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PRESCRIBED BURNING AS MITIGATION FOR ENERGY DEVELOPMENT ON BIGHORN SHEEP RANGES IN WYOMING.

KEVIN P. HURLEY[1], Department of Zoology and Physiology, University of Wyoming, Laramie, WY 82071

LARRY L. IRWIN, Department of Zoology and Physiology, University of Wyoming, Laramie, WY 82071

Abstract: Approximately 4000 Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*) inhabit the Shoshone National Forest (SNF) of northwestern Wyoming. Analysis indicates high potential for extracting oil and natural gas from bighorn winter ranges on the SNF. Preliminary results are reported from the first year of a 5-year project using prescribed burning to improve bighorn sheep habitat conditions as off-site mitigation for energy development. Bighorn sheep selected ($p < 0.05$) old burn and irrigated meadow vegetation types over sage/grass and sage/grass/juniper types. Of time spent in four vegetative types, sheep foraged significantly ($p < 0.01$) more in the irrigated meadow type. Although not significant, ($p > 0.05$), preliminary data suggest bighorns foraged more efficiently in open habitats with good visibility than in denser-canopy, shrub-dominated communities. Use of prescribed burning as potential mitigation for impacts created by energy development is discussed.

Key words: bighorn sheep, habitat improvement, oil/gas development, seismic exploration, Wyoming.

Public lands in the Overthrust Belt of the northern Rocky Mountains have received considerable attention in the search for new hydrocarbon reserves. The Overthrust Belt underlies a significant portion of the habitat occupied by Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*). Sharp conflicts have arisen over energy development and maintenance of existing mountain sheep populations (Bromley 1985).

Approximately 4000 bighorn sheep are found on the Shoshone National Forest in the Absaroka and Wind River Mountains of northwestern Wyoming. Historical accounts (Honess and Frost 1942, Buechner 1960) and recent reports (Thorne et al. 1979, Hurley 1985) indicate large populations of bighorn sheep persisted in the Absaroka Mountains for the past 200 years. On the SNF, increasing seismic exploration, over 300 existing oil and gas leases, and more than 140 pending lease applications pose new challenges for maintaining these bighorn populations.

These sheep herds may be incapable of withstanding human disturbance and associated stresses from seismic explosions, helicopters, survey crews, heavy equipment, and drilling rigs, for two reasons. First, many portions of the low-elevation winter range provide less-than-optimal forage resources. This is due to advancing forest and shrub succession in the absence of periodic wildfires, and in some cases, because of heavy use by

[1]Present address: Wyoming Game and Fish Department, 116B Four Corners Road, Gillette, WY 82716

domestic livestock. Second, up to 25% of the sheep west of Cody, Wyoming are infected with psoroptic mange or scabies (Hurley 1985), a parasitic disease associated with historical and recent dieoffs of mountain sheep in the western U.S. (Buechner 1960, Lange et al. 1980).

Mountain sheep on a high nutritional plane, dispersed over high quality habitats, are better able to withstand stresses from harsh weather, infectious diseases, recreational harassment, and industrial disturbance (Herman 1969, Lance 1980, Thorne et al. 1979, Welch and Bunch 1983). Therefore, our goal is to improve habitat conditions for wintering bighorn sheep, with the intent of minimizing impacts caused by human harassment and industrial disturbance.

Several alternatives are available to manipulate mountain shrub/grassland winter ranges, including prescribed burning (Hobbs and Spowart 1984), fertilizing (Bayoumi and Smith 1976), herbiciding (Krefting and Hansen 1960), chaining (O'Meara et al. 1981), and grazing management (Holochek et al. 1982). For the Absaroka Mountains study, prescribed burning is the treatment selected.

Major goals of the 5-year (1985-1989) study are to:

1) Enhance bighorn sheep winter range by implementing and monitoring a habitat improvement program, primarily via prescribed burning;

2) Describe responses of bighorn sheep to changes in habitat condition, and monitor behavioral and distributional responses to oil and gas exploration and development; and

3) Evaluate the applicability of wildlife habitat improvement as off-site mitigation for oil and gas development.

The predictions from several hypotheses will be evaluated using changes in foraging rate, forage and diet quality, activity profiles, habitat use, and vegetation composition and production on treated plots. For this paper, three null hypotheses will be addressed:

H1: Vegetation types are used in proportion to occurrence;

H2: Bighorn sheep activity profiles are the same among treated and untreated vegetation types; and

H3: Foraging rate is equal among treated and untreated vegetation types.

In 1985, research included collection of baseline data on foraging behavior and habitat use while planning a series of small prescribed burns along the South Fork of the Shoshone River. Our work is supported by the Wyoming Game and Fish Dep., U.S. For. Serv., Found. for North Am. Wild Sheep (FNAWS), Marathon Oil Co., Amerada Hess Corp., Natl. Rifle Assoc., C. A. Lindbergh Fund, Wisconsin Safari Club Int., FNAWS Chapters in Wyoming and Illinois, Cody Country Outfitters Assoc., Cody Country Sportsmen's Assoc., and the Bur. of Land Manage.

