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I am indebted to more than 90 employees and volunteers from these agencies who participated in the study. In particular, I appreciate the long hours and hard miles walked by Reuel Jansen, John Firebaugh, Larry Mitchell, and Steve Gilbert.

RESEARCH SUMMARY

Distributions of elk pellet groups on an area of 215 km^2 (80 mi^2) were examined for a period of 8 years. Recorded changes in annual distribution describe both elk movement in response to disturbances in the forest environment and elk habitat selection in response to weather conditions.

Over the period of study, the single most important influence on elk distribution was weather. Severity of winter weather determined the location and extent of winter range. Snowfall during the hunting season resulted in elk concentrating in the least accessible areas available. Hot, dry summer weather forced selection of habitat areas providing cool, moist conditions.

The second determinant of elk distribution was logging. Elk consistently moved away from areas in which active logging was in progress. The distance moved and the time required for return varied depending on the location and duration of logging activity. Recommendations intended to reduce the time during which habitat is unavailable to elk are presented.

CONTENTS

INTRODUCTION

The Burdette Creek drainage in western Montana is a major wintering area for Rocky Mountain elk (*Cervus elaphus nelsoni*). In summer, these elk disperse over a large area of forested land including the several drainages adjacent to Burdette Creek. One of the drainages, Deer Creek, was the location of a USDA Forest Service timber sale from 1971 through 1974. The study reported here was initiated in 1970, with the objective of describing the annual distribution of elk in the area surrounding Burdette Creek during the period of the Deer Creek timber sale. Several smaller timber sales were also conducted on or near the study area during the 8 years of investigation.

STUDY AREA

The Burdette Creek-Deer Creek study area (fig. 1) includes about 215 km^2 (80 mi^2) of forested land 40 km (25 mi) due west of Missoula, Montana. About two-thirds of the area is Lolo National Forest. The remainder is a mixed ownership of U.S. Champion International, Burlington Northern, the State of Montana, and small private ranches.

For evaluation of elk distribution, the study area was divided into 12 subunits (table 1) representing drainages or areas in which habitats for elk were considered comparable. Subunits range in size from 745 to 2 722 ha (1,840 to 6,720 acres).

The west boundary of the area is Fish Creek, which flows north and off the study area at an elevation of 975 m (3,200 ft). Three major drainages, Deer Creek, Burdette Creek, and Lupine Creek, and four smaller drainages flow west and southwest to Fish Creek from the watershed divide at 1 890 m (6,200 ft). East of this divide, Eds, Gus, and Johns Creeks, and the South Fork of Petty Creek flow east to Petty Creek. The eastern study area boundary, through 1972, was the 1 524-m (5,000-ft) contour level. In 1973, this boundary was extended to the 1 219-m (4,000-ft) contour level between the South Fork and Johns Creek.

When the study began in 1970, vehicle access was limited to county roads along Fish Creek and Petty Creek, the Wagon Mountain Road on the southern ridgelines of the South Fork and Lupine Creek, and a low standard fire-control access road on the ridge north of Eds Creek and south along the watershed divide to the ridge between Johns Creek and the South Fork. In addition, short spur roads ran 1 to 5 km (1 to 3 mi) in the bottoms of several drainages.

Throughout the study area, but especially on southerly aspects, open talus slopes and rock outcrops are common. The area is rough, steep, and deeply incised. Most slopes are in excess of 50 percent. Streams are considered intermittent above 1 500 m (4,921 ft) but most contain flowing water year round except during very dry years.

Vegetation on the area consists of subalpine fir (*Abies lasiocarpa*) and lodgepole pine (*Pinus contorta*) types above 1 500 m and Douglas-fir (*Pseudotsuga menziesii*) types below that elevation. Forests on south and west aspects contain a high proportion of ponderosa pine (*Pinus ponderosa*) and a few moist, northerly aspects support western redcedar (*Thuja plicata*). Conifer cover on most of the study area exceeds 50 percent, but drier aspects have grassy openings, and fire-created shrub fields are common on southerly aspects. The largest nonforested opening on the area is the 800- to 1 200-ha (2,000- to 3,000-acre) shrubfield in Burdette Creek. This area burned in 1917 and is

currently dominated by mixtures of snowbrush ceanothus (*Ceanothus velutinus*), mallow ninebark (*Physocarpus malvaceous*), mountain maple (*Acer glabrum*), Scouler willow (*Salix scouleriana*), and serviceberry (*Amelanchier alnifolia*).

