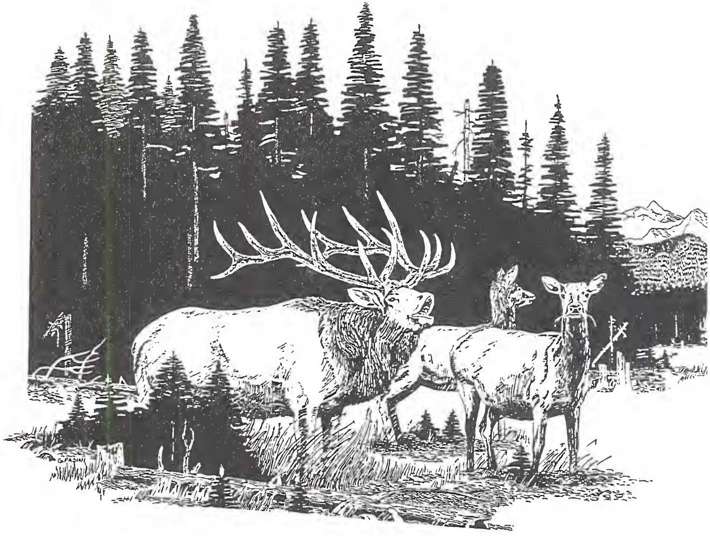
THE LOWER CLARK FORK ELK STUDY

FINAL REPORT 1985-1990



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Montana Department of Fish, Wildlife and Parks
Fall 1993

THE LOWER CLARK FORK ELK STUDY
FINAL REPORT
1985-1990

The Social Structure and Seasonal Habitat Selection of a Northwest Montana Elk Population with an Analysis of Population Characteristics, Harvest Rates, and Survey Techniques.

MONTANA DEPARTMENT OF FISH, WILDLIFE & PARKS
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ABSTRACT

Between 1984 and 1989 176 elk were captured and fitted with radio collars and neckbands in Hunting Districts 123 and 200 in northwestern Montana. Elk wintering in the Lower Clark Fork Study Area had a composite yearlong range of 613 mi^2. Nine elk herd units were defined and seasonal movements were documented. Herd units were generally exclusive. Many cow elk wintering in HD 123 summered in HD 200, but cow elk wintering in HD 200 summered primarily in HD 200 and secondarily in HD 202. Bull elk (2+ years-old) generally had seasonal movement patterns disimilar to cows, calves and yearling bulls.

Emigration was documented for both cow and bull elk. Cows seldom emigrated and did so after turning 3 years-old. Bulls were more likely at emigrate and did so at 2 years of age.

Hunting related mortality accounted for nearly 80% of known deaths. Annual weighted hunting season mortality rates were 40% for antlered bulls and 16% for cows. Harvest rates for both bulls and cows was higher for elk wintering in HD 123. Harvest rates were 54% for bulls $\geq$ 2 years old and 20% for yearling bulls and statistically different, based on small sample sizes. Evidence indicated that cow populations were stable. Bulls may have been harvested at rates that would cause a decline in age structure.

Estimates were made of elk population numbers using both Lincoln-Peterson Index and the elk sightability methodology and model developed in Idaho. Based on elk sightability surveys 1406$\pm$ 387 (90% C.I.) elk wintered within the study area in 1989. It was also estimated that during the summer and fall about 1700 elk, or 2.77 elk/mi^2 resided within the composite yearlong range, including HD 200 and portions of HDs 123, 201 and 202.

During the study 2162 hunters annually harvested 343 elk. Hunter density averaged 2.9 hunters/mi^2 in HD 123 and 4.6/mi^2 in HD 200. A slight upward trend in hunter numbers was noted. Yearling bulls with antler configurations of 2 points or less on both sides comprised slightly over 50% of the harvest. Hunters spent an estimated $1.37 million while hunting elk in the study area in 1989.

Replicated surveys provided more reliable estimates of population trends and herd composition than traditional single flight surveys. Elk sightability methods provided population estimates for age and sex classes that were more reliable and cost efficient that L-P estimates. L-P estimates were generally more expensive to make because of the need to trap and mark elk.

Observed calf/cow ratios ranged from 28-52 calves/100 cows, and elk herds in HD 123 were generally more productive than those in HD 200. Pregnancy rates were over 90% for cows at least 2 years-old. Observed post-season bull/cow ratios ranged from 9-19 bulls/100 cows in HD 123 and 12-31 bulls/100 cows in HD 200.

Analysis of over 3800 radio locations with Geographic Information System (GIS) computer methods revealed that bull elk preferred habitats with zero road density and avoided habitats with >0.5 mi of road/mi^2 during all seasons. Cow elk preferred habitats

with zero road density and avoided habitats with >1.5 mi of road/mi^2 during fall archery and rifle seasons. The analysis indicated that elk would reclaim habitats where roads were effectively closed.

Evidence from observed mortality rates, hunter harvest surveys, herd composition, and GIS elk use/road density analysis indicated that habitat security was not adequate for MDFWP to meet the objective of maintaining a diverse age structure of bulls as stated in the Montana Elk Plan.

Cooperative projects completed during the study included the BPA power line elk monitoring and mitigation study, development of timber harvest guidelines for the currently roadless Mt. Bushnell area, plans for prescribed burning of 3900 acres of winter range, development of a model to be used to analyze security in timber sale planning, a Master's thesis on elk winter habitat use, a Senior thesis on physiological condition of white-tailed and mule deer, and forest travel and timber sale planning.

Management recommendations include improved population monitoring efforts, consideration of alternative harvest regulations and increased cooperative efforts with land managers and the public to increase habitat security so that elk plan objectives can be met.

ACKNOWLEDGEMENTS

The Lower Clark Fork Elk Study benefitted from the efforts and cooperation of numerous individuals and agencies.

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INTRODUCTION

The Lower Clark Fork Elk Study was funded for fiscal years 1986-1989 through the State of Montana Executive Planning Process (EPP). EPP projects directed supplemental funds toward studies of high priority management concerns. The study was a cooperative effort involving wildlife biologists from Regions 1 (Kalispell Headquarters) and 2 (Missoula Headquarters) of the Montana Department of Fish, Wildlife and Parks (MDFWP). Preliminary findings for the first 2 years of the study were reported in the Lower Clark Fork Elk Study, Biennial Progress Report, 1985-1987 (Lemke and Henderson 1987).

At the turn of the century few, if any, elk occupied Mineral, Sanders, and Lincoln counties of northwestern Montana (Koch 1941). Much of the study area was heavily burned by catastrophic wildfires in 1910. Between 1912 and 1964, elk from Yellowstone National Park were released on 10 occasions in and near the study area (Anonymous 1976). In the 80 years since 1912, elk populations in the area have increased dramatically in both size and geographic range. Currently, Hunting Districts (HD) 123 and 200 are popular elk hunting areas, offering a variety of hunting opportunities with a relatively good chance of harvesting mature bulls. As a result, the economic impact of elk hunting in the study area is considerable. It was estimated that in 1989 elk hunters spent $1,377,589 to hunt elk in HDs 123 and 200 (Duffield 1988, Rob Brooks MDFWP, Bozeman pers. comm.).

Despite the area's popularity with elk hunters, other concerns in the area included game damage complaints and potential for timber harvests affecting habitat. Little was known about elk population numbers and trends, sex and age ratios, seasonal movements, habitat use, recruitment and harvest rates prior to this study.

During the 1940's field investigators described winter distribution and forage use, sex/age ratios, and attempted population estimates for much of the study area, often focusing on forage utilization and mange problems in the Cherry Creek Game Preserve (Rognrud 1948, McDowell 1949). After 1950 MDFWP periodically examined browse utilization and condition transects, conducted sporadic ground age/sex elk classifications in HD 200, and began annual, nonstandardized helicopter elk classification surveys in HD 123 in 1976. Warner (1970) reported the effects of timber harvest on winter forage production in Tamarack Creek.

In 1984, the first elk were trapped and radio-collared in HD 200 in the Deborgia area as part of a Bonneville Power Administration (BPA) mitigation study to monitor the impacts of a new 500-KV transmission line on elk (Hammond et al. 1985, Thompson and Sterling 1986, Thompson and Dickson 1987). Monitoring of those elk indicated substantial movement across the western half of the C-C Divide between HD 123 and HD 200. This information further underlined the desirability for a better understanding of population parameters and movements to direct management of elk in the area.

Between 1985 and 1988, the Lower Clark Fork Elk Study and the BPA Power Line Study coordinated efforts, sharing equipment, personnel, marked elk and data. Canfield (1988) reported the impacts of the newly constructed BPA powerline on elk habitat selection and hunter opportunities.

GOALS AND OBJECTIVES

The Lower Clark Fork Elk Study was a management-oriented project designed to provide data to achieve three major goals:

Goals

(1) maintain or improve elk hunting opportunities;

(2) integrate the elk resource into Lolo National Forest management planning; and

(3) address local elk damage problems on private lands.

Specific objectives within the study plan to meet these goals were:

Objectives

(1) develop techniques that account for observability bias applicable for estimating elk numbers in the study area and in similar habitats in western Montana;

(2) determine herd unit boundaries and monitor sex/age structures of those elk herd units;

(3) sample harvest rates on various sex and age segments of the population;

(4) examine patterns of habitat use, seasonal movements, and the timing of movements for various herd units; and

(5) gather information on pregnancy rates, physiological condition and occurrence of common diseases.

A major focus of the study was to encourage public resource agencies, private groups and individuals to become involved with the study and to ultimately use the results to improve wildlife/land management efforts in the area. The Lolo National Forest (LNF), University of Montana (UM), Rocky Mountain Elk Foundation (RMEF), BPA, landowners and local sportsmen have participated throughout the study (Lemke and Henderson 1987).

STUDY AREA

The study area is in southwestern Sanders and northwestern Mineral Counties of western Montana (Fig. 1) along the Idaho state border. The towns of Saltese, St. Regis, Paradise, Plains and Thompson Falls are located along those boundaries. The area encompasses 612 square miles (mi^2) of timbered and mountainous terrain in HD 123 (379 mi^2, 62% of total study area) and HD 200 (233 mi^2, 38%).

The topography is generally steep with elevations ranging from 2,400 feet (ft) at the mouth of Prospect Creek to 7,200 ft at the summit of Penrose Peak. The C-C Divide is a major geological formation, running southeast from the Montana-Idaho border to the

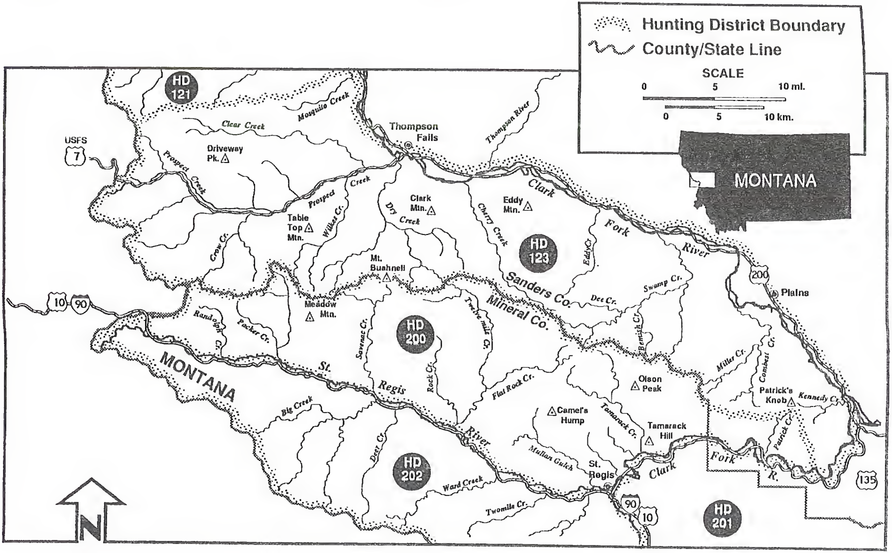

Figure 1. Map of Lower Clark Fork Study Area.

Clark Fork River near Paradise. The divide is the geographical boundary between MDFWP Regions 1 and 2, separates the Thompson Falls/Plains Ranger District from the Superior Ranger District, and is the boundary between Sanders and Mineral Counties.

In the winters of 1987 and 1988, the study area was expanded to include trapping sites in Marble and 2-Mile Creeks in HD 202, to determine possible interrelationships with populations previously sampled in nearby HD 200.

The vegetation in the study area is representative of relatively moist and cool habitats that characterize elk ranges in northwestern Montana. Mean annual precipitation is 22.5 inches at Thompson Falls (U.S. Dept. of Commerce 1980). Forest growth is extensive and lush. Coniferous species present include lodgepole pine (Pinus contorta), ponderosa pine (Pinus ponderosa), Douglas fir (Psuedotsuga menziesii), grand fir (Abies grandis), western larch (Larix occidentalis), western red cedar (Thuja plicata), Engelmann spruce (Picea engelmannii), western white pine (Pinus monticola), western hemlock (Tsuga heterophylla), and mountain hemlock (Tsuga mertensiana).

Wildfires, in the early 1900's, strongly influenced vegetation in the study area. Extensive lodgepole pine stands are legacies of those fires. On warm, dry slopes, seral brush fields replaced coniferous cover following the fires.

Over 80 percent of the land is administered by LNF. Corporate timber management is concentrated in the Miller and Combest Creek area south of Plains. Small private ownerships are located at lower elevations along the St. Regis and Clark Fork Rivers. Major human activities include timber management and outdoor recreation. Small scale mining, livestock grazing, and hay production also take place.

Elk hunting is the primary recreational activity throughout the area. From 1933 until 1950 a 60 mi^2 portion of the study area, the Cherry Creek Game Preserve, was off-limits to elk hunting to foster earlier transplant efforts. The Montana Fish and Game Commission removed the preserve status in 1950, following reports of over use of winter forage (Rognrud 1950). Prior to the 1950's most hunting was restricted to antlered bulls in the rest of the study area. As elk populations grew, more liberal 5-week either-sex general seasons were instituted in the 1950's. From the mid-1950's through the early 1960's, antlered bull-only hunting preceded either-sex seasons, during parts of September and October. Elk hunting seasons have varied from 5-6 weeks in length since the mid-1960's. Season types, but not season length, have become more restrictive over the past 20 years. Five week either-sex general seasons were open to anyone with an elk license through the 1950's and 1960's. However, by the late-1970's antlerless elk hunting was limited for rifle hunters to just the first 8 days of the season. In 1978, in the area south of Plains, hunting was restricted to antlered bulls only to allow the elk population to increase. Since 1983, limited numbers of antlerless permits have been issued for that area. In 1980 antlerless elk hunting in all of Region 2, including HD 200, was limited to hunters receiving permits through a computerized drawing. In 1986 the Fish and Game Commission created the current boundaries of HD 123 so that hunter harvest data could be collected for analysis in this study. That boundary included small portions of what had been HDs 121 and 122.

During the study period (1985-1990), elk hunting seasons consisted of 6 weeks of either-sex archery hunting, starting the first Saturday in September, followed by 5 weeks of general (firearms) hunting for antlered bulls, beginning the third Sunday in October. Antlerless harvest in the newly created HD 123 was accomplished through 2 season types: 8 days of general either-sex hunting in the western 2/3 (west of Eddy Cr.), and antlerless permits in the eastern 1/3. In HD 200 antlerless permits regulated the cow and calf harvest. Extra permits were issued for the Boyd Mountain area to address game damage complaints.

METHODS

Trapping

Efforts were made to trap and mark elk from all major winter ranges in the study area. Trapping operations were conducted from January to April from 1986 to 1989. Elk trapping and handling procedures, using portable modified Clover traps and a corral trap, were described by Lemke and Henderson (1987) and Thompson et al. (1989).

Radio Telemetry

We attempted to aerially relocate radio-tagged elk twice a month from late spring through November and less frequently from

December through April. Aerial relocation methods followed descriptions in Lemke and Henderson (1987) and Canfield (1988). With financial support from LNF, more intensive monitoring was conducted daily (weather permitting) for the periods immediately prior to and after the beginning of the general hunting seasons.

Harvest Rates and Other Mortality

When possible, the cause of death of marked animals were determined and tabulated. Investigations were made following non-movement of radio-tagged animals and reports by the public of dead animals marked with neckbands and eartags. We did not attempt to located other dead elk.

Harvest rates were based on the verified and assumed fates of radio-collared elk alive in the study area prior to each of the fall hunting seasons. If a radio-tagged elk, known to be alive in September, was not relocated at some time during or after the hunting season, we assumed that it had been harvested by hunters. That assumption was made regardless of whether or not hunters reported the elk harvested. Elk known not to be in the study area, or whose radios failed prior to the hunting season, were excluded. When calculating hunting season mortality rates, we included those elk whose radios were recovered in the field and were determined to have died as a result of wounding during the hunting seasons. There was potential for over-estimating harvest rates by counting radio failures as hunter harvests.

Because of small sample sizes in each hunting season, we pooled the number of radioed elk available and harvested for all the hunting seasons from 1985-1990. Some elk were alive at the beginning of more than one hunting season and were included in the pooled samples. The weighted annual per capita hunting season mortality rates were then calculated from the pooled samples. Chi-square (X^2) goodness-of-fit tests were applied to compare mortality rates observed in pooled samples of elk in several age, sex and geographic categories.

Population Estimates and Sex/Age Classifications

We employed two methods to estimate elk populations--Lincoln-Peterson (L-P) estimates from 1986 through 1988 and the newly developed elk sightability method in 1989.

In April 1986, 1987 and 1988 helicopter surveys were conducted to count and classify marked and unmarked elk. The helicopter was flown from 20-40 m.p.h at an altitude of 100-300 ft. Flights were made in early morning for 2-3 hours, until all "open" areas, generally southern and western aspects, on winter ranges in the two HDs were completely censused (Lemke and Henderson 1987). The same experienced observers were used each year. A 2-passenger Bell 47 was used in HD 123 and a 3-passenger Bell-47 in HD 200. All elk seen were recorded as cows, calves, yearling bulls, branched-antler bulls, unclassified bulls or unclassified elk based on morphological characteristics. Elk marked with radio-collars and neckbands were identified and recorded. A series of flights that completely surveyed winter ranges within a HD was one "replication." Three replications were made for each HD in April each year.

Population estimates for each HD were derived from the 3 completed aerial mark-recapture surveys. Separate modified L-P estimates ($\check{N}*_i$) were calculated for each replication,

$$\check{N}*_i=[(M_i + 1)(C_i + 1)/(R_i + 1)] - 1 \text{ (Chapman 1952)}$$

where for sample i, M_i is the number of previously marked elk, C_i is the total number of elk observed, and R_i is the number of marked elk observed. When all replications were completed the final estimate for each HD was set equal to the average of the K individual estimates, denoted by $\bar{N}*$. The standard error (SE) was calculated from the individual estimates,

$$SE=\sqrt{\frac{1}{K(K-1)} \sum_{i=1}^{K} (\check{N}*_i - \bar{N}*)^2} \quad \text{(Chapman 1952)}$$

$\bar{N}*\pm 2$ SE represented an approximate 95 percent confidence interval for the true population size (N).

Calf/cow and bull/cow ratios obtained from the replicated samples were weighted for sample size. Samples were large enough that weighted mean and mean sex/age ratios were identical. Best count ratios were calculated from the highest number of cows, calves and bulls observed during the 3 replicated surveys conducted each year.

In February 1989, helicopter surveys were conducted with the 3-passenger Bell-47 in HDs 123 and 200, utilizing the methodology for elk sightability surveys developed in Idaho (Samuel et al. 1987, Unsworth et al. 1991). Within winter ranges of each HD, 4-6 mi^2 subunits were deliniated on topographic maps and stratified according to expected number of elk per subunit. We based stratifications on our experiences from surveying elk in the study area during the 3 previous years. We chose to survey a random sample of stratified subunits, rather than do complete-coverage surveys, to reduce helicopter time and costs. Each randomly selected subunit was surveyed by helicopter on 100-200 ft contours at 15 to 40 m.p.h., and at altitudes of 100-200 ft, according to protocol described in Unsworth et al.(1991). Data collected during sightability surveys in 1989 included each elk group size, sex and age composition of each group, % vegetative cover, activity, and % snow cover for each observation in a sampled subunit of the winter range. Data was then entered to ASCII files (Unsworth et al. 1991).

The computer model "ELK4" had already been developed in Idaho to estimate populations from the sightability surveys conducted with a 3-passenger Hiller-12E helicopter. Since the Hiller was unavailable to us, we used the 3-passenger Bell-47 helicopter in this study. We did not know how sightability from the Bell-47 compared to the model (ELK4) developed with the Hiller-12E helicopter.

Therefore, in conjunction with our sightability surveys in 1989, we used telemetry equipment to locate radio-tagged elk within each sampled subunit. For both those radioed elk that had been observed during the survey <u>and</u> those that had not been seen, but which were located with the aid of radio telemetry after surveying the subunit, we recorded group size, age and sex composition, activity, vegetative cover and snow cover (Samuel et al. 1987).

Those and similar data collected on the Blackfoot-Clearwater Wildlife Management Area were forwarded to Dr. E.O. Garton at the University of Idaho. Dr. Garton determined the need for and made the necessary adjustments in the Hiller-based model to develop the new model "ELKMONT" for use with data collected from the Bell-47. "ELKMONT", like "ELK4", is a computer model developed by forward stepwise logistic regression of the probability of a group of elk being seen and was derived from linear multiple regression of factors influencing the sightability of elk (ie.group size, % canopy cover, % snow cover, and activity) (Unsworth et al. 1991).

With the survey data collected in February 1989 and the new Bell 47 based model "ELKMONT", we estimated population sizes and sex/age compositions with 90% confidence intervals in HDs 123 and 200.

