Bienn. Symp. North. Wild Sheep
and Goat Counc. 7:194-205.

USE OF CLEARCUTS BY ROCKY MOUNTAIN BIGHORN SHEEP IN SOUTHCENTRAL WYOMING

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Abstract: Information on use of clearcuts by a transplanted herd of Rocky Mountain bighorn sheep (Ovis canadensis canadensis) in southcentral Wyoming is presented. Distribution and habitat use patterns were estimated from 352 independent visual observations of 6 marked bighorn ewes from August through October 1987 and 1988. Thirty-eight observations occurred in clearcuts. Chi-square analysis indicated sheep selected clearcuts in proportions greater than availability during August and September. Proximity to escape terrain appeared to influence use of clearcuts by sheep. Recommendations are presented for integrating timber harvest in bighorn sheep habitat management plans.

Open vegetation communities and precipitous terrain with extensive rock outcrops have been identified as important components of Rocky Mountain bighorn sheep (Ovis canadensis canadensis) habitat (Geist 1971, Risenhoover and Bailey 1980, Wakelyn 1987). Use of open habitats near escape terrain reflects the predator-evasion strategy of bighorn sheep, where predators are detected visually and danger is communicated among sheep by visual cues (Geist 1971, Risenhoover and Bailey 1980, 1985, Wakelyn 1987).

Recent evidence suggests habitat conditions have changed considerably on many historical and occupied bighorn sheep ranges. Encroaching forest and shrub vegetation has reduced large open habitats on sheep ranges, due to fire suppression and/or lack of habitat management over the past 50 years (Wakelyn 1987). Wakelyn (1984) suggested habitat loss due to

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vegetation succession was associated with the decline or extinction of 36 herds of bighorn sheep in Colorado. Loss of suitable habitat and cessation of traditional movement patterns constitute important problems currently facing bighorn sheep (Risenhoover et al. 1988).

Restoration and maintenance of sheep habitat may increase populations and/or preclude local extinctions (Peek et al. 1979). Prescribed burning (Peek et al. 1979, Hobbs and Spowart 1984, Hurley and Irwin 1986, Cook et al. 1990) and, more recently, timber harvest (Yde et al. 1986, Young and Yde 1988) have been used to expand bighorn sheep ranges and improve foraging conditions. But no studies have documented responses of free-ranging populations of bighorn sheep to timber harvest. This paper describes sheep use of clearcuts in southcentral Wyoming and provides preliminary suggestions for integrating timber harvest with bighorn sheep habitat management.

This project was funded by the Foundation for North American Wild Sheep, Wyoming Guides and Outfitters Association, U.S. Forest Service, Bureau of Land Management, Wyoming Game and Fish Department, Boone and Crockett Club, National Rifle Association, and the Rocky Mountain Bighorn Society. B. Grauel and J. Saffran assisted with data collection. A. Wood provided a useful computer program (HABUSE) to analyze habitat use/availability data. We thank J. Bailey, J. Cook, and an anonymous reviewer for editing previous drafts of the manuscript.

STUDY AREA AND METHODS

The study area occurred in the Encampment River Canyon on the eastern flank of the Sierra Madre Range in southcentral Wyoming, approximately 97 km southeast of Rawlins (Fig. 1). Elevations range from 2,188 to 2,796 m. Annual precipitation averages 37.6 cm and mean annual temperature is 5C in Encampment (Soil Conservation Service, Saratoga, Wyoming).

The Encampment River Canyon is a complex system of valleys and ridges with a diversity of vegetative communities. Bighorn winter range, generally below 2,490 m, consists of windblown ridgetops, rolling foothills, and steep slopes within the canyon. Vegetation is dominated by big sagebrush (Artemisia tridentata)-bitterbrush (Purshia tridentata) shrub communities within the canyon, and black sagebrush (Artemisia nova) and mixed grass/forb communities on the ridgetops. The southern portion of the Encampment Canyon (summer and fall range) is dominated by lodgepole pine (Pinus contorta), Engelmann spruce (Picea engelmannii)-subalpine fir (Abies lasiocarpa), and aspen (Populus tremuloides) forest. These forest communities are juxtaposed with snowbrush ceanothus (Ceanothus velutinus)-chokecherry (Prunus virginianus) and big sagebrush-bitterbrush shrub types. Rock outcrops suitable for escape terrain (> 15 m in height) are sparsely distributed in the river canyon. Detailed descriptions of the study area are presented by Haas (1979) and Arnett (1990).