STUDY AREA

Research is being conducted in a southeast-facing valley along the upper South Fork of the Shoshone River, at 1970 m in elevation, approximately 65 km southwest of Cody, Wyoming (Fig. 1). Between 250-300 sheep use a narrow, 3760-ha wintering area located between steeply-dissected mountain slopes and gently-sloping riparian bottomlands. Detailed descriptions of the study area, land status, vegetation, geology, and climate were given by Hurley (1985).

Mountain shrub/grassland communities were dominated by big sagebrush (*Artemisia tridentata*), rabbitbrush (*Chrysothamnus* spp.), Rocky Mountain juniper (*Juniperus scopulorum*), horizontal juniper (*J. horizontalis*), bluebunch wheatgrass (*Agropyron spicatum*), Sandberg's bluegrass (*Poa sandbergii*), and prairie junegrass (*Koeleria cristata*). Stringers of Douglas-fir (*Pseudotsuga menziesii*), limber pine (*Pinus flexilis*), and lodgepole pine (*P. contorta*) were found at middle elevations and on north and east aspects. Charred logs, stumps, and snags indicate a comparatively-abundant coniferous savannah occurred on this low-elevation winter range within the past century. Barring influence by man, fires likely occur every 20-50 years in mountain shrub/grassland communities (Hobbs and Spowart 1984). Five vegetational types were recognized, varying primarily with the amount of tree or shrub components: Sagebrush/wheatgrass, Sagebrush/wheatgrass/juniper, a 10-year-old Burn (prescribed), Upland Conifer, and Irrigated Meadow. The meadow was comprised primarily of smooth brome (*Bromus inermis*).

The Absaroka Range is an erosional remnant of the vast sheet of volcanic strata that formerly extended eastward across the Bighorn Basin (McKenna and Love 1982, *in* Love 1985). The potential appears good for oil and gas reserves in the study area, and several seeps have been identified in the Absaroka region, where oil exudes onto the ground through shallow volcanic strata (USDI-BLM 1984, Love 1985).

METHODS

Ten adult bighorn sheep (8 ewes, 2 rams) were immobilized and radio-collared; more than 12 others could be identified by pelage or horn characteristics. Ground surveys, radio-telemetry, and aerial tracking flights were used to locate marked and unmarked sheep and to determine winter habitat use. Foraging behavior was determined through direct observation of randomly selected sheep. Winter was defined from 1 October to 31 May.

Vegetative communities on the upper South Fork winter range were mapped, and areal extent of the five vegetation types was determined from 212 random points located on winter range maps and color aerial photographs (Marcum and Loftsgaarden 1980). Habitat preferences of sheep were identified by comparing proportions of radiolocations in each vegetation type to percent availability (Neu et al. 1974).

Behavioral activity profiles for adult ewes were developed in 4 vegetation types. Adult ewes were randomly located throughout the day and observed for 10 minutes. Ten instantaneous samples, one minute apart, were