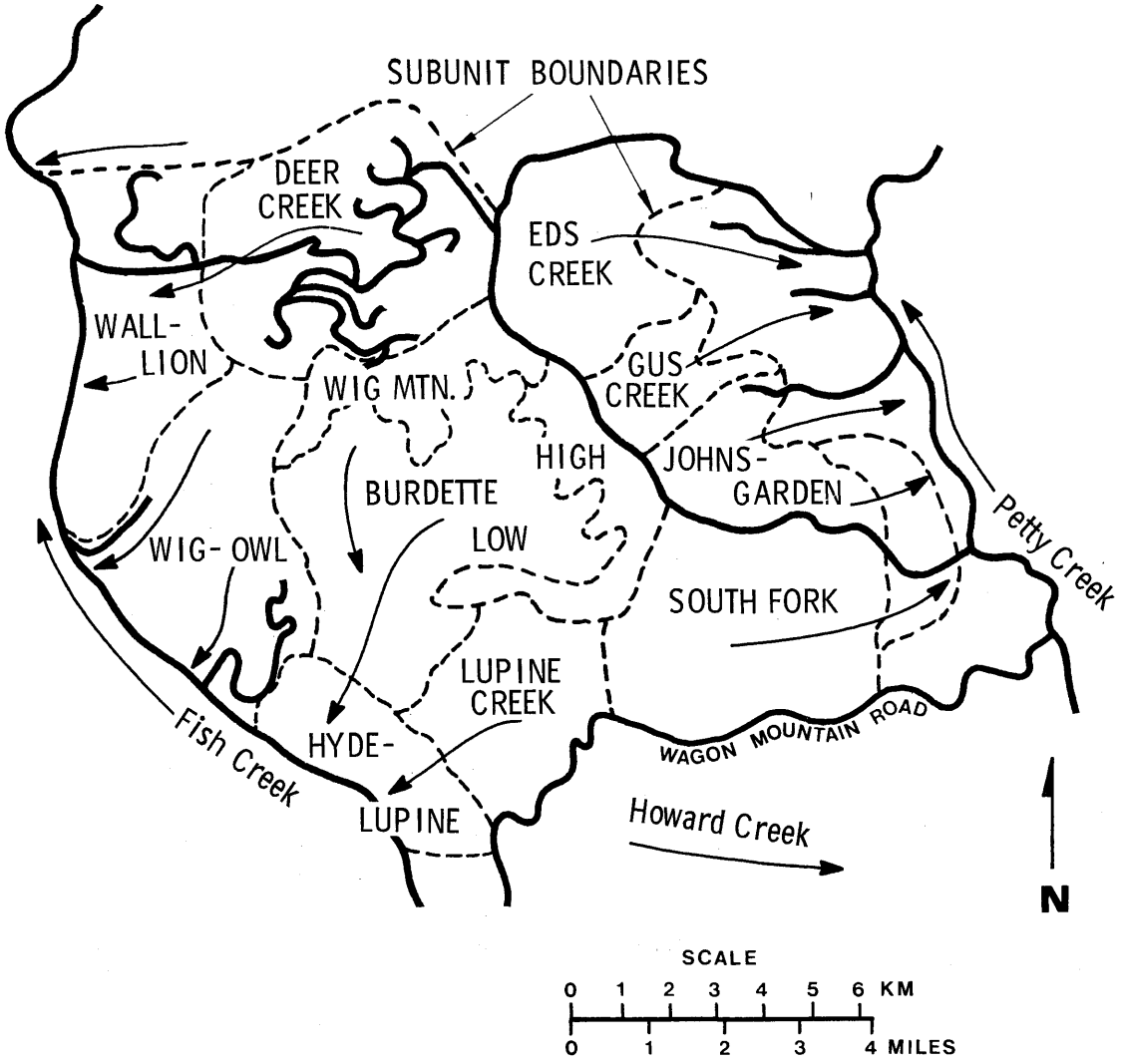

Figure 1.--Road system and diagrammatic representation of drainages and subunits, Burdette Creek-Deer Creek study area.

