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Winter range utilization and movements by elk along the Middle Fork of the Flathead River Montana

Mike G. McDonald
The University of Montana

WINTER RANGE UTILIZATION AND MOVEMENTS BY ELK ALONG THE MIDDLE FORK OF THE FLATHEAD RIVER, MONTANA

By

Mike McDonald

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ABSTRACT

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Winter Range Utilization and Movements by Elk Along the Middle Fork of the Flathead River, Montana (71 pp.)

Director: Bart W. O'Gara

Elk (Cervus elaphus nelsoni) that wintered along the Middle Fork of the Flathead River were investigated from January through May 1977 and 1978. Eight cow elk were radio-collared and 8 calves and bulls were fitted with rope collars. Population structure, winter mortality, winter range fidelity, movements on the winter range, and browse utilization were studied. Calf:cow ratios obtained from ground counts were 47:100 in 1977 and 48:100 in 1978, considerably higher than indicated by aerial count data, 19:100 and 23:100. No winter kills were found in 1977 and only 3 were found in 1978. None of the dead elk were calves, indicating high calf winter survival during both years. All 5 elk radio-collared during 1977 and at least 1 rope-collared elk returned to the winter range in 1978, implying high fidelity. Population estimates of wintering elk ranged from 184 to 270 with a weighted mean of 233 animals. Elk use in respect to elevation and slope configuration differed substantially between the mild winter of 1977 and the near-normal winter of 1978. A horizontal shift to concave and straight configurational draws and slopes was noted during February and March 1977 because of low snow accumulation. During the same months in 1978, habitat use was restricted to convex, open ridges. April comparisons showed the animals moving upward and using previously snowbound slopes in 1977 but using lower draws and drainages during 1978. Browse surveys indicated a preference for Rocky Mountain maple over serviceberry. Vigor of both species was low, most plants were less than 4 feet (1.2 m) tall; nearly 40% of all plants were decadent, and 45% of all plants classified were in form class 3, indicating consistently high utilization.

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CHAPTER I

INTRODUCTION

Development of sound management plans for a wildlife species requires knowledge concerning its life history, population structure, and habitat requirements. As human population and hunting pressure increase in Montana, maintaining or improving big game habitat is becoming crucial. Elk are 1 of Montana's great natural resources. These animals are not only prized by big game hunters but are a magnificent component of many of the State's ecosystems.

The condition of winter ranges can be the major limiting factor in a production of elk (Harris 1958), and careful management of these areas is essential. Regular, heavy use of key browse species by wintering elk occurs along the Middle Fork of the Flathead River. This use and consistently low calf:cow ratios, recorded during spring on winter ranges along the Middle and South forks of the Flathead River, indicated the need for intensive research on the elk and their habitat.

Simmons (1974), Biggins (1975), and Fuller (1976) studied elk that wintered along the South Fork of the Flathead River. To determine whether the South and Middle Fork elk herds required separate management approaches, the degree of interchange between the 2 had to be established.

When research on the elk that winter along the Middle Fork of the Flathead River was begun, it was divided into 2 complementary studies. Smith (1978) studied the spring and summer migratory routes, calving areas, calf:cow ratios, and summer habitat selection. My investigation concerned the winter population characteristics, range conditions and use.

Primary objectives of my study were to:

1) determine population characteristics;

2) identify winter habitat selection;

3) determine range condition and utilization; and

4) document fidelity to the winter range.

CHAPTER II

STUDY AREA

Location

The elk winter range lies along the Middle Fork of the Flathead River in what is now the Great Bear Wilderness (Public Law 95-546), within the Flathead National Forest of northwestern Montana (Fig. 1). The winter range is directly south of the southern tip of Glacier National Park where Bear Creek joins the Middle Fork. The winter range is primarily restricted to the southern aspect slopes north of the Middle Fork between Spruce and Twentyfive Mile creeks (Fig. 2). The 3 main tributaries to the Middle Fork within the study area are Vinegar, Lunch, and Cabin creeks. The Middle Fork south of Bear Creek is classified as a Wild River (Public Law 94-486) under the National Wild and Scenic River Act of 1968 (Public Law 90-452). Primary access is restricted to Trail 155 (The Big River Trail) from U.S. Highway 2 at Bear Creek 0.3 mile (0.5 km) above its junction with the Middle Fork.

The elk trap was located approximately 12 miles (19 km) from Highway 2 (Fig. 2). Cabins used during the study were located 6 miles (10 km) and 16 miles (25 km) from the Highway.

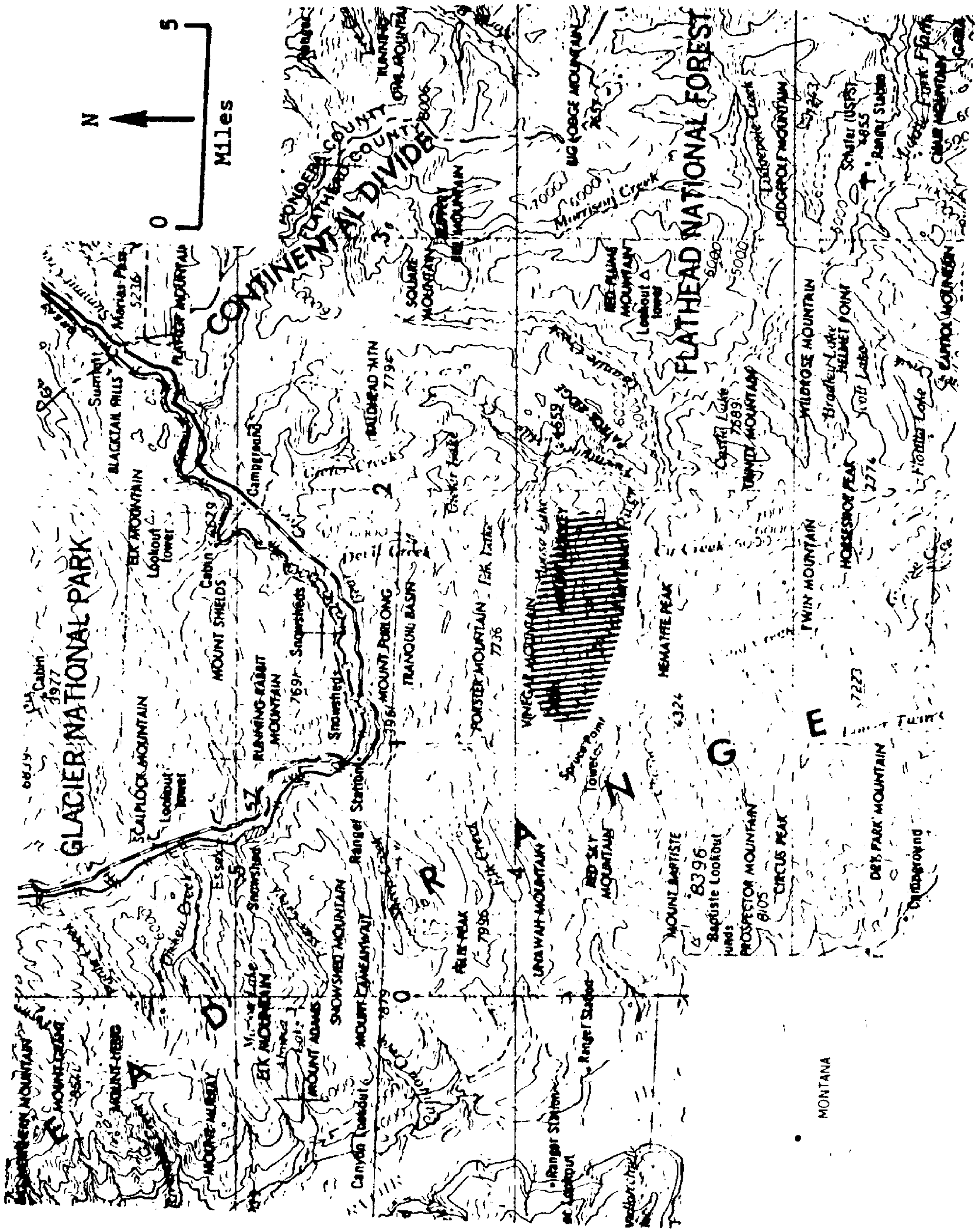
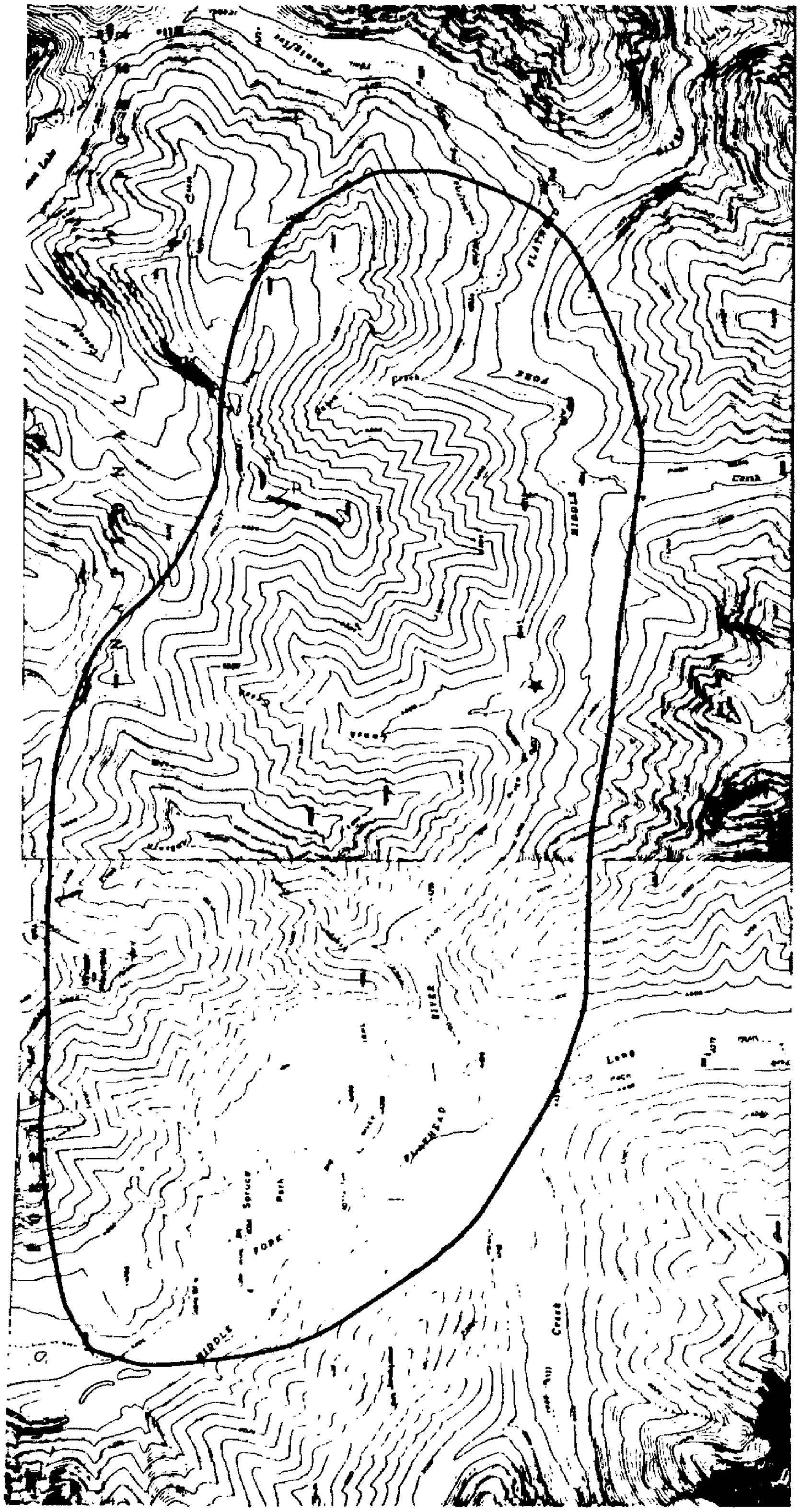