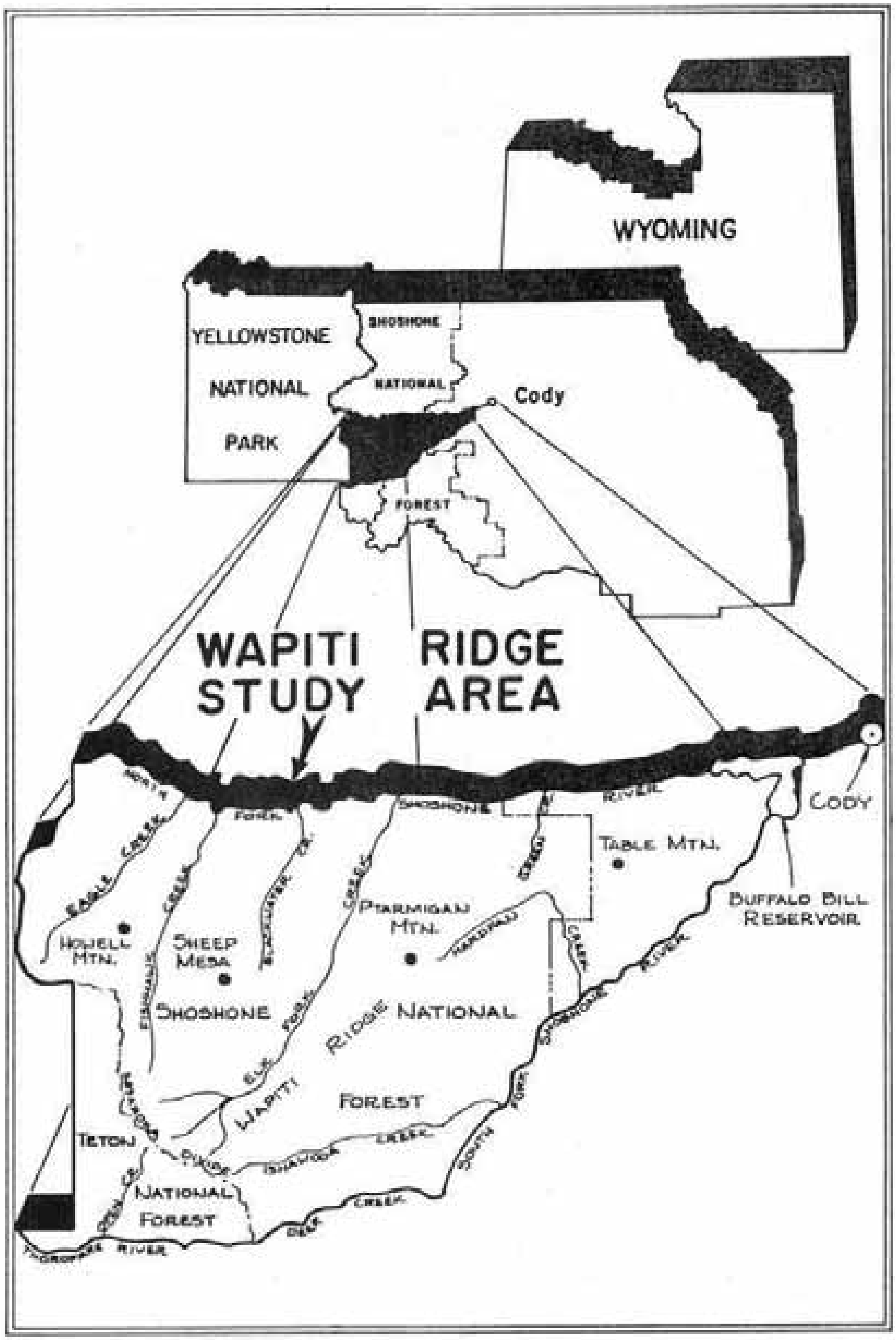

Fig. 1. Location of the Wapiti Ridge study area, South Fork Shoshone River, Wyoming.

collected during each 10-minute bout, and activity was categorized as feeding, bedding, walking, running, standing alert, courting and other. Percentages of time spent in each activity were normalized by arc-sine transformation (Zar 1974); logarithmic variance ratios were calculated and tested for differences in activity profiles among vegetation types (Zar 1974). Student's t-test was used to compare differences in distance traveled/minute of observation. Habitat quality and forage availability in each vegetative type should be reflected in the time spent feeding, bedding, moving, or watching for danger, similar to results reported by Risenhoover and Bailey (1985) for sheep in Colorado.

Foraging behavior of adult ewes in the 4 most important vegetation types was recorded. Grazing time was defined as time spent searching for, ingesting, or chewing forage, and was expressed as the time required for an animal to achieve 100 bites. Number of bites was recorded, stopping the clock when the ewe was obscured from view by topography, vegetation, or another sheep. Activities other than feeding were not included in grazing time calculations. During feeding trials, groups of bighorn sheep were observed from a vehicle, from 5- to 100-m distances, without obvious disturbance.

Forage production was determined within 30-m exclosures, in the Old Burn, sage/grass, and sage/grass/juniper types. In each exclosure, four permanent 25-m line-intercept transects were sampled to determine shrub canopy. Twenty 20- x 50-cm quadrats were located at 5-m intervals on alternating sides of line transects. Within each quadrat, graminoids and forbs were identified, percent canopy cover by species was estimated, and total wet weight of all graminoids and forbs was estimated. At alternating plots, an adjacent plot (off the line) was clipped to ground level. Graminoids and forbs were later separated, weighed, oven dried for 24 h at 60 C, and re-weighed. A regression equation to predict dry weight of all plots was calculated using data from estimated weight and actual weight in clipped plots.

RESULTS

Significant differences occurred between habitat availability and usage ($p < 0.001$, $\chi^2 = 367.4$, d.f. = 4); the null hypothesis was therefore rejected. Sheep used the Sage/grass and Sage/grass/juniper vegetation types in proportion to availability, selecting the Old Burn and Irrigated Meadow types, and avoiding the Upland Conifer community (Table 1). The burn and Irrigated Meadow types provided significantly more forage (i.e., graminoids and forbs) than did less-preferred habitats ($p < 0.05$).

Activity profiles, based on 1182 minutes of observation, showed adult ewes spent proportionately more time foraging in the Irrigated Meadow type than in the Old Burn, Sage/grass, and Sage/grass/juniper types ($p < 0.01$) (Fig. 2). Bighorn ewes traveled significantly faster ($p < 0.025$) per minute of observation while feeding in the Sage/grass and Sage/grass/juniper habitats than in the more open and more productive Irrigated Meadow and Burn types (Table 2). Based on preliminary data, rate of travel/minute of observation appeared inversely related to forage production.

Table 1. Winter habitat selection of bighorn sheep, South Fork Shoshone River, Wyoming.