Elk Harvest Surveys

MDFWP conducted hunter harvest surveys annually, using statewide telephone interview methods (Cada 1987). We examined annual harvest survey summaries for trends in harvest, hunter effort, and antler point distribution for elk harvested in HDs 123 and 200.

Road Density and Elk Use Patterns

Over 3,800 elk radio locations were analyzed using standard Geographical Information System (GIS) computer technology to determine elk use patterns relative to road densities. Computer generated maps were overlaid on detailed digitized road maps for the entire study area (Mace 1992). The raster (cell) resolution used for analysis was 30 meter^2. At this resolution, the C-C Divide study area was composed of 1,654,318 cells.

Roads in the study area were assigned to 1 of 4 classes: primary open road, secondary open road, tertiary open road, and seasonal or yearlong closed road. Two road density maps were generated, one with all roads digitized and another with only open roads present. Road densities were classified into 7 levels: 0.0-0.5, 0.5-1.0, 1.0-1.5, 1.5-2.0, 2.0-2.5, 2.5-3.0, and >3.0 miles of road per mi^2.

Elk radio locations were analyzed with respect to the road density levels within which they were positioned. Female and male elk of all ages were analyzed separately using 5 seasonal categories with inclusive dates: winter (Dec.1-Feb.29), Spring (Mar.1-May 30), Summer (June 1-Aug.31), Archery Season (Sept. 1-Oct.15), and General Hunting Season (Oct. 15-Nov. 30). Female and male locations, stratified by season, were overlaid on the 2 GIS road density maps. The number of locations occurring in each road density class was determined and constituted "elk use." The amount of each road density class within the study area was determined and constituted "available" road density acreage. Simultaneous Bonferronni confidence limits were used to statistically determine if each road density level was preferred, avoided, or used in proportion to availability. Confidence limits were constructed at 95%.

Blood Sampling

We drew blood samples from trapped elk and forwarded them to the Montana Wildlife Research and Veterinary Research Laboratories in Bozeman for analysis. Pregnancy was determined from the presence of Protein B and age specific fates of pregnancy were calculated. Exposure to Brucellosis, Anaplasmosis, bluetongue and Leptospirosis was determined from antibodies present in blood samples.

RESULTS

Trapping

During the 1986-1989 trapping seasons, winters were mild with little snowfall. As a result, elk were widely dispersed, and trapping success depended on our ability to move Clover traps to areas occupied by elk. Trapsites and elk captures were well distributed on winter ranges in the study area with the exceptions of Cherry Creek (HD 123) and Donlan Flats (HD 200) (Table 1 and Fig. 2).

From 1984 through 1989, 176 elk (142 cows and 34 bulls) were captured and marked in HDs 123 and 200. Among the cows, 84 (60%) were adults (>3.0 years), 21 (15%) were two-year-olds, 21 (15%) were yearlings, and 16 (11%) were calves. Of 34 bulls captured, 1 (3%) was an adult (>3.0 years), 2 (6%) were two-year-olds, 12 (35%) were yearlings, and 20 (56%) were calves (Fig. 3).

In HD 123 66 elk (approximately 8% of the estimated population) were captured during the study (Appendix 1), and 110

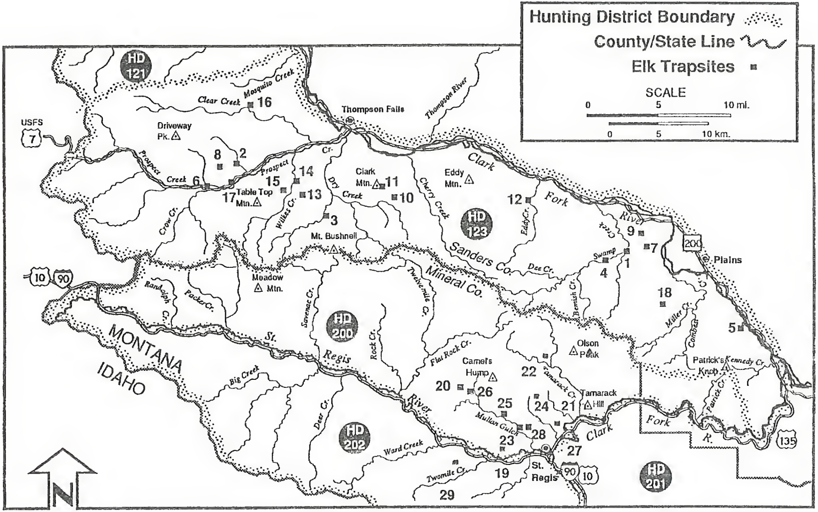

Figure 2. Location of elk trapsites from 1986 - 1989.

elk (approximately 25% of the estimated population) was captured in HD 200 (Appendix 2). Since the last progress report, 11 elk were captured in HD 123 in 1988, and an additional 5 elk were trapped in 1989. In HD 200 28 elk were captured in 1988, while no trapping was attempted in 1989. Included in the trapped sample were 18 elk captured during the summers of 1984 and 1985 for the BPA study (Appendix 3). An additional 10 cows were captured and radio-tagged in HD 202 during the study (Appendix 4).

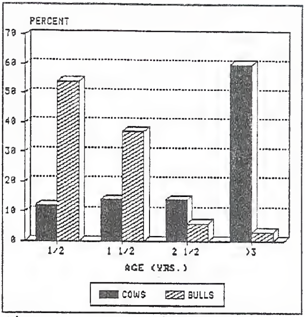

Fig. 3. Age distribution of captured cow and bull elk, expressed as percent of total in each sex.

During elk trapping we also captured 54 white-tailed deer (Odocoileus virginianus) and 85 mule deer (Odocoileus hemionus) between 1986 and 1989. Eighty-eight deer were marked in HD 123 (Appendix 5), and 51 were marked in HD 200 (Appendix 6). Hurley (1987) reported results from blood sampling, DAPA fecal analysis, and physical measurements of many of those deer. Numerous other deer were captured incidental to elk trapping and released unmarked. Subsequent hunter harvests of eartagged deer were recorded in R-1 and R-2 annual reports.

Table 1. Geographic description of elka trapsites for 1986-89.Trap site locations appear by number in Figure 2.

Trap Site #	Trap Location	HD	Herd Unit	UTM	
				Lat	Long
1	Swamp Cr.	123	Swamp	52808	6520
2	Brush Gul.	123	Prospect	52692	6135
3	Dry Cr.	123	W.Fork Dry	52642	6222
4	Sheep Gap	123	Swamp	52600	6499
5	Barth's Ranch	123	Pat's Knob	52535	6632
6	Therriault Gul.	123	Prospect	52670	6104
7	Webster Ranch	123	Swamp	52812	6540
8	Shamrock Gul.	123	Prospect	52689	6118
9	McCrea Ranch	123	Swamp	52625	6534
10	Clark 1	123	Clark	52659	6290
11	Clark 2	123	Clark	52646	6282
12	Eddy	123	Eddy	52656	6423
13	Hill 7	123	Wilkes	52662	6200
14	Wilkes Cr.	123	Wilkes	52675	6194
15	Table Top	123	Wilkes	52667	6181
16	Clear Cr.	123	Prospect	52748	6149
17	Kraak's Ln.	123	Prospect	52672	6128
18	Miller Cr.	123	Miller	52557	6556
19	Boyd	200	Boyd-Tam.	52403	6385
20	Mayo 1	200	Boyd-Tam.	52440	6415
21	Tamarack	200	Boyd-Tam.	52461	6476
22	Dry Fk. Tamarack	200	Boyd-Tam.	52494	6435
23	Keith	200	Boyd-Tam.	52441	6414
24	Mayo 2	200	Boyd-Tam.	52450	6432
25	Wolf	200	Boyd-Tam.	52454	6398
26	Camel's Hump	200	Boyd-Tam.	52475	6365
27	Mayo 5	200	Boyd-Tam.	52420	6455
28	Camel's Hump 3	200	Boyd-Tam.	52479	6355
29	2-Mile Cr.	202	2-Mile	52381	6358
*	Marble Cr.	202	Marble	52321	6482
*	Wanda's	202	Marble	52322	6516
*	Bouchard Lk.	202	Marble	52322	6521

*Trap sites not included in Figure 2.

Elk Distribution and Movements

Seasonal movements and distribution of 119 radio-collared elk (92 cows, 27 bulls) were documented through radio telemetry for the period July 1985 through June 1990. Additional information was gathered from eartag returns and observations of neck-banded elk.

Aerial telemetry efforts resulted in 3,865 relocations in HDs 123 and 200. In addition, 118 relocations were made in HD 201, HD 202 and Idaho. Relocations were obtained during each month for all years, but more relocations were collected in October than for any other month, because of our interest in elk responses to the general rifle season. Radio relocations were entered in dBase III computer files, and hard copies were forwarded, as collected, to LNF biologists.

The study area initially encompassed 629 mi^2 defined by the boundaries of HDs 123 and 200. However, examination of 2866 radio locations of 82 adult cows wintering within those HDs revealed that the composite yearlong range of elk was not conterminous with the original study area boundaries but actually occupied 613 mi^2 in HD 200 and portions of HDs 123, 201, and 202 (Fig. 4 and Table 2).

Elk Herd Units

Based on radio telemetry we initially described 7 elk herd units within HDs 123 and 200 (Lemke and Henderson 1987). Additional trapping and telemetry in 1988 and 1989 identified 2 other small, but distinct, herd units in Miller and Wilkes Creek.

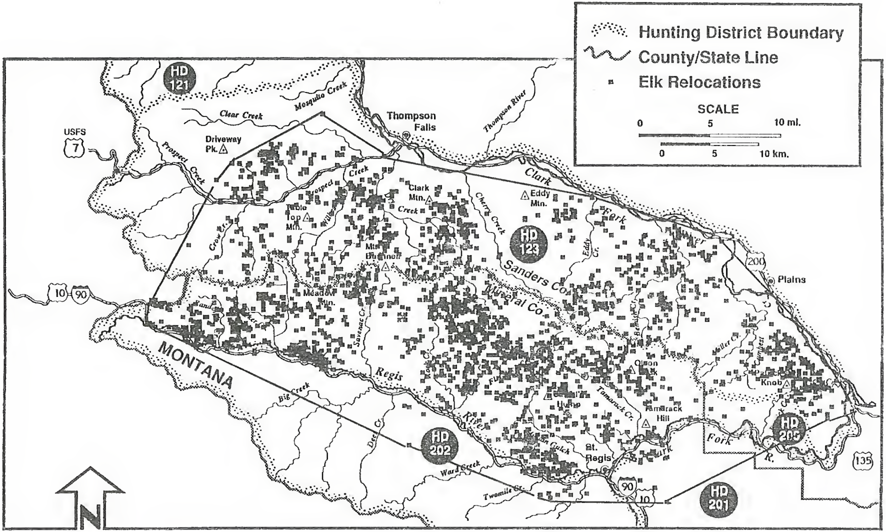

Figure 4. Composite yearlong range of cow elk captured on winter ranges in HDs 123 and 200, 1986 - 1990.

Table 2. Description of nine elk herd units in Lower Clark Fork Study Area.

Elk Herd Unit	Yearlong Range Size[1]	Winter Population Size(1989)[2]	Seasonal Movements/Herd Unit Interactions
Prospect Creek (based on 8 radio-tagged cows, 328 fixes)	281.8 km^2/ 108.8 mi2	325±	**Winter:**north side of Prospect(Valentine-Antimony Cr.). **Summer:**Some remain near winter range;many cross C-C Divide to Randolf Cr. area. Occassional summer overlap with Boyd-Tam. herd in Hemlock & Meadow Mtn. areas.
Wilkes Creek (based on 5 radio-tagged cows, 156 fixes)	249.7 km^2/ 96.4 mi^2	290±	**Winter:**lower Wilkes Cr. Prospect Cr. & Dry Cr. **Summer:**upper Wilkes, W.Fk.Dry Cr.,crossing C-C Divide to Packer Cr. & Hemlock Mtn. Occassional overlap with eastern end of Pospect herd during winter and Prospect & Boyd-Tam. herds around Hemlock Mtn. during summer.
Dry Creek (based on 4 radio-tagged cows, 176 fixes)	156.1 km^2/ 60.3 mi^2	150±	**Winter:**W.Fk.Dry-Joan Cr. **Summer:**Upper W.Fk.Dry, crossing C-C Divide, upper Savenac Cr. & Cruzane Mtn. Occassional summer overlap with Boyd-Tam. herd in Cruzane area.
Clark Mountain (based on 7 radio-tagged cows, 291 fixes)	149.9 km^2/ 57.8 mi^2	145±	**Winter:**southern aspects of Clark Mtn. to Cherry Cr., Knox & Goldrush Cr. up to C-C Divide. **Summer:**upper reaches of Knox, Goldrush, & Twelvemile Cr. near Mt. Bushnell. Summer overlap with the Dry Cr. herd unit near Bushnell and Boyd-Tam. herd unit in upper Twelvemile.
Eddy Creek (based on 3 radio-tagged cows, 60 fixes)	50.0 km^2/ 19.3 mi^2	40±	**Winter:**lower sections of Quartz Cr.,Poacher Gul. & Eddy Cr. **Summer:**upper to mid reaches of Quartz, Malone, Poacher Cr. up to Eddy Mtn. No overlap with other herd units.
Swamp Creek (based on 12 radio-tagged cows, 418 fixes)	309.6 km^2/ 119.5 mi^2	180±	**Winter:**lower Swamp Cr., Bemish Cr., and E. Fk. Swamp Cr. to agricultural land along Clark Fork R. **Summer:**upper Swamp Cr., Bemish Cr., Dee Cr., and crossing C-C Divide into Flatrock, Tamarack Cr. and Olsen Pk.Summer overlap with Boyd-Tam. herd unit in Flatrock and Tamarack Cr.
Miller Creek (based on 4 radio-tagged cows, 49 fixes)	44.9 km^2/ 17.4 mi^2	35±	**Winter:**lower Miller Cr. to W. Fk. Combest Cr. **Summer:**upper Miller Cr. and Combest Cr. to Combest Pk. Some summer overlap with Boyd-Tam. south of C-C Divide near Combest Pk.
Pat's Knob (based on 4 radio-tagged cows, 206 fixes)	51.4 km^2/ 19.8 mi^2	40±	**Winter:**north of Pat's Knob and south of Clark Fork R. between Combest and Kennedy Cr. **Summer:**Combest Cr. to Pat's Knob and east to Sheep Cr. Some summer overlap with Miller herd unit along Combest Cr.
Boyd-Tamarack (based on 35 radio-tagged cows, 1182 fixes)	646.2 km^2/ 249.4 mi^2	495±	**Winter:**Boyd Mtn. east to Tamarack Cr. Occassionaly in Rock Cr., E. Fk. 12Mile Cr. & Henderson Hill. **Summer:**Flatrock Cr., upper 12Mile Cr., Cruzane Mtn., & Meadow Mtn. Some summer near UpUp Mtn.(HD202) & Mill Cr.(HD201). Some summer overlap with other herd units in Packer-Randolf, in Trapper Cabin, & in Flatrock and Tamarack areas.
All herd units combined (based on 82 radio-tagged cows, 2866 fixes)	1589.9 km^2/ 613.7 mi^2	1400±	Composite yearlong range includes all of HD 200, HD 123 (excluding upper reaches of Prospect Cr.), SW corner of HD 201, and small portion of HD 202 just S of St.Regis R. between 2mile and Deer Cr.

[1] From TELDAY maximum home range polygon.
[2] Based on elk sightability surveys and model (interpolation for incompletely surveyed herd units).

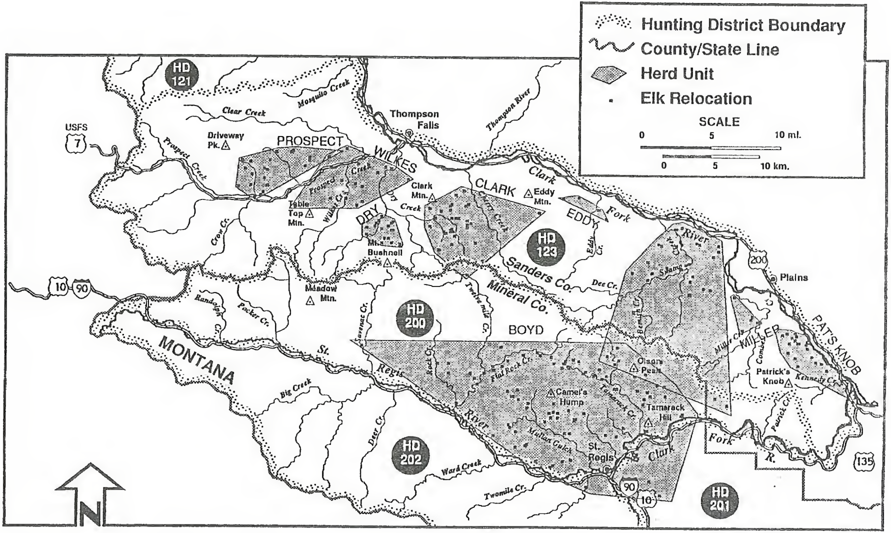

Figure 5. Location of nine major elk winter ranges in HDs 123 and 200 defined by radio-collared cows and calves between the dates Jan. 1 - March 31.

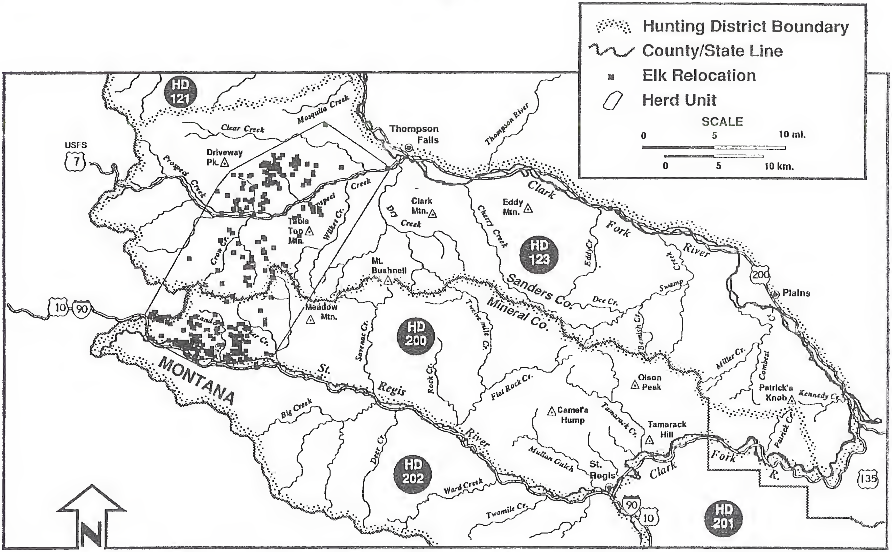

Figure 6. Composite yearlong range of cow elk in the Prospect Creek herd unit, 1986 - 1990.

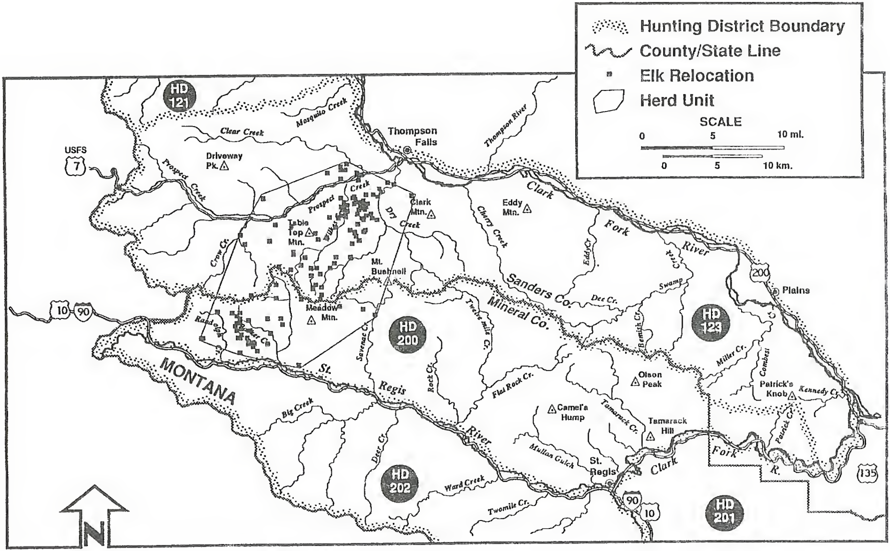

Figure 7. Composite yearlong range of cow elk in the Wilkes Creek herd unit, 1986 - 1990.

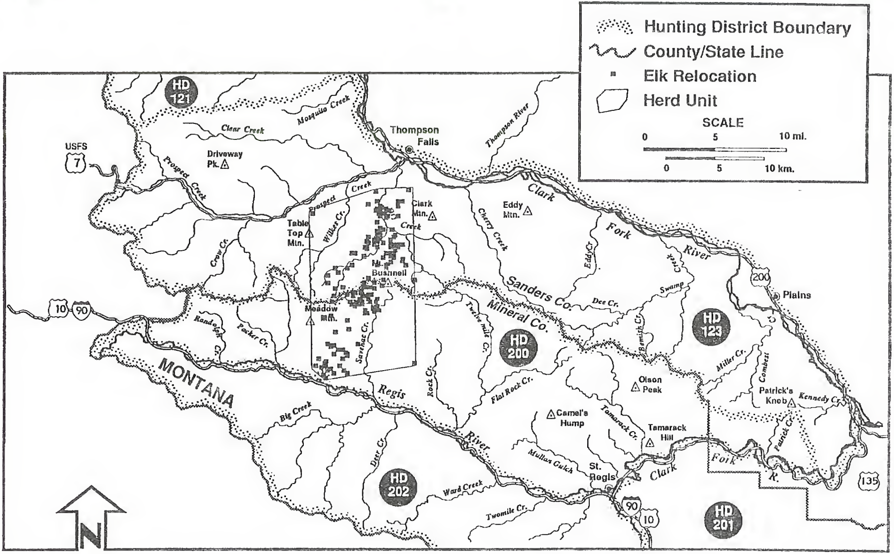

Figure 8. Composite yearlong range of cow elk in the Dry Creek herd unit, 1986 - 1990.