Table 1.--*Subunits of the Burdette Creek-Deer Creek study area*

Subunit name	Areas		Description
	Hectares	*Acres*	
Wall-Lion	2 428	6,000	Wall Canyon to Lion Creek including lower Deer Creek. Mostly open timber stands on south- and west-facing steep slopes.
Deer Creek	2 720	6,720	Upper two-thirds of drainage. Mostly closed canopy, undisturbed forest until 1 017 ha (2,512 acres) were logged, 1971-74.
Eds Creek	2 639	6,520	Drainage above 1 524 m (5,000 ft). Mostly closed canopy, undisturbed forest.
Wig-Owl	2 363	5,840	Two small drainages. Both are extensively roaded and logged. South- and west-facing slopes.
Wig Mountain	745	1,840	Burdette Creek drainage above 1 524 m (5,000 ft) adjacent to the ridge of Deer Creek. About half forested and half open shrubfields.
Burdette High	987	2,440	Drainage above 1 524 m (5,000 ft) adjacent to the watershed divide and Lupine Creek. Mostly closed canopy forest.
Burdette Low	2 639	6,520	Drainage below 1 524 m (5,000 ft). Major winter range in open shrubfields on south aspects. Closed canopy on north aspects.
Gus Creek	1 117	2,760	Drainage above 1 524 m (5,000 ft). Closed canopy, undisturbed forest.
Johns-Garden	1 489	3,680	Two drainages above 1 524 m (5,000 ft). After 1972, transects were installed in Garden Creek to 1 219 m (4,000 ft). Closed canopy until the 1975-77 timber sale.
South Fork	2 169	5,360	Drainage above 1 524 m (5,000 ft); to 1 219 m (4,000 ft) after 1972. Closed canopy, undisturbed forest with some shrubfield openings.
Lupine Creek	1 441	3,560	Upper 4.8 km (3 mi) of drainage. Open shrubfields on south and west aspects, closed canopy forest on north aspect.
Hyde-Lupine	777	1,920	Lower 1.6 km (1 mi) of Hyde Creek, Burdette Creek, and Lupine Creek. Selectively logged, pastureland, and several homesites.
Study area	21 513	53,160	Total Burdette Creek-Deer Creek study area.

METHODS

Within the area described, pellet groups were counted in continuous belt transects 1.2-m (4-ft) wide. Transects were located along the contour at 152 m (500 ft) vertical intervals from 1 067 to 1 981 m (3,500 to 6,500 ft) elevation. Counts were conducted during late August and early September from 1970 to 1977. Locations of pellet groups were recorded and each group was categorized as fresh, new, old, or very old on the basis of softness, color, and degree of weathering. Approximately 547 km (340 mi) of transect were surveyed and 7 to 10 thousand pellet groups were recorded each year.

In analysis, very old pellet groups were deleted on the assumption that such pellets were deposited in previous years. Some loss of information concerning winter distribution may be inherent in this assumption. All other pellet groups and transect areas were summarized to obtain the average pellet group density for each subunit and for the study area (table 2).

Table 2.--*Pellet groups per hectare by subunit, Burdette Creek-Deer Creek study area, 1970 to 1977 (pellet groups per acre = 0.405 times pellet groups per hectare)*

Subunit	Pellet groups per hectare by year							
	1970	1971	1972	1973	1974	1975	1976	1977
Wall-Lion	113	102	68	42	41	98	66	59
Deer Creek	122	71	40	28	27	33	32	58
Eds Creek	163	125	79	92	77	56	68	50
Wig-Owl	140	113	55	38	62	121	128	71
Wig Mountain	167	122	55	97	55	30	54	137
Burdette-High	92	122	30	65	45	86	85	40
Burdette-Low	203	108	111	87	123	115	218	174
Gus Creek	156	97	54	83	81	79	78	50
Johns-Garden	118	65	59	75	40	78	62	29
South Fork	155	100	74	77	86	90	65	43
Lupine Creek	155	114	96	70	106	169	95	49
Hyde-Lupine	105	65	72	24	45	96	82	56
Study area, average	147	101	68	63	68	88	89	76

CULTURAL DISTURBANCES AND WEATHER

During the 8 years of study, a variety of human activities with potential influence on elk distribution occurred within and adjacent to the study area. The timber sale on Deer Creek was the activity of major interest. Table 3 presents a brief summary of other timber sales, vehicle traffic, and hunting seasons. In addition, the severity of winter weather and other unusual weather conditions are indicated.