Habitat Type	Proportion of total acreage	Number of relocations expected	Number of relocations observed	Proportion observed in each area	Confidence interval on proportion of occurrence (90% simultaneous CI)	Selection behavior[a]	Dry Weight[b]
Sage/Grass	0.514	109	93	0.439	$0.351 \leq P \leq 0.526$	NS	171-197
Sage/Grass/Juniper	0.288	61	67	0.316	$0.234 \leq P \leq 0.398$	NS	187-208
Old Burn	0.005	1	17	0.080	$0.032 \leq P \leq 0.128$	+	306
Irrigated Meadow	0.024	5	26	0.123	$0.065 \leq P \leq 0.181$	+	1,740
Upland Conifer	0.169	36	9	0.042	$0.007 \leq P \leq 0.077$	-	c
Total			212				

[a]NS = no significant difference in use vs. availability.
+ = significantly greater use than availability.
- = significantly lower use than availability.

[b]kg/ha.

[c]Not sampled for forage production.

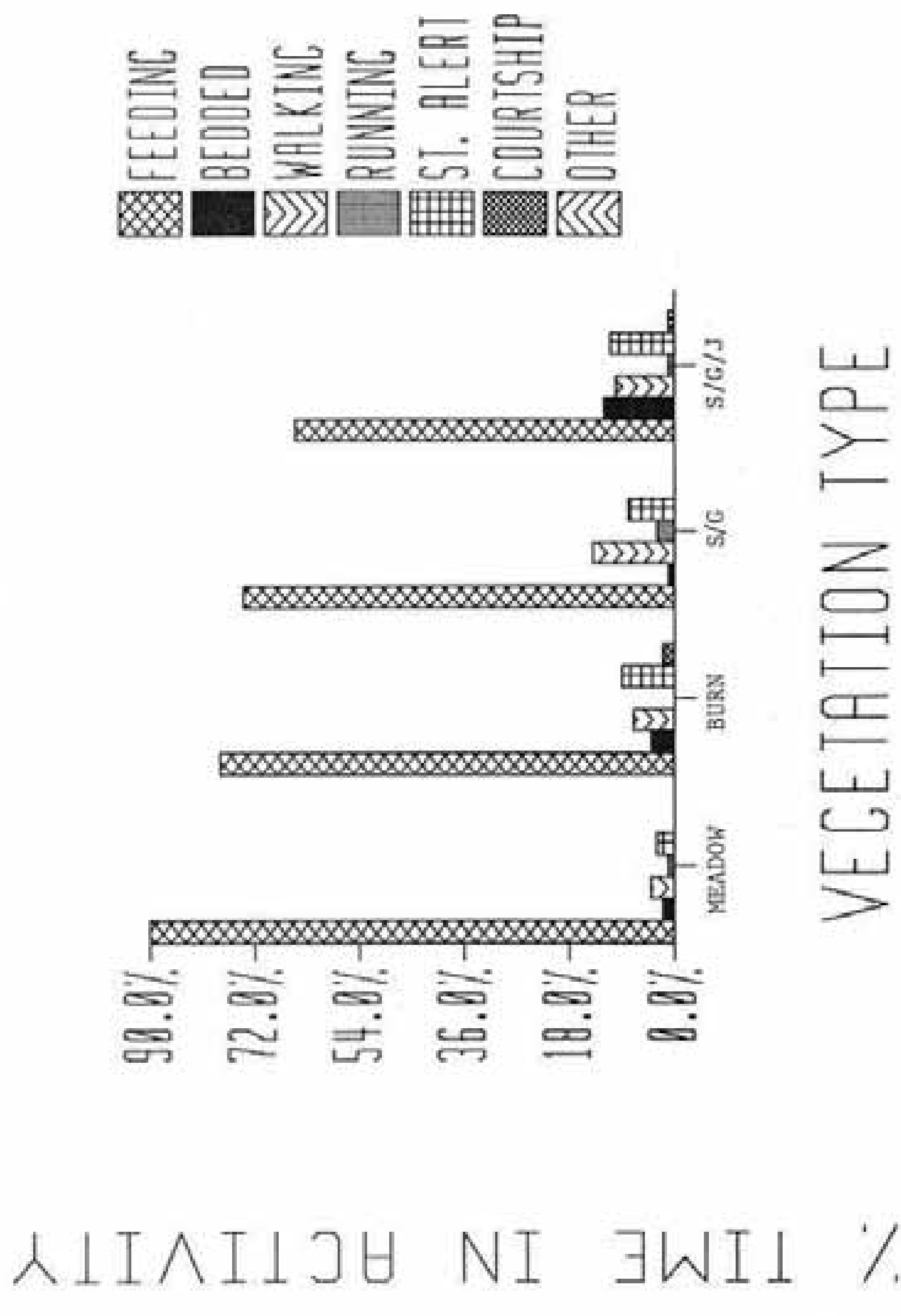

Fig. 2. Bighorn sheep activity profiles, by vegetation type, South Fork Shoshone River, winter 1985-86.

Table 2. Distance traveled (m) per minute of observation of bighorn ewes South Fork Shoshone River, Wyoming, 1985.