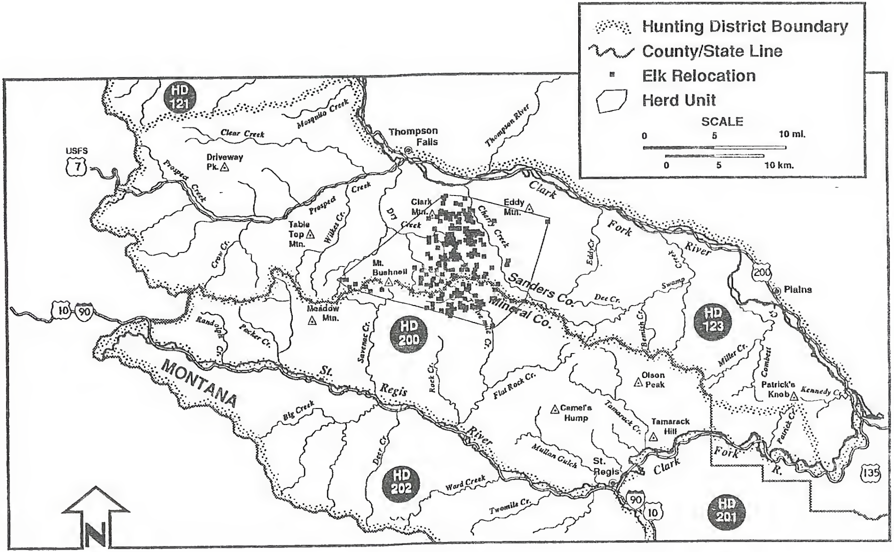

Figure 9. Composite yearlong range of cow elk in the Clark Mtn. herd unit, 1986 - 1990.

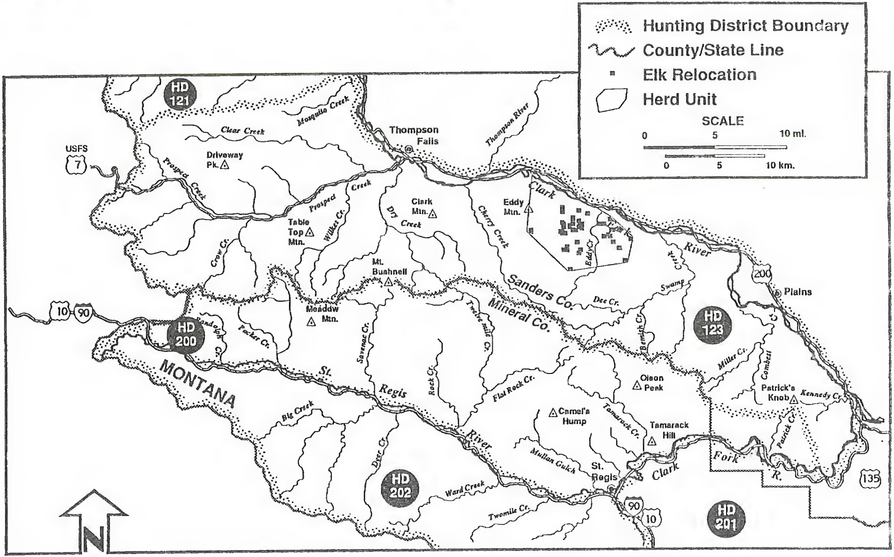

Figure 10. Composite yearlong range of cow elk in the Eddy Creek herd unit, 1986 - 1990.

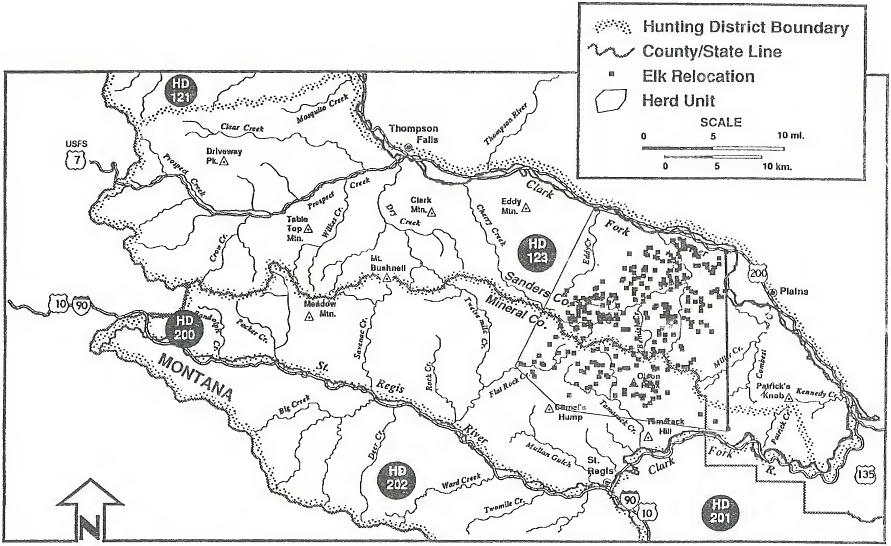

Figure 11. Composite yearlong range of cow elk in the Swamp Creek herd unit 1986 - 1990.

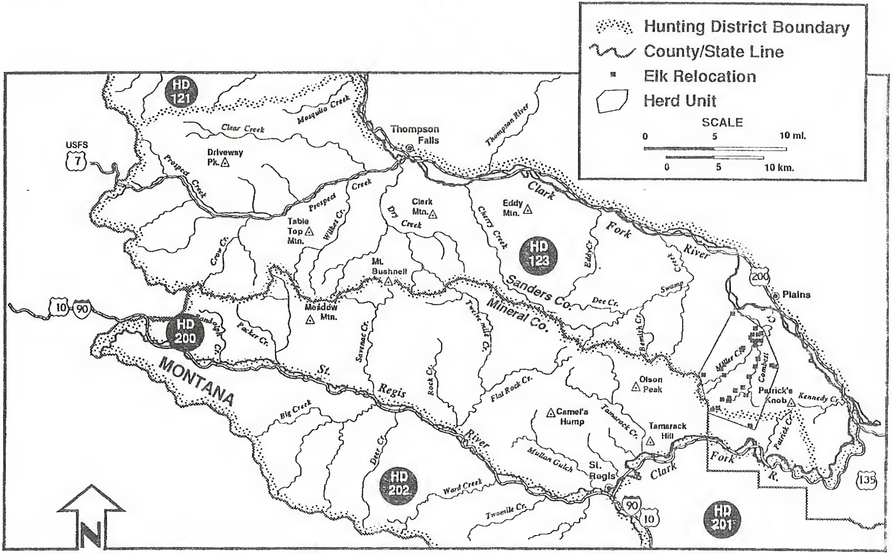

Figure 12. Composite yearlong range of cow elk in the Miller Creek herd unit 1986 - 1990.

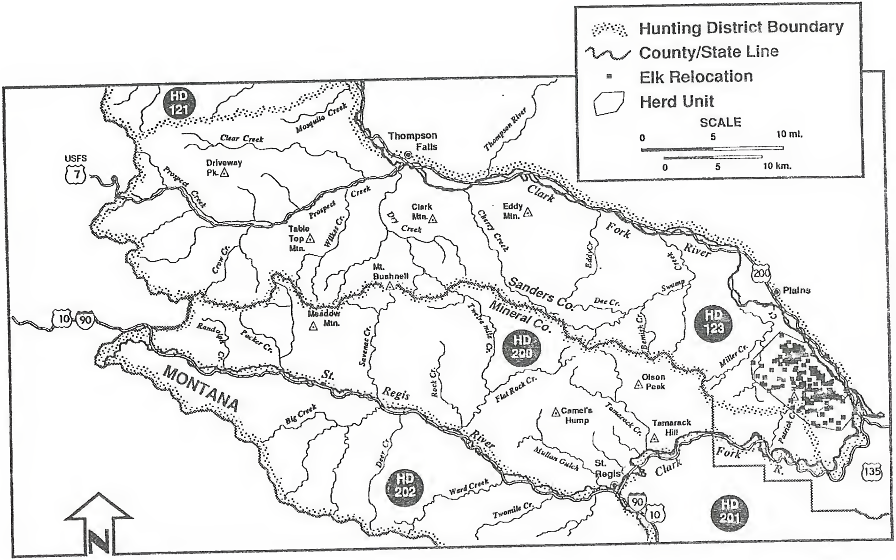

Figure 13. Composite yearlong range of cow elk in the Pat's Knob herd unit, 1986 - 1990.

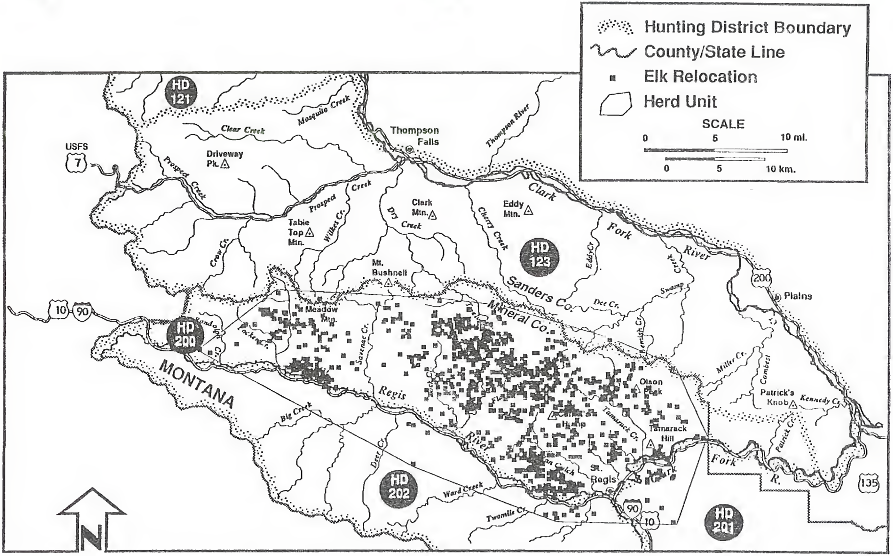

Figure 14. Composite yearlong range of cow elk in the Boyd - Tamarack Creek herd unit, 1986 - 1990.

Herd units were defined by radio locations of cows and calves that shared a specific geographical area that met their annual habitat requirements (Edge et al. 1986). Herd units are named for the particular winter range areas that those elk had in common (Table 2 and Fig. 5). Typically herd units do not overlap during the winter months, but may partially overlap during other seasons. Herd unit size (Table 2) and distribution (Fig. 6, 7, 8, 9, 10, 11, 12, 13, 14) varied considerably.

Our data indicated that movement patterns of many adult bulls (2+years-old) were substantially different than those of cows, calves and yearling bulls with which they shared winter ranges (Lemke and Henderson 1987). To a large degree earlier evaluations were supported by additional data collected after 1987. It appeared that mature bulls, particularly 2-year-olds, were the most likely population segment to act as dispersers and, therefore, not suitable for defining herd unit boundaries (see Seasonal Movements).

It was interesting to note that 8 of the 9 herd units occurred in HD 123 north of the C-C Divide, while elk wintering in HD 200 belonged to a single Boyd-Tamarack herd unit.

Seasonal Movements-HD 123

Elk winter ranges for the 8 herd units in HD 123 are primarily distributed from east to west with minor overlap between the Prospect and Wilkes Creek herd units (Fig. 6,7). In the eastern 1/3 of HD 123 winter ranges occur on lower elevation south-facing slopes from Pat's Knob to Miller Creek, from Swamp Creek to Sheep Gap, and around the mouth of Eddy Creek. A large portion of the winter range is located on private agricultural land and corporate-owned forest land. In Figure 5 the southern extention of the Swamp Creek winter range was exaggerated by early spring (March) movements of one cow. By comparison, the majority of elk wintering in the western 2/3 of the hunting district (west of Eddy Cr.) are on National Forest Lands in Knox Creek, Joan Creek, Dry Creek, Wilkes Creek, Clear Creek, Mosquito Creek, and on the north side of Prospect Creek from Valentine Gulch to Therriault Gulch. Generally, elk showed strong fidelity to a particular winter range through the course of the study, returning annually to the same wintering area. A few marked elk occasionally travelled between Wilkes Cr. and Prospect Cr. winter ranges.

Cow movements

Cow and calf migration from winter ranges to higher elevation summering areas usually occurred from early March through April and May (Fig. 15,16). The timing was dependent on snow depth in transitional areas, weather, and the emergence of new vegetation.

Elk that wintered south of Plains in the Swamp Cr. and Miller Cr. areas generally moved south to upper elevations, and approximately 30-40% of the radio-collared cows crossed the C-C divide to summer ranges in tributaries of Flatrock and Tamarack Creeks. Routes heavily used by elk residing south of Plains included Miller Creek, Bemish Creek, Swamp Creek, and Arvilla Ridge (Fig. 15).

During the calving season (May 15-June 10) adult cow elk were in the Sheep Gap area, lower elevations in Swamp Creek, East Fork Swamp Creek, Poacher Gulch, Dee Creek, Bemish Creek, Combest Creek, Miller Creek and above the private agricultural land on the mid-elevation slopes of Pat's Knob (Fig. 18). With very few exceptions cow elk wintering in the eastern 1/3 of HD 123 selected calving sites north of the C-C Divide.

Summer ranges were located on mid to upper elevations on Pat's Knob and the head of drainages and upper elevations along the C-C Divide. The Eddy Creek Herd Unit summered at high elevations in Poacher Creek and Quartz Creek (Fig. 19).

Elk that wintered in the western 2/3 of HD 123 generally exhibited southwesterly movements to higher elevation summer ranges near the C-C Divide (Fig. 16). Many of those elk crossed the C-C Divide to summer ranges in the western half of HD 200. However, some Prospect Creek elk in upper Crow, Wilkes, Dry, and Knox Creeks moved very little and summered on and near their winter ranges. Geographic saddles and passes are well-used migration corridors (Fig. 16). In HD 200, Brimstone, Randolph, Packer, McManus and Savenac Creeks were commonly used as summer ranges for some elk wintering in the Prospect area.

Many May and June calving season relocations occurred in Brush Gulch, Hill 7, Knox Creek, Trapper Cabin, and Hemlock Mountain areas. Less frequently used areas selected by cow elk were the South Fork of Wilkes Creek, West Fork of Dry Creek, Crow Creek, Clark Mountain, and Savenac Creek in HD 200 (Fig. 18).

Hunting season security areas were mostly in upper elevation drainages and ridges generally greater than one mile from an open road (Fig. 20). Migration from summer range to lower elevation winter range occurred during November or December, the timing dependent on temperatures and snow accumulation. Travel corridors were similar to those used during the spring migration.

Most cow elk radio-tagged in HD 123 were relocated in the study area. Some exceptions were notable. A cow (1575) from the Pat's Knob Herd Unit traveled north across the Clark Fork River and Highway 200 to spend one to two months in HD 122 around Paradise Gulch before returning to the Pat's Knob area. Another 2 year-old cow (0157) was shot on the Idaho side of Mullan Pass in mid-September, after being trapped the previous March in Therriault Gulch in HD 123.

Emigrating cows, those that permanently left their herd units, were notable, because most cow elk repeatedly returned to the same winter ranges. Cow (0012), captured in Sheep Gap (HD 123) in January 1987 as a two year old, summered along the C-C divide near Drury Peak in HD 200 in 1987. She returned the following winter to Combest Creek (HD 123). Then in 1988 and 1989, she was relocated in Tamarack Cr.(HD 200) during winters and summers, never returning to HD 123.

A second emigrating cow (0914), was captured in W. Fk. Dry Cr. (HD 123) in February 1987 as a 3+ year-old. The following summer she was in the Meadow Mtn. area(HD 200), and she remained in HD 200 between Timber and Savenac Creeks that winter. During the 1988

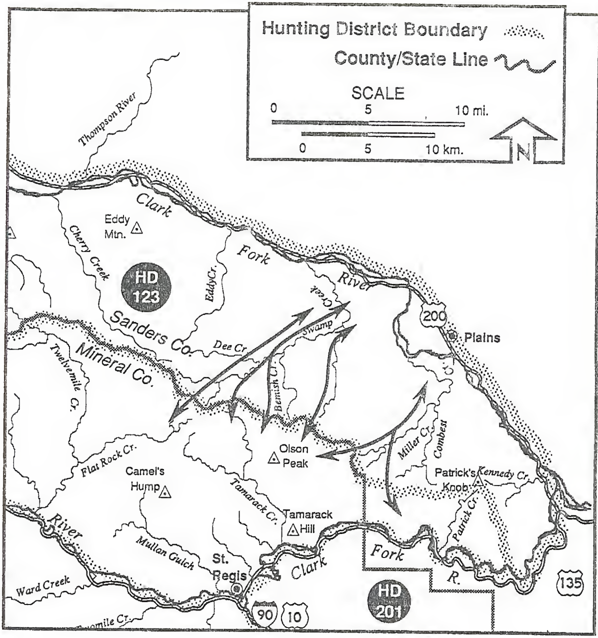

Figure15. Migration corridors for elk crossing the east end of the C-C Divide.

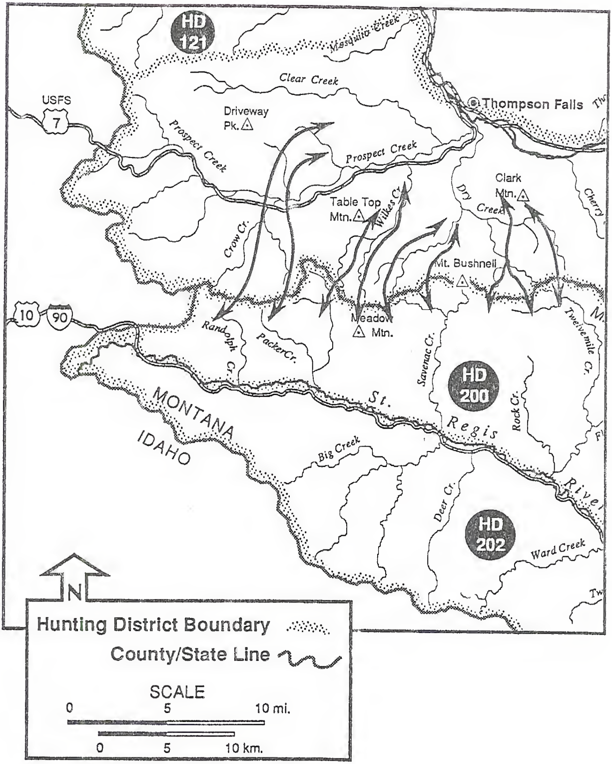

Figure16. Migration corridors for elk crossing the west end of the C-C Divide.

summer she was relocated between Savenac and Packer Creeks, until she was legally harvested in Savenac Creek that fall.

Most remarkable is the long distance movement of a cow (1067), captured as an adult in Therriault Gul. (HD 123) in March 1987. This animal subsequently was harvested in November 1991 near Sheep Mtn. (HD 283), some 90 air miles from her capture site. Unfortunately, no radio locations were available to further document this rare record of a long distance emigration for an adult cow elk.

Bull movements

Movement of bull elk was strongly related to the individual's age. Five radio-collared bull calves and 3 radio-collared yearling bulls followed very similar movement patterns as those for the cow elk with which they wintered.

One exception was a bull calf (0925). Captured in Miller Creek in HD 123, it summered as a yearling around Combest Peak and wintered that year in the Mayo Gulch-Wolf Creek area in HD 200.

In contrast, seasonal movements of older bulls (2+ years-old) often did not follow those of radioed cows with which they wintered (Fig. 17). Adult bulls generally utilized higher elevations than cows, calves and yearling bulls throughout the year and began upward migrations to summer ranges earlier in the spring (Fig. 23). Their unpredictable and sometimes long distance movements made relocations difficult and resulted in fewer summer range locations. Two adult bulls (0370, 0502) did move to the same summer range, as

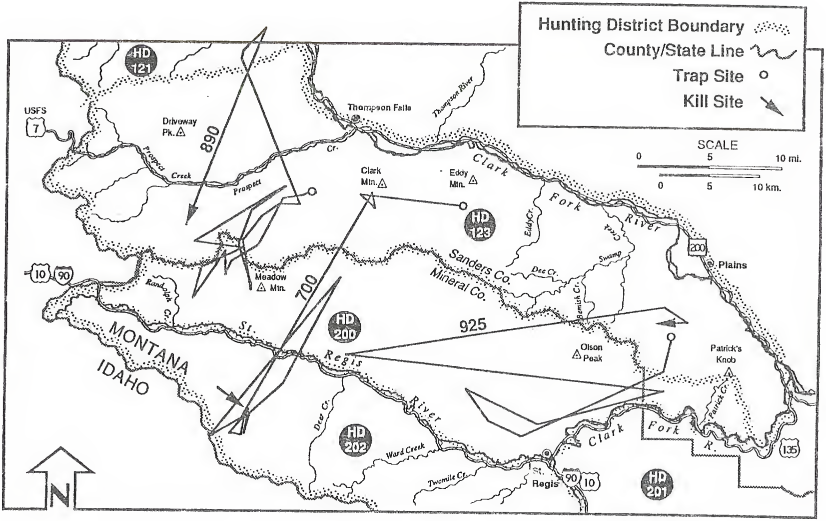

Figure17. Movements of 3 migrating bull elk captured in HD 123

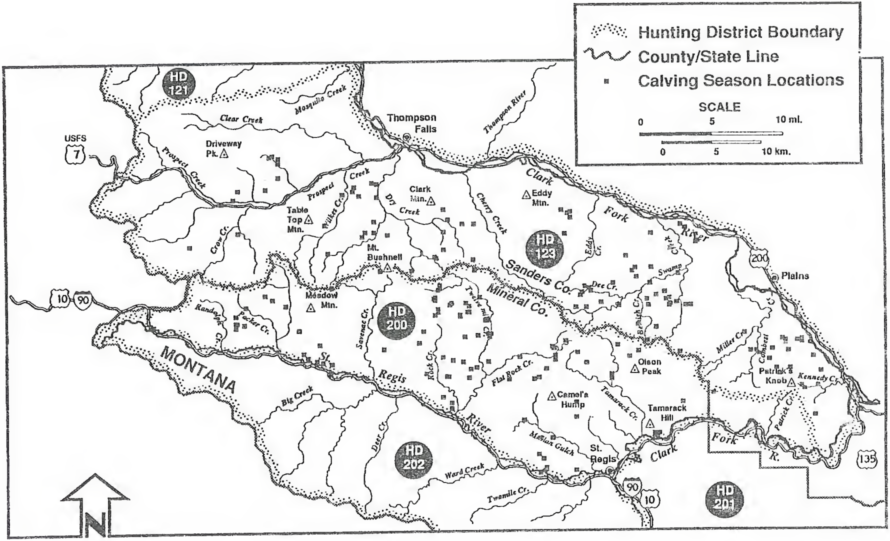

Figure18. Calving season locations (May 15 - June 10) for 82 adult cows in the Lower Clark Fork Study Area, 1986 - 1990.