Fig. 1. Location of study area.



★ = trap location

0 0.5 1
Miles

Fig. 2. Study area.

Physiography

Elevations of the winter range extend from 4000 feet (1220 m) at the River, to 7740 feet (2360 m). Eighty percent of the range consists of slopes greater than 40%, with many interspersed cliffs. Elk tend to stay on steep south-facing slopes during winter because snow accumulation on the flat areas makes movement and foraging extremely difficult.

Glaciation substantially affected the topography of the Middle Fork Drainage, but bedrock geology consists primarily of sedimentary rocks--argillites, quartzites, and limestones. Sandstone and limestone outcroppings form the many cliffs and rocky ridges. Erosive exposures of sandstone, shale, and limestone occur throughout the study area. The River Valley bottom consists of preglacial alluvial deposits of sandstone, siltstone, and conglomerate, with some shale and lignite (USFS 1978).

Soils of the Valley bottom are shallow to moderate over alluvium and gravel; they tend to be highly permeable. "U"-shaped drainage bottoms along the Middle Fork also have shallow to moderate profiles but with a loess cap over till and colluvium. High basins have a shallow loess cap over loose till with much local fragmented rock. Valley sides are shallow, loess-influenced cobbly profiles over shallow bedrock. Subalpine cirques have a shallow loess cap over loose till, again with local rock fragments. Rocky ridges are covered with small patches of loess on sedimentary bedrock (USFS 1978).

Productivity on southerly slopes above the River is moderate, mostly because the soil is highly permeable and unable to hold moisture. Drainages of the Middle Fork are also moderately productive but are good sites for spruce species. Productivity in the high basins is moderate and controlled by short growing seasons and elevation. Valley sides, cirques, and rocky ridges all have low productivity, especially on the south and west aspects because of thin soils, high elevation, and short growing seasons (USFS 1978).

Erosion hazard is high for steep slopes, high basins, and cirques, but low to moderate for the drainage bottoms and rocky ridges.

Recent History

A major flood occurred in 1964, but probably had little effect on the winter range which is well above the River.

A moratorium on timber harvest and road construction was imposed in 1969. Beginning in 1973, the Great Bear Wilderness, which includes the study area, was studied for wilderness classification. The upper Middle Fork (from Bear Creek to the headwaters) was designated as a component of the National Wild and Scenic River System in 1976.

Until the Middle Fork was classified a Wild River, motorized travel was allowed. Snowmobile use before 1976 was already limited because trail conditions made it difficult and hazardous. Use of vehicles and horses was minimal and hiking was moderate (USFS 1978). Foot travel during winter was restricted to cross-country skis and snowshoes. People using the area during winter rarely went beyond Spruce Park, so the wintering elk herd was relatively undisturbed by human activity.

Few elk occupied the Middle Fork Drainage prior to major wild fires in 1914 and 1919 (Pengelly 1960). The close succession of these 2 major fires, on what is now the winter range, inhibited overstory development because seedlings stimulated by the first were destroyed by the second, leaving few viable cones (Smith 1978). Grasses and browse plants then invaded much of the range, providing forage for a wintering herd. Elk numbers increased until 1933 and 1935, when severe winters and range deterioration from overuse caused high winter mortality and population declines (Rognrud 1950).

Vegetation

Vegetation on the wintering area consisted primarily of coniferous forest, with seral brush fields in burned areas. Avalanche chutes were numerous on the study area and timberline habitat types were located on the highest ridges.

Forest habitat types were classified to predict the climax community by indicator species (Pfister et al. 1977). Because the seral fields lacked regeneration of coniferous trees and did not fit the Pfister et al. classification of scree, they could not be classified with the system used. Description of those brush fields was restricted to the primary browse plants and grasses present on them. Common names of plants are used in the text with scientific names presented in Appendix A.

The driest habitat type found on the study area was an isolated occurrence of a Douglas-fir/common juniper type at an elevation of 4550 feet (1385 m) on a steep (60+%) slope with avalanche chutes. Most of the junipers were hard to recognize because they had been heavily browsed by elk.

Several other Douglas-fir habitat types occurred between 4000 feet (1220 m) and 4900 feet (1495 m). The Douglas-fir/snowberry habitat type, bluebunch wheatgrass phase, represents a moderately warm and dry site. The dominant overstory species was Douglas-fir while the understory consisted primarily of snowberry, bluebunch wheatgrass, and Idaho fescue. Two phases of the Douglas-fir/blue huckleberry habitat type, the beargrass and blue huckleberry, indicated more moist and slightly cooler terrain. Overstory in both phases was predominantly Douglas-fir and lodgepole pine. Understory species in the beargrass phase were chiefly beargrass, elk sedge, heartleaf arnica, and white spiraea. The blue huckleberry phase contained

Oregon grape, buffaloberry, and bluebunch wheatgrass.

The cooler and moister extreme was represented by the subalpine fir/wood-rush habitat type, menziesia phase. This type is the major subalpine habitat type in Montana west of the Continental Divide (Pfister et al. 1977). Besides the wood-rush habitat type, 3 other subalpine fir types were present on the study area indicating several moisture and temperature regimes.

The subalpine fir/queencup beadlily habitat type was represented by 2 phases, the queencup beadlily phase, the most common in northwestern Montana according to Pfister et al. (1977) and the dwarf huckleberry phase. Along the Middle Fork, the queencup phase occurred on the low lying benches and flats which had a dense canopy cover and high moisture content. The huckleberry phase was usually located on well-drained benches with moderate overstory cover. Lodgepole pine, Douglas-fir, and subalpine fir were characteristic overstory species in both phases while the understory varied somewhat. The queencup phase was dominated by twinflower and queencup with subdominants of kinnikinnick, snowberry, blue huckleberry, and western meadowrue. The dwarf huckleberry phase was predominantly twinflower, grouse whortleberry, and beargrass but also contained some Oregon grape, white spiraea, and dwarf huckleberry.

The subalpine fir/beargrass habitat type occurred between 5000 (1525 m) and 6800 feet (2070 m) on dry sites associated with steep, well-drained slopes. Lodgepole pine was the major seral species of the habitat type below 6000 feet (1830 m); whitebark pine increased as a seral dominant with altitude above that elevation. Both phases of this habitat type were on the winter range; the blue huckleberry phase was found at lower elevations and warmer exposures than the grouse whortleberry phase.

The subalpine fir/alder habitat type was restricted to the southeast and eastern exposures of the larger drainages along the Middle Fork, such as Lunch Creek. This habitat type occurred on steep moist slopes between 5000 (1525 m) and 6000 feet (1830 m) and was usually bordered above by the subalpine fir/beargrass habitat type, grouse whortleberry phase. Several sites were classified as the subalpine fir/alder habitat type without the presence of subalpine fir on the plot, because they were adjacent to reproductive stands of that tree species. Subalpine fir and Douglas-fir were the dominant overstory species; the understory was predominantly alder, mountain gooseberry, and elk sedge.

Much of the study area was vegetated by open, seral brush fields that contained several of the more important browse species necessary to maintain the wintering elk herd. Rocky mountain maple and serviceberry were well represented throughout these open stands while shinyleaf ceanothus and, to a lesser extent, chokecherry were scattered. Common juniper occurred on rocky outcrops and very steep slopes. Several species of grasses were also used extensively because many of the lower ridges were blown free of snow much of the winter. Bluebunch wheatgrass appeared to be the major grass used by elk.

Climate

The weather along the Middle Fork is milder than it is east of the Continental Divide, but extremes range from -50°F (-45°C) to over 100°F (40°C). Mean annual precipitation at Essex, 8 miles (13 km) northwest of the study area, is 40.8 inches (103.7 cm). Much of the precipitation occurs as snow between November and April. Average annual snowfall is 210 inches (533 cm).

Temperatures during the winter of 1976-1977 were substantially higher than normal and precipitation was lower. The combination of these factors left many of the steeper slopes and ridges free of snow. Much of western Montana recorded the lowest snowpack and runoff since records were kept. Records for the winter of 1977-1978 indicated near-normal precipitation and temperatures.