Habitat Type	Total Minutes of Observation	Total Distance Traveled (m)	Av. Distance Traveled (m/minute)
Sage/Grass	331.5	1615	4.87
Sage/Grass/Juniper	280.0	740	2.64
Old Burn	180.0	208	1.15
Irrigated Meadow	390.0	332	0.85

Bighorn ewes appeared to forage more efficiently (i.e., less time to achieve 100 bites) in the Old Burn and Irrigated Meadow habitats than in the Sage/grass/juniper and Sage/grass types (Fig. 3), but the only significant difference ($p < 0.05$) in foraging rate was between the Burn and Sage/grass types.

DISCUSSION

Habitat use, rate of travel while feeding, and foraging efficiency may be related to forage production. Further data collection and analysis, including forage quality, will clarify these relationships. Preliminary results indicate that the 10-year-old burn and the Irrigated Meadow were preferred foraging habitats. Significant differences ($p < 0.01$) were found in use versus availability of the burn and meadow types, as sheep selected these communities over adjacent, shrub-dominated vegetation tyeps.

By initiating prescribed burns in the non-preferred types, characterized by relatively lower forage production and reduced visibility, an improvement in foraging efficiency and a change in sheep distribution are anticipated. Based on the findings of Hobbs and Spowart (1983), prescribed burning on the South Fork winter range should increase forage availability and ecological carrying capacity, and positively influence distribution of wintering sheep (Wikeem and Strang 1983).

Although some biologists believe mountain sheep are best adapted to stable, climax bunchgrass communities (Smith 1954, Buechner 1960, Blood 1967, Geist 1971), recent literature indicates extensive bighorn use of seral grasslands created by prescribed burning or wildfires. Peek et al. (1979) noted bighorns made heavy use of prescribed burns in mountain shrub/grassland habitats in Idaho. Riggs and Peek (1980) concluded seral vegetation was at least as palatable to mountain sheep as that occurring in climax bunchgrass communities. Extensive wildfires around the turn of the century contributed to increases in bighorn sheep populations (Stelfox 1976, Peek et al. 1985). Burned areas attract bighorns (Peek et al. 1979, Wikeem and Strang 1983, Risenhoover and Bailey 1985, Spowart and Hobbs 1985), as the sheep respond to increased availability of forage (Elliott 1978, Johnson and Strang 1983) and higher-visibility habitats.

On many bighorn ranges, suppression of periodic wildfires has been indirectly responsible for loss of sheep habitat via shrub and tree encroachment (Stelfox 19/6). These changes in habitat conditions lead to changes in range-use patterns, including loss of traditional migratory patterns (Wakelyn 1984). The most consistent differences between existing vs. historic sheep ranges, and between ranges with large vs. small bighorn populations, are related to the amount of open, high-visibility habitat and escape terrain present (Wakelyn 1984). Bighorn sheep prefer open habitats with low-growing vegetation and avoid habitats with dense, tall vegetation (Smith 1954, Oldemeyer et al. 1970, Constan 1972, Risenhoover and Bailey 1980, Tilton and Willard 1982, Hurley 1983).

In addition to changes in visibility, foraging efficiency, and habitat use, a major benefit of prescribed burning might be that nutritional quality of bighorn sheep winter diets will be increased substantially. The quality of individual forages (i.e., protein content, digestibility) may improve only a few percentage points, but bighorn diets should improve markedly (Hobbs and Spowart 1984). As a result of prescribed fire, bighorn sheep will eat more green grass during winter, because it is much more available after burning (Elliott 1978, Hobbs and Spowart 1984, Seip and Bunnell 1985). Also, earlier spring greenup of grasses following burning (Peek et al. 1979, Seip and Bunnell 1985) provides phenologically younger and thus more nutritious forage for a longer period of time each year. For pregnant ewes, nutrition in spring plays an important role in determining birth weight and subsequent survival of lambs (Geist 1971). In addition, the increased production of palatable forage that is expected following burning in sagebrush communities should provide for a nutritionally superior diet because of greater ability to select the most nutritious plant parts (Jarman 1974, Irwin 1985).

As prescribed burning proceeds in this area, it is planned to gather more data on vegetation response, as well as sheep foraging and habitat use behavior, to fine-tune burning prescriptions. This includes gathering data on fire behavior, weather, and fuel conditions, to achieve maximum forage production. Examination of the relative importance of forage quantity and quality in foraging relationships of bighorn sheep is also planned. Finally, sheep responses to oil and gas-related disturbances will be monitored, to develop recommendations as to the extent of habitat improvement necessary for mitigation.

SYNTHESIS

Positive results from prescribed burning on bighorn winter ranges will be realized only if a proper plan is developed which identifies specific objectives and recognizes factors which limit the population (Peek et al. 1985). Caution must be exercised, as prescribed burning will not always benefit mountain sheep. As with any task, "the right tool for the right job" is an appropriate axiom.

A possible mitigation measure for impacts to bighorn sheep created by oil/gas exploration and development is habitat improvement. To be effective, habitat treatments must be integrated into a scientifically sound program of data collection and population monitoring. Habitat improvement efforts should complement other mitigation strategies, including seasonal operating stipulations on important wildlife ranges, limited human access to critical habitats, grazing management, land acquisition or conservation easements, and environmental awareness education.

