example, say the oak savanna type as mapped included a mosaic of understories such that the 1.5
Fig. 2. Sierra foothill habitat types: (a) rock-grass, (b) buckbrush, (c) oak savanna, (d) oak woodland, (e) oak thicket, and (f) riparian forest.
Table 1. Habitat utilization and preference of 3 ungulates for 17 habitat types as indicated by fecal sign on 0.005 ha plots on the Dye Creek Ranch, California. Values in parenthesis indicate habitat preference is not statistically significant (\( p > 0.05 \)).

<table>
<thead>
<tr>
<th>Habitat type</th>
<th>Hog scats</th>
<th>Deer pellet groups</th>
<th>Cattle pats</th>
<th>Habitat Preference Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Freq</td>
<td>Mean</td>
<td>N</td>
</tr>
<tr>
<td>1. Plains, Pasture</td>
<td>17</td>
<td>59</td>
<td>0.8</td>
<td>11</td>
</tr>
<tr>
<td>2. Plains, Upland Plain</td>
<td>81</td>
<td>36</td>
<td>0.7</td>
<td>49</td>
</tr>
<tr>
<td>3. Plains, Boulder Wash</td>
<td>9</td>
<td>78</td>
<td>1.9</td>
<td>7</td>
</tr>
<tr>
<td>4. Rock Grass, S. Slope</td>
<td>109</td>
<td>5</td>
<td>0.5</td>
<td>63</td>
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<tr>
<td>5. Rock Grass, Ridge</td>
<td>73</td>
<td>8</td>
<td>0.8</td>
<td>42</td>
</tr>
<tr>
<td>6. Rock Grass, N. Slope</td>
<td>38</td>
<td>18</td>
<td>0.2</td>
<td>21</td>
</tr>
<tr>
<td>7. Buckbrush, S. Slope</td>
<td>19</td>
<td>21</td>
<td>0.3</td>
<td>11</td>
</tr>
<tr>
<td>8. Buckbrush, Ridge</td>
<td>14</td>
<td>21</td>
<td>0.4</td>
<td>6</td>
</tr>
<tr>
<td>9. Buckbrush, N. Slope</td>
<td>12</td>
<td>42</td>
<td>0.9</td>
<td>6</td>
</tr>
<tr>
<td>10. Oak Savanna, S. Slope</td>
<td>89</td>
<td>32</td>
<td>0.7</td>
<td>62</td>
</tr>
<tr>
<td>11. Oak Savanna, Ridge</td>
<td>94</td>
<td>20</td>
<td>0.3</td>
<td>62</td>
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<tr>
<td>12. Oak Savanna, N. Slope</td>
<td>81</td>
<td>47</td>
<td>0.9</td>
<td>45</td>
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<tr>
<td>13. Oak Woodland, S. Slope</td>
<td>13</td>
<td>62</td>
<td>1.4</td>
<td>5</td>
</tr>
<tr>
<td>14. Oak Woodland, Ridge</td>
<td>10</td>
<td>60</td>
<td>0.7</td>
<td>6</td>
</tr>
<tr>
<td>15. Oak Woodland, N. Slope</td>
<td>45</td>
<td>56</td>
<td>1.1</td>
<td>31</td>
</tr>
<tr>
<td>16. Oak Thicket, S. Slope</td>
<td>15</td>
<td>93</td>
<td>4.7</td>
<td>7</td>
</tr>
<tr>
<td>17. Oak Thicket, N. Slope</td>
<td>20</td>
<td>95</td>
<td>4.4</td>
<td>13</td>
</tr>
</tbody>
</table>

Chi Square Goodness of Fit., 16 df.

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</thead>
<tbody>
<tr>
<td>Total Study Area</td>
<td>739</td>
<td>32</td>
<td>0.7</td>
<td>448</td>
<td>76</td>
<td>3.8</td>
<td>739</td>
<td>91</td>
<td>4.6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( \chi^2 = 928.6 \) \( \text{df} = 16 \)

\( G^2 = 663.4 \)

\( F = 1227.9 \)

X \( 32 \) m sample plots within that type could be further classified into sub-types with shrub or grass understories. Both deer and cattle could obtain a high preference index for oak savanna but a very low association index if deer primarily defecated in sample plots with a shrub understory while cattle primarily defecated in sites with a grass understory. In this case the habitat classification would be inadequate for assessing sites of potential competition without recognizing these sub-types. The case of hogs versus deer in oak woodland on north slopes (Fig. 3B) was the only one in which both species showed significant preference for the habitat but a negative association index. I cannot suggest an aspect of the oak savanna that these species might be responding to, causing this spatial segregation.

Summary and Conclusions

The preferences of hogs, deer and cattle for the various habitat types was assumed to be proportional to the amount of the time the animals spent in each habitat type beyond that expected from the extent of the habitat in the study area. Animal use (time spent including all behaviors, not just foraging) was assumed proportional to the abundance of fecal sign found in each type. The latter assumption may not have been met, weathering being more rapid in the mesic habitats, particularly irrigated pastures. However, it appeared that weathering of droppings of all three ungulates proceeded at approximately the same rate within each habitat. Consequently, relative habitat preference indices should be comparable even if the absolute values are biased (i.e. underestimated in mesic habitats). Other signs, including trails, rooting, and forage utilization substantiated the relative habitat preferences indicated by fecal signs (Barrett 1971).

The results presented above reveal considerable habitat partitioning by hogs, deer and cattle on the Dye Creek Ranch. Deer

Fig. 3. Relationships between association indices for 3 ungulates and their respective habitat preferences for 17 habitat types (see Table 1 for names of habitats). Positive association is noted by \( \Delta \). Positive association and joint preference for a habitat, \( \square \), indicates potential for interspecific competition within the habitat. Relationships include (A) hogs versus cattle, (B) hogs versus deer, and (C) cattle versus deer.
seem relatively unselective of topography in the Sierra foothills but avoid the open plains of the Sacramento Valley. They are a brush-loving species here as in all other places they have been studied. Cattle show strong preference for level topography and for vegetation types producing large amounts of herbage, a pattern noted in many other studies.

In contrast to these species, feral hogs are more specialized. Topography does not appear to be particularly important; hogs will travel directly across all types of topography to reach water, bedding cover and feeding areas. Vegetation, however, is a very important determinant of hog distribution; in general, the denser the vegetation, the greater the use by hogs. This is especially true where the dominant vegetation is a major source of food as well as cover.

During the hot, dry summer, water and green forage become critical for hogs even though deer and cattle leave the area. At this time, hogs within about 5 km of the edge of the Sacramento Valley prefer to forage nocturnally in the irrigated pasture and boulder washes. These hogs exhibit greater reproductive success, higher growth rates, and lower juvenile mortality than those hogs remaining in the foothills (Barrett 1978).

The most extensive point of overlap in habitat use among the three ungulates occurred between cattle and deer on ridge tops in oak woodland, oak savanna and buckbrush types. Direct interactions between cattle and deer were observed in these sites and in all cases deer were dominated if not excluded by cattle. It may be that both interference and resource competition exists between cattle and deer in these habitats.

Potential for resource competition between deer and hogs exists in the irrigated pastures. Over 30% of some pastures have been rooted up in a single month, completely destroying cattle forage. Loss of this relatively expensive forage for cattle, even for a month until regrowth occurs, is an important management problem.

Literature Cited