CHAPTER III

METHODS AND MATERIALS

Snow Depth and Temperature Measurements

Snow depth was measured with an aluminum pole with 3-inch (7.6-cm) calibrations. Measurements were made on flat open and flat timbered sites around Spruce Park Cabin and on the steep exposed and timbered, south-facing ridges and slopes near the trap. Readings were taken after snow or rain fell on these sites using an average of 4 measurements. Measurements were also made while backtracking elk.

I attempted to correlate temperature and snow depth readings with those of weather stations near the study area to obtain accurate records for those days when I was not in the field. Precipitation was most similar to that recorded at Essex, 8 miles (14.5 km) northwest of the study area. Several months of these records were missing and those from Summit, 10 miles (18 km) northeast on the Continental Divide, were used. Summit's snow depth measurements averaged 6 inches (15.3 cm) greater than measurements I made in flat, open sites near Spruce Park Cabin. My temperature readings were usually higher than those recorded at Summit and lower than those of Hungry

Horse Dam, 40 miles (64 km) west of the study area.

Trapping

Two portable corral traps were flown into the study area by helicopter. Traps consisted of 9x6 foot (2.8x1.9 m) panels forming holding pens, chutes, and gates with tripwire closing mechanisms. Trapsites were selected because they were relatively flat and clear, but high winds, especially during late summer and early fall, extensively damaged both traps. They were repaired in October 1976, but high winds during late October again damaged both traps and 1 could not be repaired for the 1976 trapping season. This trap was reconstructed in October 1977 but was abandoned after being damaged by wind a third time.

Alfalfa hay was used as bait, and salt blocks were added at the onset of spring green-up. Trapping began in mid-January and was ended in early May to avoid the possibility of stress-caused abortions. A radio transmitter was rigged to send a constant signal when the trap door was open. When the door closed, the wires connecting the battery and transmitter were pulled apart, halting the signal. This mechanism minimized approaches to the trapsite. General condition, age, and sex of the animals that were caught were recorded. Ages were determined using techniques described by Quimby and Gaab (1957) based on tooth replacement and wear, and Greer and Yeager

(1967) based on wear on the upper canines. Examination of teeth was restricted to the upper canines and incisiforms in live animals, making accurate aging of old animals difficult.

Urine from captured cow elk was collected, chilled, and stored. Urinalysis to verify pregnancy was completed by a Missoula, Montana, pediatrician. All trapped animals were ear-tagged with 2 individually numbered Montana Fish, Wildlife and Parks Department ear tags. Collars with radio transmitters were assembled as described by Smith (1978) and placed on adult cow elk.

Rope collars with individual color patterns and pendant numbers (Craighead et al. 1969) were used on bulls and calves. These collars were highly visible at first but became less so, especially on bulls, as they aged. Two collared bulls were shot during the 1978 hunting season and in both instances the rope collars were not discovered by the hunters until after the dead animals were approached (Daneke, pers. comm.). Matted hair and dirt obscured the ropes and the colored fabric was badly worn.

No deer were trapped during the 1977 field season. Deer trapped during the 1978 field season were rope-collared and ear-tagged until handling them in the large chute proved hazardous for the animals.

Radio Tracking

An AVM LA-12 receiver, in combination with a 3-element yagi antenna and later with a collapsible telonics RA-2A antenna, was used to track elk. The extremely rugged terrain caused considerable bounce of radio signals, so precise locations could not usually be determined from the ground. Ground tracking was useful, however, to determine general locations and to identify individuals once the animals were sighted.

For aerial tracking, a Cessna 180 with 2 Telonics RA-2A antennas attached to the struts was used (Smith 1978). Tracking flights made by Smith during November and May, when elk were moving to and from the winter range, were most essential. Severe weather during December through April often precluded flying, but elk were concentrated on the winter range during that time so the necessary tracking and observations could be accomplished from the ground.

Visual Observations

Observations of elk were made from January through May of the 1977 and 1978 field seasons using 7x21 binoculars and a 15-60 variable power telescope. Time spent observing an individual or group varied between a few minutes and 3 hours depending on weather, time of day, individual behavior, and movements. Numbers seen, aspect, elevation, distance to cover, and weather conditions were recorded. Apparent activities of the animals were also noted on an elk observation form to define feeding and bedding sites (Appendix B). All locations were plotted on 1:24,000 USGS topographic maps. These maps provided more accurate information on slope, topographic configuration, and distance from trails than did field estimates. Configurations were recorded as straight, concave, or convex, in most cases straight being slopes located between ridges and draws, concave associated with draws or drainages, and convex with ridge apices.

Unnecessary disturbance of the elk was avoided to minimize stress. Occasionally, animals that were disturbed along the River would attempt to cross deep snow on steep north-facing slopes, greatly increasing energy demands.

Population Estimates

The Lincoln Index was used as a censusing tool to estimate the number of elk on the Middle Fork of the Flathead River winter range. This technique was first described by Schnabel (1938) and later modified by Chapman (1952). The capture-recapture method involved visual observations of elk from the ground, noting the total number of animals seen along with the number of collared animals seen.

Beall (1974) described the following formula used to estimate population number:

$$x = a(n+1) / (r+1)$$

Where: x = population estimate

a = number tagged in population

n = the number seen

r = number tagged seen

Browse Surveys

An adaption of the "closest plant" sampling technique (USFS 1963) was used for browse surveys. This method involved selecting a random starting point and the closest key browse plant to that point. The transect was then run using that plant as the first plant in that survey. The next closest key browse plant in an arc of 180° was then selected and so on until 50 plants were sampled, excluding those browse plants that were dead or unavailable to the wintering elk (form classes 7 and 8). To avoid biases that might be introduced by running a transect in areas that receive little use because of inaccessability during winter or of high productivity, such as gullies and benches, transects were run parallel to the River. Thus transects crossed gradients, taking them into account without adding significant biases.

Browse survey forms supplied by the Montana Department of Fish, Wildlife and Parks were used to record data (Appendix C). Form class, age class, and percent leader use were recorded.

Percent leader use was an estimate of the ratio of browsed twigs versus total twigs available. All the leaders of several plants for each of the key species were counted during the first few transects and an actual percent leader use was determined to establish a visual picture of the different leader use categories used in this study.

Although utilization determined by a visual estimate of the twigs browsed may not be as accurate an assessment of use as actual measurement methods, it does furnish information accurate enough to provide an overview of browsing pressure (Patton and Hall 1966, Stickney 1966). Stickney found a high correlation between the number of twigs browsed and percent linear utilization of twigs for chokecherry and serviceberry at 55% and 60% use levels, respectively. Similar results were reported by Hemmer (1975) in his study of serviceberry in Montana. Fuller (1976) determined utilization levels of rocky mountain maple and serviceberry by both visual estimates and direct measurements on the Spotted Bear Mountain winter range and found actual measurements more accurate.

Use, as determined by the ratio of the number of browsed twigs to total numbers of twigs, required more samples for the same degree of precision than measurements before and after browsing. Stickney (1966) counted the number of browsed twigs in twig clusters that consisted of 10-20 stems of current annual growth (CAG) on each selected plant in his study. He determined that a minimum of 100 twig clusters were required for serviceberry to make estimates of length utilization within 10% of the mean at the 95% confidence level. Even so, he believed that sampling time could be cut roughly in half using the ratio of browsed twigs to total number of twigs method.

By doing the browse surveys using the visual leader use method, I was able to sample a greater number of the key browse species and more of the winter range than by any of the direct measurement methods.

Form classes were determined according to Cole (1958). A plant was considered all available if it was under 7 feet (2.1 m) tall; plants over that height were deemed partly available. Lower branches and small plants may have been inaccessible during part of the winter because of snow cover, but observation of elk indicated that the animals were present on the winter range before snow accumulated in early winter and after much of the snow had melted in early spring.

Plants with stem diameters up to and including 0.25 inches (0.64 cm) were classified as young plants. Those with diameters over 0.25 inches (0.64 cm) were tabulated in the mature category while living plants with 25% or more of their crown area dead were classed as decadent (USFS 1963).

CHAPTER IV

RESULTS AND DISCUSSION

Weather

A winter severity index (Peek et al. 1976) was used by Fuller (1976) for analyzing weather data from Hungry Horse Dam. This index was based on the temperatures and precipitation during December through March, with high index numbers indicating relatively severe weather. Fuller computed a 28-year mean of 89.2 for Hungry Horse Dam.

Smith (1978) calculated a winter severity index value of 19.3, a very low value, for the 1976-77 winter. Snow accumulation never exceeded 39 inches (99 cm) on flat open sites. A warm, dry period during February, with temperatures reaching 50°F (10°C), reduced snow cover to 15 inches (38 cm) on open and forested benches, flats, and eastern exposures. Most southern aspects and exposed ridges were snow-free up to an elevation of 6000 feet (1830 m) by the end of February. During March, the deepest snow accumulation measured was 23 inches (58 cm) on 9 March. Snow depth on the southern aspects of ridges never exceeded 11 inches (28 cm). Temperatures warmed to 52°F (11°C) on 21 March, and occasional rain showers rapidly reduced snow cover throughout the winter range. Daytime high temperatures were above freezing throughout April, averaging over 49°F (9.5°C). By mid-month, the only snow remaining was in steep draws, dense timber stands, and on open slopes above 6500 feet (1980 m).

I calculated a winter severity index value of 105.4 for the winter of 1977-78. This value is slightly above average but certainly would not indicate an exceptionally severe winter for the Middle Fork winter range. Maximum snow depths reached 69 inches (175 cm) during the early part of February. Snow accumulation on the southern aspects of ridges exposed to wind action rarely exceeded 10 inches (25.4 cm) while southern open slopes that had straight configurations (versus concave) had up to 24 inches (61 cm) of snow. Fourteen days with highs above freezing were recorded during February, 9 of them occurring consecutively from 18 through 26 February. The first 3 days of March were the coldest during the study with a low of -22°F (-30°C) recorded. Highs between 33 and 62°F (0.5 and 17°C) then occurred between 5 and 31 March with only 1 day of subfreezing high temperature. Snow was reduced to 33 inches (83 cm) in timbered areas and very little remained on exposed ridges below 6000 feet (1828 m) by the end of the month. As in 1977, April highs were all above freezing and lows averaged near 31°F (-0.5°C).