Table 3.--*Summary of cultural disturbances and weather, Burdette Creek-Deer Creek study area, 1969 through 1977*

Events	Occurrence in the year preceding August and September pellet counts							
	1970	1971	1972	1973	1974	1975	1976	1977
Deer Creek timber sale								
Roads constructed, 85 km (53 mi)		X	X			- - Roads closed - -		
Active logging, 26,372 MBF on 1,017 ha (2 512 acres)		X	X	X	X			
Slash disposal, planting						X	X	[1]X
Other timber sales (subunit):								
Howard Creek (off area)			X	X	X			
Lupine Creek (Hyde-Lupine)				X	X			
Garden Creek (Johns-Garden)					[2]R	X	X	X
South Fork						[2]R	X	X
Lion Creek (Wall-Lion)							X	
Wagon Mountain Road (off area)							X	
Johns Creek (ridge with Gus Creek)						[2]R	X	X
Eds Creek						[2]R	X	X
Elk trap in Wig Creek				X	X	- - Road washed out - -		
Fire patrol, recreation traffic	X	X	X	X	X	X	X	X
Hunting season, days (year preceding count)	36	43	[3]48	[3]25	29	[3]34	37	36
Snow during hunt	X				X		X	
Winter weather severity[4]	2	3	4	2	3	3	2	1
Hot, dry summer				X				X

[1]A planting crew was in the drainage briefly during the spring of 1977.
[2]Road construction preceding active logging.
[3]In these years, a 5-day bull season in September preceded the general October-November hunting season.
[4]On a scale of 5, 3 is average, 1 is very mild, and 5 is severe. These judgments are based on both weather records and Montana Department of Fish, Wildlife and Parks evaluations for western Montana.

ELK DISTRIBUTION

Variance analysis of pellet density data (table 2) revealed that significantly high ($P < 0.05$) elk use occured on the winter range in Burdette Creek and that the study area elk population declined significantly during the first 2 years of study. This decline was not considered a treatment effect. A similar trend was indicated by Montana Department of Fish, Wildlife and Parks checking station records for Game Management Unit 203, which includes the study area.

Evaluation of annual changes in elk distribution was based on the hypothesis that the proportion of elk use in each subunit should remain constant from year to year if elk are uninfluenced by disturbances or weather. For this test, pellet density data were adjusted to an annual population base of 100, distributed to reflect the percentage of elk use in each subunit. Within subunits, elk use was further subdivided by aspect and altitude and tested with variance analysis for differences among years. Annual percentages of elk use by subunit, 1970 to 1977, and significant changes in elk distribution ($P < 0.10$) are presented in figure 2.

Comparison of figure 2 and table 3 revealed that most of the significant changes in elk distribtuion could be explained as responses to identified cultural disturbances or weather. Many smaller changes that were not statistically significant were also explained; however, there were few instances in which elk response was a simple negative or positive reaction to a single event. Several distributional changes represent cumulative shifts in elk use over a period of years and, in a few cases, significant change occurred because of sequential similar responses to completely unrelated events. Negative response to active timber sales occurred several times and, in every year of the study,

the influence of weather on elk distribution was apparent. The following discussion identifies the causes and examines the importance of weather and human activities in determining the way elk use the available habitat.

