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Field Tests of Elk/Timber Coordination Guidelines

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Field Tests of Elk/Timber Coordination Guidelines

L. Jack Lyon

RESEARCH SUMMARY
During recent years, conceptual models for elk habitat have been widely used as guidelines for coordinating elk habitat management and timber management. The generalized model, consisting of a cover/forage function and a road density function, has been used at the Forest and Regional level for planning required by the Resources Planning Act. In addition, several management biologist teams have developed specific models that recognize local variations in elk behavior. At the present time, despite the wide acceptance and use of the elk/timber guidelines concept, variations in application and calculation methods are common. The many forest biologists and land managers who make decisions based on elk/timber guidelines require confirmed validation of the model.

During the summers of 1980 and 1981, field validation tests were conducted in 11 different areas in Montana and northern Idaho. The objectives of this research were (1) to evaluate several methods of determining cover/forage ratios, (2) to evaluate several different road-influence models, and (3) to determine the combination of cover/forage function and road model that best describes actual elk selection among different available habitats.

Comparison of on-the-ground cover samples with several indirect methods for determining cover demonstrated that indirect methods generally overestimate actual cover. A reliable indirect method for using photo interpretation (PI) types is presented.

Comparison of several different road-influence models demonstrated that predictions and accuracy vary considerably. Acceptable models and precision limits are described. Evaluations of elk habitat quality based on different combinations of cover/forage function and road models were compared to actual habitat selections as indicated by elk pellet group distributions. Findings show that within the range of cover values tested, elk response to habitat quality is primarily determined by road densities. Acceptable road models predict over 50 percent of the variation in habitat use by elk. The best of the cover/forage functions tested improved this prediction on only half the validation areas, and then by less than 10 percent.

In the concluding discussion, it is suggested that a more comprehensive habitat model will be required to provide a valid test of the simple cover/forage functions now being used. Specifically, such a model must account for changes in cover requirements over time.

ACKNOWLEDGMENTS
In all, 46 observers participated in fieldwork for this study. I am particularly indebted to Thomas O’Neil in 1980 and Leonard Young in 1981. O’Neil successfully compiled and defended a master’s thesis (O’Neil 19’”) based on the first year of data collection.
INTRODUCTION

Two papers describing preliminary models for coordinating big game habitat management with timber management in the Blue Mountains of Oregon and Washington were presented in 1976 (Black and others 1976; Thomas and others 1976). After similar models for elk/timber coordination were developed throughout much of the West.

As additional research was completed, habitat models were expanded to include the influence of forest roads and traffic on elk use of the remaining habitat. By 1979, Thomas and others had developed a more sophisticated model to predict habitat potential as a function of cover/use ratios and habitat effectiveness as a function of road densities (Thomas and others 1979).

In this work, Oregon teams of biologists from State game and fish departments, the USDA Forest Service, and usually from other agencies, have cooperated in developing elk/timber coordination guidelines for the East-side and Central Zone Forests in Montana, for northern and southern Idaho, and for the Bitterroot, Kootenai, Bridger-Teton, and other National Forests. Considering the speed with which these models were accepted, modified, for local application, and applied in land management, it is not surprising that some guidelines have been interpreted inconsistently.

Differences have been further emphasized by continuing research that has modified some guidelines annually.

Although there is no valid reason to assume that all elk in all situations will respond to environmental modifications in the same way, it was nevertheless considered desirable to conduct a field validation test of existing models to determine what standardization is possible and whether the models do, in fact, predict elk behavior in a variety of environments. Accordingly, field validation tests of elk/timber coordination guidelines were conducted on 11 study areas in western Montana and northern Idaho during the summers of 1980 and 1981. The test hypothesis was that adjacent and topographically similar to the same elk would be used by those elk in the proportions predicted by the guidelines.