In 1973, 28 ha of timber were clearcut in 3 units near the Jones Creek drainage in the southern portion of the Encampment Canyon (Fig. 1). Clearcuts were between 2,675 and 2,865 m in elevation, and generally faced south to southwest. Southerly aspects in clearcuts supported orchard

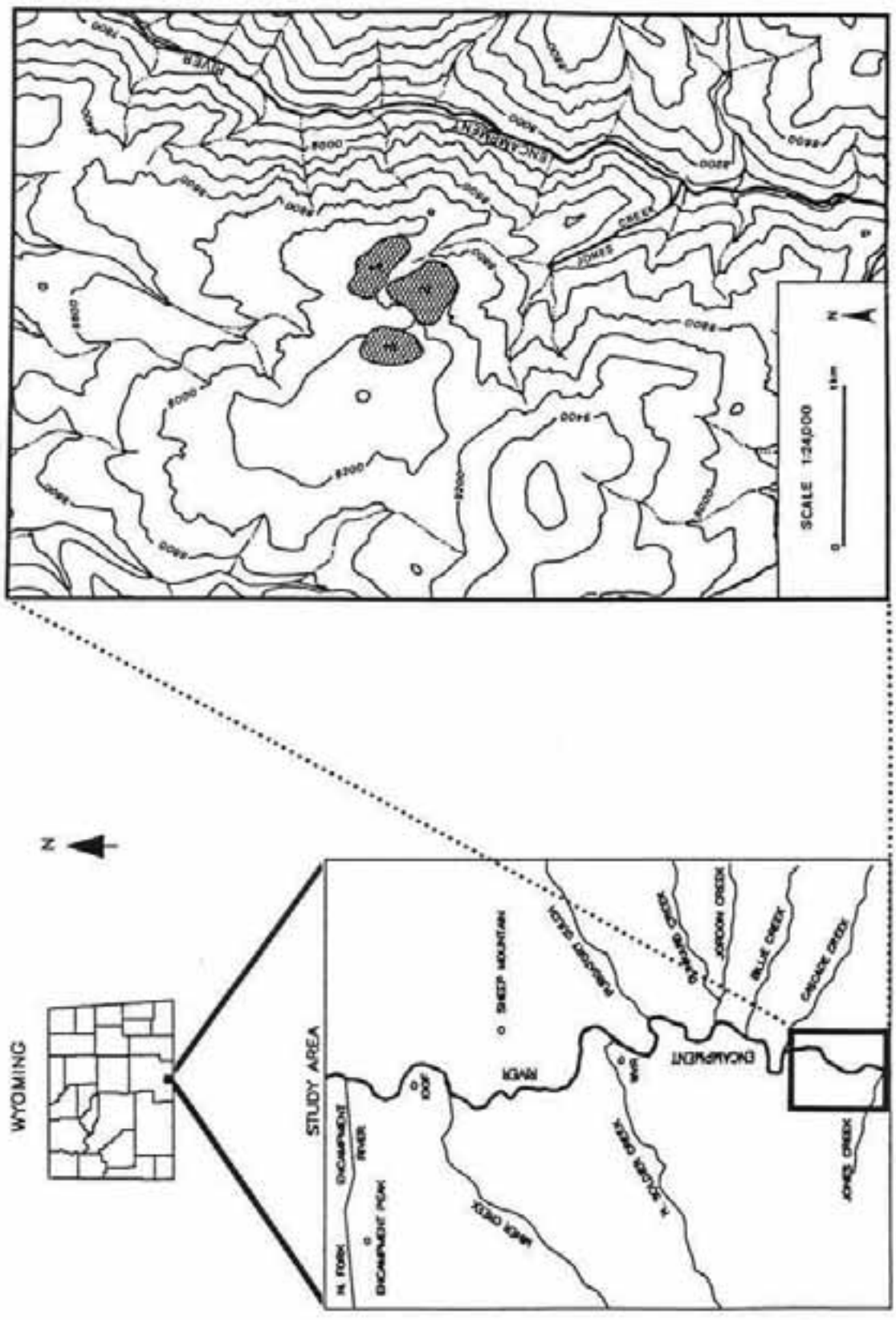

Fig. 1. Location of the Encampment River Canyon study area and 3 clearcuts used by bighorn sheep in southcentral Wyoming.

grass (Dactylis glomerata), spike trisetum (Trisetum spicatum), nodding brome (Bromus anomalus), Wheeler bluegrass (Poa nervosa), Ross sedge (Carex rossii), and silvery lupine (Lupinus argenteus). East aspects were dominated by grouse whortleberry (Vaccinium scoparium), Ross sedge, and lupine. Mesic sites in clearcuts contained King spikefescue (Leucopoa kingii) and Canada wildrye (Elymus canadensis). Before 1988, lodgepole pine, subalpine fir, and aspen saplings (1 to 4 m high) were common throughout the clearcuts.