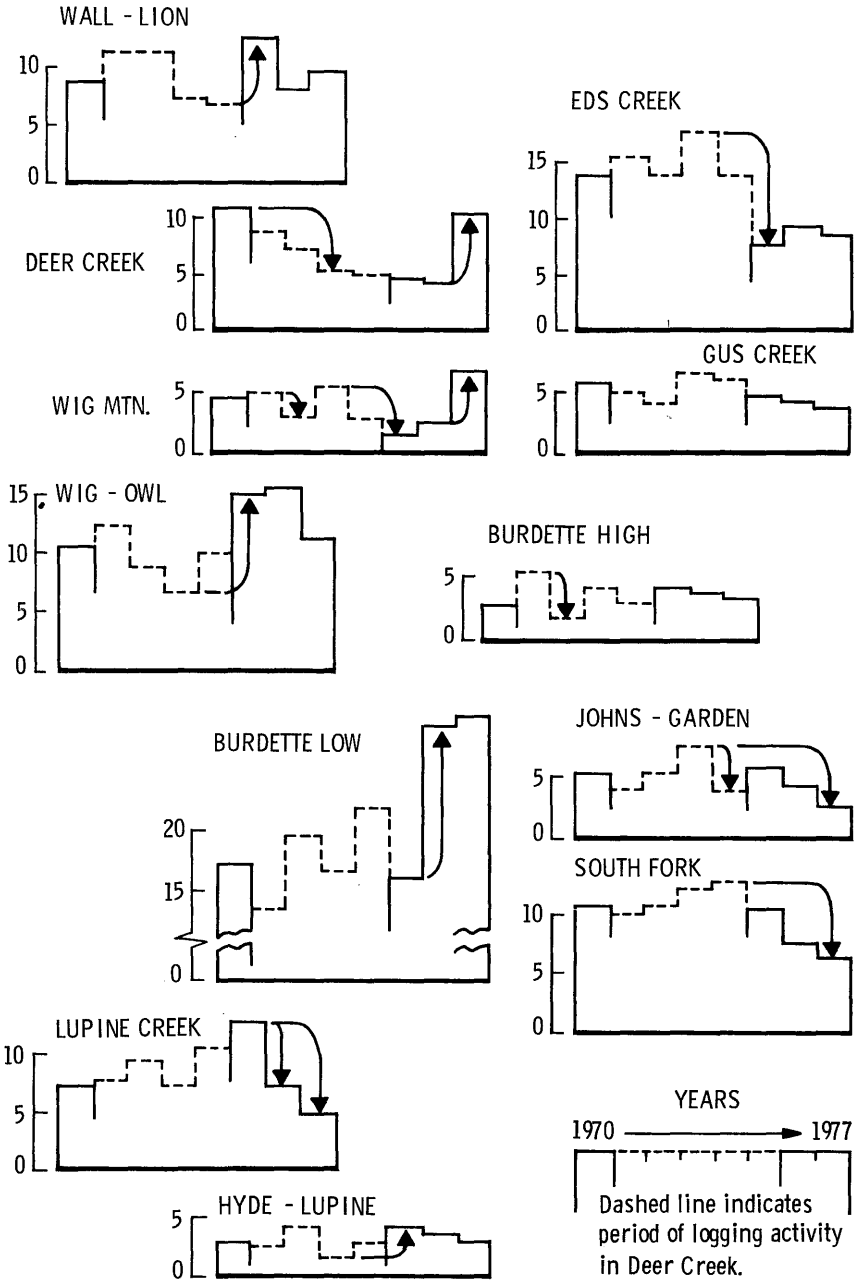

Figure 2.--Annual percentages of elk use by subunit, 1970-1977. Arrows indicate significant ($P < 0.10$) changes.

1970 Count

In the year preceding the first (1970) pellet count, human activities on the study area included the hunting season, fire patrols, recreation traffic, and some timber-marking work in Deer Creek. Final timber sale preparation activities in Deer Creek may have caused a slight depression in elk use; but with the exception of the Burdette Creek winter range (Burdette Low), all subunits of the study area were used by elk about as expected on the basis of proportionate area. The Burdette winter range received more use than might have been expected during a relatively mild winter. Snow fell during the 1969 hunting season, and I suspect that elk movement into the relatively inaccessible Burdette Creek drainage was precipitated by hunting pressure rather than winter weather.

1971 Count

Beginning in September 1970, activity in Deer Creek increased from occasional foot travel to substantial road construction, daily logging traffic, and major modifications of forest cover. All of the main roads and about half the timber harvest were completed during this period, but most of the logging took place on the north side of the drainage. The proportion of elk use declined in Deer Creek and increased in the immediately adjacent subunits. While none of these changes in elk use of subunits were individually significant, the probability of simultaneous random increases in all five subunits adjacent to Deer Creek is only one in 32 ($P = 0.03$).

The winter of 1970-71 was more severe than the preceding winter, but there was little early snowfall and elk were not forced onto the traditional winter range in Burdette Creek. As a result, the Wall-Lion and Wig-Owl subunits had increased winter use. The influence of late-season, deeper snow is also evident in the decline of elk use in subunits east of the watershed divide. Elk wintering in Gus Creek, Johns-Garden, and the South Fork subunits remained below 1 524 m (5,000 ft) for a longer than usual period of time. As a result, fewer pellet groups were detected on transects located above that elevation.

1972 Count

In the year preceding this count, logging and road construction continued in Deer Creek. The focus of activity, however, shifted to the south side of the drainage. There a spur road was built to the ridge at the Wig Mountain subunit between Deer Creek and Burdette Creek. The proportion of elk use in Deer Creek continued to decline, and declines were recorded in the subunits immediately adjacent to the ridgeline disturbance (Wig Mountain, Wig-Owl, and Burdette High). Two of these declines were statistically significant. The pattern was consistent with a hypothesis that elk move away from areas that have direct, line-of-sight contact to a source of disturbance.