Guidelines and operating plans for energy development must focus on maintaining wildlife populations and exploiting management opportunities within wildlife habitats. In this way, exploration and production may proceed, impacts to wildlife and their habitats are reduced, wildlife habitats may be enhanced, and the public will be aware that agencies and industry are cooperatively working to better serve the needs of wildlife.

LITERATURE CITED

Bayoumi, M. and A. D. Smith. 1976. Response of big game winter range vegetation to fertilization. J. Range Manage. 29:44-47.

Blood, D. A. 1963. Some aspects of behavior of a bighorn herd. Can. Field Nat. 77:77-94.

Bromley, M. 1985. Wildlife management implications of petroleum exploration and development in wildland environments. USDA--For. Serv. Gen. Tech. Rep. INT-191, Ogden, Utah. 42 pp.

Buechner, H. K. 1960. The bighorn sheep in the United States; its past, present, and future. Wildl. Monogr. No. 4. 174 pp.

Constan, K. J. 1972. Winter food and range use of three species of ungulates. J. Wildl. Manage. 36:1068-1076.

Elliott, J. P. 1978. Range enhancement and trophy production in Stone sheep. Pp. 113-118 in D. M. Hebert and M. Nation (eds.), Proc. Bienn. Symp. North. Wild Sheep and Goat Counc., Penticton, British Columbia, April 2-4.

Geist, V. 1971. Mountain sheep: A study in behavior and evolution. Univ. chicago Press, Chicago, Illinois. 683 pp.

Hanley, T. A. 1982. The nutritional basis for food selection by ungulates. J. Range Manage. 35:146-151.

Herman, C. M. 1969. The impact of diseases on wildlife populations. Bioscience 19:321-330.

Hobbs, N. T. and R. A. Spowart. 1983. Prescribed burning of bighorn sheep and mule deer winter range. Colo. Div. Wildl., Job Final Rep. 45-01 503-15050. 83 pp.

Hobbs, N. T. and R. A. Spowart. 1984. Effects of prescribed fire on nutrition of mountain sheep and mule deer during winter and spring J. Wildl. Manage. 48:551-560.

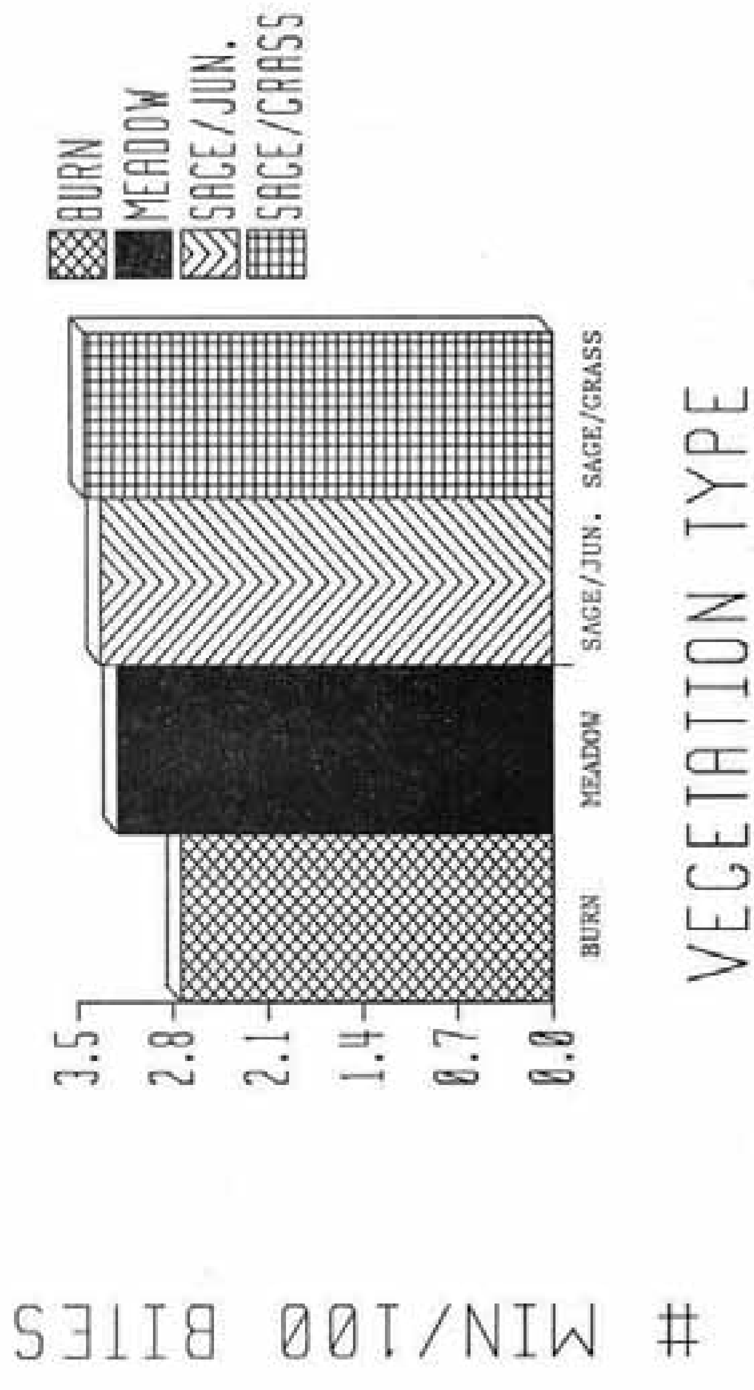

Fig. 3. Forage biting rate of bighorn ewes, by vegetation type, South Fork Shoshone River, winter 1985-86.