Two of the 3 clearcuts are being managed by the U.S. Forest Service as permanent openings for bighorn sheep. In early June 1988, all conifer and aspen saplings were cut with chainsaws from clearcuts 1 (C1) and 2 (C2) (Fig. 1). Slash was piled and burned in fall 1988. After saplings were removed, ammonium nitrate fertilizer (approximately 29.6 kg/ha) was applied from a helicopter to half of each clearcut. Saplings were not removed from clearcut 3 (C3) (Fig. 1), but fertilizer was applied.

Sheep habitat selection was determined by monitoring 6 radio-collared adult ewes during August-December, 1987-88. We attempted to locate each marked ewe at least 10 times per month. Marked ewes were visually observed, thus eliminating triangulation errors (Springer 1979). We minimized statistical dependence of relocations by (1) locating a radio-collared sheep only once each day, (2) locating each collared ewe at different times of the day throughout each month, and (3) using a single relocation for groups of sheep containing more than 1 marked ewe (groups were defined as all sheep within 100 m of each other). Available habitat was defined by connecting the outermost relocation points of all marked ewes (Porter and Church 1987), and quantified by measuring the area of each vegetation community with an electronic planimeter.

Data were partitioned by seasons and Chi-square analysis was used to test the null hypothesis that vegetation communities were utilized in proportion to their availabilities (Neu et al. 1974). If a null hypothesis was rejected, Bonferroni confidence intervals were used to identify which vegetation communities were selected, avoided, or used proportionally (Byers et al. 1984).

During the first year of the study, conifer regeneration had not yet been removed from C1 and C2. After observing sheep use of clearcuts, we hypothesized they chose more open sites in clearcuts. We used observations in C1 to test this hypothesis. The outermost boundary of relocations observed in C1 during 1987 defined the used area, while the remaining portion of C1 was considered unused. We randomly selected 20 points in the used and 20 in the unused areas of C1. From each point, we defined an 8 m radius circular plot (0.02 ha), and the number of conifer and aspen saplings was counted and heights measured. A t-test was used to detect differences in number of trees or tree height between used and unused portions of C1.

RESULTS

Collared ewes selected clearcuts during late summer (August-September) but used them in proportion to their area during fall (October-

December) in both years (Fig. 2). Sheep avoided clearcuts during other seasons. In September and October 1987, 21 and 15%, respectively, of all relocations during each month occurred in clearcuts (Table 1). In 1988, 26% of August relocations were in clearcuts, but use decreased as fall progressed. Sheep used clearcuts more extensively during August 1988 and less in September 1988, compared to those months in 1987. Frequency of use differed among the 3 clearcuts. Eighty-four percent of relocations in clearcuts were in C1; 3 and 10% of these observations were in C2 and C3, respectively (Fig. 3).

Used sites in C1 had fewer and shorter trees than did available unused areas (Table 2). But sheep use of C1 and C2 did not increase significantly following removal of conifer regeneration (17 observations in C1 and C2 in 1987, versus 17 in 1988). Although some sheep were observed in portions of C1 which were unused in 1987, they generally used the same area within C1 each year (Fig. 3).

DISCUSSION

Arnett (1990) found bighorn sheep in the Encampment River Canyon preferred more open vegetation communities (e.g., open montane shrub types, windblown ridges, or burns) and consistently avoided aspen and coniferous forests. Other studies corroborate sheep preference for open vegetation types and avoidance of dense shrublands and forests (Thorne et al. 1979, Risenhoover 1981, Brundige and McCabe 1986, Cook 1990). Shannon et al. (1975) reported that abundance of bighorn sheep is negatively related to forest crown closure. MacArthur et al. (1979) and Stemp (1982) found bighorns entering forested areas experience an increase in heart rate, an index to energy expenditure.