STUDY AREAS

Study areas were recommended by local biologists within the limitations of the following criteria:

1. Area has a stable elk herd in a productive habitat.
2. Study area can be subdivided into three or four adjacent and topographically similar subunits.
3. All subunits must be equally available to the same elk.
4. No logging or other unusual major disturbance has occurred on the area within the last 2 years.
5. Areas with recognizable differences in road densities and cover among subunits were preferred. Table 1 and the following narrative briefly describe the 11 study areas.

Table 1.—Summary descriptions of 11 study areas

<table>
<thead>
<tr>
<th>Area</th>
<th>Sub-units</th>
<th>Acres</th>
<th>Hectares</th>
<th>Forest</th>
<th>Average elevation</th>
<th>Trees1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skalkaho</td>
<td>4</td>
<td>8,774</td>
<td>3,553</td>
<td>Bitterroot</td>
<td>7,600</td>
<td>2,317</td>
</tr>
<tr>
<td>Blue Mountain</td>
<td>4</td>
<td>8,978</td>
<td>3,636</td>
<td>Fishhead</td>
<td>5,200</td>
<td>1,585</td>
</tr>
<tr>
<td>Jim Creek</td>
<td>4</td>
<td>10,701</td>
<td>4,334</td>
<td>Kanaka</td>
<td>4,700</td>
<td>1,433</td>
</tr>
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<td>Beaver</td>
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<td>12,901</td>
<td>5,225</td>
<td>Lolo</td>
<td>3,500</td>
<td>1,173</td>
</tr>
<tr>
<td>Pasco River</td>
<td>4</td>
<td>8,666</td>
<td>3,510</td>
<td>Lolo</td>
<td>5,400</td>
<td>1,646</td>
</tr>
<tr>
<td>Hyattie</td>
<td>4</td>
<td>16,843</td>
<td>6,621</td>
<td>Gallatin</td>
<td>7,100</td>
<td>2,164</td>
</tr>
<tr>
<td>Judith</td>
<td>4</td>
<td>15,445</td>
<td>6,255</td>
<td>Lewis &amp; Clark</td>
<td>6,900</td>
<td>2,072</td>
</tr>
<tr>
<td>Red Ives</td>
<td>4</td>
<td>7,844</td>
<td>3,177</td>
<td>St. Joe</td>
<td>5,300</td>
<td>1,810</td>
</tr>
<tr>
<td>Neosho</td>
<td>4</td>
<td>8,185</td>
<td>3,307</td>
<td>Clearwater</td>
<td>4,500</td>
<td>1,372</td>
</tr>
<tr>
<td>Skalkaho</td>
<td>4</td>
<td>8,185</td>
<td>3,307</td>
<td>Pescott</td>
<td>5,200</td>
<td>1,585</td>
</tr>
</tbody>
</table>

1Although habitat types (Pfister and others 1977) were recorded, the most important tree species provides a broader description for the study area. ABLA = Abies lasiocarpa, PICO = Pinus contorta, PSMEM = Pseudotsuga menziesii, THPL = Thuja plicata, TSME = Tsuga heterophylla, TSME = Tsuga mertensiana, AGBR = Abies grandis.

Blue Mountain—The Blue Mountain area is 7 miles (11 km) west of Missoula, Mont., in an area that has been moderately to heavily logged. All three subunits are accessible in some degree by way of old logging roads.

Jim Creek—Jim Lake, located in the southernmost subunit of the Jim Creek area, is a popular and easily accessible recreation site 5 miles (8 km) northwest of Condon, Mont. All four subunits border the Missoula Mountain Wilderness, and logging has taken place in three of the subunits.

Pettit—This study area is located at the headwaters of Big Rouge Creek, 14 miles (22 km) southwest of Trout Creek, Mont. All three subunits have been logged to some degree.

Hyalite—The four subunits of the Hyalite study area include both sides of Hyalite Creek about 8 miles (13 km) south of Bozeman, Mont. All four subunits have been logged, but many of the logging roads are closed to vehicular traffic and much of the recreational use occurs near the valley bottom.

Judith—The four subunits of the Judith study area lie on both sides of Deadhorse Creek in the Little Belt Mountains about 25 miles (40 km) northeast of White Sulphur Springs, Mont. All four subunits have been logged, and road densities are relatively high throughout the area.