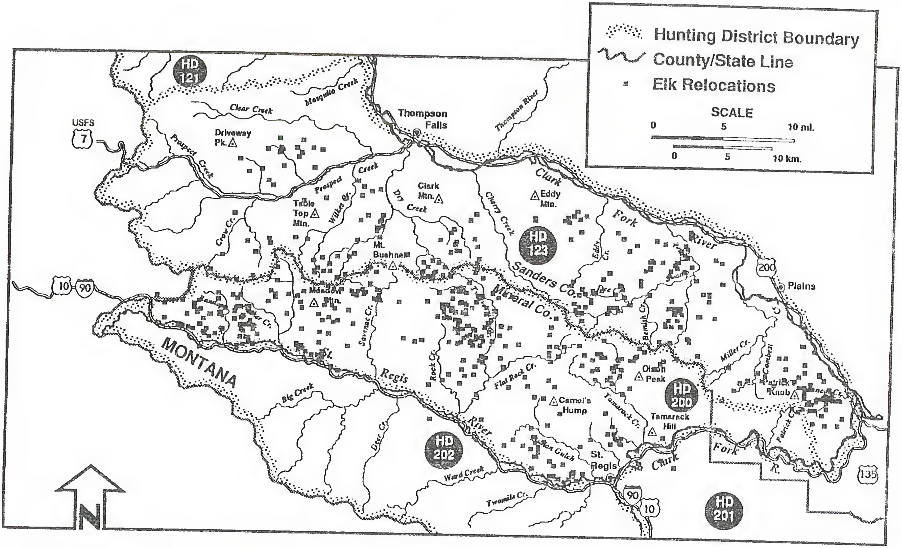

Figure 19. Summer range locations (June 30 - Sept. 30) for cows and calves in the Lower Clark Fork Study Area, 1986 - 1989.

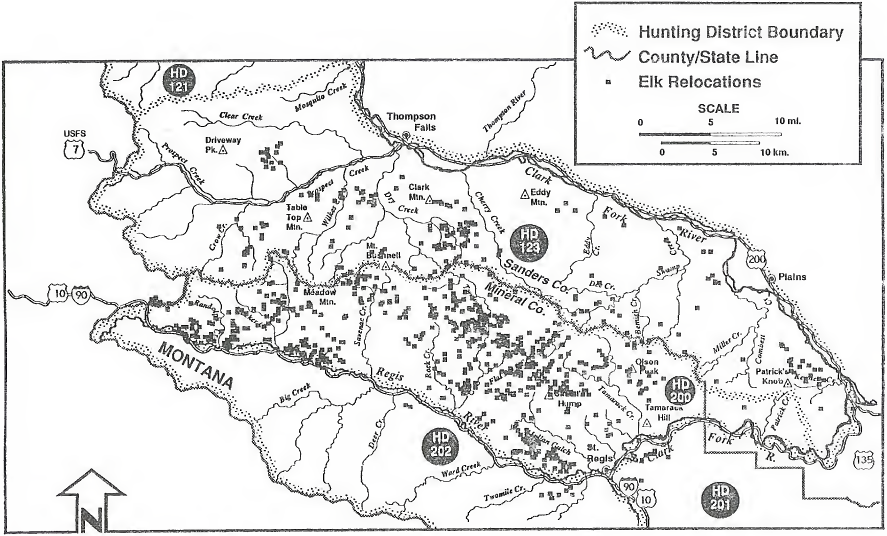

Figure 20. Early hunting season elk security areas used from Oct. 15 - Nov. 5, 1986 - 1989.

those occupied by the cows with which they shared winter ranges. However, four adult bulls had different movement patterns.

Bull (0700) was captured in HD 123 on Clark Mountain as a 2 year-old, summered south of Interstate Highway 90 on Gilt Edge Ridge in HD 202 and was shot in nearby W. Fk. Big Creek. During his migration from winter to summer range, this bull left behind the summer range occupied by the cows with which he wintered, passed through the summer range occupied by cows in the Boyd-Tamarack herd unit, and spent the summer and fall with an elk herd adjoining, but socially distinct from the Boyd-Tamarack elk.

Emigrating bulls were noted. A bull calf neckbanded in Combest Creek (HD 123) was shot as a 2.5 year-old near Arlee, Montana in the North Fork of Valley Creek on the Flathead Indian Reservation, 34 air-miles northwest from its capture site.

Yearling bull (0890) was captured on Hill 7 (HD 123), summered in Packer Creek (HD 200) and Crow Creek (HD 123), was not found for most of 1989, but was relocated on winter range in Little Beaver Creek and Rock Hill in HD 121, 10 miles northwest of its original winter range. This adult bull was not found again in the summer of 1990 and was subsequently shot that fall around Mosquito Peak in HD 121, as a 4.5 year-old (Fig. 17).

Bull calf (0925) was captured in Miller Creek in HD 123. As a yearling, it spent the summer around Combest Peak, then wintered in Mayo Gulch and Wolf Creek (HD 200). The following summer, as a 2 year-old, it was relocated again around Combest Peak and the upper Miller Creek drainage. Although this bull's radio apparently failed in July 1990, it was shot that September on Mineral Ridge in HD 200, 15 air miles west of its last relocation in June (Fig. 17).

Seasonal Movements - HD 200

Elk generally wintered at lower elevations on south-facing slopes from Camel's Hump to Mayo Gulch and Butler Creek, from Tamarack Creek to Sesame Creek, and on Boyd Mountain (Fig. 5). During mild portions of the winter, a few elk were found on Henderson Hill and in Middle Rock Creek, East Fork 12-Mile, Lower Flatrock and the Burnt Flats area of Tamarack Creek. The winter range in Figure 5 was exagerated by early spring (March) westerly movements of one cow to Timber Creek. Elk generally returned to the same wintering sites.

Cow movements

As cold weather and snow gave way to warmer temperatures and the regrowth of vegetation, cows and juveniles that wintered from Boyd Mountain to Seven-mile Creek moved west and north. Heavily used areas during the calving season (May 15-June 10) were Flatrock, Middle Rock, and Mineral Mountain Creeks (Fig.18). By early summer many were on summer ranges in Flatrock, Mineral Mountain, Trapper Cabin, and Cruzane Creeks (Fig. 19). Most elk wintering on the eastern end of Boyd Mountain remained there during the summer in proximity to irrigated hay meadows (Fig. 19).

Migratory routes followed a southeast to northwest direction (Fig. 21). Flatrock Creek, Middle Rock Creek and the ridge complexes between East Fork 12-Mile Creek and Breen Creek were heavily used as elk travelled between low elevation winter/spring

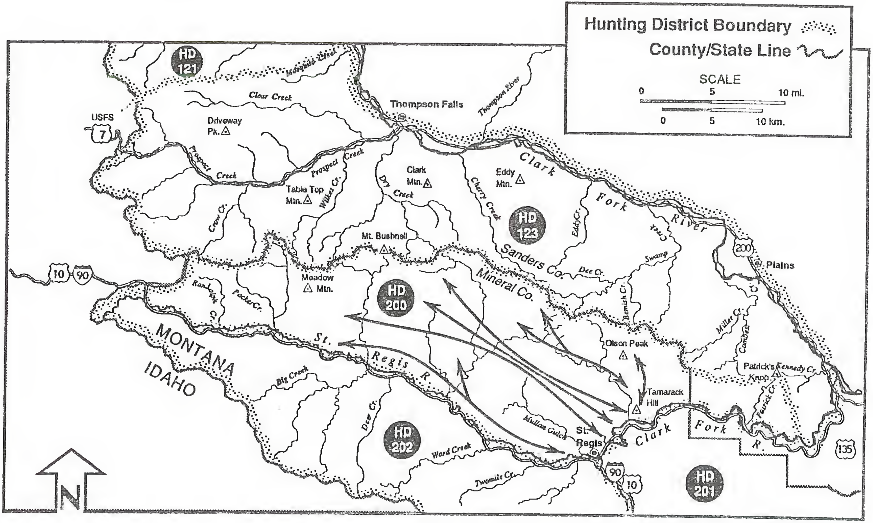

Figure 21. Migration routes followed by elk in the HD200 Boyd Mtn.-Tamarack Creek elk herd unit.

range to higher summer ranges in the Cruzanne Mtn. and Brooks Mtn. areas. Those movements were not confined to specific mountain passes or saddles, as seen in HD 123. Cows, calves and yearling bulls wintering in HD 200 did not cross the C-C divide to enter HD 123. Overlap of annual herd unit home ranges of elk wintering in HDs 123 and 200 resulted from movements of HD 123 elk to summer ranges south of the C-C Divide.

While most of the radioed elk remained east of Twin Creeks, there were exceptions. For example, 7 radio-tagged cows (17% of radioed females) journeyed 20-25 miles from winter grounds in Wolf Creek and Mayo Gulch to summer range around Cruzanne and Hemlock Mountains. Three others (7% of radio-tagged females) moved south of the St. Regis River to summer in HD 202, between Little Joe and Big Creeks. One cow, summering in Tamarack Creek, occasionally crossed the Clark Fork River into HD 201 to use the Mill Creek area.

Movements from summer range to winter range typically occurred during the fall hunting season or later in December. Hunting season security was noted primarily in the Brooks Mtn., Flatrock Cr., Camel's Hump, and Boyd Mtn. areas (Fig. 20). Those movements of elk returning to winter ranges were most concentrated in the Flatrock Creek and Camels Hump areas during the hunting season.

One cow elk radio-tagged in HD 200 permanently left the Boyd-Tamarack herd unit. Adult (>3 years-old) cow (0120) was captured in Mayo Gulch in 1986, moved that summer to Big Creek in HD 202, and was relocated there for 3 years before being harvested.

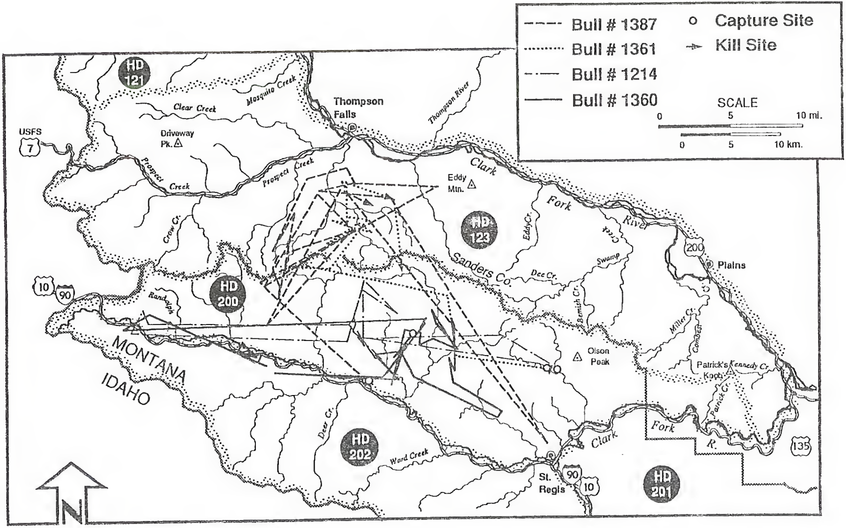

Figure 22. Movements of 4 migrating bull elk (1387, 1361, 1214, and 1360) captured in HD 200.

Bull movements

Seasonal movements of bull elk partially overlapped the movement of cows with which they wintered (Fig. 22). Again, bull movement patterns were related to the individual's age. Bull calves (1788, 1467, 0104, 0674, 0078, 1720, 1701, and 1523) and yearling bulls (0103, 1467, 0104, 0674, 0078, 1720, 1701, and 1523) followed the same patterns described by cow elk wintering in HD 200.

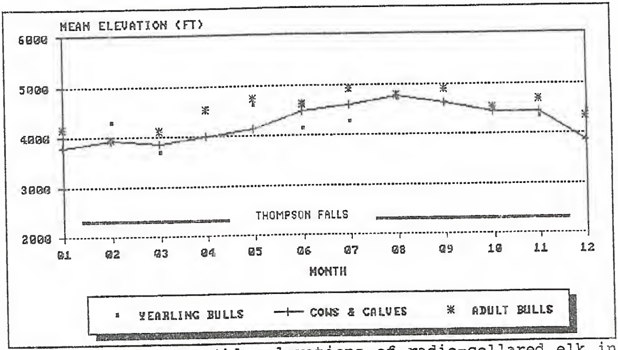

Figure 23. Mean monthly elevations of radio-collared elk in study area, 1985-1990.

Adult bulls (≥2 years-old) generally used higher elevations than cows, calves and yearling bulls during all seasons and began upward elevational movements earlier in the spring (Fig. 23).

Seasonal movements of older bulls did not necessarily follow those made by cows with which they wintered (Fig. 22). Six adult (2+ years-old) bulls (1539, 1164, 1467, 0136, 1701, and 0674) did go to the same summer ranges. However, 4 other adult bulls which wintered in HD 200 summered with cows from the Prospect Herd Unit in Dry Creek (1387 and 1361) and Brimstone Creek (1214 and 1360).

Additionally, 6 bulls (1301, 0104, 0078, 1436, 1788, 1344), upon turning 2 years-old, were not relocated within the study area. Most often we lost contact with these 2 year-olds in June. Radio failure could have accounted for some of these disappearances. Nevertheless, two of those bulls (1344 and 1788) were later harvested in the St. Joe River and Sandpoint areas of Idaho, 70-90 mi from where they were radio-tagged, and the collar from a third bull (0104) was found by an Idaho hunter near 4th of July Pass, about 35 airmiles west of the study area.

Road Densities and Elk Use Patterns

A 560 mi^2 analysis area, defined by elk relocations in only HDs 123 and 200, contained 747 mi of roads in all classes (Table 3) for an average road density of 1.33 mi of road/mi^2. When seasonal and permanently closed roads were omitted, the open road density decreased to an average of 0.88 mi/mi^2. Evidently, very few tertiary roads remain open. Thirty percent of the total road map and 46% of the open road map were classified as unroaded (0 mi/mi^2) (Table 4). Unroaded habitat occurred in only 3-4 large habitat patches of variable size, so that road densities were higher in the roaded areas than the above averages might imply.

Male and female elk responded differently to open road densities during most seasons. Bull elk showed a greater reluctance to use higher road density habitats thoughout the year (Table 5). In all seasons, bulls avoided road densities >0.5 mi/mi^2. Bulls showed the strongest preference for zero road density habitats during the archery and general hunting seasons. The seasonal relationship for the use of roadless areas by bulls appears in Figure 24.

Cow elk were more evenly distributed throughout the study area in a wider variety of road densities than bull. During the winter cows generally confined their activities to road densities <1.5 mi/mi^2 (Table 6). During spring and summer, habitats having open road densities of up to 3 mi/mi^2 were used greater or equal to availability. Although cow elk preferred to be in areas with zero road density during summer, archery and general hunting seasons, they were present as expected in habitats with road densities of up to 1.5 mi/mi^2. Seasonal use patterns by cows of roadless areas are displayed in Figure 25.

Thirty-four percent of the study area roads were closed on either a seasonal or year-long basis. By looking at elk locations in relation to the total road system, it is possible to determine, if elk were using habitats adjacent to closed roads.

Road Class	Number miles in study area
Primary Open	248.02
Secondary Open	243.79
Tertiary Open	1.15
Seasonal/yearlong closed	254.34
Total	747.3

Table 3. Miles of road in the Lower Clark Fork Study Area.

Road Density (mi/mi^2)	Percent of Study Area	
	All Road Map	Open Road Map
0	33.52	46.36
0-0.5	9.87	48.47
0.5-1.0	10.03	2.42
1.0-1.5	14.72	1.71
1.5-2.0	9.71	0.73
2.0-2.5	7.72	0.22
2.5-3.0	5.26	0.09
>3.0	9.16	0.01

Table 4. Percent of study area occurring in various road density levels.

Road Density (mi/mi^2)	Seasonal Use by Bull Elk				
	Winter	Spring	Summer	Archery	General
0.0	=	=	+	+	+
0.0-0.5	=	=	-	-	-
0.5-1.0	-	-	-	-	-
1.0-1.5	-	-	-	-	-
1.5-2.0	-	=	-	-	-
2.5-3.0	-	-	-	-	-
>3.0	-	-	-	-	-

+ = preferred, = = used as available, - = avoided
based on simultaneous Bonferroni C.I. (95%)

Table 5. The availability and use of road density classes by bull elk in the Lower Clark Fork Study Area. Open road density only.

Bull elk preferred to be in zero road density habitats when their locations were overlaid on both the open road map (Table 5) and the total road map (Table 7). By comparing Tables 5 and 7, differences in habitat use occur in road densities of 0.0-0.5 and 1.0-1.5 mi/mi^2. In table 5 it is apparent that bull elk avoid open road habitats throughout the year. However, in Table 7 it clearly shows that bulls were using the medium road densities even during the hunting seasons. This suggests that bulls were "regaining" lost habitats found behind gated roads.

Cow elk also preferred habitats with zero road density (Table 6). However, no such strong preference was shown by cows, when all roads were considered; nearly all road densities were used as available (Table 8). Like bulls, cow elk were using habitats where roads had been closed.

Road Density (mi/mi^2)	Seasonal Use by Cow Elk				
	Winter	Spring	Summer	Archery	General
0.0	=	=	+	+	+
0.0-0.5	+	=	+	=	=
0.5-1.0	=	+	=	=	=
1.0-1.5	=	=	-	=	=
1.5-2.0	-	=	=	-	-
2.0-2.5	-	=	=	-	-
2.5-3.0	-	=	=	-	-
>3.0	-	-	-	-	-

+ = preferred, = = used as available, - = avoided
based on simultaneous Bonferroni C.I. (95%)

Table 6. The availability and use of road density classes by cow elk in the Lower Clark Fork Study Area. Open road densities only.

We did not attempt to evaluate other factors influencing habitat selection, such as population levels, forage availability, cover, topography and proximity to water.

Road Density (mi/mi²)	Seasonal Use by Bull Elk				
	Winter	Spring	Summer	Archery	General
0.0	=	=	+	+	+
0.0-0.5	=	=	=	=	=
0.5-1.0	=	=	=	=	=
1.0-1.5	=	=	=	=	=
1.5-2.0	=	=	=	=	-
2.0-2.5	=	=	-	=	-
2.5-3.0	=	=	=	-	-
>3.0	=	=	-	-	-

+ = preferred, = = used as available, - = avoided
based on simultaneous Bonferroni C.I. (95%)

Table 7. The availability and use of road density classes by bull elk in Lower Clark Fork Study Area. All roads included.

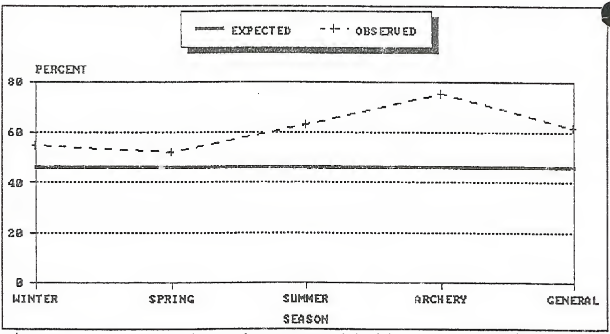

Figure 24. Seasonal preferences of bull elk for habitats with zero road density, expressed as percent use of zero road density habitats.

Road Density (mi/mi²)	Seasonal Use by Cow Elk				
	Winter	Spring	Summer	Archery	General
0.0	-	-	=	=	=
0.0-0.5	=	=	=	=	=
0.5-1.0	=	=	=	=	-
1.0-1.5	+	=	=	=	=
1.5-2.0	=	=	=	=	=
2.0-2.5	=	=	=	=	=
2.5-3.0	=	=	=	=	=
>3.0	=	=	=	=	-

+ = preferred = = used as available - = avoided
based on simultaneous Bonferroni C.I. (95%)

Table 8. The availability and use of road density classes by cow elk in Lower Clark Fork Study area. All roads included.

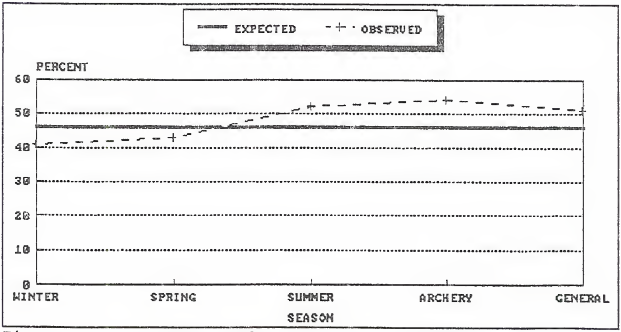

Figure 25. Seasonal preferences of cow elk for habitats with zero road density, expressed as precent use of zero road density habitats.