Studies clarifying the relationships between bighorn sheep and timber management are lacking. In northwestern Montana, Young and Yde (1988) used a selective timber harvest system (designed to leave 37-74 mature trees/ha), rather than clearcutting, to improve bighorn sheep seasonal ranges. Preliminary information suggests sheep utilize these timber harvest treatments (C. Yde, Montana Dept. Fish, Wildl., and Parks, pers. commun.).

Sheep in the Encampment River Canyon used clearcuts primarily during late summer and early fall, and may have used them more extensively than we documented during this study. Ewes were often observed feeding in clearcuts after they had been located in other vegetation communities earlier in a day. We also observed unmarked groups of sheep in clearcuts.

That sheep selected more open areas within a clearcut and consistently avoided sites with greater tree density and height is probably related to greater visibility (Risenhoover and Bailey 1980, 1985) and forage production (Basile 1975, Dealy 1975, Austin and Urness 1982) in open areas. Although we expected distribution of sheep to extend into formerly unused portions of clearcuts and anticipated increased use of clearcuts after saplings were removed, use in 1988 was generally similar to that in 1987. We are uncertain why sheep used clearcuts more extensively in August 1988, compared to August 1987. However, in

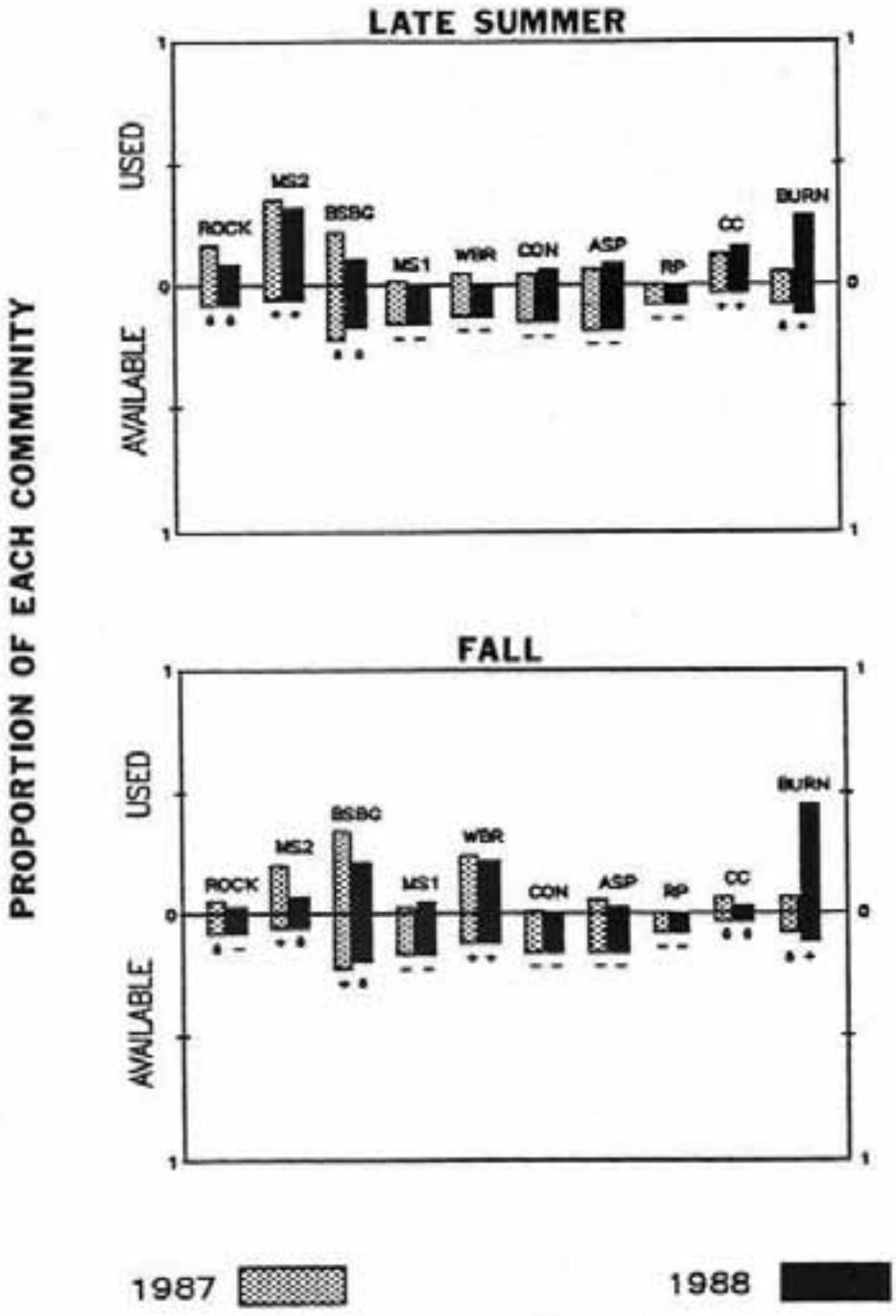

Fig. 2. Habitat use by 6 radio-collared bighorn ewes compared to habitat availability during late summer (August-September) and fall (October-December) 1987 and 1988 (+ = habitat selected, - = habitat avoided, $P < 0.05$; 0 = habitat use similar to availability, $P > 0.05$). MS2 = ceanothus-chokecherry shrub, BSBG = big sagebrush-bitterbrush/grass, MS1 = serviceberry-mountain mahogany shrub, WBR = black sagebrush/grass (windblown ridge), CON = conifer, ASP = aspen, RP = riparian, CC = clearcut.

Table 1. Use of clearcuts by 6 radio-collared ewes during those months when clearcuts were utilized, Encampment River Canyon, Wyoming.

Year	Month	No. locations in clearcut	Total locations	% use of clearcuts
1987	September	11	53	21
	October	7	46	15
1988	August	14	54	26
	September	3	74	4
	October	3	60	5

Table 2. Sapling density and height in portions of clearcut 1 that were used versus unused by bighorn sheep during 1987, Encampment River Canyon, Wyoming.

Area[a]	$\bar{X}$ density (S.E.)[b]	P	$\bar{X}$ height (S.E.)[c]	P
Used	25 (3.5)		108.2 (5.4)	
		< 0.001		< 0.001
Unused	101 (9.0)		149.1 (5.1)	