Holochek, J. L., R. Valdez, S. D. Schemnitz, R. D. Pieper, and C. A. Davis. 1982. Manipulation of grazing to improve or maintain wildlife habitat. Wildl. Soc. Bull 10:204-210.

Honess, R. F. and N. M. Frost. 1942. A Wyoming bighorn sheep study. Wyoming Game and Fish Dept., Bull. 1. 127 p.

Hurley, K. P. 1985. The Trout Peak bighorn sheep herd, northwestern Wyoming. M.S. Thesis, Univ. of Wyoming, Laramie. 173 pp.

Irwin, L. L. 1985. Foods of moose, Alces alces, and white-tailed deer, Odocoileus virginianus, on a burn in boreal forest. Can. Field-Nat. 99: 240-245.

Jarman, P. J. 1974. The social organization of antelope in relation to their ecology. Behaviour 48:215-267.

Johnson, A. H. and R. M. Strang. 1983. Burning in a bunchgrass/sagebrush community: The southern interior of B.C. and northwestern U.S. compared. J. Range Manage. 36:616-618.

Krefting, L. W. and H. L. Hansen. 1969. Increasing browse for deer by aerial applications of 2,4-D. J. Wildl. Manage. 33:784-790.

Lance, W. R. 1980. The implications of contagious ecthyma in bighorn sheep. Pp. 262-269 in W. O. Hickey (ed.), Proc. Bienn. Symp. North Wild Sheep and Goat Counc., Salmon, Idaho, April 23-25.

Lange, R. E., A. V.Sandoval, and W. P. Meleney. 1980. Psoroptic scabies in bighorn sheep (Ovis canadensis mexicana) in New Mexico. J. Wildl. Dis. 16:77-82.

Marcum, C. L. and D. O. Loftsgaarden. 1980. A non-mapping technique for studying habitat preferences. J. Wildl. Manage. 44:963-968.

McKenna, M. C. and J. D. Love. 1982. High-level strata containing early Miocene mammals on the Bighorn Mountains, Wyoming. Amer. Museum. Novit. No. 1490. 31 pp in J. D. Love, 1985. Oil and Gas Potential of the Washakie (South Absaroka) Wilderness and Adjacent Study Areas, Wyoming. Geol. Surv. Wyoming Rep. of Invest. No. 33. 10 pp.

Neu, C. W., C. R. Byers, and J. M. Peek. 1974. A technique for analysis of utilization-availability data. J. Wildl. Manage. 38:541-545.

Oldemeyer, J. L., W. J. Barmore, and D. L. Gilbert. 1971. Winter ecology of bighorn sheep in Yellowstone National Park. J. Wildl. Manage. 35:257-269.

O'Meara, R. E., J. B. Haufler, L. H. Stelter, and J. B. Nagy. 1981. Nongame wildlife responses to chaining of pinyon-juniper woodlands. J. Wildl. Manage. 45:381-389.

Peek, J. M., R. A. Riggs, and J. L. Lauer. 1979. Evaluation of fall burning on bighorn sheep winter range. J. Range Manage. 32:430-432.

Peek, J. M., D. A. Demarchi, R. A. Demarchi, and D. E. Stucker. 1985. Bighorn sheep and fire: Seven case histories. Pp. 36-43 in J. E. Lotan and J. K. Brown. (eds.), Fire's Effects on Wildlife Habitat--Symposium Proceedings. USDA--For. Serv. Gen. Tech. Rep. INT-186, Ogden, Utah. 96 pp.

Riggs, R. A. and J. M. Peek. 1980. Mountain sheep habitat-use patterns related to post-fire succession. J. Wildl. Mange. 44:933-938.

Risenhoover, K. L. and J. A. Bailey. 1980. Visibility: An important habitat factor for an indigenous, low-elevation bighorn herd in Colorado. Pp. 18-28 in W. O. Hickey (ed.), Proc. Bienn. Symp. North Wild Sheep and Goat Counc., Salmon, Idaho, April 23-25.

Risenhoover, K. L. and J. A. Bailey. 1985. Foraging ecology of mountain sheep: Implications for habitat management. J. Wildl. Manage. 49:797-804.

Seip, D. R. and F. L. Bunnell. 1985. Nutrition of Stone's sheep on burned and unburned ranges. J. Wildl. Manage. 49:397-405.

Smith, D. R. 1954. Bighorn sheep in Idaho. Idaho Fish and Game Dept., Wildl. Bull. No. 1. 154 pp.

Spowart, R. A. and N. T. Hobbs. 1985. Effects of fire on diet overlap between mule deer and mountain sheep. J. Wildl. Manage. 49:942-946.