Severity varied between the 1976-77 and 1977-78 winters. Beall (1974) noted year-to-year changes in elk movements and habitat use related to weather, this was also true for elk wintering along the Middle Fork of the Flathead River.

Snow Avalanches

Because much of the winter range consisted of steep slopes, heavy snow accumulation at higher elevations caused avalanches. During the first winter of the study, avalanche danger was slight although several small slides occurred.

During February and March of 1978, avalanche paths were frequently seen near trail 155 (Fig. 3). Many of these avalanches were large enough to endanger elk caught in their paths. No avalanche-related fatalities were directly observed during either winter, but scattered bones of an elk were found during July 1978 on a site where an avalanche had occurred the previous February. When the avalanche path was first seen during the winter, tufts of elk hair were noted, implying an avalanche-related death.

Trapping and Marking

Because of the mild winter during the first field season, few elk were caught. Snow cover was light and many of the ridges and windswept slopes were free of snow for much of the winter. Most of the elk remained on upper ridges far above the trap. After the alfalfa bait was spread 500-800 vertical feet (150-245 m) above the trap, some elk were caught. Attraction to the alfalfa was probably lowered

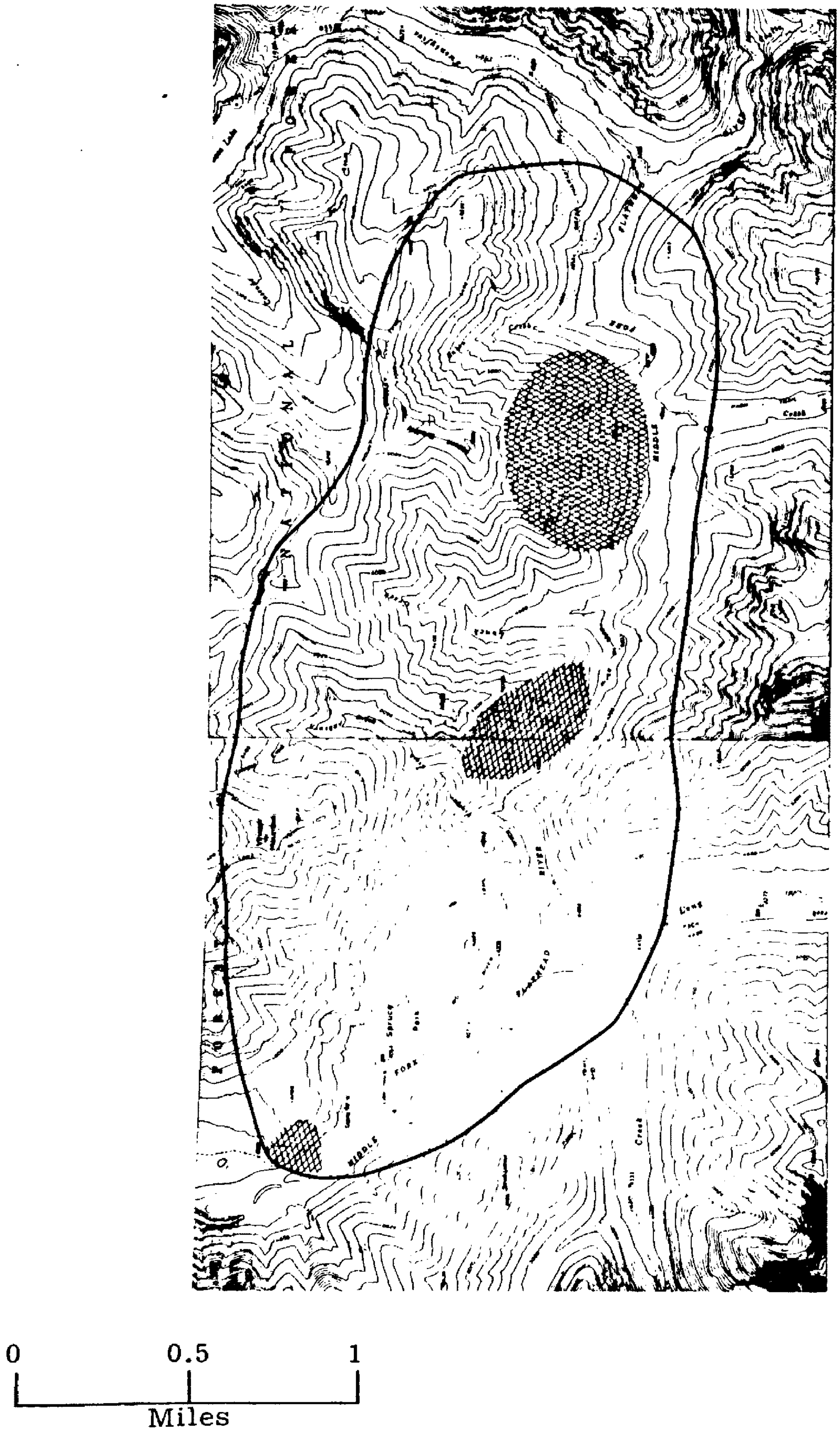


Fig. 3. Areas of frequent snow avalanches.

because of the availability of natural vegetation throughout the winter range. Salt blocks might have been more effective had they been placed on the trapsite the spring before the trap was built. Trapping began in mid-January 1977, but the first elk was not caught until 20 March. Including a bull found entangled in old telephone wire and released, 9 elk were marked and released during the 1977 field season. Five radio collars were placed on cows and 3 rope collars on calves (Smith 1978).

During the 1978 trapping season, the study area had colder temperatures and received more snow than during the previous winter. Contrary to the previous year, deer were seen on the winter range and were attracted to the alfalfa bait. Nearly as many deer were trapped as elk. On those days when deer were captured, elk tracks and pellet groups indicated elk would probably have been trapped if the deer had not entered the trap first. On 2 occasions, elk stepped on the trip wire and broke it but the trap door failed to close.

Only 7 elk were successfully collared--3 cows were fitted with radio transmitters, 3 calves and 1 spike bull were rope-collared (Daneke 1980). During the same period, 3 deer were rope-collared and ear-tagged before we decided to release deer without collaring them (Appendix D). Several elk and 1 deer jumped out of the trap because 2.5-3 feet (75-90 cm) of hard packed snow had accumulated inside the trap. A trench 4 feet (1.2 m) wide was dug along the interior wall of the trap to prevent animals from jumping.

On 13 February 1978, the first elk of the season were captured--6 calves, 1 cow, and 1 spike bull. To facilitate handling, the cow and spike were immobilized with 18 mg of sucostrin. The cow was released too soon after she became mobile and collapsed, sliding more than 300 yards (275 m) down to the River. She was killed. The spike was held in the trap for 50 minutes after he became mobile and was then released. Close observation of this animal as he traveled up the slope indicated that he should have been held in the trap for an additional 15 minutes after he became mobile. The spike appeared slightly unsteady on his feet but did ascend over 1000 vertical feet (305 m) before disappearing from sight. Several factors contributed to the death of the cow. She should have been held in the trap longer, the trap was situated on a knoll that had slopes greater than 50% surrounding it, and the top crust prevented her from being cradled in the snow after she fell.

Urinalysis failed to verify pregnancy in cows caught after February. The test reveals high levels of gonadotrophic hormone in female urine. Hormone levels are reduced during late pregnancy in humans and apparently the same is true of elk. An attempt was made to determine pregnancy in elk using a portable electronic stethoscope to hear fetal heart beats. This method works well in humans after

9 weeks of pregnancy but failed with elk because of static caused by hair on the abdomen.

Mortality

Winter 1977

During the 1977 field season, no dead elk were found on the winter range. All animals observed during that season appeared healthy with no obvious signs of malnutrition.

Winter 1978

Three elk carcasses were located during 1978. One dead elk was seen across the Middle Fork about 25 yards (23 m) from the River's edge among spruce and cottonwood trees. At first observation, a mountain lion (Felis concolor) was feeding on the carcass. I was unable to reach the area to necropsy the elk and determine the cause of death. The animal appeared larger than a calf and, because the death occurred on or before 12 January, malnutrition probably was not a factor leading to its death. The mountain lion may have killed the elk.

A second carcass found along the lower Lunch Creek Drainage, on 16 January 1978, was that of a 6- to 8-year-old cow. Although a kidney fat index was not taken, much fat was present around the kidneys and along the back. A femur marrow compression test (Greer 1968) resulted in no compression of the whitish-pink, dry flaky marrow.

Rumen contents were mostly grasses, Rocky Mountain maple, and serviceberry. Lung, liver and intestinal tissue appeared normal with no signs of infection or disease. The uterus and ovaries had been removed by scavengers so reproductive activity could not be determined. Numerous bruises were found on the back and neck above the shoulder and on top of and inside the right hindquarter. At least 3 separate coyote (Canis latrans) tracks could be distinguished around the site. A trail indicating the elk had slid from a bench 15 yards (14 m) above was followed. Snow covered her tracks to the point where she had fallen and if any predator tracks were mixed in with the elk's, they could not be distinguished. USFS telephone wire was laying about and could possibly have obstructed the animal. The bruises indicated that predators had injured her before death, but because of scavenger activity, cause of death could not be determined.

On 6 March, the carcass of an elk was seen along the River 500 yards (455 m) east of the trap. Elk had been observed on the slope above that site on 5 March, and the dead animal may have been associated with that herd. The carcass was examined on 7 March. Tooth wear on the lower jaw indicated an age of 12+ years. Back and kidney fat was lacking and the full rumen contained mostly common juniper. A femur marrow compression test revealed greater than 40% compression. The marrow did not fill the marrow cavity, and was gelatinous and nearly translucent. Lung tissue indicated pneumonia along the outer edge of the lung, flukes were found in the small dark liver, and the kidneys were a greenish color, except for small portions in the centers. No puncture wounds were found in the hide, but several ribs on the right side along with the clavicle were broken. Hemorrhages in those areas indicated that injuries occurred just prior to death. The animal had slid over 200 yards (185 m) from the slope above which had an incline of over 60%. The slide trail began in exposed, loose shale. This animal apparently slipped and, because of its weakened condition, was unable to recover its balance or regain its feet.