[a] 20 plots per treatment

[b] trees/0.02 ha plot

[c] height in cm

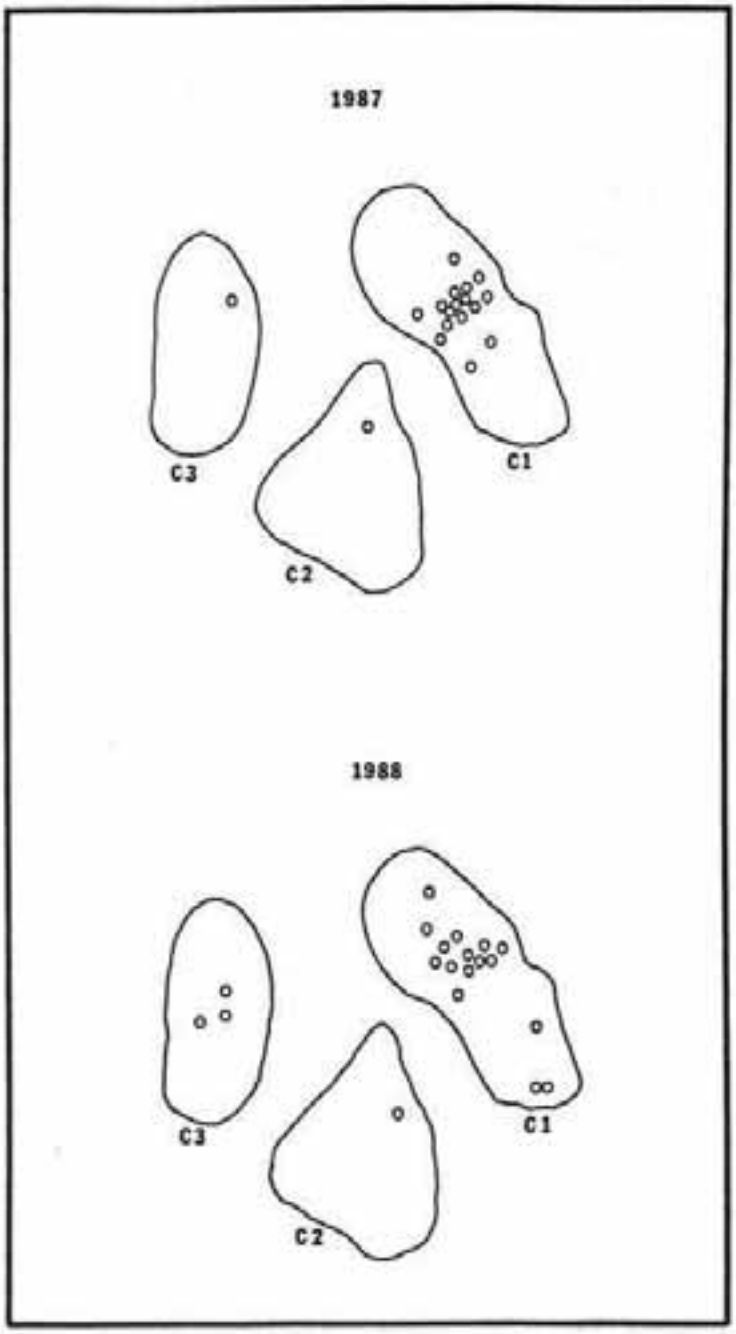

Fig. 3. Distribution of observations of marked bighorn ewes in clearcuts from August to October, 1987 and 1988, showing little change in use patterns before (1987) and after (1988) saplings were removed entirely from clearcuts 1 and 2.

September and October 1988, marked ewes frequented the winter range and utilized prescribed burns more than they did in 1987. Had these ewes remained on the summer/fall range, clearcuts may have been used more extensively during these months in 1988.

Although sample sizes were inadequate to statistically examine variables that influenced selection of clearcuts (e.g., slope, aspect, distance to water), distance from escape terrain apparently is an important determinant of sheep use of clearcuts. Twenty-eight clearcuts occurred within 5 km of the river canyon in the southern portion of the study area. Of these, only 3 were used and 84% percent of relocations in clearcuts were in C1, nearest rock outcrops in occupied sheep habitat. The average distance from relocations to rock outcrops > 15 m in height was 354, 450, and 841 m for C1, C2 and C3, respectively. These distances are further from rock outcrops than sheep typically prefer (Wakelyn 1984), suggesting clearcuts would be used more often if they were located closer to escape terrain.

We speculate bighorn sheep will generally prefer to feed in clearcuts because they provide high-visibility habitat, which facilitates early predator detection, and good forage production and availability, both which improve foraging efficiency (Dale and Bailey 1982, Risenhoover and Bailey 1985). Whether forage quality was elevated in clearcuts, as found by Crouch (1985), is unknown, but increased plant production results in higher nutrient density per unit area, and potentially improves nutrient intake by sheep.

MANAGEMENT RECOMMENDATIONS