Identification of the subunits into which elk moved is conjectural. Statistically significant increases were not recorded for any subunit, and all apparent increases could reasonably have been caused by factors other than the Deer Creek timber sale. Increased elk use of the Burdette Low, Lupine Creek, and Hyde-Lupine subunits, for example, was highest around 1 372 m (4,500 ft) as was expected following the severe winter weather of 1971-72. Increased elk use of the Johns-Garden and South Fork subunits appeared to be a result of elk movement away from an active timber sale just outside the study area in Howard Creek. Nevertheless, use of subunits to which elk might have been expected to retreat does suggest that animals moved as much as 8 km (5 mi) from the ridgeline disturbance in Deer Creek.

1973 Count

Timber harvest in Deer Creek was virtually completed and, by August 1973, most of the heavy equipment had been removed. The decline in elk use continued and finally reached a statistically significant level. Elsewhere on the study area, other distributional changes of less than statistical magnitude appeared to correlate with weather conditions and man-caused activities.

During the mild winter of 1972-73, there was little reason for elk to concentrate on the traditional winter range, and a decline in the use of Burdette Low was recorded. Elk response to hot and dry summer weather is persuasively demonstrated by declines in the use of all south- and west-facing subunits and concurrent increased use of all east-facing subunits and subunits above 1 524 m (5,000 ft). At the same time, the Howard Creek timber sale may have amplified the increased use of the South Fork and Johns-Garden subunits. The depressed use of Wig-Owl and Lupine Creek also reflects response to an elk trap in Wig Creek and some selective logging at the mouth of Lupine Creek.

1974 Count

Final logging operations and hauling of logs from Deer Creek were completed in the spring and summer of 1974. The disturbance was not continuous, but roads remained open and elk use remained low. Minor declines in elk use of the Wig Mountain and Burdette High subunits and an increase in Wig-Owl usage might have been associated with logging traffic, but these changes probably represent a general return to normal from the increases associated with hot summer weather in 1973.

Snowfall during the 1973 hunting season, and a winter of average severity, are reflected in increased elk use of Burdette Low and Lupine Creek and declines in elk use of Eds Creek and Gus Creek above 1 524 m (5,000 ft). New transects below 1 524 m in the South Fork also confirm increased elk use during the winter; but road construction in Garden Creek resulted in significant elk movement out of the Johns-Garden subunit.

1975 Count

Following an early bull season, but before the general elk hunting season in October 1974, the road to Deer Creek was closed with a gate. Only slash-burning crews and USDA Forest Service vehicles entered the drainage. Thus, the 1975 pellet count represents the first year of road closure after logging. Despite reductions in disturbance, elk use continued to decline. Elk use was also significantly depressed in the Wig Mountain subunit adjacent to some of the Deer Creek slash treatment areas.

Significant increases in elk use of the Wall-Lion and Wig-Owl subunits were not considered a response to the closure of Deer Creek. Similar increases in elk use occurred in all west- and south-facing drainages except Burdette Creek. And, in every case, the increase was recorded on transects at 1 372 m (4,500 ft)--which is considered indicative of winter use. Apparently, the initially mild winter weather of 1974-75 allowed elk to remain in areas outside Burdette Creek and, despite extremely cold weather during February, the expected movement to traditional winter range never occurred.

Road construction activity in the South Fork was reflected in a minor depression of elk use; and road construction on the ridge between Gus Creek and Johns Creek caused a minor depression in elk use of Gus Creek. Concurrently, a significant decline in elk pellet densities occurred in Eds Creek. During 1975, road construction and logging were initiated on a private holding on the north side of Eds Creek at about 1 524 m (5,000 ft). The area involved was relatively small, but the location, on a ridge overlooking much of the drainage, was very disturbing to elk.

1976 Count

In 1976, a combination of events resulted in a significant increase in elk use of the Burdette Creek drainage: the 1975 hunting season began in mid-October; and snowfall in October was the highest recorded during this study. As a result, elk moved into Burdette Creek earlier than in any previous year. The winter of 1975-76 was relatively mild, but low temperatures persisted through March; so elk movement off the winter range was delayed. Also, active timber sales in Lion Creek to the west and in all subunits east of Burdette Creek further inhibited normal spring and summer dispersal.