Femur marrow of the collared cow that had fallen after being released on 13 February 1978, was whitish-pink, flaky, and had 0% compression. Kidney and back fat was good and she generally appeared to be in excellent health. The majority of the rumen contained the alfalfa used as bait. She was not pregnant at the time.

Finding no dead elk during the winter of 1977 and only a few in 1978 can be attributed, in part, to the mild winter of 1977 and a warming trend in March 1978, when maximum temperatures reached 62°F (17°C). The warm weather exposed previously inaccessible browse and grasses. Elk observed throughout 1977 showed no obvious signs of malnutrition. During late March and April 1978, some animals exhibited evidence of undernourishment. Nearly a third of the animals seen during that period had rough and straggly hair. The ribs and hip bones were prominent on many of these elk.

Summer 1978

On 13 June 1978, the carcass of a 3-year-old female was located along the Morrison Creek Trail (154), 0.5 mile (0.9 km) northwest of Crescent Creek (Fig. 3). Numerous puncture wounds in the neck and left side, associated with hemorrhaging and broken ribs, indicated death by predation. Though the uterus and many of its associated parts had been scavenged, 1 ovary remained. The ovary contained a reddish-orange corpus albicantia 0.24 to 0.28 inches (6-7 mm) in diameter. No obvious degeneration had taken place and I assumed the size was indicative of the original luteum during later pregnancy. According to Morrison (1965), a corpus this size is evidence of a secondary corpus that would occur during pregnancy. Further examination of the carcass had to be abandoned because a grizzly bear (*Ursus arctos*) approached the kill. Numerous grizzly tracks and several scats were noted in the vicinity of the carcass. The injuries sustained by the elk reasonably infer that she was killed by a grizzly (Jonkel, pers. comm.). Elk usually calve during late May or early June. Presumably, this one had already dropped her calf, but no signs of a calf or its remains were found in the area.

Mountain lions and grizzly bears kill elk in some areas of the northern Rocky Mountains (Hornocker 1970, Cole 1972). Biggins (1975) documented 1 instance of each on the Spotted Bear winter range, and also reported that some elk calves were killed by coyotes during adverse snow conditions. Schlegal (1976) found black bears (Ursus americanus) responsible for extensive predation on elk calves in Idaho. Although all 4 types of predator kills may have occurred on or near the Middle Fork winter range, I think they have only a minor effect on the elk population.

Hunter-Caused Deaths

During the 1978 hunting season, 2 rope-collared bulls were shot, both along the upper end of Lynx Creek approximately 2 miles (3.6 km) north of the winter range. Apparently both animals were in good health (Daneke, pers. comm.); both had been collared as calves, No. 51 in 1977 and No. 43 in 1978.

Visual Observations

Elevational and Configurational Use

Table 1 lists monthly average elevations and standard deviations of elk groups obtained from observational data. Group sizes ranged from 1 to 33 animals. An analysis of variance indicates no significant difference in mean monthly use by elevation, at the 5% confidence level, during 1977. Significant differences in monthly averages during 1978 and between the 2 winters were noted. These differences occurred primarily during the month of April in interyear comparisons, and February versus March and January, and March versus April during 1978.

Table 1. Mean monthly elevation and standard deviation in feet (m) of elk sightings.

Month/Year*	No. of groups observed	Mean elevation	Standard deviation
February/1977	7	5385 (1641)	261 (78)
March/1977	14	5244 (1598)	594 (181)
April/1977	19	5721 (1744)	658 (201)
January/1978	7	4900 (1494)	624 (190)
February/1978	16	5418 (1651)	918 (280)
March/1978	21	4720 (1438)	406 (124)
April/1978	26	5173 (1577)	496 (151)

*Records for January and a portion of February 1977 were destroyed.

In spite of the difference in snow depths during the 2 years of study, little statistical difference exists in monthly means during February and March 1977 and their respective months in 1978. This observation appears to be the result of a horizontal habitat use difference rather than a vertical use difference. Many group observations in 1978 were nearly identical to 1977 sightings elevationally, but they shifted from 15 to 300 yards (14 to 275 m) horizontally. During 1978, exposed southern-aspect ridges were used most frequently. Snow was usually less than 10 inches (25 cm) deep and, in many instances the ridges were snow-free. Often a shift to either side of the ridge apex resulted in an increased snow depth of up to 3.5 feet (107 m).

During 1977, 78% of the observations were recorded on either straight (44%) or concave (34%) slopes during February and March. During the same months in 1978, 40% of the observations were recorded in these 2 categories with concave making up only 9% of the total.

Average use in April was at elevations of 5721 (1743) and 5173 feet (1577 m) during 1977 and 1978, respectively. This difference probably resulted from differences in snow depths between the 2 years. Use of drainage bottoms and draws was high in 1978 when melting snow exposed previously unavailable forage. However, the previous year these same areas had been used by elk during the preceding 2 months, and their foraging activities shifted to higher elevation, open slopes in April.

Snow depth during 1978 was greatest during February. Nearly 64% of the elk sighted during that period were on or near ridges. Movement along drainage bottoms was greatly restricted because of snow accumulation. January and March observations indicated a more evenly distributed use of concave, convex, and straight configurations.

As snow accumulation increased, the animals shifted their activities to ridges. Because ridge apices were steep between 4600 and 6500 feet (1402 and 1981 m), allowing snow to blow off, the elk foraged and bedded between these elevations. This altitudinal dispersion resulted in use of higher elevations during February than in January and March 1978. Apparently, snow depth in January had not reached the point where movement in lower draws and drainage bottoms was as restricted as in February. During March, snow began melting and those areas were again available for intensive browsing.

As snow melt increased in April, feeding frequently occurred on sites with concave configurations. Fifty eight percent of April's sightings were in draws and drainages. An upward shift occurred between March and April from 4720 (1438) to 5173 feet (1576 m), respectively.

Bedding Locations

Most daybeds were located by direct observations of elk and were therefore biased towards open areas and sites along the fringes of timber stands. Benches, knolls, and small mid-slope depressions were the most frequent topographic features associated with daybeds. Open sites exposed to direct sunlight were most often used during clear, cold weather. The only observable preferences for timbered sites occurred when winds exceeded an estimated 15 miles per hour (21 km/hr) with daytime temperatures below 25°F (-4°C).

Nightbeds were located by backtracking elk that had been seen during the morning. Observations of these bedding sites were restricted to elevations below 5800 feet (1768 m). Higher altitudes were difficult to reach during 1 day excursions. I did not find enough beds to determine an aspect preference. Beds were located most frequently in timber where canopy coverage was greater than 50%. Snow depth did not appear to affect selection of nightbeds. Beds were found during the same day on eastern exposures in snow depths of over 4 feet (1.2 m) and on western exposures in snow depths of 19 inches (48 cm).

Animals Located South of the Middle Fork

Between mid-January and the first of May 1977, the only elk seen south of the Middle Fork River was a group of 22 animals that I had scared from the north side. Where these animals crossed the River, numerous tracks indicated they had been crossing to the south side of the River for some time before. This occurred in mid-April when snow depth was greatly reduced. Prior to this, occasional tracks indicated elk had moved back and forth across the River.

During the 1978 winter, 1 cow stayed along the southern bank of the River for 3 consecutive days where snow depths appeared to be between 3 and 4 feet (91 and 122 cm). She was feeding on willows that formed a narrow rectangular patch along the bank, probably the reason she remained there. A group of 4 elk (3 cows and 1 calf) were seen browsing on willows on a group of small islands about 0.25 miles (0.45 km) down-river from Spruce Park Cabin. These animals were probably part of a small group that wintered northwest of the Cabin on the north side of the River. As in 1977, tracks indicated that elk did cross the River occasionally throughout the winter.

Fidelity to the Wintering Ground

During the course of the second winter, all 5 radio-collared elk from the previous winter were relocated. During a tracking flight in mid-May 1978, all 8 instrumented animals were located on the wintering grounds.

Only 1 rope-collared cow from 1977 was relocated during the 1978 winter. Of the 3 other animals rope-collared in 1977, 1 bull collared as a calf was shot during the 1978 hunting season, confirming his retention of the collar. The large adult bull, collared after he was cut loose from old telephone wire, may not have retained the collar. During the collaring process, there was insufficient time to attach the rope ends properly. The third animal, a female calf at the time of collaring was never relocated.

Winter Sex and Age Ratios

Table 2 presents the sex and age ratios observed during 1977 and 1978. Both field seasons began in January and ended in late May.

These numbers represent only a small portion of the observations made during both field seasons because many animals were unclassified. The lower number of animals classified in 1977 reflects the loss of January/February records and increased dispersion on the winter range because of the mild weather. Cow and calf elk were classified only after careful examination with a 15-60 variable power telescope; bulls were much more easily classified, making ratio comparisons to cows higher than actually seen.

Table 2. Summary of winter composition counts.

Year	Cows	Calves	Spike bulls	Branch-antlered bulls	Total	Calves: 100 cows	Branch-antlered bulls:100 cows
1977	74	35	7	23	139	47.3	31.1
1978	321	154	47	16	538	48.0	5.0

A large discrepancy existed between the cow:calf ratios shown on this table and those obtained by personnel of the Montana Department of Fish, Wildlife and Parks during spring composition counts. Their counts were 19 and 23 calves per 100 cows for 1977 and 1978, respectively (Cross, pers. comm.). Simmons (1974) noted similar differences, although not as great, when comparing his ground counts to the Department's helicopter counts. He wrote that "On such flights it is often impossible to make a careful examination of every animal, and it is probable that some of the larger calves were classed as cows." This is probably true on the Middle Fork winter range, especially when considering the extreme ruggedness of the topography. Another more probable source of discrepancy between my ground counts and the aerial counts was that access on the ground was extremely limited. Many of my observations were restricted to open slopes and fringes of timber stands that could be seen from vantage points on the Big River Trail. Peek and Lovaas (1968) reported differential distribution of elk by both sex and age on a Montana winter range. Possibly, I saw a greater percentage of cow/calf groups because the areas I observed most frequently were those used by such groups. Aerial surveys include a much greater portion of the winter area than can be seen from the ground.