Red Ives—The Red Ives study area is located 50 miles (80 km) east of St. Marys, Idaho, on the divide between the St. Joe and Clearwater Rivers. Two of the subunits have been logged, and all three are accessible from a road running along the divide.

Canyon—This study area is located 10 miles (16 km) north of the junction of the Lochsa and Selway Rivers in northern Idaho. Two of the three subunits have been logged, one very heavily, and the third is accessible only from a ridgeline.
In preliminary analyses, significant differences among transects were detected on all but the Red Ives study area (table 3). There were only three study areas in which significant differences were not detected among subunits, and three with no significant differences among transects within subunits. For the most part, these differences were assumed to indicate residues in elk distribution that were related to habitat quality. The initial analysis, however, also demonstrated strong elk responses that were unrelated to the fairly simplistic model of habitat quality tested in this study. In two cases elk response to extraneous factors could be clearly identified, data were either deleted or restructured.

In the Judith study area, for example, the selection criterion requiring all subunits to be equally available to the same elk was not satisfied. Two subunits north of the Judith River had 34.6% and 34.0% forage, respectively. Forage was thus distributed south of the river. Pellet group density estimates were adjusted upward in the two southern elk distribution that were related to habitat quality. The results of an analysis also demonstrated strong elk responses to extraneous factors could be clearly identified, data were either deleted or restructured.

In addition to calculations based on individual study area data, two indirect rules for determining cover were developed and tested. Observations from all Idaho study areas were combined in one set, and observations from the more seric lodgepole and Douglas-fir types in Montana in a second set, to obtain, respectively, the Idaho and Montana Rules (table 4). And, finally, several arbitrary assignment rules that assume certain P1 types to be cover were evaluated. A complete presentation and discussion of these methods is not necessary here because most were found to be unsatisfactory. Any arbitrary assignment rule that classifies elk cover as cover will be considered complete. A full presentation and discussion of these methods is not necessary because most were found to be unsatisfactory. Any arbitrary assignment rule that classifies elk cover as cover will be evaluated. 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VALIDATION ANALYSES

Following the preliminary summary analyses, cover and road density data were used as indicated in a generalized model of the elk habitat guidelines to predict elk habitat quality for each subunit. All analyses were duplicated using the cover values determined by observers and the cover values derived from State PI rules. There were only minor differences in results from these two analyses, but because management biologists are almost always restricted to indirect methods for determining cover, only the State PI analysis is presented in this report.

Habitat Potential

According to the hypothesis proposed by Black and others (1976), the relationship between cover and foraging areas determines habitat potential for elk. Cover is defined as: thermal cover when the ground is within 12.2 m tall with average crown canopy >70 percent; or hidden cover when it will hide 90 percent of an elk < 200 feet (61 m). Forage is defined as: forested forage when forested, but not classified as cover; or open forage when the area is without trees. Both thermal cover and hiding cover are required by elk, and all areas not classified as cover become foraging areas by default. A forest area with a cover surplus can be improved for elk if cover is removed until an optimum ratio between cover and foraging areas is obtained. Continued removal of cover, however, leads to a precipitous decline in habitat potential.

The initial versions of habitat management guidelines proposed a different function for each of several land type, habitat types, or both. More recent versions assume that elk movement between cover and foraging areas adequately integrates available habitat as long as the size and spacing of different stands are satisfactory.

For this study, evaluation was concentrated on a "Single c+f" function (Fig. 1) with a theoretical potential for doubling habitat quality as cover is reduced from 100 to 40 percent and an equivalent loss in quality as cover declines from 40 to 25 percent. Several other cover/forage functions were tested, and I also tested a single cover/forage function.  