Stelfox, J. G. 1976. Range ecology of Rocky Mountain bighorn sheep. Can. Wildl. Serv. Rep. Ser. No. 39. 50 pp.

Thorne, E. T., G. B. Butler, T. Varcalli, K. Becker, and S. Hayden-Wing. 1979. The status, mortality, and response to management of the bighorn sheep of Whiskey Mountain, Wyoming. Wyoming Game and Fish Dept., Tech. Rep. No. 7. 213 pp.

Tilton, M. E. and E. E. Willard. 1982. Winter habitat selection by mountain sheep. J. Wildl. Manage. 46:359-366.

USDI-Bureau of Land Management. 1984. North Fork Well Final EIS. BLM--Worland District, Worland, Wyoming. 159 pp.

Wakelyn, L. A. 1984. Analysis and comparison of existing and historic bighorn sheep range in Colorado. M.S. Thesis, Colorado State Univ., Fort Collins, Colorado. 274 pp.

Welch, G. W. and T. D. Bunch. 1983. Census of psoroptic scabies in desert bighorn sheep (Ovis canadensis nelsoni) from northwestern Arizona during 1979-1982. Desert Bighorn Counc. Trans., pp. 8-10.

Wikeem, B. H. and R. M. Strang. 1983. Prescribed burning on B.C. rangelands: The state of the art. J. Range Manage. 36:3-8.

Zar, J. H. 1974. Biostatistical analysis. Prentice-Hall, Inc., Englewood, New Jersey. 620 pp.

QUESTIONS AND ANSWERS

Bill Shuster, Colorado: You were talking about doing some burns on the winter range. Can you give us an idea of what percentage you're trying to ultimately look at getting burned there, and secondly, do you have much trouble with those areas potentially being completely unavailable in a bad winter? Do you have times where you have enough snow cover where sheep can't get to anything that you burn?

Kevin Hurley: Let me answer the second part of your question first. No, that is mostly a south-facing valley. Snow cover at times would be a foot or more, but it's very temporary. This year was a bad winter, and there were only a few days when there was any persistent snow cover. It's a real favorable snow shadow, based on the topography and the wind patterns in that area, so I don't think we would render any of this unavailable. Elevation is probably 6500 feet where we're working. The first part of your question, about the area we intend to burn or hope to burn; the total of all the areas that we've identified, if we were to burn them all 100% and we know that's not going to happen because of some patchy fuel conditions, we're talking somewhere on the order of 5 - 10% of the winter range, quite a small area in comparison to the size of the winter range and the number of sheep that are in there.

Jon Swenson, Montana: You were talking about how much of that area was wilderness and then you were talking about all the seismic activity and drilling and everything. Is that occurring in wilderness or adjacent to it?

Hurley: Those activities are not occurring in the wilderness, just adjacent to it. The Snyder oil well that I talked about is probably less than 100 yards outside the Wilderness boundary. What happened in October 1984, with the passage of the Wyoming Wilderness Bill, was that the Wilderness line was dropped from ridge line right down to the bottom of the valley. Public pressure tried to get that area totally designated as wilderness, to prevent this very thing, but they were unsuccessful. There was a little sliver of nonwidlerness, and that's right where the oil comparnies want to go. Another possibility being talked about is directional drilling from adjacent private land. The geology of the Absarokas, as you probably well know, is pretty tricky and they're not sure they can directionally drill from any great distance. But, this is another option.

Jim Bailey, Colorado: What is the written legal document that says you can not use habitat management, or prescribed fire in particular, in a wilderness area?

Hurley: Well, the Region 2 Forest Service policy that I'm aware of came out last summer. The way I've read it, and this is their new policy, it says for wildlife habitat improvement purposes, prescribed fire is not a viable option. There are two ways that you can implement fire in the Wilderness, and my understanding is, one, to prevent the great conflagration of every 100 years, and the other one is to maintain certain vegetative communities that may have existed there. So, that's a loophole that possibly could be used to get in and burn.

Shuster: The only other loophole you're talking about is if you can document that man has caused natural succession by stopping fires, something like that. If you can show that somehow, then you can go ahead and burn in wilderness, but that's the only way you can do that.

Ernie Garcia, Washington: I think there are at least two examples of proposals by the Forest Service to get approval to burn in Wilderness, and I think they both involve endangered species. I think they've both been approved. I just read something recently, that indicates there may be some changes in the burning policy real soon.

Hurley: Well, I'll just make one comment. If there is to be a precedent in the Yellowstone area, as far as habitat manipulation within the Wilderness, I think it may possibly occur for the benefit of the Yellowstone grizzly bear, and that may set a precedent which enables some other work to be done for sheep, but that's part of a pending proposal.

Garcia: Right, I think both those examples involved either grizzly bear or red-cockaded woodpecker.

Bailey: Just one final thing now, you're all agreeing that this is a Forest Service policy,. It's not in Congressional legislation?

Hurley: Right

Bailey: It's an edict by the Forest Service?

Hurley: That's my understanding, Jim.