Elk Mortality

During the 1985-1990 study period, the cause of death was recorded for 56 marked (eartagged, radio-tagged, or neckbanded) elk within the study area (Fig. 26). Legal hunter harvest accounted for 40 (71%) of these. Another 4 (7%) elk were legally harvested outside the study area.

Of the 26 marked bulls verified as being dead during the study, 3 (12%) were harvested outside the study area, after having left it as 2 year-olds. Only 1 (3%) of 31 dead, marked cows was harvested outside the study area.

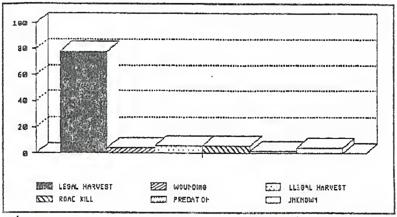

Figure 26. Causes of mortality for 56 marked elk, expressed as percent of known mortality.

Other causes of death included wounding (4%), during both bow and rifle seasons, illegal harvest (6%), and collisions with motor vehicles (6%). Other causes of death, including predation and winter kill, were negligible.

Only one of the marked elk was known to have been harvested by bowhunters, despite the popularity of the area with archers. Members of the Confederated Salish/Kootenai Tribe hunted and harvested elk within the study area, but the only ear-tag return obtained from tribal hunters was from a bull captured in HD 123, taken by a tribal hunter west of Arlee on the Flathead Reservation.

Bull Mortality

The observed annual weighted harvest rate was 40.5% (SE=13.07, Var.=1195.25) for a pooled sample of bulls radioed in both HDs (Fig. 27). By age-class, harvest rates were 20% (N=15 elk years) of the yearling bulls, 53.8% (N=13 elk years) of the 2-year-old bulls, and 55.5% for the older bulls (Fig. 28). Harvest rates of radio-collared bulls at least 2 years-old (54.5%) were significantly higher than for yearling (spike) bulls (20%) (X^2=4.41, df=1, .05>p>.025) (Appendix 8).

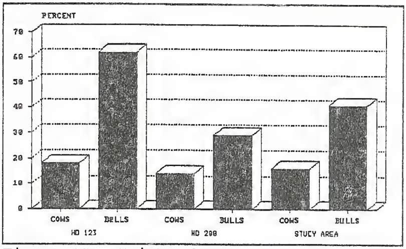

Figure 27. Weighted annual harvest rates for radio-collared bulls and cows in HD 123, HD 200, and both HD's combined.

We obtained eartag returns for 26 (76%) of the 34 bulls captured in the study area (Appendix 1, 2, 3). Based on this sample, legal harvest accounted for 73% of the known mortality. Other sources of mortality included wounding, vehicle accidents, and predation.

HD 123

Of 13 bull elk captured in HD 123, 11 (85%) were known to be dead by the end of the 4-year study. Seven were harvested by hunters in the study area. One bull calf was killed by a mountain lion in March, one month after capture. One bull died in September in Crow Creek, possibly wounded during the archery season. Another

3 year-old bull was shot and abandoned by hunters in Big Creek (HD 202). A neckbanded bull was harvested by a tribal member in North Valley Creek on the Confederated Salish-Kootenai Indian Reservation, approximately 35 miles from the study area. The fate of 2 neckbanded bulls was unknown.

A 61.5% (N=13 elk years) harvest rate was found in the pooled sample antlered bulls radio-tagged in HD 123 (Table 9). The harvest rates were 50% (N=4 elk years) for yearling bulls, 60% (N=5 elk years) for 2 year-olds, and 75% (N=4 elk years) for 3-year and older bulls (Table 10).

HUNTING SEASON	1986	1987	1988	1989	1990	POOLED SAMPLE T[illegible]
# ALIVE (beginning season)	1	4	3	3	2	13
# HARVESTED	1	3	1	1	2	8
% HARVESTED	100	75	33.3	33.3	100	61.5

Table 9. Annual harvest of bulls radio-collared in HD 123.

HD 200-Of 21 bulls captured in HD 200 between 1984 and 1988, 10 (50%) were harvested by hunters in the study area, 2(10%) were legally harvested in Idaho, 1(5%) was shot and not retrieved, 1(5%) was killed by a vehicle, and 1(5%) was a trapping mortality. The fates of 6 other marked bulls are unknown.

	AGE (YRS.)			
	1.5	2.5	>3.0	TOTAL
# ALIVE-beginning season (pooled sample)	4	5	4	13
# HARVESTED	2	3	3	8
% HARVESTED	50	60	75	61.5

Table 10. Harvest rates of 3 age-classes of bulls radio-tagged in HD 123.

HUNTING SEASON	1984	1985	1986	1987	1988	1989	POOLEDSA MPLETOTA L
# ALIVE (beginning season)	4	6	6	4	3	1	24
# HARVESTED	0	1	1	3	1	1	7
% HARVESTED	0	12.5	12.5	75	33.3	100	29.2

Table 11. Annual harvest of bulls radio-tagged in HD 200.

	AGE (YRS.)			
	1.5	2.5	>3.0	TOTAL
# ALIVE-beginning season (pooled sample)	11	8	5	24
# HARVESTED	1	4	2	7
% HARVESTED	9.1	50	40	29.2

Table 12. Harvest rates of 3 age-classes of bulls radio-tagged in HD 200.

The annual harvest rate was 29.2% (N=24 elk years) for the pooled sample of antlered bulls radio-tagged in HD 200 (Table 11), significantly lower (X^2=3.58, df=1, .10>p>.05) than the harvest rate observed for bulls radio-collared in HD 123 (Appendix 7). The harvest rates were 9.1% (N=11 elk years) for yearling bulls in this sample, 50% (N=8 elk years) for 2 year-olds, and 40% (N=5 elk years) for 3+ year-old bulls (Table 12).

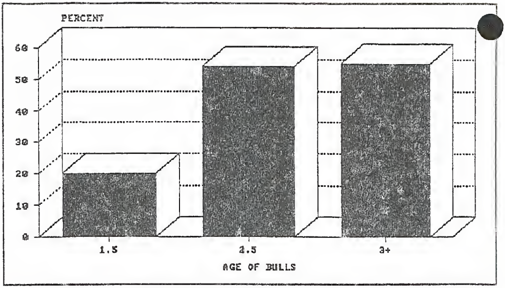

Figure 28. Hunting season mortality rates for 3 age-classes of bulls in the study area.

Cow Mortality

The annual weighted harvest rate for for the pooled sample of radio-tagged cows in the study area was 16% (SE=4.23, Var.=125.41)(Fig. 27).

We had eartag returns for 31 (22%) of the 142 cows captured during the study. Over 70% were legally harvested in the study area. Other sources of mortality included wounding loss, illegal harvest and collisions with motor vehicles.

HUNTING SEASON	1986	1987	1988	1989	1990	POOLED SAMPLE TOTAL
# ALIVE (beginning season)	21	31	26	9	8	95
# HARVESTED	4	6	7	0	0	17
% HARVESTED	19	19.4	26.9	0	0	17.9

Table 13. Annual harvest of cows radio-tagged in HD 123.

	EAST	WEST
# ALIVE-beginning season (pooled sample)	43	52
# HARVESTED	7	10
% HARVESTED	16.3	19.2

Table 14. Harvest rates of cows radio-tagged in eastern and western portions of HD 123.

HUNTING SEASON	1984	1985	1986	1987	1988	1989	POOLED SAMPLE TOTAL
# ALIVE (beginning season)	2	14	29	31	8	2	86
# HARVESTED	0	0	3	5	3	1	12
% HARVESTED	0	0	10.3	16.1	37.5	50	13.9

Table 15. Annual harvest of cows radio-collared in HD 200.

HD 123

Out of 53 cows, captured and marked in HD 123, 14 (26%) were known to have died during the study period. Causes of death included legal harvest within the study area (71%), legal harvest in Idaho (7%), and illegal harvest (21%) in the study area.

The annual harvest rate for the pooled sample (N=95 elk years) of cow elk radio-tagged in HD 123 was 17.9% (Table 13). The harvest rate for cows radioed in the eastern third of the district (HD123-EAST), where antlerless permits were available, was 16.3% (N=43 elk years), compared to 19.2% (N=52 elk years) for the western 2/3 of the district (HD123-WEST), where antlerless elk were legal during an 8-day either-sex season (Table 14). The rates of harvest in the two halves of HD 123 were not significantly different (X^2=0.13, df=1, .90>p>.50) (Appendix 10).

HD 200

Of 89 cow elk captured and fitted with eartags and either neckbands or radio collars, 17 (19%) were known to have died during the study period. Causes of death were legal harvest in the study area (76%), wounding (12%), motor vehicle collision (6%), and illegal harvest (6%).

The annual weighted harvest rate was 13.9% (N=82 elk years) for the pooled sample of cow elk radio-tagged in HD 200 and remaining in the study area during the hunting seasons (Table 15).

The harvest rate for cows radio-collared in HD 200 was lower, but not statistically different (X^2=0.52, df=1, .50>p>.10), from that for all cows radioed in HD 123 (Appendix 9). Even though the differences were greatest between the harvest rates of cows radio-tagged in the western side of HD 123 (19%) and in HD 200 (14%), this difference was not significant either (X^2=0.67, df=1, .50>p>.10)(Appendix 9).

Hunter Harvest Survey

Hunter harvest statistics for HD 123 (Table 16) and HD 200 (Table 17) are based on the statewide telephone survey of elk license holders. An average of 343 elk were harvested by 2,162 hunters annually in the study area between 1986 and 1989. Each district averaged between 1,050 and 1,100 hunters annually during the study period. The average annual harvests were slightly higher in HD 200 (Table 16). An estimated 164 (48%) elk were taken in HD 123, while 179 (52%) came from HD 200.

Antlerless elk harvests in HD 123 were characterized by substantial fluctuation, rising and falling over 50% annually.

The 1986-89 average elk harvest in HD 200 was 7% greater than the average for 1980-85. The increase in the antlerless permits accounted for the increased harvest during the study period. The 1988 hunter harvest was much higher than average in both hunting districts. The 1988 elk harvest set a statewide record of an estimated 26,211 elk.

Hunter density averaged 2.9 hunters/mi^2 in HD 123 and 4.6 hunters/mi^2 in HD 200 from 1986 through 1989. For the 1988 and 1989 seasons, an average of 3.5 and 4.7 hunters/mi^2 used HD 123 and HD 200, respectively, reflecting a slight upward trend in the number of elk hunters in the study area.

YEAR	HUNTERS	PERCENT SUCCESS	NO. PERMITS*	HARVEST			
				TOTAL	BULLS	COWS	CALVES
1986	746	17	50	190	94	94	2
1987	958	14	75	132	78	48	5
1988	1343	14	100	194	108	72	10
1989	1337	11	100	142	101	25	15
AVE.	1096	15	81	164	95	60	8

*Permits valid in eastern 1/3 of HD 123; either-sex season for 8 days in western 2/3.

Table 16. Estimated elk harvest in HD 123 from statewide hunter harvest survey, 1986-1989.

YEAR	HUNTERS	PERCENT SUCCESS	NO. PERMIT	HARVEST			
				TOTAL	BULLS	COWS	CALVES
1980	1215	16	100	157	122	27	5
1981	1060	11	100	119	95	17	6
1982	786	19	100	148	112	32	5
1983	1032	9	100	97	65	29	3
1984	1001	22	125	204	148	49	7
1985	893	13	150	114	58	48	7
1986	1057	14	150	149	94	51	4
1987	998	17	150	166	106	53	8
1988	1077	23	175	249	180	62	6
1989	1130	13	175	153	98	50	5
AVE.	1025	16	133	156	108	42	6
1980-85 AVE.	998	15	113	140	100	34	6
1986-89 AVE.	1066	17	163	179	120	54	6

Table 17. Estimated elk harvest in HD 200 from statewide hunter harvest survey, 1980-1989.

Antler Point Distribution

Distribution of antler point configurations, as reported by hunters during harvest surveys, was similar for the two hunting districts (Table 18 and 19). During the 4 hunting seasons, 55% of the bulls harvested in HD 123 had antlers with 2 points or less

ANTLER PTS.	1986 (no.)	1987 (no.)	1988 (no.)	1989 (no.)	TOTAL (no.)	%
1X	23	13	24	19	79	48
2X	4	2	2	3	11	7
3X	4	1	1	3	9	5
4X	7	2	3	5	12	10
5X	12	7	3	7	34	21
6X	3	2	3	5	13	8
7X	0	1	0	0	1	1
TOTAL	53	28	41	42	164	100

*Antler points refer to antler side with fewest number of points.For example, 1X includes 1x1, 1x2, and 1x3 configurations.

Table 18. Antler point* distribution for bull elk harvested in HD 123, 1986-1989.

(configurations characteristic of yearling bulls), while 52% of the bulls harvested in HD 200 had those configurations.

In HD 123 9% of the bulls were reported to have at least 6 points on a side, and in HD 200 8% had at least 6 points. No trend in antler point distribution was apparent for that 4-year period.

ANTLER PTS.	1986 (No.)	1987 (No.)	1988 (No.)	1989 (No.)	TOTAL (No.)	%
1X	20	19	29	18	86	48
2X	2	2	3	1	8	4
3X	0	2	5	2	9	5
4X	4	2	8	7	21	12
5X	9	8	15	8	40	22
6X	1	4	6	2	13	7
7X	1	0	0	1	2	1
TOTAL	37	37	66	39	179	99

[a]Antler points refer to antler side with fewest number of points. For example, 1X includes 1x1, 1x2, and 1x3 configurations.

Table 19. Antler point distribution for bull elk harvested in HD 200, 1986-1989.

Population Estimates

HD 123

No population estimate was attempted for HD 123 in 1986, because of a very small number of marked animals. But for 1987 and 1988 L-P population estimates and 95% C.I.'s ($p<.05$) for elk wintering in HD 123 were 1035±159 and 1136±395, respectively (Table 20). Fewer marked animals resulted in higher standard errors and larger confidence intervals in 1988. The 95% confidence intervals were relatively large, representing 15% and 35% of the population estimates, respectively for the 2 years. From 36 to 42 marked animals available during any one survey.

In 1989, using elk sightability methodology, we estimated that 911±305 elk were wintering in HD 123 (Table 25). Stratified random sampling of 10 units out of 28 subunits in 2 strata resulted in a large confidence interval, 33% of the estimate. The population

		1987	1988
1st Repl.	Elk Observed	497	598
	Marks Observed	21	14
	Marks in Pop.	42	36
	Observ. Index*	50	39
	L-P Estimate	972	1477
2nd Repl.	Elk Observed	487	502
	Marks Observed	21	26
	Marks in Pop.	42	39
	Observ. Index*	50	67
	L-P Estimate	953	779
3rd Repl.	Elk Observed	411	431
	Marks Observed	14	14
	Marks in Pop.	42	39
	Observ. Index*	33	36
	L-P Estimate	1180	1151
Mean Observability Index		44	47
	95% Confidence Interval	±11	±19
Mean L-P Estimate		1035	1136
	95% Confidence Interval	±159	±395

*Observability Index=(#Marks Observed/#Marks in Population)x100.

Table 20. Lincoln-Peterson population estimates for elk wintering in HD 123.

	TOTAL	COW	BULL	CA	SP	RAG	AD.	UNC.
RAW COUNT	263	188	13	58	8	4	1	5
EST. NO.	911	611	68	162	54	9	6	76
90% C.I.	±305	±216	±53	±60	±51	±6	±10	±81

*ELKMONT-2 strata (10 of 28 subunits)

Table 21. Elk population estimate in HD 123 using "ELKMONT" sightability model* in 1989.

estimate resulting from the 1989 sightability survey was lower than either L-P estimate from previous years. The confidence limits about the estimates partially overlapped for all three years (Fig. 29).

HD 200

Population estimates, using L-P methodology, for elk wintering in HD 200 were 814±252 in 1986, 544±136 in 1987, and 627±137 in 1988 (Table 22). Lower standard errors were obtained in 1987 and 1988, when 53 to 65 marked elk were known to be in the population of 409 to 764 elk. The 95% confidence interval represented 15% of the population estimate in 1986, 12% in 1987, and 22% in 1988.

In 1989, using the sightability model, we estimated that 495±82 elk were wintering in HD 200 (Table 23). A stratified random sampling technique was used, in which 12 of 18 subunits were sampled in 3 strata. The confidence interval was not large, 16% of the estimate.

All L-P estimates were higher than that obtained with the sightability model (Fig. 30). The 1986 estimate was substantially higher than those for succeeding years; however, the 1986 estimate was based on a relatively low proportion of the population being marked (5%) and resulted in large standard errors and confidence limits. Although estimates resulting from the two methodologies differed, confidence intervals about the estimates partially overlapped for 1986, 1987, 1988, and 1989.

The elk sightability surveys resulted in an estimated 1,406±387 elk wintering in the study area (both HDs) in February 1989. If the estimated 900 overwintering cows produced 300 surviving calves the following summer (as indicated by observed calf/cow ratios), about 1700 elk would have occupied approximately

613 mi^2 (defined by 2866 radio locations of 82 cow elk) during the summer and fall of 1990 at an average density of 2.77 elk/mi^2.

		1986	1987	1988
1st Rep.	Elk Observed	262	133	274
	Marks Observed	10	15	19
	Marks in Pop.	40	57	53
	Observ.Index*	25	26	36
	L-P Estimate	979	485	742
2nd Rep.	Elk Observed	305	184	195
	Marks Observed	13	23	24
	Marks in Pop.	40	60	61
	Observ.Index*	33	38	39
	L-P Estimate	896	469	505
3rd Rep.	Elk Observed	262	269	249
	Marks Observed	18	24	25
	Marks in Pop.	40	62	65
	Observ.Index*	45	39	38
	L-P Estimate	567	679	634
Mean Observability Index		35	34	38
95% Confidence Interval		±11	±8	±2
Mean L-P Estimate		814	544	627
95% Confidence Interval		±252	±136	±137

*Observability Index=(#Marks Observed/#Marks in Population)X100.

Table 22. Lincoln-Peterson population estimates for elk wintering in HD 200.

	TOTAL	COW	BULL	CALVES	SP	RAG	AD. BULL	UNCL
RAW COUNT	294	163	33	59	25	6	2	33
EST. NO.	495	282	69	100	43	13	13	33
90% C.I.	±82	±62	±28	±23	±14	±9	±14	±1

*ELKMONT-3 strata (12 of 18 subunits sampled)

Table 23. Elk population estimate in HD 200 using "ELKMONT" sightability model.

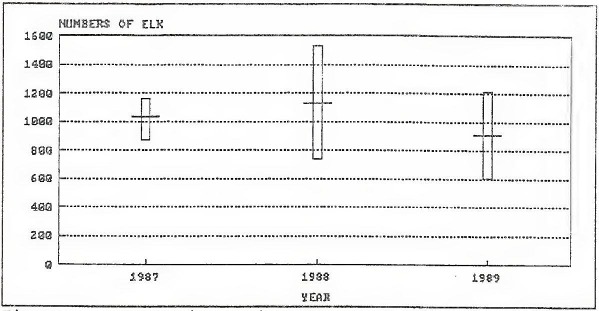

Figure 29. Population estimates and 95% C.I.'s for wintering elk populations in HD 123. 1987-1988 estimates based on L-P Index. 1989 estimate based on "ELKMONT" sightability model.

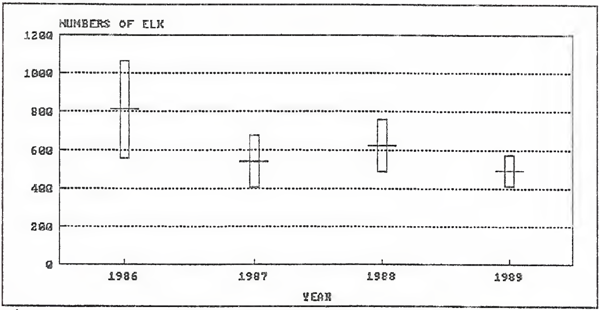

Figure 30. Population estimates and C.I.'s for wintering elk populations in HD 200. 1986-1988 estimates based on L-P Index. 1989 estimate based on "ELKMONT" sightability model.

Elk Observability

Observability of elk, calculated as that proportion of marked animals seen on any one complete winter range survey in each of the HD's, was highly variable (25-67%). Annual mean observabilities from replicated flights, however, were very similar from year to year in each HD. Mean observability values were higher for HD 123 than HD 200.

The observability of elk in HD 123 ranged from 33% to 67% during 6 helicopter surveys made in 1987 and 1988. Mean observability values were 44% and 47% in 1987 and 1988, respectively (Table 20).

The proportion of marked elk observed in HD 200 varied from 25% to 45% during 9 helicopter surveys in 1986, 1987, and 1988. Mean observabilities were 35%, 34%, and 38% for the 3 years, respectively (Table 22). The lower mean observabilities of elk in HD 200 was consistent with higher cover values reported for its winter ranges (Lemke and Henderson 1987).

Calf/Cow ratios

HD 123

Observed ratios of calves/100 cows in HD 123 varied from 31 to 52 for eight surveys flown between 1986 and 1989. The ratios found in 1987 were slightly higher than those in 1986 and 1988. The lowest ratios of 27 estimated and 31 observed calves/100 cows were found in 1989 (Table 24).