Montana Department of Fish, Wildlife and Parks aerial surveys may be biased downward because the flights take place only once at the end of winter when cows and calves are least distinguishable (Lovaas et al. 1966).

Records indicate that the calf:cow ratios for the Middle and South Fork winter ranges have been consistently classed as poor with a 16-year average from 1958 to 1973 of 25:100 (Weckwerth and Cross 1973). Counts along the Middle Fork winter range from 1971 to 1978 averaged 18:100 with extremes of 3:100 in 1975 and 29:100 in 1971.

Biggins (1975) noted a drop in calf:cow ratios between January and April 1975 on the Spotted Bear winter range and attributed it to the severity of the winter. He stated, "In May, calf composition of the classified 'winter kills' reached 31.2 percent . . . ." During both field seasons on the Middle Fork winter range, no dead calves were found. This, coupled with the fact that no decrease occurred in calf:cow ratios between January-February counts and April-May counts in 1978, indicated high calf survival.

The difference between the branch-antlered bull composition between the 2 years can, in part, be attributed to a group of 6 bulls, 4 adults and 2 spikes, that were located on the winter range in 1977. These animals were seen on 3 separate occasions and make up a total of 53% of the branch-antlered bull observations.

A number of authors have determined that differential habitat use exists between adult bulls and other elk. These animals tend to select more densely forested areas (Marcus 1975) and to winter in high remote areas away from the herd (Murie 1951, Anderson 1958).

Population Estimates

During the 2 years of study, 16 animals were collared with either radio collars (8) or rope collars (8). Of the 9 animals collared in 1977, 6 were relocated on the winter range in 1978. One was known to have been shot during the 1978 hunting season, and 2 were not accounted for. Because collar losses in elk average over 7% per year

(Craighead et al. 1969), I assumed that one of the 1977 animals had lost its collar.

At the beginning of the 1978 winter, I assumed the population contained 8 marked animals. This number increased to 15 as new animals were caught, tagged, and released. Beall (1974) also indicated that larger sample sizes should most closely represent the population and each sample should be weighted "by dividing the sample size by the sum of all samples." The final population estimate is the accumulated sum of the individual estimates times the corresponding weighted values, divided by the sum of the weighted values.

During the course of the 1978 winter, I had 3 samples to obtain a weighted mean from. These samples consisted of elk sightings when 8, 13, and 15 tagged animals were assumed to be in the population. My population estimates ranged from 184 to 270 animals on the wintering grounds in 1978 with a weighted average of 233. My largest sample contained 169 sightings including 10 collared elk with an assumed total of 15 tagged animals in the population. Using these numbers, the population estimate was 232 elk.

These estimates should only be considered as rough guides to the numbers of animals present. Beall (1974) stated that a number of assumptions may not be met as far as random mixing of marked and non-marked animals is concerned; intermixing of the male with the female component of the population may not occur freely. A lack of intermixing of adult bulls with cow or cow/calf groups was apparent. Although bulls were occasionally seen with cows, they were usually seen individually or in bull groups. Tracks and sightings also indicated that adult bulls spent much more time in timbered areas than cows, calves, and spikes.

Migration

Seasonal migrations during 1977 were described by Smith (1978). All radio-collared elk had left the winter range by the second week of May. Smith noted that this was at least a week earlier than indicated by other studies of western Montana and northern Idaho elk herds. This early migration was probably a result of the mild winter rather than a unique aspect of the Middle Fork elk herds. During 1978, all radio-collared elk were located on the wintering grounds in mid-May. Apparently, migrational movements did not begin until the last week of May. Grkovic (1976) reported that spring elk migrations from Idaho to summering areas in Montana coincided with snow-melt and green-up. Although the winter range was relatively snow-free by the first of May in 1978, the spring migration routes described by Smith were still snowbound.

All 5 elk instrumented in 1977 were on or near the wintering area by 1 December 1977. Four of the 5 radio-collared animals were directly across the River from the winter range by the first week of

November. The animal that was not in the area during the early part of November may have been delayed by hunting pressure. Her summer range was in an area that had a logging road between it and the winter range (Smith 1978). This access road received frequent hunter vehicle use in 1977. During 1978, checking station data documented heavy hunter use of this road (Daneke, pers. comm.).

Hunting on the Winter Range

During the 1977 and 1978 hunting seasons, only 1 legal outfitter's camp was located on the winter range. This camp was located directly below the trapsite and was used by only a small number of hunters both years. The outfitter indicated the camp normally was used by more hunters but an ownership change was in progress and normal camp use would resume in 1979. Daneke (1980) established a game checking station along Highway 2 at the Big River Trail entrance, his preliminary findings indicated that hunting on the winter range was moderate.

Biases

A number of biases were associated with observations, and elk movements may have been altered somewhat by our activities on the wintering grounds. During both field seasons, travel along the Big River Trail (155) east of the trapping site was avoided to reduce elk disturbance in the vicinity of the trap. Because trapping success was low, we hoped the animals would remain near the trap and be lured to the alfalfa bait. A large number of elk spent much of the winter between the trapping site and Cabin Creek to the east.

Though a large portion of the wintering ground was visible from vantage points along trail 155, certain areas could not be seen. Pellet group counts were used to confirm use by elk on those sites, but specific movement patterns and activities could not be described. Most of the observations took place between 0830 and 1500 to allow for travel to and from the wintering area during daylight hours.

Travel by snowmobile between Spruce Park Cabin and Vinegar Creek, and daily cross-country ski use of the trail beyond Vinegar Creek probably altered elk use near the trail. Elk were seen on or near the trail more frequently after the trail had not been used for several consecutive days.

Observations were restricted during adverse weather. Heavy snow or rain and fog occasionally reduced visibility, making the animals difficult to see. Observational records for January and part of February 1977 were destroyed in a house fire.

Browse

"A key browse species should be one of the most important big-game foods on a range" (USFS 1963). I selected Rocky Mountain maple and serviceberry as the key species because of their relative abundance, nutritional value, and utilization (Julander 1937, Asherin

1974), although several other browse species were present.

Rocky Mountain maple varies in size at maturity from a shrub to a small tree 7-30 feet (2.1-9.2 m) tall. It grows along mountain streams, on mountain slopes, and in most canyons and flats among trees such as Douglas-fir, aspen, western larch, and ponderosa pine (USDA 1937, Marks 1963). Montana Department of Fish, Wildlife and Parks personnel consider maple an important browse plant in District 1, the northern part of District 2, and the western portion of District 4 (Lonner 1972). This plant's ability to resprout from root crowns after a fire (Lyon and Stickney 1974) and its tolerance of heavy browsing (Aldous 1952) explain, in part, its co-dominance with serviceberry on the Middle Fork winter range.

Serviceberry grows as a low shrub to small tree, 3-20 feet (1-6.1 m) tall. It grows under environmental conditions varying from dry, rocky slopes in full sunlight to moist, deep, and fertile soil in aspen and lodgepole pine stands. Because of its wide distribution and palatability, it is among the most valuable browse plants (USDA 1937, Lonner 1972, Hemmer 1975). Like Rocky Mountain maple, its ability to resprout from root crowns after fire (Asherin 1974) and withstand heavy browsing (Young and Payne 1948, Shepherd 1971) contribute to its co-dominance role.

Other browse species occurring throughout the winter range were shinyleaf ceanothus, pachistima, common juniper, creeping juniper, chokecherry, and willow. Although some of these species were heavily browsed by elk, their relatively low abundance on the winter range prevented them from being considered key species.

My surveys in 1977 included leader use estimates of 447 Rocky Mountain maple and 553 serviceberry. In 1978, the numbers of plants were 715 and 785 respectively. Periodic checks throughout the surveys indicated that leader use estimates I made were placed in the correct category more than 90% of the time. Plants in the 0%, 5%, and 25% groupings were the most accurately judged while those placed in either the 50% or 70% use categories were more frequently misjudged.

I did not calculate actual densities of Rocky Mountain maple and serviceberry. Both species were moderately abundant (Hemmer 1975). The ratio of serviceberry to Rocky Mountain maple was approximately 1.15:1.0.

Transect Results

Twenty browse surveys involving 50 plants of the 2 key species each (excluding form classes 7 and 8) were completed during May 1977. During 1978, 30 transects were established and surveys completed. Results of the 2 years are summarized in Tables 3, 4, and 5. The data presented here were used to make all of the following comparisons, computations, and conclusions unless stated otherwise.

Table 3. Summary of 1977 and 1978 browse surveys, percent leader use.

Percent leader use	Serviceberry		Rocky Mountain maple		Combined	
	Number	Percent	Number	Percent	Number	Percent
			1977			
0	49	8.86	13	2.91	62	6.20
5	33	5.97	14	3.13	47	4.70
25	60	10.85	39	8.72	99	9.90
50	140	25.31	123	27.52	263	26.30
70	178	32.19	105	23.49	283	28.30
90	93	16.82	153	34.23	246	24.60
Total	553	100.00	447	100.00	1000	100.00
			1978			
0	100	12.74	15	2.10	115	7.67
5	79	10.06	43	6.01	122	8.12
25	70	8.92	36	5.04	106	7.07
50	122	15.54	119	16.64	241	16.07
70	244	31.08	191	26.71	435	29.00
90	170	21.66	311	43.50	481	32.07
Total	785	100.00	715	100.00	1500	100.00

Table 4. Summary of 1977 and 1978 browse surveys, form class.

Form class	Serviceberry		Rocky Mountain maple		Combined	
	Number	Percent	Number	Percent	Number	Percent
			1977			
1	122	22.06	31	6.93	153	15.30
2	219	39.60	149	33.33	368	36.80
3	195	35.26	258	57.72	453	45.30
4	14	2.53	7	1.57	21	2.10
5	3	0.55	2	0.45	5	0.50
Total	553	100.00	447	100.00	1000	100.00
			1978			
1	209	26.62	73	10.21	282	18.80
2	281	35.80	209	29.23	490	32.67
3	275	35.03	419	58.60	694	46.27
4	8	1.02	9	1.26	17	1.13
5	12	1.53	5	0.70	17	1.13
Total	785	100.00	715	100.00	1500	100.00

Table 5. Summary of 1977 and 1978 browse surveys, age class.