Table 4—Average percentage cover for PI types, Montana Rule, and Idaho Rule

<table>
<thead>
<tr>
<th>PI type</th>
<th>Montana Rule</th>
<th>Hiding/Thermal</th>
<th>Idaho Rule</th>
<th>Hiding/Thermal</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Cover</td>
<td>Cover</td>
<td></td>
<td>Cover</td>
</tr>
<tr>
<td>11</td>
<td>58</td>
<td>41</td>
<td>39.4</td>
<td>51</td>
</tr>
<tr>
<td>12</td>
<td>38</td>
<td>29</td>
<td>39.4</td>
<td>46</td>
</tr>
<tr>
<td>13</td>
<td>31</td>
<td>22</td>
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</tr>
<tr>
<td>14</td>
<td>63</td>
<td>56</td>
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<td>46</td>
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<td>45</td>
<td>39.4</td>
<td>46</td>
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<td>28</td>
<td>39.4</td>
<td>46</td>
</tr>
<tr>
<td>17</td>
<td>57</td>
<td>33</td>
<td>39.4</td>
<td>46</td>
</tr>
<tr>
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<td>23</td>
<td>30</td>
<td>30</td>
<td>39.4</td>
<td>46</td>
</tr>
</tbody>
</table>

A table containing the percentage cover for PI types, Montana Rule, and Idaho Rule. The table includes values for cover and hiding thermal of PI types 11 to 20. The values are rounded and presented in a tabular format.

Table 5—Cover percentages in subunits as determined by observers on the ground and by indirect estimates based on Montana and Idaho Observer applications applied to PI types

<table>
<thead>
<tr>
<th>Area</th>
<th>Observers</th>
<th>State PI rules</th>
</tr>
</thead>
<tbody>
<tr>
<td>St. John</td>
<td>52.1</td>
<td>41.5</td>
</tr>
<tr>
<td>Montana</td>
<td>54.5</td>
<td>52.8</td>
</tr>
<tr>
<td>Jum Creek</td>
<td>55.6</td>
<td>57.0</td>
</tr>
<tr>
<td>Beaver</td>
<td>57.8</td>
<td>57.9</td>
</tr>
<tr>
<td>Payette</td>
<td>56.7</td>
<td>55.8</td>
</tr>
<tr>
<td>Bannock</td>
<td>57.3</td>
<td>54.0</td>
</tr>
<tr>
<td>Hillys</td>
<td>58.3</td>
<td>53.5</td>
</tr>
<tr>
<td>Judith</td>
<td>54.6</td>
<td>53.8</td>
</tr>
<tr>
<td>Red laces</td>
<td>61.0</td>
<td>53.0</td>
</tr>
<tr>
<td>Canyon</td>
<td>76.5</td>
<td>45.2</td>
</tr>
</tbody>
</table>

A table containing cover percentages in subunits as determined by observers on the ground and by indirect estimates based on Montana and Idaho Observer applications applied to PI types. The table includes values for St. John, Montana, Jum Creek, Beaver, Payette, Bannock, Hillys, Judith, Red laces, and Canyon.

Examination of table 5 shows that the State PI rules usually produce estimates of cover within 10 percent of on-the-ground sampling estimates. Only the Bannock study area deviated greatly. Nonetheless, it is clear that local sampling should supplement and modify indirect conversion of cover percentages. In particular, PI types 11 and 14 should be sampled where they constitute a large proportion of available habitat.
Habitat Evaluation

After determination of a coefficient for habitat potential cover/forage, and a coefficient for habitat effectiveness road, the habitat value for each subunit was estimated as the product of the two coefficients. The test hypothesis assumes that elk use of the study area, as estimated by the sum of all pellet groups recorded, should be distributed among subunits in the proportions indicated by the habitat values. An example r² validation test is presented in table 6.

In this example, cover ranged from 40.0 to 66.1 percent and road densities from 0.28 to 1.90 miles per section. 0.17 to 1.18 km/km² among the four subunits. Coefficients for habitat potential were all close to 1.00, but coefficients for habitat effectiveness ranged from 0.65 on the least roaded subunit to less than 0.35 in the heavily roaded subunit. The products of the cover and road coefficients provide estimates of relative habitat value ranging from 0.49 to 0.85.