HD 200

Productivity was generally lower in HD 200. Observed ratios of calves/100 cows varied from 21 to 42 during 10 surveys conducted from 1986 to 1989. The observed and estimated ratios of 36 calves/100 cows for 1989 were somewhat higher than weighted mean and best count ratios for 1986 and 1987 (Table 25). This contrasts with HD 123 where in 1989 calf/cow ratios were the lowest in 4 years.

Year	Survey #	No.Elk	Calves/100 Cows	Bulls/100Cows
1986	1	400	44	11
1987	1	497	51	15
1987	2	487	49	15
1987	3	411	52	9
1987 mean			51	13
1987 best count			51	15
1988	1	598	49	14
1988	2	502	46	14
1988	3	431	43	19
1988 mean			46	16
1988 best count			49	14
1989	1	263	31	7
1989 estimate*			27±6	11±10

*ELKMONT 90% confidence intervals

Table 24. Elk classifications for HD 123 from direct observations (1986-1988) and sightability model estimate (1989).

Bull/Cow ratios

HD 123

The observed ratio of bulls/100 cows varied from 9 to 19 during 8 surveys in HD 123 (Table 24). Annual mean, best count an estimated ratios varied from 11 to 16 bulls/100 cows in the post season population. Comparison of mean, best count, and ELKMONT estimated ratios indicated very little annual variation during the study period. The "ELKMONT" estimated bull/cow ratio was similar to the directly observed ratio; however, the 90% bound was large, 91% of the point estimate.

Year	Survey#	No.Elk	Calves/100Cows	Bulls/100Cows
1986	1	262	32	31
1986	2	305	28	21
1986	3	262	21	25
1986 mean			27	25
1986 best count			28	25
1987	1	133	31	15
1987	2	184	42	20
1987	3	269	27	16
1987 mean			33	17
1987 best count			27	16
1988	1	274	40	12
1988	2	195	26	27
1988	3	249	24	13
1988 mean			30	17
1988 best count			40	20
1989	1	294	36	20
1989 estimate*			36±9	25±11

*ELKMONT 90% confidence intervals

Table 25. Elk classifications for HD 200 from direct observations (1986-1988) and sightability model estimate (1989).

HD 200

The proportion of bulls in the post-season wintering population in HD 200 was consistently higher than in HD 123. Observed ratios varied from 12 to 31 bulls/100 cows on 10 surveys flown from 1986 to 1989 (Table 25). Mean, best count, and estimated ratios ranged from 16 to 25 bulls/100 cows during the study period, but no trend was evident. The 1989 "ELKMONT" bull/cow ratio was higher than the directly observed ratio, but the 90% bound was large, 44% of the point estimate.

Time/Cost Comparisons of L-P vs. Sightability Surveys

An examination of L-P and sightablity surveys conducted in HD 123 revealed some differences in the inherent costs of the two methodologies (Table 26). L-P methodology required an average of 28.6 hours of flight time per year to conduct 3 replicating surveys of winter ranges in HD 123 in both 1987 and 1988. This effort averaged 9 days each year to complete. Using the stratified random sample option for a sightability survey of this same area in 1989, only 15.4 hours and 2 days were required to complete the survey. Only 36 percent of all the units were sampled in HD 123, so the necessary flight time, costs and days needed to complete the survey were greatly reduced.

Nine days and approximately 19 hours of helicopter time was required to complete the 3 replicating surveys needed for L-P estimates in HD 200. Just 2 days and nearly the same number of helicopter hours were required to complete one sightability survey. Only 4 days were required for the same personnel to complete surveys of both hunting districts in 1989.

Some of the differences between costs in the two HD's were due to the means by which these surveys were conducted in HD 200. First, in 1989, even though a stratified random sample of subunits was chosen, 75% of all units were surveyed and the survey covered

Table 26. Comparison of flight time needed to complete helicopter surveys.

HD	Type	Hours	Days	Costs*
1987 123	L-P	27.8	8	$ 7923.00
1988 123	L-P	29.4	10	$ 8379.00
1989 123	Sightability	15.4	2	$ 4389.00
1986 200	L-P	19.1	9	$ 5443.50
1987 200	L-P	19.4	9	$ 5546.10
1988 200	L-P	18.7	9	$ 5346.60
1989 200	Sightability	19.8	2	$ 5643.00

*Calculated @$285.00/hour for helicopter;other costs excluded.

Table 27. Comparison of total operations costs for Lincoln-Peterson vs. "ELKMONT" sightability surveys in HD's 123 and 200.

	HD 123	HD 200
Ave. Flight Time for L-P Survey	28.6hr	19.1hr
Ave. Cost for Flight Time (L-P)*	$8,151.00	$5,443.50
Estimated Cost of Marking Elk**	$4,667.88	$7,224.10
Total Operations Costs	$12,818.88	$12667.60
Flight Time for Sightability Survey***	15.4hr	19.8hr
Cost for Sightability Flight Time*	$4,389.00	$5,643.00
Total Operations Cost	$4,389.00	$5,643.00

*Calculated @$285/hr for helicopter;other costs excluded.
**Based on estimated costs of $111.14/marked elk; 42 marked elk in HD 123, 65 marked elk in HD 200.
***Based on a stratified sample of 36% of subunits surveyed in HD 123 and 75% of subunits surveyed in HD 200.

all of the high density, most of the moderate density, and just 2 of the low density subunits. In reality, virtually all of the winter range was surveyed in HD 200. Secondly, the strict adherence to flying contours within subunit boundaries resulted in substantially better coverage and more flight time per unit area than we accomplished on L-P surveys in 1986, 1987, and 1988. Thirdly, in an attempt to standardize our survey techniques in 1986, 1987, and 1988, all flights were conducted during the first few morning hours of daylight. Therefore, because 3 flights were necessary to conduct 1 complete survey of the winter range, 9 days were necessary to complete 3 replicating surveys. On the other hand, the survey conducted using elk sightability methodology was flown throughout the day, beginning with first good light and ending in late afternoon with stops only for rest, refueling, and weather.

Additional significant costs inherent to L-P estimates involved the cost of marking the elk for later aerial surveys. We (Thompson et al. 1989) estimated that it cost $111.14 to capture an elk during this study. Given a maximum of 42 marked elk in HD 123 and 65 marked elk in HD 200, the additional costs of doing L-P surveys and estimates were $4,667.88 in HD 123 and $7,224.10 in HD 200. Summing these additional costs with those for average annual flight time, we found that a more accurate estimate of costs for doing L-P estimates was $12,818.88 in HD 123 and $12,667.60 in HD 200 (Table 27). Total operations costs using the "ELKMONT" sightability technique was $7,025-$8,429 less than the operations costs for the L-P Index methodology. This represents a 55-66% savings, depending on which HD was surveyed.

Blood Sampling

Blood samples were taken from 84 elk during the 1986, 1987, and 1988 trapping seasons. Several samples were lost by the laboratory. Samples from 41 elk were tested for the presence of antibodies to brucellosis, bluetongue, anaplasmosis, and Leptospira spp. 26 samples were tested for Protein B, the indicator of pregnancy.

Pregnancy

Ninety-two percent of older cows ($\geq$2 years-old) were determined to be pregnant with high levels of protein B. One of 3 yearling cows was pregnant. No calves nor bulls tested pregnant, using this method.

Disease

Antibodies for Leptospira autumnalis were found in 4 (10%) samples. One sample contained antibodies for Anaplasmosis. No samples tested seropositive for brucellosis or bluetongue antibodies.

Investigations in Adjoining Hunting Districts

Seasonal Movements-HD 202

Cow elk radio-collared in the Marble Creek area generally moved west in the summer to third order drainages on both sides of the Idaho-Montana border near Little Joe Mountain. However, 2 of 5 cows radioed in the Marble Creek area did not migrate west, but remained in close proximity to irrigated hay meadows between Marble and Dry Creeks. All 3 cows captured in 2-Mile Creek migrated to summer ranges in the Ward Peak area in both Montana and Idaho.

In only two instances did any of the 8 radioed cows move east, leaving HD 202. One cow (1815) radioed in 2-Mile Creek in 1988 was located once in HD 200 in Mayo Gulch in spring 1989; she then

H.D.	YEAR	No.Elk	Calves/100 Cows	Bulls/100 Cows
121	1986	706	58	36
121	1987	823	55	29
121	1988	1033	49	22
121	1989	1025	37	16
201	1986	165	31	8
201	1987	207	31	10
201	1988	135	35	5
201	1989	122	28	5
202	1986	467	26	27
202	1987	276	43	22
202	1988	266	28	27
202	1989	342	28	9

Table 28. Elk helicopter classifications in HDs adjoining the Lower Clark Fork Study Area.

returned to HD 202.

The other instance was permanent emigration from HD 202 to HD 201. A 3+ year-old cow (1126) captured in Marble Creek spent the summer of 1987 in the Simmons Creek area of Idaho, returning to her winter range in December. She again moved to the Idaho border in summer of 1988. Reversing course that summer, she returned to Marble Creek, crossed the Clark Fork River into HD 201, continued northeast and recrossed the Clark Fork River into HD 200 near Sesame Creek. She remained there until October 1988, when she re-entered HD 201, crossing the Clark Fork River. She spent that winter and the entirety of 1989 in the Four-mile drainage of HD 201.

<u>Sex/Age Ratios-HD 121, 201, and 202</u>

Helicopter surveys were conducted in HD's 121, 201, and 202 during the study period. These surveys were not conducted in the same standardized or intensive form as those conducted in HD's 123 and 200; however, calf/cow and bull/cow ratios derived from those surveys are presented for comparison in Table 28.

Calf/cow ratios were generally higher in HD 121 and HD 123 than in HD 200, HD 201, and HD 202. Bull/cow ratios were lowest in HD 201, which has comparatively high open road densities, seldom reaching 10 bulls/100 cows during post-season surveys. Bull/cow ratios were lowest for all HDs in February 1989, following record harvests in Fall 1988.

Coordination and Interagency Activities

From its inception, the Lower Clark Fork Elk Study emphasized and sought cooperation with LNF, Intermountain Forest and Range Experiment Station, the UM, and local landowners. Coordination activities included:

1. The study provided several students at UM with considerable field experience.
2. Milo Burcham completed a master's thesis of winter range habitat selection by elk under the directions of C. L. Marcum, UM, and L. Jack Lyon, USDA (Burcham 1990).
3. The MDFWP and LNF completed the Mt. Bushnell area analysis of a 50,000-acre roadless area, very important to elk in the study area. The analysis resulted in setting long-term guidelines for road constuction and timber harvest in the area.

4. The MDFWP and the Superior Ranger District completed the 12-Mile area analysis, resulting in protection of security and summer range habitat.
5. Information collected in the study guided MDFWP comments on the LNF Travel Plan and several timber sale proposals.
6. L.J. Lyon (USDA), J. Canfield (MDFWP) and M. Hillis (LNF) used radio relocation data collected during the study to develop "security habitat guidelines" for forest management (Hillis et al. 1991).
7. J.Canfield (1988) reported on the impacts of the construction of the BPA powerline on elk security and hunter opportunities. Cooperation between the 2 projects greatly improved the results of both studies.
8. In exploring the various methods of population estimation, the authors met several times with Idaho Fish and Game biologists J. Unsworth and L. Kuck. We also assisted them in validation of the sightability model on the National Bison Range (Unsworth et al. 1990).
9. A 6-year prescribed burning program for nearly 4000 acres of elk winter range was planned and implemented with LNF. Funds were provided by the RMEF and LNF.
10. MDFWP worked with landowners who have elk depredation problems. When possible elk were trapped, radio-tagged, and tracked to understand when and how elk used those properties. Survey information was used to set

antlerless permit levels in portions of districts with game damage problems.

11. The Lower Clark Fork Elk Study cooperated with the Upper Blackfoot Elk Study and Dr. E.O.Garton in modifying the Idaho elk sightability model into the "ELKMONT" model which utilizes a different type of helicopter.

12. M. Hurley completed a Senior Thesis at the UM on analysis of blood and fecal parameters in white-tailed and mule deer incidentally captured during this study (Hurley 1987).

13. M. Thompson and the authors of this report co-authored a publication describing and analyzing the use of the modified Clover trap for capturing elk (Thompson et al. 1989).

DISCUSSION

From 1984 through 1989, 176 elk were trapped and marked with neck-bands or radio-collars on all winter ranges within the study area with the exceptions of Cherry Creek and Donlan Flats. Marked samples of elk provided information on seasonal movement patterns and habitat use and were the basis for making modified L-P estimates of populations from 1986 through 1988. In 1989 population estimates were made using elk sightability methodology. An additional 10 elk were marked in the Marble Creek and 2-Mile Creek area of HD 202 to evaluate possible herd interactions.

We learned that the elk wintering in the study area comprised a considerable resource of more than 1,400 individuals after the fall hunting seasons. After calving in 1989, an estimated 1,700 elk occupied 613 mi^2 at an estimated average fall density of 2.77 elk/mi^2. Analysis of radio telemetry data revealed maternal elk movements to be predictable for described herd units, that herd units included habitats for year round needs and varied in size and composition, that most mortality (>80%) was human caused, and that rates of hunter harvest depended on the elk's sex, age, and hunting district.

Seasonal Movements and Elk Habitat

Herd Units

Aerial relocations of radioed cows and yearling bulls revealed the existence of 9 herd units within the study area. Seasonal movements of those elk within each herd unit were predictable from year to year. Herd units were generally exclusive on their particular winter range, but exhibited partial overlaps of summer ranges. Three areas of overlap were on summer ranges in the Trapper Cabin/Upper 12-Mile, upper Flatrock/Tamarack, and the Cruzanne/Hemlock/Meadow Mtn. areas where cows, wintering in HD 123, had summer ranges overlapping with those of elk wintering in HD 200.

Such predictability was not documented for bulls once they attained 2 years of age. However, few bulls were followed from year-to-year before radio failure or death of the animal; hence, established patterns of movement may not have been detected. It was clear, however, that bulls from one winter range often mixed with cows from another winter range during the summer and fall.

Possible explanations for the formation of several elk herd units in HD 123 and only one in HD 200 include differences in topography and winter range distribution. HD 123 is characterized by more rugged terrain with several relatively narrow deep north-south running drainages separated by high steep ridges. HD 200 is characterized by flatter topography and broader drainages separated by lower ridge lines. In HD 123 browse dominated winter ranges are scattered throughout the district typically on south and southwest aspects in the mid to low portions of several major drainages. In contrast, most productive elk winter range in HD 200 is located in low elevation "foothills" at the eastern end of the district. Topography and habitat in HD 123 appears more conducive to forming smaller segregated herd units than in HD 200.

Edge et al. (1986) suggested that knowledge of herd units should be incorporated into management decisions. In this study, an understanding of herd units based on telemetry data improved inferences about movements, key habitats, and population characteristics upon which management decisions were made. The herd unit descriptions aided the Mt. Bushnell analysis, the BPA powerline mitigation study, the 12-Mile analysis, forest travel planning, individual timber sale planning, population estimation, development of strategies for relieving game damage and our analysis of mortality.

Herd units were not described for elk wintering in Cherry Creek and Donlan Flats. Therefore, we do not know whether or not those elk were part of larger herd units. Those geographic areas were bordered by sampled areas and were small enough that reasonable inferences about movements could be made. It is likely that elk wintering in Cherry Creek are socially related to the Clark Mtn. herd unit and that they summer along the C-C Divide in the Cherry Creek and 12-Mile Creek drainages. It is most probable that elk wintering in the Donlan Flats area are socially related to the Boyd-Tamarack herd unit and that they summer along the C-C Divide between Patrick and Flatrock Creeks. It would be desirable to capture and monitor elk in those 2 areas in the future to check our assumptions.

Relocation data revealed that virtually none of our radioed animals occupied summer ranges within the upper portion of Prospect Creek (Glidden, 23-Mile, 24-Mile), although these areas supported large numbers of elk in the summer and fall. Those third order drainages near the Idaho border may be part of a herd unit of elk wintering near Mullan, Idaho, or possibly wintering further west in Montana HD 121. We have no data to confirm these suppositions.

Winter/Spring Habitat

Winter habitat can be the most important limiting factor for elk productivity and survival (Skovlin 1982). In this study, elk chose lower elevations with south aspects, available palatable forage, and coniferous cover. Winter habitat was available in both HD's and generally described in Fig. 4 and 12. Elk winter ranges overlapped those of white-tailed deer and mule deer, as evidenced by our ability to capture both deer species at sites where we also captured elk.

Primary elk winter range in the study area is synonymous with young to medium age shrub brush fields. The most important browse species are serviceberry (Amelanchier alnifolia), mountain maple (Acer glabrum), snowbrush ceanothus (Ceanothus velutinus), redosier dogwood (Cornus stolonifera), willow (Salix spp.) and chokecherry (Prunus virginiana).

Burcham (1990) described and analyzed winter habitat selection for radio-tagged elk on 3 winter ranges in the study area for winters concurrent with our study. Climatic conditions were near long-term temperature and precipitation norms. The southeast, south, and southwest aspects accounted for 68% of elk locations. Elevations ranged from 2,640 to 5,760 ft and averaged 3,950 ft. Coniferous stands with basal areas between 10-150 ft^2/acre, densities between 50 and 250 trees/acre, and hiding cover of 0-50% accounted for the majority of the locations. Elk favored those habitats with little or no down and dead materials. They also favored areas of ground cover having high proportions of available and palatable forage. Those data were not compared to availability of those habitats, so while instructive, do not address habitat selection.

Canfield (1988) noted that most winter elk relocations were on low elevation south facing slopes and were often near clearcuts and away from open roads. Important Land Survey Inventory (LSI) types chosen were LSI 33, 31, and 43, where LSI types represented distinct combinations of landform, habitat groups, and soils. This information should guide the LNF in planning winter habitat improvement projects. Such projects may be particularly important in HD 200, where lower calf/cow ratios may result from lower forage production on winter ranges where conifer encroachment appears to be more advanced.

Burcham (1990) reported some elk chose northern aspects, often feeding on arboreal lichens (Alectoria spp.), until a crust-forming event, such as rain, would force them to move to southern aspects with less snow depth. He also noted that where there was little coniferous cover, such as in that portion of Prospect Creek which burned in 1973, elk were most commonly found in or near that portion of the winter range which still had mature tree stands.

As photoperiod lengthened and temperatures rose in early spring, we noticed elk utilizing lower elevations and slopes with little or no coniferous cover. Those sites produced early and abundant graminoid regrowth sought by elk. Canfield (1988) found that elk preferred moist moderately steep coniferous sites in the spring and avoided roads in the Packer Creek Zone. Two LSI types (23, 53) explained some variation in elk distribution in 12-Mile Creek. In some areas such as Swamp Creek, Combest Creek, Donlan Flats, Marble Creek, and Middle Rock Creek, private hay meadows with a coniferous border were heavily used by elk.

Summer/Fall Habitat

As temperatures continued to rise and snow recede, most elk moved up in elevation following the emergence of succulent vegetation. Elk wintering in HD 123 often moved 8-12 miles to summer range in portions of HD 200. Cow and juvenile elk wintering in HD 200 typically found suitable summer range in HD 200 within 6-8 miles of wintering areas. Some bulls (>2 years-old) marked in HD 200 moved north of the C-C divide to summer in HD 123. Some elk in both HD's remained at lower elevations closer to their winter range, where suitable cover and succulent forage were available.

Calving areas were generally located in areas that elk occupied on their way to summer ranges. Most areas used during the calving season were in or near early successional sites producing large quantities of newly emergent grasses.

During the summer, elk selected cool, moist mountain slope land-types in HD 200 (Canfield 1988). Clearcuts of intermediate age were selected for, while those less than 5 years-old and greater than 20 years were avoided. Important LSI types were 14, 23, 34, 36, 43, 44, 45, 54 and 55. During the September-October breeding season elk chose denser timber stands and lower elevations than during the summer and avoided clearcuts.

During the Mt. Bushnell analysis process, the LNF redrew "critical elk summer range" (Management Area 26) in the Forest Plan based on analysis of summer radio locations.

Fall Security Habitat

The lack of security, reflected in distributional responses and mortality rates, can result in elk selecting suboptimal habitat (Irwin and Peek 1983), in elk having suboptimal energy budgets (Morgantini and Hudson 1979), in higher hunting season mortality (Irwin and Peek 1979, Hurley and Sargent 1991, Leptich and Zager

1991), and ultimately in losses in hunter opportunity (Lonner and Cada 1982).

The analysis provided by Canfield (1988) documented distributional responses of elk to hunting season disturbances in a portion of our study area in HD 200. In that analysis elk often chose contiguous cover in LSI types 34, 44, and 54 during the hunting season. The amount of contiguous cover needed to maximize elk density during the pre-hunting and early-hunting seasons was 300 acres in the Packer Creek Zone and 500-600 acres in the 12-Mile Creek Zone. This was not the kind of cover selected by elk in the summer. Open and closed roads and trails were avoided. An examination of radio locations revealed increased movements and elevational changes by elk in response to hunting seasons. Fewer elk responded to hunting seasons in the less intensively habitat managed Packer Creek Zone compared to the Boyd Mtn. and 12-Mile Creek Zones. It was concluded that pre-hunting season habitats were not secure enough to hold elk during the hunting seasons.

While Canfield's (1988) analysis focused on a portion of HD 200, our GIS analysis of all radio-locations relative to road densities throughout the study area substantiated the conclusion that habitats were not secure enough across our study area.

The harvest rates we documented also indicated that fall security habitat was inadequate for keeping hunting mortality of older bulls below recruitment in the present hunting season framework. The harvest rates of antlered bulls captured on various winter ranges differed, suggesting that amounts of security varied within the study area, ie. there was less suitable elk security cover in HD 123 than HD 200.

Response of Elk to Road Densities

The GIS analysis of elk habitat use and road density showed dramatic and statistically significant negative responses of elk to even moderately roaded areas. Both cows and bulls tended to avoid habitats with >0.5 miles of road/mi^2 throughout the year. Bull elk were more selective and actually showed a preference for only roadless habitats.