Age class	Serviceberry		Rocky Mountain maple		Combined	
	Number	Percent	Number	Percent	Number	Percent
			1977			
Young	107	19.35	28	6.26	135	13.50
Mature	265	47.92	197	44.07	462	46.20
Decadent	181	32.73	222	49.67	403	40.30
Total	553	100.00	447	100.00	1000	100.00
			1978			
Young	164	20.89	57	7.97	221	14.73
Mature	405	51.59	318	44.48	723	48.20
Decadent	216	27.52	340	47.55	556	37.07
Total	785	100.00	715	100.00	1500	100.00

Vigor of serviceberry and Rocky Mountain maple was low; plants rarely exceeded 4 feet (1.2 m) in height and were moderately to heavily clubbed (Cole 1958). Plants that exceeded 7 feet (2.1 m) in height, placing them in form classes 4, 5, or 6, occurred in drainage bottoms where snow accumulation rendered them inaccessible to elk during most of the winter. Many of these plants had their lower stems browsed to varying degrees, indicating they were partly available in either early winter or spring.

Chi-square results indicate that, at the 95% confidence level, the transects run in 1977 and those in 1978 are representative of the same population when comparing intraspecific age classes in inter-specific plant ratios.

Utilization

Utilization was calculated by both mean and median estimates for the 2 species separately, and combined for each year. The median appears to be the more accurate of the 2, yet this estimate is probably low. Of those plants tabulated in the 0% and 5% leader use categories, 80% were also classified as young plants. These plants were usually less than 1 foot (30 cm) in height and composed a relatively small portion of the available CAG on the winter range.

Chi-square test results showed a significant difference in utilization levels of serviceberry and Rocky Mountain maple. The latter had higher utilization during both winters (59.2% vs 66.6% in 1977 and 61.7% vs 75.1% in 1978). Fuller (1976) obtained similar results for the Spotted Bear Mountain winter range, 40 miles (64 km) west of the study area. She suggested that the "Differential use could indicate greater preference for mountain maple by elk or it might reflect more favorable micro-habitat location of mountain maple in winter." On the Middle Fork winter range, Rocky Mountain maple was preferred even in areas where the 2 species were well interspersed with each other. However, the increased utilization of Rocky Mountain maple during the 1977-78 winter may reflect a micro-habitat difference between it and serviceberry. More snow fell during 1978 than in 1977 and remained on the ground longer. Movements of elk were more restricted and feeding took place with greater frequency and intensity on sites where mountain maple predominated over serviceberry.

Utilization, as estimated by the median for both species combined, was 61.2% for the first winter and 67.6% the second. A Chi-square value of 60.93 was calculated when comparing these 2 years of data, indicating a significant difference in utilization at the 0.05 confidence level. The percentage of plants in the different leader use categories shifted. Fewer plants were in the 0% and 5% categories during the first winter, probably because of the reduced snowfall and accumulation exposing them to potential browsing for a longer period of time.

During the 1977-78 winter, use of both plant species increased substantially at the 90% level of leader use. Apparently, this increase was correlated with a reduction in the 50% category. I could not determine whether this shift was a result of more intense feeding on some of those plants that had had 50% leader use the previous year or if it reflected an overall change in those plants in the 25-90% categories.

The differential use that the 2 key browse species received during the winters of this study was, in part, caused by the availability of forage. During the mild winter of 1976-77, a large area was accessible to the elk, and alternate species of forage, such as bluebunch wheatgrass, were available.

Form Classes

Chi-square values calculated intraspecifically for both years indicated no change in the form class (see Appendix C for description of form classes) composition in Rocky Mountain maple (x^2 = 5.3) but a slight change for serviceberry (x^2 = 11.3) at the 0.05 confidence level and 4 degrees of freedom. These calculations were done using each of the individual categories compared year-to-year. The most significant change for serviceberry occurred in form classes 4 and 5, which contained relatively few individuals. When these 2 groups were combined into 1 (partly available), no significant change occurred during the 2 years (x^2 = 4.3). No plants were classified as form class 6 during this study, although they probably do occur on the winter range.

Age Classes

Age classes did not change significantly from year-to-year for the 2 species. No plants were classified as seedlings because most, if not all, reproduction on the Middle Fork winter range resulted from root crown development and tillering. Hemmer (1975) stated that 80-95% of reproduction in unbrowsed or lightly browsed serviceberry is the result of tillering and that reproduction by seed is a "luxury." Plants that are heavily browsed divert carbohydrate reserves to regrowth, rather than seed production, and the terminal buds where the seeds are usually produced are removed by the browsing animal (Young and Payne 1948, Aldous 1952, Hemmer 1975).

The consistently heavy browsing pressure on Rocky Mountain maple, indicated by the number of decadent plants, may be the cause of the relatively few plants classified as young. Little information is available concerning the effect of heavy use on Rocky Mountain maple seed production, tillering, or root crown development. Aldous (1952) found that after 6 years of 100% clipping of CAG, Rocky Mountain maple responded with a 10% increase in production of CAG. This increased production may result in decreased tillering and seed production.

Serviceberry responds to continued heavy use by channeling more energy to tillering. Hemmer (1975) stated that "Tillering may have evolved as a method of escaping browsing, as suckers are low and beneath the snow." This was evident by the number of serviceberry classified as young (20.3%).

Although several investigators stated that 80% utilization of CAG on serviceberry (Young and Payne 1948, Shepherd 1971) and 100% utilization of Rocky Mountain maple (Aldous 1952) increased production, continued use at these levels is probably harmful (Peek et al. 1971). Peek's et al. work involved the comparison of diameter at point of browsing (DPB) to diameter of proximal end of current annual growth (DCG) expressed as a percentage of DPB/DCG. I did not collect data pertaining to these measurements but the number of decadent plants and the general appearance of the 2 key species indicate consistent heavy utilization.

Miscellaneous Forage Species

Usually when willow was encountered on the winter range, it was heavily browsed. Leader use was usually in the 90% category. Many plants that occurred on harsh sites, such as exposed south-facing slopes, were decadent or dead. Common juniper was used extensively on a southern exposure adjacent to the east side of the trapping site. Utilization by elk was confirmed by observation and the gross examination of the rumen content from the winter kill located directly below this site. Shinyleaf ceanothus received moderate use but was only occasionally encountered. Pachistima appeared in dense stands of timber and was browsed lightly by both moose and elk. Daneke (1980) found a relatively high occurrence of Oregon grape in fecal samples during winter. He also noted some use of dogwood, hawthorne, ninebark, buffaloberry, and snowberry.

Observations of animals feeding indicated high use of bunch-grasses, primarily bluebunch wheatgrass, on exposed ridges. Use decreased as snow cover increased and slopes were denuded of available grass.

Competition with Other Ungulates

During the 1976-77 winter, deer were not seen on the winter range and only 2 separate tracks were identified. A small herd of 15-25 deer, identified by 3 collared animals, was on the winter range during the second winter. Deer of this group occasionally mixed with elk. They were readily drawn to the alfalfa bait and may have remained in the area for that reason. Tracks were not seen west of the trap. From 1 March to 1 May 1978, deer were not sighted on the wintering grounds. Competition by deer is only minor because elk are able to survive winter better where the animals compete for the same supply of winter forage. Elk "can reach higher, paw through deeper, crusty snow and can utilize both grasses and browse" (Rognrud and Janson 1971).

Moose tracks were found on several occasions along the trail between Spruce Park Cabin and Highway 2 during 1977. In 1978, moose were frequently encountered on this section of trail. Size and shape of tracks indicated at least 3 individuals. Their activities appeared restricted to the area along the River and its drainages from the Highway to the Cabin. Elk sightings were limited because of dense timber, but they were only occasionally encountered on the trail. Several mature bulls apparently used this section regularly during both winters, and small cow/calf groups used the trail as access to the wintering grounds. As with deer, moose competition with elk is probably minor.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

The upper drainage of the Middle Fork of the Flathead River is within the Great Bear Wilderness. Although security, involving preservation of habitat and reduced disturbance by man is associated with wilderness classification, a need for management, especially of critical habitat, still exists. Because winter range is usually considered the limiting factor for elk populations in the northern Rocky Mountains (Harris 1958, Pengelly 1960, Boyd 1970, Rognrud and Janson 1971), the Middle Fork winter range should be considered critical habitat. Key browse species on the wintering area receive consistently heavy use, and most of the elk herd returns each year.

The lack of winter kills suggests the winter range is able to support elk numbers as they exist now during average to easy winters. Careful monitoring of cow/calf ratios and the number of winter kills would provide valuable information for management of the Middle Fork herd.

Spring aerial surveys presently conducted by Montana Department of Fish, Wildlife and Parks personnel are restricted by time, fuel, and weather. Ideally, surveys should be conducted by helicopter 3 or 4 times each winter beginning in mid-January and ending by mid-March. The helicopter could be refueled by landing along Highway 2 near the confluence of Bear Creek and the Middle Fork River, allowing time to conduct thorough counts. Preferably flights should be made on clear, cold, calm days when elk remain on open hillsides.

Decreases in calf/cow ratios could be documented as winter progressed, providing some indication of winter kills of calves that may not be detected by 1 flight. Later flights after most winter kills had occurred would provide information on the number of animals that exist and can be expected to contribute to the population the following year.

Snow depth influenced elk use of the Middle Fork winter range. During February and March 1977, elk used draws and middle and upper slopes with straight and concave slopes because of minimal snow cover. During the same months in 1978, elk were at similar or even higher elevations as the snow melted; during 1978, they moved to lower bottoms and drainages as they became accessible that year.