The sum of all pellet groups in the study area, taken to represent the elk population, was distributed among subunits in proportions indicated by habitat value coefficients. For this example, predicted pellet-group density came within 2% of pellet groups per 1.00 ha for two subunits and within 5 per acre for the other two subunits. The mean square deviation, or variance, among the four estimates tests precision. Had the predictions agreed with measured elk use, variance would have been zero.

To complete the evaluation and allow for comparison among models, the calculated variance was divided by the average pellet group density on each study area. This standardized variance (SV = variance/mean) is comparable for all study areas even where actual elk populations are far different. SV was selected instead of the more familiar coefficient of variation (CV = standard deviation/mean) because the CV tended to overestimate estimates from areas with small elk populations.

In all but two study areas, at least one combination of a cover/forage function and a road model produced a deviation variance smaller than the mean (SV < 1). No tested combination produced SV < 1 on more than six areas. Table 7 presents average standardized variances for the Single c.f and No c.f functions and for three of the many road models tested. None of the 14 other tests gave results as precise as the best of these.

The smallest average SV in table 7 has a P=0.005 confidence interval of 0.57 to 1.97. Calculation of similar confidence intervals for other SV averages confirms that estimates of habitat value using the linear cover/road model are less precise than estimates made with other road models. There were no significant differences between estimates based on the Perry-Overly and Single function road models. Nevertheless, the Perry-Overly model should not be used because, in all combinations, it estimates greater losses in habitat effectiveness when primary and secondary roads are evaluated separately than when an equivalent density of primary roads is evaluated alone.

Initially, the results in table 7 seemed to provide an evaluation of relative importance for cover/forage functions and road models in the habitat management guidelines for the road model alone (No c.f predicted about 56 percent of the variation in elk use among subunits, and the addition of the cover/forage curve failed to consistently improve predictions). In retrospect, the apparent failure of the cover/forage function should have been anticipated because a majority of subunits examined in this study had cover percentages between 40 and 55 percent—a range where little difference in elk response could be expected. Moreover, cover values among subunits ranged more than 10 percent in only four of the study areas, and this study was almost certain to provide a more powerful test of road effects than of cover/forage influences.

Examination of SV for individual study areas (table 7) reveals that the Single c.f did improve predictions on half the study areas but failed on the other half. For the six areas where an improvement was recorded, r² = 0.63 (n = 20 subunits); for the remaining five areas r² = 0.19 (n = 18 subunits). As a result of this observation, predictions for all study areas were examined for possible relationships correlated with cover, roads, habitat diversity (Simpson's diversity index), disturbances, seasonal habitat selection, and elk population levels. Considering the relatively narrow range of cover values tested in most of the study areas, it was expected that the cover/forage function might have the greatest influence on those study areas with the greatest range of cover values. This did not prove to be the case. Instead, the predictions improved most on study areas where cover among subunits was most similar. Nor was there any indication that geograph ic location, timing of fieldwork, elk population levels, or habitat diversity contributed in any way to the failure of the c.f function to consistently improve predictions made with the road model. The only strong relationship discovered indicated that for the five areas in which the c.f function failed to improve predictions, elk use of subunits with the heaviest available cover was greater than use predicted by the model. Subunits with relatively less cover were avoided.
CONCLUSIONS

Results of these field tests suggest that the road-density model is a very powerful tool for evaluating and manipulating elk habitat quality. The failure of the cover-forage curve to demonstrate equal power cannot be viewed as sufficient reason to reject the cover-forage concept. It would be somewhat surprising if a single simple function were able to account for changes in elk habitat requirements over the summer season. A more comprehensive model will be required to achieve adequate evaluation of cover and forage requirements that may change substantially between June and September.

REFERENCES


CONCLUSIONS

Any major local disturbance requiring elk to seek the best available cover should have been detected during fieldwork. Observers, however, recorded no such disturbances. During the study a pole was used in the cover/forage function to account for changes in elk habitat requirements over the summer season. A more comprehensive model will be required to achieve adequate evaluation of cover and forage requirements that may change substantially between June and September.

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