Road density appears to be a major factor in determining elk habitat use within the study area. The implications of increasing road densities in core elk habitat are serious. Elk, particularly bulls, can effectively "lose" the use of important habitat due to the existence of road densities that are below allowable Forest Service Habitat Effectiveness Index (HEI) standards. Many Forest Plans have HEI standards of 50-70% for elk habitat. This translates into allowable road densities of 0.7-1.8 mi of road/mi^2, which may not be sufficient to protect elk habitat use, according to our data.

The LNF Forest Plan (1985) established a road density standard of 1.1 mi/mi^2 maximum on highly productive big-game summer range and provided for closing newly built roads in areas of moderate big-game summer range. Our data indicated that these standards would not adequately accomodate elk security needs in many areas, since elk showed a strong preference for habitats with less than 0.5 mi/mi^2 during most times of the year.

Our data indicated that closing roads may allow elk, to some extent, re-inhabit roaded habitats. The likelihood of significantly expanding road closures is uncertain, given the public's demand for vehicular access to National Forest lands. Continued education and interaction with agency personnel and the public need consideration.

Emigration

Though known to occur, elk emigration is a poorly documented and analyzed phenomenon. Emigration from our study area and from one herd unit to another within the study area was documented.

Eartag returns and movements of radio-tagged elk indicated that bulls were more likely to emigrate from their maternal herd units than cows. Radio-collared bulls left maternal groups in the summer, after turning 2 years-old. Radio telemetry and eartag return data indicated that some travelled more than 50 miles before being harvested. Three of 4 bulls emigrated west into Idaho.

Cows were less likely to emigrate than bulls, but radio data suggested that, if they did, they were more likely to emigrate to an adjoining herd unit. In addition, evidence from our small sample suggested that cows accomplished emigration as mature individuals ≥3 years-old. Geist (1982) also noted that bulls were more likely to colonize than cows.

Sexually dissimilar emigration patterns may result from the different repoductive strategies employed by cows and bulls. Through frequent emigration 2 year-old bulls may accomplish a mixing of gene pools by breeding with a new, sometimes distant cow-dominated herd unit and can expect to do so for several years before senility or death. Less extensive gene flow is further accomplished by adult bulls summering and rutting with cows in herd units adjoining those with which they spend the winter and with which they may or may not be related. Both adaptive behaviors were observed in this study.

Infrequent adult cow emigration may insure a stable social structure within which calves learn to use the most productive seasonal habitats. Although long distance cow emigrations were rare, we observed both short and one long distance emigration by individual cow elk.

Herd Composition and Productivity

Herd composition varied within the study area. Calf/cow and bull/cow ratios were within the ranges reported by Rognrud and Jansen (1971) for other northwestern Montana elk herds. Annual variation in calf/cow and bull/cow ratios indicated that herd composition was dynamic.

Generally, HD 123 had a lower proportion of bulls and a higher proportion of calves on winter ranges, when compared to HD 200. The proportion of yearlings among all bulls was higher in HD 123 than in HD 200. The lowest bull/cow ratios were recorded in HD 201, adjoining the study area, where open road densities appeared to be higher and hiding cover appeared to be lowest. All HDs overwintered fewer bulls following the 1988 hunting season, dramatizing the potential impact of one "good" hunting season on populations occupying insecure habitat.

The calf/cow ratios in HD 123, HD 121 and HD 201 were generally higher than those in HD 200 and HD 202. This may have resulted from lower forage production or higher densities of elk in HD 200. Winter range habitat improvement projects, such as prescribed burning (Leege and Hickey 1971) and well-planned timber harvests (Warner 1970), may be needed to reduce coniferous enchroachment and increase browse production in order to maintain elk productivity at present levels.

Serology exams indicated a very low incidence of exposure to leptospirosis and anaplasmosis, both of which may negatively effect production in domestic livestock. Kistner et al.(1982), in their review of these two diseases in elk, reported that the effects of either disease on elk was not understood and that serology exams had so far proven undependable.

Pregnancy rate determined from blood analysis for Protein B was very high. The >90% pregnancy rate for adult cows in the study area was consistent with pregnancy rates found in HD's 121 and HD 202 that were based on examinations of reproductive tracts collected in winter (Henderson, 1990 unpublished).

In 1983 and 1990 the peak date of conception in HD's 123 and 202 was mid-September with few conceptions coming later than October 1 (Henderson, unpublished). Since pregnancy rates, sex/age ratios and habitats were similar for these adjoining herds, we can reasonably assume that most breeding also occurred during September in our study area. Herd productivity, therefore, was not limited by conception. Habitat quality probably was the major factor influencing the health of pregnant cows and their calves' health and survival.

The proportions of bulls in the herds and the age structure of the bull populations were dependent on age differentials in mortality rates. Since most mortality occurred during the hunting season, so that the size and age structure of the bull segment were largely dependent on rates of harvest (see Harvest and Population Management).

Harvest and Population Management

Direct measurements of harvest rates were difficult to obtain. In this study, constraints on budgets and manpower resulted in small sample sizes. Our interpretations are therefore qualified.

Cow management

As expected, mortality rates for cow elk were much lower than for bulls. Hunting regulations have limited antlerless harvests since the 1970's. The lower female mortality was reflected in higher eartag return rates for bulls, older age distribution for females in trapped samples, and higher hunting season mortality rates observed for radioed males than females. Through 1990, only 20% of the ear-tagged cows were known to have died, but at least 76% of the marked bulls had died during the study.

Numbers of male and female calves trapped were nearly identical. Assuming no differential mortality between bull and cow calves during late winter and spring, yearling males and females would have entered the summer in nearly equal numbers. Similar proportions (12-14%) of cow calves, yearlings and 2 year-olds were trapped, while 3+ year-olds represented 60%. In contrast, those same age-classes of bull elk were trapped in ever decreasing proportions (58%, 32%, and 3%, respectively), indicating strongly differential sex and age dependent mortality, trapability, or a combination of both.

The overall harvest rate for radioed cow elk in the study area was 16%, similar to that reported by Leptich and Zager (1991) for cows in the nearby Cour d' Alene drainage in Idaho. The harvest rate for cow elk in HD 200 was 14%, not significantly lower than a 18% harvest rate in HD 123, in spite of different harvest regulations for antlerless elk harvest in the 2 HD's. The rates were similar (14-16%) for HD123-EAST and HD 200, both of which harvest cows on permits, and for HD123-WEST (19%) in which any elk could be harvested by any license holder during the first 8 days of the general season.

The major difference between HDs was in the timing of the antlerless harvest. All antlerless harvest was concentrated in the first 8 days of the season in HD123-WEST, whereas the antlerless harvest is spread fairly evenly throughout the season in HD123-EAST and HD 200. Antlerless harvest in HD 123 may display greater variation in number because different fall weather patterns can produce good or bad hunting conditions during the first 8 days of the season, when either-sex harvest is authorized. Permitted harvest of antlerless elk over the 5-week season resulted in more predictable and stable harvests.

Since many cows captured on winter ranges in Dry Creek and Prospect Creek utilized habitats south of the C-C Divide in the western end of HD 200, some were hunted on a permit basis during the first part of the season. At some time during or after the season, those cows moved north over the C-C Divide, where they could be harvested only during the first 8 days of the season. This increased the probability of lower antlerless harvests in HD 123-West, when hunting conditions were poor in the first week of the season.

The cow populations appeared to be stable during the study period. Confidence intervals of estimated post-season populations overlapped during the study period. Harvest rates for cows were close to the 14-20% recruitment rate, predicted from observed post-winter calf/cow ratios. Also, the estimated harvest of 109 cows in fall 1989 was similar to the 131±43 cow calves estimated to be in the study area in February 1989.

While most evidence suggested that cow populations were nearly stable, other considerations suggested that this conclusion should be cautiously accepted. Other sources of mortality (i.e., tribal and illegal harvest, wounding losses, and predation) were noted and were probably underestimated by our study methods. Also, the proportion of aerially classified calves was consistently higher than the proportion of calves in the trapped sample of cow elk, suggesting the possibility of identification bias in aerial surveys or higher trapability of calves. Either could lead to over-estimating recruitment. If survival of cow calves was nearer the

10-14% in the trapped sample, then harvest could have been slightly higher than recruitment.

Winters were generally mild during the study, and weather related mortalities were few. Since harvest rates were weighted annual means encompassing only 5 seasons, other climatic conditions could have produced both higher harvest rates and greater overwinter mortality. Because estimated mortality was so near estimated recruitment, the above considerations underline the need for conducting regular, standardized population surveys with measureable reliability.

Bull management

The observed annual weighted harvest rates for antlered bulls was 40% for the study area, 61% for those trapped in HD 123, and 30% for those trapped in HD 200. Those rates are based on relatively small samples; however, they did fall within the range of values (31-62%) reported by Leptich and Zager (1991) for the Cour d' Alene area. In HDs 282/285 of the Blackfoot drainage, over 50% of all antlered bulls were harvested annually (Hurley and Sargent 1991). Vore and DeSimone (1991) reported hunting mortality for all bulls in the Elkhorn Mountains to be 90% when any bull was legal, 59% during branched-antler bull (BAB) seasons, and 40%, when spikes were legal and branched bulls were taken on limited access permits.

It was not clear that antlered bull numbers in our study area were declining under current harvest pressure, as hunting-season mortality sample sizes were small, previous aerial surveys were inadequate for demonstrating changes, and antler point distributions for harvested bulls showed a flat trend during the study period.

Nevertheless, there was reason to be concerned that the MDFWP objectives for maintaining a diverse age structure with mature bulls (MDFWP 1992) might not be met in the future. Sampled bull age structures, sampled harvest rates, and a comparison of estimated harvest and estimated recruitment indicated that harvest could cause a decline in the number of mature bulls.

The overall harvest rate of 40% for antlered bulls was 2-3 times higher than for cows in the study area, which would be acceptable, if the number of bulls recruited into each older age class met or exceeded the number of deaths in that age class. As discussed above regarding observed cow mortality rates, our study methods probably underestimated actual mortality rates for antlered bulls. Moreover, the number of males (210) estimated to have been harvested in the study area in fall 1989 slightly exceeded the number of new bulls (131 ± 43) estimated to be entering the population in 1989. The low proportions of 2+ year-old elk in both the trapped and aerial classification samples were also indicative of high mortality, or biases in observability and trapability.

Harvest rates in our study appeared to be highest on bulls that were at least 2 years-old and lowest for yearling bulls, suggesting possible hunter selection for larger bulls and/or older bulls exhibiting behaviors predisposing them to greater vulnerability. This difference was statistically significant, but based on small sample sizes. This finding contradicted the popular opinion that "spike" bulls were more likely to be harvested because of their inexperience. Other studies have also reported age-dependent hunting season mortality in which yearling bulls were harvested at rates lower or equal to those found for older bulls. During hunting seasons in which all antlered bulls were legal in HD 380, 86% of the marked yearling bulls and 100% of the 2.5 year-old bulls died (Vore and DeSimone 1991). In Idaho, harvest rates were nearly identical for yearling (spike) and older (branched) bulls (Leptich and Zager 1991). In the Blackfoot River drainage (Hurley and Sargent 1991), 2 year-old bulls exhibited the highest harvest rates (60%), while yearling and 3+ year-olds were harvested at similar lower rates (40 and 41%, respectively). In the Blackfoot study, the higher harvest of 2 year-old bulls was attributed to greater hunting season movements and limited experience of that age class, while yearling bulls may have found increased security by their association with larger groups led by experienced cows.

The uncertainty generated by the data we were able to collect and analyze, underscores the need for regular and reliable population surveys to monitor changes in bull numbers and age structure, as well as changes in overall population numbers. Such surveys had not been available and not in use until this study, and their future utilization depends on budget and manpower re-allocations.

If future surveys demonstrate that numbers of raghorn (2 year-old) and mature bulls are declining, the MDFWP goal of maintaining a diverse age structure of bulls would not be accomplished. Since most mortality was related to fall hunting seasons, improved habitat security and/or adjustment of hunting season regulations would be necessary and require public support and inter-agency cooperation.

Habitat Security

Many studies have established that elk tend to avoid roads and that the degree of avoidance is related to traffic volume, topographic features, and road side cover (Marcum 1975, Perry and Overly 1976, Lyon 1979). Marcum (1975) suggested that the loss of habitat resulting from elk avoidance of roads could be at least partially offset by road closures. Using GIS methodology (see above), our analyses support earlier findings that elk, particularly bulls, choose habitats away from roads, but will reclaim roaded areas, once roads are effectively closed.

In addition, roaded habitats lead to higher mortality rates where hunting is the principal cause of mortality (Irwin and Peek 1979). Leptich and Zager (1991) reported that hunting season mortality rates for antlered bulls in the Couer d' Alene River drainage in Idaho varied from 61.7% in highly roaded habitats to 31.2% in areas with few roads. The higher mortality rates led to relatively low bull/cow ratios with few bulls living to be 5 years-old. Our results (40% annual bull mortality, 16% annual cow mortality, 15-20 bulls/100 cows post-season) were comparable to data from "managed access" areas with security intermediate between those with few and many roads in the Cour d' Alene drainage.

Hillis et al. (1991) provided general guidelines for planning for habitat security, when developing timber management projects. Canfield (1988) also recognized the limits of fall hunting season security and suggested that roads built for the construction of the BPA powerline would increase the likelihood of timber sales in the vicinity of the powerline corridor. Road building and reductions in cover associated with those sales would increase elk vulnerability to hunter harvest. The Mt. Bushnell Analysis (Appendix 11) recognized movement patterns and security areas and provided guidelines for future timber management actions within that 50,000 acre portion of the study area.

Fall habitat security may be lower in HD 123 than in HD 200. The annual harvest rate of 62% for bulls radioed in HD 123 was twice that observed for bulls radioed in HD 200, and, whil[e] differences were statistically significant, sample sizes were relatively small. The lower bull/cow ratios observed in HD 123 also suggested a higher harvest rate for bulls wintering in HD 123. The higher proportion of yearling bulls in both aerially observed and hunter harvest samples further supported the conclusion that bulls wintering in HD 123 were more vulnerable to hunter harvest.

The difference in harvest rates between the two HD's was surprising, considering hunter densities were lower in HD 123, bull harvest regulations were identical, and many bulls used both hunting districts sometime during the hunting season. Apparently, habitats in the two districts provided different levels of vulnerability to hunter harvest. An overall approach to planning for security is needed in the study area with emphasis on improving security for bulls wintering in HD 123.

Hunting Seasons

Our results indicated that hunting regulations that reduce overall bull mortality would be more appropriate than ones that favored a specific (ie. yearling) age-class. Throughout the study area yearling bulls experienced harvest rates of only 20%, while nearly 55% of the older bulls were harvested annually.

Given the age-specific harvest rates found in this and other study areas, the popular BAB or brow-tine bull (BTB) seasons instituted elsewhere in the state would not be appropriate where the objective is to maintain a diverse bull age structure. If BTB seasons were applied, one could expect an even higher rate of harvest on that bull age-class (2+ year-old) which already is the most heavily harvested. The lightly harvested yearling class would receive an even smaller harvest, resulting in an ever-declining number of older bulls in the population.

Although HD boundaries did not reflect elk herd unit boundaries (particularly on the western end of the study area), the similarities of harvest rates for cow elk in the two hunting districts, regardless of the different season types, indicated that a change of district boundaries is not warranted on that basis. In addition, since a proportion of the bulls in each herd unit crossed herd unit, as well as hunting district, boundaries during the summer and fall, and, as antlered bulls were hunted throughout the 5-week season in both hunting districts, it was improbable that a change of hunting district boundaries would change harvest rates on the antlered segment of the populations.

Illegal harvest and wounding losses claimed an unknown proportion of the population. The small sample sizes and low probability of the public reporting marked animals dying from these causes limited our ability to do more than document their occurrence. Vore and DeSimone (1991) also reported wounding losses and illegal harvest of bulls.

If game managers want to reduce the mortality rate on older age class bulls through changes in regulations, perhaps the best alternatives include shortening the season and/or going to limited access permits.

Game Damage Problems

Elk depredation was chronic in several parts of the study area from spring through summer. Depredating elk were radio-collared and monitored in Swamp Creek (HD123), Combest Creek (HD123), Boyd Mtn. (HD 200), and Marble Creek (HD 202).

While most radioed elk in the study area followed the development of green forage from low elevations in the spring to higher elevations in the summer, some remained as residents at low elevations throughout the summer and fall, often in the vicinity of hay and/or oat fields. The elk involved in depredation represented a small proportion (<10% estimated) of total elk numbers in the two hunting districts.

When irrigated, grain crops and hay meadows were particularly susceptible to depredation late in the summer, when native vegetation cured. Most fields were relatively small in size (<100 acres) and bordered by hiding cover in coniferous timberlands.

Crop depredation was tolerated at moderate levels for several years, before landowners lodged official complaints with MDFWP. Landowner tolerance of both hunters and elk was limited in many areas. Rural subdivisions near agricultural lands often made hunting more restricted on and near these properties than on public lands some distance away.

Strategies for dealing with elk depredation in these situations have included herding, raising harvest rates on antlerless elk in the entire hunting district, raising harvest rates in those portions of the hunting districts affected by depredation, encouraging landowners to accept more hunters, improving hunter access near depredation sites, increasing elk security at higher more remote portions of the range, and authorizing early or late season damage hunts in areas affected by depredation.

The relatively small numbers (20-100 elk) and limited seasonal movement of depredating elk in most cases suggested that increased harvest in those limited areas would reduce the level of depredation without seriously reducing populations elsewhere in the the HD's. Such efforts already made in Boyd Mtn., Marble Creek, Pat's Knob, and Swamp Creek areas should be evaluated for efficacy at reducing depredation and for impacts on resident and migratory populations.

Evaluation of Survey Techniques

Traditionally, aerial surveys in western Montana have been conducted either from helicopters or fixed-winged aircraft during the spring "green-up". Because elk were thought to be more visible during the spring there is a greater likelihood of observing a larger proportion of the population during this brief "window of opportunity". Age and sex composition of the herds, as well as assumed trends in population levels, were obtained from what was most often a single flight over the winter ranges in April. Nevertheless, the reliability of this method of inventorying big game populations has been questioned privately by wildlife managers, and by researchers (Caughley 1974, Caughley et al. 1976).

Caughley (1974) stated that aerial surveys invariably contained biases, generally resulting in underestimates of the actual population levels. Samuel et al. (1987) developed a survey method that corrected for biases inherent in surveying elk from the air in northern Idaho.

Rice and Harder (1977) noted that larger proportions of a white-tailed deer population needed to be marked to obtain reliable L-P estimates where more vegetative cover obscured deer observability. We also found that a smaller proportion of elk needed to be marked in HD 123 where there was less vegetative cover than in HD 200 to obtain similar confidence intervals, which were still very large.

The results of replicated flights in 1986, 1987, and 1988 to obtain L-P estimates of population numbers demonstrated the difficulties involved with interpreting data collected by the traditional methods. The proportions of marked elk observed during aerial surveys fluctuated considerably from survey to survey within a 2-week period. For example, in 1986 25% of the marked animals in HD 200 were seen on the first survey, but 45% were seen on the third survey about 10 days later. The actual number of elk observed on surveys during the same year also varied considerably. As examples, in 1987, as few as 431 elk were seen in HD 123 on one survey and as many as 598 on another, and in HD 200 only 133 were seen on the first survey, but 269 were counted on the last replication.

Replicated surveys for L-P Indices did yield fairly consistent annual mean observabilities and mean population estimates in each hunting district, suggesting that populations were nearly stable. In addition, where elk were more observable in the relatively more open habitats in HD 123, population estimates could be obtained with narrower confidence intervals than in the more densely vegetated habitats of HD 200. As an alternative to traditional survey methods, replicated surveys utilizing averages or highest counts would more likely reflect the actual trends in population levels and composition. More than 3 replications might be needed in some areas of western Montana with abundant coniferous cover.

Replicated aerial surveys required a considerable time to complete. Given the vagaries of weather, up to 2 weeks was needed to complete 3 replications. More time would be required to conduct additional replications to provide more precise estimates.

Additional flights greatly increase the number of hours flown and inflate survey costs dramatically.

Conducting L-P estimates was expensive. In addition to the costs for helicopter time, trapping and marking elk were required. A substantial investment of time, manpower and money (approximately $111/elk, excluding salaries) were needed to mark enough elk to yield reliable estimates before ever conducting the aerial surveys. Those costs were nearly equal to the costs for flight time alone.

As with L-P methodology, a major expense for using the elk sightability model is the cost for helicopter time. An earlier limitation was corrected by the modification of the computer model, so that data can now be collected from the 3-seat Bell-47, not just the Hiller, which is a helicopter largely unavailable in Montana.

The advantages of the elk sightability model were described by Unsworth et al. (1991). Our experience with the elk sightability survey and model in the Lower Clark Fork Study demonstrated several things: 1) complete and consistent survey methodology was important and had been lacking, 2) the method can be applied at anytime during the winter, not just during some narrow window of opportunity (ie. spring "green-up"), when observability is highest, 3) confidence intervals were obtained, so that testing for future changes can be done, 4) stratified random sampling can greatly reduced helicopter costs, 5) no costs were associated with trapping and marking animals to obtain an estimate, 6) surveys could be repeated without the loss of consistency, 7) estimates for all sex and age classes of elk may be obtained, and 8) the method has direct application for many other mountainous, timbered elk habitats in northwest Montana.

Non-consumptive Elk Values

While the study was not designed to address non-consumptive values, we believe that the study area offers a good opportunity for viewing wild elk from public roadways, particularly during the winter and spring. Elk on winter ranges in Prospect Creek, West Fork Dry Creek, Swamp Creek, Pat's Knob, Donlan Flats, Tamarack Creek and St. Regis River are often visible from highways and forest roads, especially in the early morning or late afternoon hours.