Inaccessibility of the Wig-Owl subunit during the hunting season (table 3) contributed to continued heavy use; but Lupine Creek, which hunters can reach on foot from the Wagon Mountain Road, received significantly less elk use than in previous years. In Deer Creek, the roads remained closed, but some slash burning and tree planting occurred and no increase in elk use was recorded.

1977 Count

Following 6 consecutive years of declining elk use, including 3 years of post-logging road closure, elk pellet densities in Deer Creek nearly doubled between 1976 and 1977. Proportionately, elk use in 1977 was almost the same as that recorded in the year before logging started. Elsewhere on the study area, declining elk use was recorded in all subunits in which logging was in progress; and in two of these subunits, Johns-Garden and the South Fork, the declines were statistically significant. In Lion Creek, logging was completed and even though the roads remained open, a minor increase in elk use occurred in the Wall-Lion subunit.

Independent of the response to timber sale activities, elk distribution in 1977 again demonstrated the strong influence of weather conditions. The winter of 1976-77 was extremely mild and, in the absence of snow pack, elk were able to remain at all elevations throughout the study area. Elk use of the Burdette winter range should have declined from the high recorded in 1976. However, the mild winter was followed by a hot, dry summer and elk response was limited by a number of conditions that did not exist in the hot, dry summer of 1973. Use of the south- and west-facing subunits (Wall-Lion, Wig-Owl, Lupine Creek, and Hyde-Lupine) was depressed, as in 1973, but movement to the cooler, moist subunits on the east side of the study area was inhibited by active timber sales. Use of the Wig Mountain subunit, which is above 1 524 m (5,000 ft) increased significantly, but a similar increase in the use of Burdette High was inhibited by logging activity in adjacent drainages.

For a substantial period of time in 1977, Deer Creek and Burdette Creek were the only areas of suitable habitat actually available to elk. In both subunits, a large drainage without active disturbance included a considerable area of north aspect on which small streams provided either flowing water or moist vegetation. Thus, while it is significant that Deer Creek became acceptable to elk following the timber sale, it may be even more significant that reoccupation of the drainage was not an elective choice. Instead, it appears that elk reentry to the drainage was forced by circumstances of weather and active timber sales.

DISCUSSION AND CONCLUSIONS

While the foregoing narrative description provides a persuasive summary of elk distributional changes and causal relationships, several assumptions were necessary to the continuity of the narrative. Implicit in all interpretations is the assumption that established patterns will ordinarily be repeated. Thus, any major modification of elk distribution requires repeated reinforcement to overcome behavioral patterns based on reenactment of previous experience. Elk response to weather occurs relatively quickly because the reinforcement is virtually continuous until the animal locates acceptable habitat. Response to timber sale activities, on the other hand, may require several years because the disturbance involves sporadic seasonal shutdown and substantial changes in logging activity patterns.

Changes in the annual distribution of pellet groups on the Burdette Creek-Deer Creek study area describe both elk movement in response to disturbances in the forest environment and elk habitat selection in response to weather conditions. In any year and for a variety of reasons, areas of otherwise acceptable elk habitat are caused to be unavailable for a period of time. The net result must be utilization of less desirable habitat or crowding of animals into habitat that remains acceptable. Management recommendations to reduce the time period of habitat unavailability and recommendations to improve the habitat where crowding does occur should benefit elk.

Over a period of years, the single most important influence on elk distribution in the Burdette Creek-Deer Creek area was weather. And, whereas the manager has no control over weather, there were at least three responses by elk that can be used by managers. There was fairly strong evidence that acceptable winter range may include more area than is usually considered in habitat improvement planning. In 4 of the 8 years of study, elk were able to spend a substantial part of the winter period above 1 524 m (5,000 ft) on areas normally considered summer range. Increased forage production at this elevation is not as critical for elk as increases below 1 372 m (4,500 ft) might be, but the benefits could be greater than is usually assumed.

Another important response by elk was the early movement to less accessible areas when snow fell during the hunting season. Normally, snow aids the hunter in tracking elk and thereby increases the annual harvest. If adequate refuge areas do not exist, overharvest is a distinct possibility.

Finally, the behavorial response of elk to hot, dry summer weather in 2 different years can be taken as further evidence of the importance of cool, moist habitat types to the overall integrity of elk summer ranges (Lyon 1975)[1]. Maintenance of body temperature at some relatively constant level may be comparable to feeding as a daily preoccupation for elk.