Lack of continuous escape terrain, moderate slopes, and dense coniferous forests on the southern portion of our study area restrict bighorns to islands of preferred habitat within the Encampment River Canyon, precluding expansion of the majority of the population to high quality alpine summer ranges in the Sierra Madre mountains (Arnett 1990). Results from this study suggest timber harvest conceivably could be used to expand suitable habitat for bighorn sheep. However, more research is needed to further quantify bighorn sheep-timber harvest relationships, particularly type, size, and placement of silvicultural treatments that would most effectively benefit sheep. Until further research is completed, the following recommendations seem prudent:

1. To ensure that clearcuts will be discovered and used by bighorns, managers should locate areas occupied by sheep and place clearcuts within or near these areas.

2. Sheep exhibit strong affinity to escape terrain, particularly during the lambing/nursery period. Clearcuts should be placed near steep precipitous terrain and rock outcrops (preferably < 300 m) to maximize use by sheep.

3. Conifer saplings within clearcuts intended to benefit sheep probably should be thinned to approximately 125 stems/ha (4 m spacing between trees) within 15 years (Cole 1975, Dealy 1975). This would improve

visibility and maintain understory vegetation, providing more available forage for sheep. Removing all conifer regeneration from clearcuts and maintaining them in a grass/forb community is probably most optimal for sheep, but does not appear necessary to encourage use. A series of timber harvest treatments which maintain open habitat over time may prolong sheep use.

4. Slash in clearcuts should be reduced to facilitate sheep movements, allow early detection of predators, and optimize forage availability.

5. Roads that provide access to clearcuts in occupied sheep range should be closed following timber harvest to reduce human disturbances to sheep (MacArthur et al. 1979).

6. Managers should seed clearcuts with palatible sod-forming grasses to establish herbaceous plant cover and suppress conifer regeneration. Fertilizer could be applied with seed to enhance herbaceous plant production.

7. Timber harvest should occur during seasons when clearcuts are unoccupied or when short-duration disturbance is considered less stressful to sheep.

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