The mild winter of 1977 was probably the key reason that no dead elk were found on the winter range in 1977 and also why so few were found during 1978. Previously unavailable forage was used in 1977, allowing heavily browsed plants to recover somewhat. Utilization of serviceberry and Rocky Mountain maple was below what many researchers believe is critical. However, the number of decadent plants indicates that heavy use is the norm rather than the exception, and may have lasted so long that the winter range is deteriorating. The extremely mild winter of 1976-77 coupled with a moist summer probably allowed many of the plants to increase production, allowing utilization to remain below critical levels again during winter 1977-78.

Asherin (1974) found increased big game use on recently burned sites. Burning not only stimulates growth of serviceberry and Rocky Mountain maple, it removes decadent material that hinders new growth. Fire should improve the forage on the winter range. A let-burn policy should be established for the Middle Fork winter range.

If a let-burn policy does not produce the desired effects, supplemental controlled burning using the following steps is suggested.

1. For controlled burning that will increase shrub and bunchgrass production and quality, care should be taken to begin with small burns followed by larger burns once forage has reestablished on the first burns. Areas of marginal elk use, such as open slopes and upper drainages that have moderate snow accumulation during average winters, should be burned first. As those areas become more productive, burning should begin on open ridges and areas of shallow snow depth. Those areas where snow accumulation is high (east aspects of ridges and draws) could be left out of any burning plan because they are normally inaccessible to elk during most winters.

Ridgetops below 6500 feet (1981 m) and south-to-southwest aspect open slopes below 5500-6000 feet (1676-1829 m) had the shallowest snow depths and were heavily utilized by elk.

2. A rotational plan that will maintain areas of optimum forage production throughout the winter range would be most helpful.

3. Additionally, seeding and fertilization for bunchgrasses would help contribute to forage production and availability, especially on open ridges.

Care should be taken to maintain those timber stands that exist on the winter range. Several investigators found that winter cover is very important (Beall 1974, Simmons 1974). Much of the Middle Fork winter range is open, and small stands of timber were frequently used by elk for nightbeds. These timber stands also provided protection during cold, windy periods. Although much dense timber surrounds the winter range, destruction of trees within the area would reduce needed cover.

Cross-country skiing was the primary recreational activity during winter months along the Big River Trail. During this study, few people ventured as far as Spruce Park and even fewer beyond, and disturbance to wintering elk was minimal. Monitoring cross-country skiers by maintaining a check-in/out station at the entrance to the Big River Trail would help to determine if and when numbers of skiers increased enough to pose a problem to the elk.

CHAPTER VI

SUMMARY

From January through May 1977 and 1978, research was conducted on the elk herd and its winter range along the Middle Fork of the Flathead River. Since the research was completed, the upper Middle Fork Drainage, including the winter range, has been designated as the Great Bear Wilderness (Public Law 95-546).

During the 2 winters of study, 16 elk were collared, 8 cows with radio collars and 8 bulls and calves with rope collars. Tracking of instrumented animals was done primarily during late spring, summer, and fall 1977 by Smith (1978). Ground triangulation was attempted during winter months but proved unreliable because of signal bounce. Ground tracking was useful, however, to determine the general location of animals and identities of individuals once they were sighted. Rope collars were useful in identifying animals.

All 5 elk radio-collared during 1977 returned to the winter range the following winter. Wintering elk population estimates ranged from 184 to 270 with a weighted mean of 233 animals.

Winter weather during 1977 was extremely mild with low precipitation and above normal temperatures. The 1978 winter was somewhat more severe than normal and had much greater snow accumulation than 1977. Year-to-year changes in elk use of habitat were undoubtedly related to weather. When midwinter snow depths were near normal, elk use of the winter range was mostly restricted to windswept ridges. Below normal snow accumulations resulted in horizontal shifts to draws and drainages. A vertical shift upward was noted in late winter and early spring during 1977 because of early snowmelt at higher elevations. Lower elevation draws and drainages became accessible during the same period in 1978 while upper elevation slopes were still inaccessible.

Month-to-month difference in habitat use during 1978 were both vertical and horizontal. In January, draws and drainages were still open to elk use. During February, when snow depths were deepest, elk shifted their activities to windswept ridges resulting not only in a horizontal change but also a vertical shift upwards. As snow melted during March and April, elk used more draws and drainages and gradually moved upward following the snowmelt.

No winter-killed elk were found during the 1977 winter because of the mild weather. Much of the winter range remained accessible throughout midwinter months leaving forage readily available. Three dead elk were located on the winter range during the 1978 winter. Two of the deaths were of undetermined cause; 1 of these animals appeared to have been in excellent health. The third death was probably the result of an aged animal in poor condition falling to its death.

A large discrepancy occurred between calf:cow ratios determined by ground reconnaissance and those determined by aerial surveys during both years of this study. This discrepancy may have resulted because of sampling techniques. Ground counts may have been biased upward because of more frequent observations of cow:calf groups than actually occurred on the study area. Aerial surveys may be biased downward because such surveys are quite extensive and are conducted at the end of winter when cows and calves are less easily distinguished.

Browse surveys indicate a preference for Rocky Mountain maple over serviceberry. Vigor of both species was low with most plants less than 4 feet (1.2 m) tall. The percentage of decadent plants (nearly 40%) and plants in form class 3 (over 45%) indicate the winter range is consistently heavily browsed.

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APPENDIX A

PLANT SCIENTIFIC NAMES (Hitchcock and Cronquist 1973)

Common name	Scientific name
Trees	
alder	Alnus sinuata
alpine fir	Abies lasiocarpa
aspen	Populus tremuloides
Douglas-fir	Pseudotsuga menziesii
lodgepole pine	Pinus contorta
ponderosa pine	Pinus ponderosa
spruce (spp.)	Picea (spp.)
western larch	Larix occidentalis
whitebark pine	Pinus albicaulis
willow (spp.)	Salix (spp.)
Shrubs and Subshrubs	
blue huckleberry	Vaccinium globulare
buffaloberry	Shepherdia canadensis
chokecherry	Prunus virginiana
common juniper	Juniperus communis
creeping juniper	Juniperus horizontalis
dogwood	Cornus canadensis
dwarf huckleberry	Vaccinium caespitosum
grouse whortleberry	Vaccinium scoparium
hawthorn	Crataegus (spp.)
kinnikinnick	Arctostaphylos uva-ursi
menziesia	Menziesia ferruginea
mountain gooseberry	Ribes montigenum
ninebark	Physocarpus malvaceus
Oregon grape	Berberis repens
pachistima	Pachistima myrsinites
Rocky Mountain maple	Acer glabrum
serviceberry	Amelanchier alnifolia
shinyleaf ceanothus	Ceanothus velutinus
snowberry	Symphoricarpos albus
twinflower	Linnaea borealis
white spiraea	Spiraea betulifolia

Common name	Scientific name
Graminoids	
bluebunch wheatgrass	Agropyron spicatum
elk sedge	Carex geyeri
Idaho fescue	Festuca idahoensis
wood-rush	Luzula hitchcockii
Forbs	
beargrass	Xerophyllum tenax
heartleaf arnica	Arnica cordifolia
queencup beadlily.	Clintonia uniflora
western meadowrue	Thalictrum occidentalis

APPENDIX B

ELK OBSERVATION FORM

Observation no. __________ Date ____/____/____

Observer(s)______________________ Time beginning________

Ending________ (24 hr.)

Total elk____, Br. ant. bulls____, Spikes____, Cows____, Calf____.

Weather Conditions:

Temperature__________

Cloud cover: 100% 75% 50% 25% 0 Fog

Wind velocity: Calm, Steady, Gusty.

Wind direction: N, S, E, W, NE, NW, SE, SW.

Precipitation: Snow: heavy, light Rain: heavy, light

Snow Conditions: Powder, Bottom crust, Top crust, Wet.

Aspect: N, S, E, W, NE, NW, SE, SW.

Slope: 0-5, 5-15, 15-25, 25-35, 35-45, 45-55, 55+ (%)

Topography: Ridge, Upper, Mid, Lower, Bench, Stream bottom.

Configuration: Convex, Concave, Straight, Undulating.

Canopy Coverage: 0, 1-5%, 5-25%, 25-50%, 50-75%, 75-100%

Distance from Ecotone_______ Distance from Cover_______

Distance from Previous Sighting_______

Distance from Trail_______

Distance from Available Water_______

Activity:

No. bedding_______, No. feeding_______

Movement: Speed_______, Direction_______

Comments:____

____

____

____

APPENDIX C

MONTANA DEPARTMENT OF FISH AND GAME GMBG-1

Browse Survey Form

Region________ Area________ Date______________ Key Sp.______________ Plot No.________

Location____

Forage Availability________________________ Veg. Type________________________

Dot-Tally - Form Class 7______________ 8______________ Examiner______________

Plant no.	Form class 1	2	3	4	5	6	Age class	Leader use	Plant no.	Form class 1	2	3	4	5	6	Age class	Leader use
1									26								
2									27								
3									28								
4									29								
5									30								
6									31								
7									32								
8									33								
9									34								
10									35								
11									36								
12									37								
13									38								
14									39								
15									40								
16									41								
17									42								
18									43								
19									44								
20									45								
21									46								
22									47								
23									48								
24									49								
25									50								

Form Classes

Percentages

______ ______ 1. all available, little or no hedging
______ ______ 2. all available, moderately hedged
______ ______ 3. all available, severely hedged
______ ______ 4. partly available, little or no hedging
______ ______ 5. partly available, moderately hedged
______ ______ 6. partly available, severely hedged
______ 7. unavailable
______ 8. dead

Dot - tally

Age classes

______ S - Seedling
______ Y - Young
______ M - Mature
______ R - Resprout
______ D - Decadent

Leader use est. %

0 non-use
5 1-10
25 10-40
50 40-60
70 60-80
90 80-100

Leader use ave.

____

APPENDIX D

DEER MARKING RECORDS FOR 1978

		Ear tag numbers		Rope collar
Date	Sex	Right	Left	Flags*-Pendant no.
2 Feb	♀	A2729	A2702	RBG(Y)-39
16 Feb	♀	A2795	A2794	GWR(Y)-46
17 Feb	♀	A2781	A2783	RGR(Y)-41

*Rope collar letters represent colored flags: R = red, B = black, G = green, W = white, (Y) = yellow rope.