The second determinant of elk distribution--and one over which the manager has considerable control--was logging. Elk consistently moved away from areas where active logging was in progress; however, the distances traveled varied considerably. The greatest movement and the strongest negative response were recorded following logging operations on ridgelines where men and heavy equipment were visible over large areas (Deer Creek, 1972; Eds Creek, 1975; South Fork, 1975-77). A somewhat less negative response and shorter movement occurred when logging was conducted below ridgelines (Deer Creek, 1971; Lion Creek, 1976); at the ends of ridges (Garden Creek, 1974-77; Johns Creek, 1975-77); and at the mouths of drainages (Lupine Creek, 1973-74; Eds Creek, 1976-77).

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[1]Lyon, L. Jack. 1975. Coordinating forestry and elk management in Montana: Initial recommendations. Trans. North Am. Wildl. and Nat. Resour. Conf. 40:193-201.

Despite the variations, all elk movement away from active logging did follow relatively consistent patterns. In no case did a disturbance result in complete abandonment of a subunit and, in all cases where logging was completed, a return movement to the logged area was indicated. Elk retreat from logging appeared to continue only as long as men and machinery were active. The distance elk moved appeared to be only as far as necessary to cross a topographic barrier. Undisturbed forest and even long spans across undisturbed drainages did not appear to be as effective as topography in reducing the distances moved.

Return movement to the area disturbed by logging was considerably harder to evaluate on the basis of available data. If Deer Creek represented a typical situation, removal of heavy equipment and even road closure did not compensate for the continuing sporadic disturbance caused by the presence of slash burning and planting crews. In addition, the learned behavior imposed by 5 consecutive years of logging activity may have further contributed to a delayed return. In several other sale areas, where logging activity was not prolonged, minor recoveries from depressed elk use were recorded as an immediate response to removal of men and equipment (Hyde-Lupine, 1975; Johns-Garden, 1975; Eds Creek, 1976; Lion Creek, 1977).

In accordance with these results, several management actions can be suggested for reducing the distances moved by elk and reducing the time during which the habitat is unacceptable. As suggested in 1975 by the initial recommendations of the Montana Cooperative Elk-Logging Study (Lyon 1975, *see* footnote 1):

> Planning for timber sales in elk summer range should provide for a security area immediately adjacent to the disturbed area during active logging and road construction.

We are still unable to specifically define a security area other than to point out that the area selected "...should provide a line-of-sight topographic barrier and be inaccessible to motorized traffic." The area probably should be at least as large as the area disturbed, and any ridgeline between the timber sale and the security area should be protected from disturbance.

In addition to providing a nearby area to which elk can retreat, several further options can reduce the total effect of disturbance. Logging completed on summer range during the winter months, for example, may result in little distributional change. Where winter logging is not possible, there may be opportunities to reduce the time elapsed between first entry and completion. Smaller sales, completed in 1 or 2 years, are less disturbing and the areas involved are more likely to be reoccupied immediately. Road closures, like the closure imposed on the Deer Creek drainage of this study, would probably be more effective if vehicle traffic was severely limited and all disturbance, including slash disposal and planting, was completed in a short time.

Finally, it is suggested that the number of concurrent active timber sales in any one management unit on elk summer range should be limited. In this study, the original objective involved evaluation of the influence of a single large timber sale on elk distribution. As the study progressed, the number of active sales on the study area increased each year until only one of the study area subunits remained undisturbed. Concurrently, the proportion of elk use in that undisturbed subunit increased from 17 percent to over 30 percent of all use on the study area. The ridgeline road running south from Deer Peak was closed in 1978 to help alleviate this problem; at the same time, the difficulties of access for fire control and hunting have been substantially increased.

Land managers constantly encounter situations in which the solution of one problem becomes the cause of another. In the context of multiple-use management there is probably no logic capable of eliminating all conflicts between resource values. However, the degree of conflict can be considerably reduced and, in the management of elk habitat, very substantial positive results can be achieved through appropriate planning.

Lyon, L. Jack
1979. Influence of logging and weather on elk distribution in western Montana. USDA Forest Serv. Res. Pap. INT-236, 11 p. Intermt. For. and Range Exp. Stn. Ogden, Utah 84401.

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Boise, Idaho
Bozeman, Montana (in cooperation with Montana State University)
Logan, Utah (in cooperation with Utah State University)
Missoula, Montana (in cooperation with University of Montana)
Moscow, Idaho (in cooperation with the University of Idaho)
Provo, Utah (in cooperation with Brigham Young University)
Reno, Nevada (in cooperation with the University of Nevada)