Evening rides on forest roads along the C-C Divide during the summer and fall will often encounter elk. Off-road travel in most drainages will provide opportunities to see elk or fresh elk sign throughout the year. Elk that are habituated to feeding in agricultural fields south of Plains and near St. Regis can often be viewed early or late in the day.

These apparently benign activities can occassionally have negative consequences. Displacement from preferred habitats by human disturbance can result in loss of productivity. Also, landowners reported instances in which viewers had frightened elk, causing them to flee, breaking down fences and injuring themselves.

MANAGEMENT RECOMMENDATIONS

Both the MDFWP and LNF have long recognized the value and importance of elk populations that inhabit the Lower Clark Fork study area in HD's 123 and 200 of northwest Montana. The social, economic, recreational and ecological values of this resource should not be underestimated. Elk are very closely tied to the quality of life of the people living in this region.

Many resource decisions are currently and should continue to be judged by their potential effects on elk and elk habitats. State and federal agencies have a public responsibility to protect and foster thriving elk populations through well planned management efforts.

Based on the findings of the 1985-1990 Lower Clark Fork Elk Study, we recommend that the MDFWP and the LNF consider the following management actions regarding the elk population found along the C-C Divide in HDs 123 and 200. Additional details are found in the Discussion section.

Population Management

1. **We recommend that elk management goals be established for the size and composition of the C-C Divide elk population. Population management goals have been generalized over a larger 5 HD area in the Statewide Elk Plan. We suggest that it is more relevant and effective to define specific minimum/maximum population goals for elk in HD 123 and 200.**

The elk hunting season structure should be flexible enough so that periodic adjustments can be made to achieve and maintain the population management goals. Opportunity for adult female harvest should be based on the annual surplus provided by net recruitment.

When hunter harvest and natural mortality of the antlerless population exceeds recruitment, the population will decline.

2. **Population monitoring efforts should shift from early spring trend counts to the use of the "ELKMONT" sightability model on a stratified random sampling of subunits during the winter.**

The comparison of survey methodologies (trend counts vs. L-P Index vs. sightability model) indicates there are several advantages in adopting the "ELKMONT" model-ability to calculate sample size for desired precision level, standardized survey methods, predictability and economics. We recommend that a stratified sample of 50-75% of the winter range subunits be surveyed to reduce the size of the confidence intervals generated. The "ELKMONT" model and sightability methodology has application in other areas of northwest Montana. It would probably work well in nearby HDs 104, 121, 201, 202 and 203.

3. **We are concerned about the ability of this elk population to sustain high mortality rates of older age class bulls, particularly in HD 123. It may be desirable to reduce overall bull mortality through a combination of hunting season changes and habitat management.** .

Wildlife managers need to decide if the current overall annual harvest levels of 41% for all antlered bulls and 56% for 3+ year-old bulls are acceptable, considering our attempt to maintain a diverse age structure of bulls; harvest rates for bulls in HD 123 are higher. Shorter bull seasons and/or limited access bull harvest should be considered to help develop a more diverse age structure in the bull segment of the population. We do not believe that the standard 5-week BTB season would improve the bull age structure. Concurrently, habitat management that protects or develops security habitat, particularly in HD 123, should be a priority. Increasing elk security may allow more bulls to reach older age classes.

4. When time and funding allow, a small sample of elk wintering in Cherry Creek and on Donlan Flats should be radio-collared and monitored to determine their annual movement patterns and herd unit boundaries.

These are the only 2 potentially significant elk winter ranges that were not sampled in this study. Data from these areas would help complete the picture of elk use and herd unit interactions. Information from these areas could be used in making site specific project decisions.

Habitat Management

1. We recommend that forest management practices emphasize the importance and perpetuation of relatively large 300-600 acres blocks of security habitat, particularly in LSI types 34, 44, and 54.

Hunting season relocations indicate that 300-600 acre blocks of undisturbed forest provide very important security for elk, particularly bulls. Protecting these areas will help improve the survivability of older age class bulls and reduce harvest vulnerability of elk in general. Existing security areas identified by relocations and similar habitat types should receive special management consideration at the project level.

2. Additional new road construction of all types be minimized in core elk habits, particularly those areas used heavily during the fall hunting seasons. We encourage further road closures in these same areas to allow elk to regain the use of habitats lost because of activities associated with roads.

One of the most significant and disturbing findings of this study relates to elk non-use or "avoidance" of habitats that are moderately roaded at densities of 0.5-1.0 miles of road/mi^2. As with other species, the question of road densities relating to habitat use is one basic to management. Elk appear to be quite sensitive to certain road density thresholds which are often considered acceptable as habitat objectives for elk. We urge that the LNF take this new information into account when planning future development projects in HD's 123 and 200. Essential elements that should be addressed are:

1. Location of seasonal high use areas;
2. Variables that could compromise security/bull carryover (ie. past logging, poorly recovered cutover areas, concentrated bull activity in hunting seasons, areas of high open road density, gentle topography or sparse vegetation, concentrations of hunters, large contiguous blocks of timber in MA's allocated to timber harvest);
3. Existing and desired levels of security (assuming that 300-600 acre patches of timber are required);

4.Acceptable road density;

5.Road closures needed (location, seasonal or yearlong);

6.Desired vegetative pattern and acceptable seasons for logging.

3. **The importance of a systematic controlled burning program to improve and create shrub field elk winter range should be recognized and incorporated into long-term forest management plans.**

We encourage the LNF to actively continue with its winter range controlled burning program. The habitat program begun with the assistance of the RMEF will have long-term benefits for elk and other wildlife in HD 123 and 200.

4. **We recommend that documented migratory corridors used by elk be recognized as special management areas in the course of ongoing resource development planning. Movement corridors over major ridges and saddles should be maintained with as little future disturbance as possible.**

During this 5-year study of 9 elk herd units, we documented several elk migration routes and corridors over topographical divides. Management planning in the 50,000 acre Mt. Bushnell roadless area used this information to protect important migration routes used by elk. We encourage similar recognition and protection of major elk travel routes throughout the study area. There is a need for a security strategy that addresses special problems that arise when bulls are concentrated in a narrow zone during hunting season, especially where the habitat is fragmented by timber harvest. The "Hillis Paradigm" may not apply migration corridors, where special measures (ie. higher than normal levels of cover, additional access restrictions, or special regulations) may be required.

Public Relationships

1. We recommend that MDFWP and LNF maintain a close working relationship with the people of Sanders and Mineral counties regarding the management of elk and elk related recreation.

The success and public acceptance of a long-term elk management plan depends on clear two-way communication between resource agencies and the interested public, to include sportsmen's clubs, landowners, commercial outfitters, commodity interest groups, local businesses and government groups, non-consumptive users, off-road vehicle/horse groups and others.

Public meetings in Thompson Falls, Plains, and Superior hosted by MDFWP and LNF could periodically update interested parties on current elk population surveys, harvest information, habitat improvement projects, quota recommendations, travel planning changes and timber management activities related to elk. Public meetings focused on elk would allow for public input regarding elk management in their own "backyard". To be more effective, there should be good media coverage prior to and following such meetings.

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APPENDICES

Appendix 1. CAPTURE AND KNOWN FATE DATA FROM ELK TRAPPED IN HD 123, 1986-89.

DATE	TRAP SITE	SEX	AGE	FREQ.	COLLAR COLOR/SYMBOL	EAR TAG NUMBER	EAR STREAMER COLOR	BLOOD SAMPLE	FATE
01-10-86	Swamp Creek	M	Calf	150.826	WPVC	20621/22	Blue	-	Shot
01-19-86	Brush Gulch	F	3-10	151.563	WPVC	60233/34	Blue	-	Unknown
02-06-86	Dry Creek	F	3-10	151.045	WPVC	20645/47	Blue	-	Winter Kill
02-20-86	Sheep Gap	F	2	151.012	WPVC	21545/46	Blue	-	Unknown
02-22-86	Dry Creek	F	10+	150.782	WPVC	21535/36	Blue	-	Unknown
02-23-86	Barth's Ranch	M	Calf	--	Blue/ ●/ ●/ ●	21532/33	Blue	-	Unknown
02-26-86	Barth's Ranch	F	3-10	151.575	WPVC	21530/47	Blue	-	Unknown
02-26-86	Barth's Ranch	F	10+	151.664	WPVC	21548/49	Blue	-	Unknown
03-01-86	Sheep Gap	F	3-10	151.673	WPVC	21514/15	Blue	-	Shot
03-06-86	Barth's Ranch	F	10+	150.039	WPVC	21507/08	Blue	-	Shot
03-13-86	Therriault Gul.	F	2	150.157	WPVC	21518/20	Blue	+	Idaho Shot
03-22-86	Therriault Gul.	F	3-10	150.620	WPVC	None	Blue	+	Unknown
03-23-86	Sheep Gap	F	3-10	150.058	WPVC	20688/89	Blue	+	Shot
03-24-86	Sheep Gap	F	10+	151.270	WPVC	20686/87	Blue	+	Unknown
03-25-86	Webster's	F	3-10	150.220	WPVC	20676/77	Blue	+	Poached

03-28-86	Barth's Ranch	F	3-10	150.240	WPVC	20678/79	Blue	+	Unknown
04-03-86	Webster's	F	1	150.924	WPVC	20690/91	Blue	+	Shot
04-04-86	Brush Gulch	M	Calf	--	Blue/	20665/66	None	+	Unknown
04-08-86	Webster's	F	1	150.965	WPVC	20667/68	Blue	+	Shot
04-09-86	Webster's	M	Calf	--	Blue/....	20699/70	None	+	Shot
04-10-86	Barth's Ranch	M	Calf	--	Blue/MMM	20671/72	None	+	Shot (FIR)
04-15-86	Webster's	F	Calf	150.360	WPVC	20652	Blue	+	Unknown
04-20-86	Webster's	F	Calf	150.864	WPVC	20655	Blue	+	Unknown
04-21-86	Shamrock Gulch	F	3-10	151.060	WPVC	20658/59	Blue	+	Shot
04-22-86	McCrea's Ranch	F	2	150.501	WPVC	20653/62	Blue	+	Shot
04-23-86	Websters	F	Calf	--	ORANGE/▲▲	20656/57	None	+	Unknown
04-24-86	Shamrock Gulch	F	1	150.198	WPVC	21551/52	Blue	-	Poached
12-18-86	Clark Mtn.	M	2	150.700	WPVC	21566/67	Red	-	Shot
01-11-87	Sheep Gap	F	3-10	150.995	WPVC	21597/98	Yellow	+	Shot
01-12-87	Clark Mtn.	F	3-10	150.333	WPVC	21564	Yellow	-	Unknown
01-16-87	Sheep Gap	F	2	150.012	WPVC	20571/73	Yellow	+	Unknown
01-18-87	Clark Mtn.	F	3-10	150.459	WPVC	20561/62	Yellow	-	Shot
01-24-87	Clark Mtn.	F	2	150.181	WPVC	20559/60	Yellow	+	Unknown
01-30-87	Dry Creek	F	3-10	150.845	WPVC	20553/54	Yellow	-	Unknown

01-30-87	Clark Mtn.	F	3-10	151.224	WPVC	20551/52	Yellow	+	Unknown
01-31-87	Sheep Gap	M	1	151.034	WPVC	21576/77	Red	-	Shot
01-31-87	Therriault Gul.	M	Calf	150.370	WPVC	21578/79	Red	-	Shot
02-02-87	Sheep Gap	M	Calf	150.733	WPVC	21582/83	Yellow	-	Shot
02-02-87	Therriault Gul.	F	2	150.017	WPVC	20536/37	Yellow	+	Shot
02-05-87	Clark Mtn.	F	3-10	150.578	WPVC	20534/35	Yellow	-	Unknown
02-08-87	Clark Mtn.	F	1	150.091	WPVC	20532/33	Yellow	+	Unknown
02-09-87	Clark Mtn.	F	10+	--	YELLOW/■■■	20530/31	Yellow	+	Unknown
02-11-87	Dry Creek	F	3-10	150.914	WPVC	20528/29	Yellow	+	Unknown
02-21-87	Eddy Creek	F	3-10	151.180	WPVC	20547/48	Yellow	-	Unknown
02-28-87	Clark Mtn.	F	2	150.637	WPVC	20584/87	Yellow	+	Unknown
03-03-87	Eddy Creek	F	2	150.292	WPVC	20517/18	Yellow	+Shot	
03-06-87	Therriault Gul.	F	1	151.067	WPVC	20521/22	Yellow	-	Shot
03-19-87	Eddy Creek	F	1	151.062	WPVC	20511/12	Yellow	+	Unknown
03-22-87	Clark Mtn.	F	3-10	--	YELLOW/XXX	21436/37	Yellow	+	Unknown
01-07-88	Wilkes Creek	F	3-10	150.312	WPVC	21472/73	Unknown	+	Unknown
01-08-88	Wilkes Creek	M	1	150.890	WPVC	21489/90	Unknown	-	Shot
01-09-88	Wilkes Creek	M	1	150.502	WPVC	21476/77	Unknown	-	Shot
01-10-88	Wilkes Creek	F	2	150.349	WPVC	21463/64	Unknown	+	Unknown

01-14-88	Wilkes Creek	F	3-10	150.059	WPVC	21465/66	Unknown	-	Unknown
01-19-88	Wilkes Creek	F	3-10	150.966	WPVC	21438/39	Unknown	+	Unknown
01-21-88	Wilkes Creek	F	2	--	ORANGE/	21443/44	Unknown	-	Unknown
01-21-88	Wilkes Creek	F	Calf	--	ORANGE/o o o	21445/46	Unknown	-	Shot
01-26-88	Wilkes Creek	F	Calf	--	ORANGE/	21491/92	Unknown	-	Unknown
02-04-88	Kraak's	F	Calf	151.046	WPVC	21453/54	Unknown	-	Shot
02-04-88	Clear Creek	M	Calf	150.996	WPVC	21451/52	Yellow	-	Mt. Lion Kill
02-05-88	Clear Creek	F	1	150.660	WPVC	21455/56	Yellow	+	Unknown
01-18-89	Miller Creek	F	Calf	150.137	WPVC	21467/68	Yellow	-	Unknown
01-20-89	Miller Creek	F	3-10	150.734	WPVC	21563	None	-	Unknown
01-20-89	Miller Creek	F	3-10	150.827	WPVC	21469	None	-	Unknown
01-21-89	Miller Creek	F	2	150.997	WPVC	21459/60	Orange	-	Unknown
01-25-89	Miller Creek	M	Calf	150.925	WPVC	21461/62	Red	-	Shot

(REF: 5123.BS)

WPVC = White PVC pipe collar
\+ = Blood Sample Collected
Age = At capture
Fate = Through June 1991

Appendix 2. CAPTURE AND KNOWN FATE DATA FROM ELK TRAPPED IN HD 200, 1986-88.

DATE	TRAP SITE	SEX	AGE	FREQ.	COLLAR COLOR/SYMBOL	EAR TAG NUMBER	EAR STREAME RCOLOR	BLOOD SAMPLE	FATE
01-10-86	Boyd	M	Calf	150.562	WPVC	20801-02	Blue	-	Shot
01-14-86	Boyd	F	1	150.475	WPVC	20803	Blue	-	Unknown
01-14-86	Mayo 1	F	1	150.716	WPVC	-	-	-	Unknown
01-15-86	Tamarack 2	F	2	150.437	WPVC	20815	Blue	-	Unknown
01-16-86	Boyd	M	1	-	BB w/black bars	20805-06	-	-	Unknown
01-16-86	Tamarack 2	M	Calf	150.103	WPVC w/blue stripes	20810-11	Blue	-	Roadkill
01-16-86	Boyd	F	3-10	-	OB w/open black triangle	20822-23	-	-	Shot
01-18-86	Tamarack 2	F	3-10	150.404	WPVC	20819	Blue	-	Shot
02-01-86	Dry Fork	F	3-10	150.606	WPVC	20835-36	Blue	-	Woundingloss
02-08-86	Dry Fork	F	2	151.489	WPVC	20832-31	Blue	-	Shot
02-08-86	Dry Fork	F	3-10	151.098	WPVC	-	-	-	Poached
02-12-86	Boyd	F	3-10	150.877	WPVC	20829-30	Blue	-	Unknown
02-12-86	Boyd	F	1	-	OB w/black bars	20827-28	Blue	-	Unknown
02-13-86	Dry Fork	F	3-10	150.542	WPVC	20883-84	Blue	+	Unknown

02-14-86	Dry Fork	F	Calf	151.467	WPVC & blue band	20877-78	Blue	+	Shot
02-19-86	Dry Fork	F	1	151.438	WPVC & blue band w/black stars	20885-86	Blue	+	Unknown
02-19-86	Tamarack 2	F	3-10	150.765	WPVC	20880-82	Blue	+	Unknown
02-19-86	Keith	F	8-10	151.453	WPVC	20887-79	Blue	+	Roadkill
02-19-86	Boyd	F	10+	-	OB w/black H's	20837-38	-	+	Unknown
02-20-86	Dry Fork	F	Calf	-	OB w/solid black circles	20839-40	-	-	Unknown
02-21-86	Keith	M	1	151-301	WPVC w/blue stripe	-	-	-	Unknown
03-04-86	Dry Fork	F	3-10	150.429	WPVC	20845-47	Blue	+	Shot
03-06-86	Mayo 2	F	3-10	150.120	WPVC	20846	Blue	+	Shot
03-06-86	Boyd	F	3-10	150.080	WPVC	20843-89	Blue	-	Unknown
03-10-86	Mayo 2	F	10+	150.520	WPVC	20890-91	Blue	+	Unknown
03-10-86	Dry Fork	F	10+	-	OB w/black ='s	20895-94	-	+	Trap Mort.
03-15-86	Dry Fork	M	1	151.360	WPVC w/blue stripe	20900 20855	-	-	Unknown
03-20-86	Boyd	F	3-10	-	OB w/black bull	20860-61	-	-	Unknown
03-25-86	Dry Fork	F	1	150.280	WPVC	20872-74	Blue	+	Unknown
03-27-86	Tamarack 2	F	1	-	OB w/black X's	20865-66	-	-	Unknown
01-07-87	Boyd	F	Calf	-	YB w/Black T	20446-47	-	+	Unknown
01-07-87	Boyd	F	3-10	151-425	WPVC	20444-45	Yellow	+	Unknown
01-07-87	Boyd	F	3-10	151.253	WPVC	20464-65	Yellow	+	Unknown

01-08-87	Dry Fork	F	Calf	-	YB w/black bars	20436-477	Yellow	+	Unknown
01-21-87	Boyd	F	3-10	151.626	WPVC	20443-42	Yellow	+	Unknown
01-21-87	Boyd	F	2	-	YB w/black +	20460-61	Yellow	+	Unknown
01-21-87	Boyd	M	Calf	150.103	WPVC	20440-41	Red	-	Unknown
01-22-87	Tamarack	M	Calf	-	RB w/white +	20456-57	Red	+	Unknown
01-23-87	Tamarack	F	3-10	151.157	WPVC	20454-88	Yellow	+	Unknown
01-24-87	Tamarack	F	1	-	YB w/black -•	20458-59	Yellows	-	Unknown
01-30-87	Wolf	F	3-10	150.318	WPVC	20705-06	Yellow	+	Unknown
02-04-87	Camels Hump	F	6-8	151.655	WPVC	20702-01	Yellow	+	Shot
02-05-87	Dry Fork	M	2	150.136	WPVC	-	-	-	Shot
02-05-87	Camels Hump	F	3-10	150.337	WPVC	20474-75	Yellow	+	Unknown
02-17-87	Camels Hump	F	10+	151.554	WPVC	20433-34	Yellow	-	Woundingloss
02-19-87	Wolf 2	F	3-10	151.739	WPVC	20466.67	Yellow	+	Unknown
02-20-87	Boyd	F	3-10	150.633	WPVC	20788-89	Yellow	+	Shot
02-20-87	Boyd	F	3-10	-	YB w/black moons	20432-69	Yellow	+	Shot
02-20-87	Boyd	M	Calf	150.674	WPVC w/red stripe	20784-85	Red	-	Woundingloss
02-20-87	Boyd	F	10+	-	YB w/black solid diamonds	20782-83	Yellow	-	Shot
02-24-87	Wolf 2	F	Calf	-	YB w/black arrows	20755-56	Yellow	-	Unknown
02-26-87	Mayo 5	F	3-10	150.039	WPVC	20757-58	Yellow	+	Unknown

02-27-87	Mayo 5	F	3-10	-	YB w/black open diamonds	20759-60	Yellow	+	Unknown
03-03-87	Dry Fork	F	3-10	-	YB w/black S	20761-62	Yellow	+	Unknown
03-10-87	Mayo 5	F	3-10	-	YB w/black P	20765-66	Yellow	+	Shot
03-11-87	Camels Hump 3	F	3-10	151.194	WPVC	20780-81	Yellow	+	Unknown
03-20-87	Mayo 5	F	3-10	-	YB w/black +	20703-04	Yellow	+	Unknown
03-21-87	Boyd	F	10+	-	YB w/black ./././	20773-74	Yellow	+	Unknown
03-21-87	Camels Hump	F	10+	151.565	WPVC	20767-68	Yellow	-	Unknown
03-24-87	Mayo 5	F	3-10	-	YB w/black Ø	20463	Yellow	+	Unknown
03-25-87	Mayo 5	F	6-8	-	YB w/black >>	20769-70	Yellow	+	Unknown
03-26-87	Dry Fork	M	1	151.360	WPVC w/red stripe	20771-72	Red	+	Shot
03-26-87	Mayo 5	F	10+	-	YB w/black ZZ	20751-52	Yellow	+	Unknown
03-27-87	Mayo 5	F	3-10	-	YB w/black ∀|∀|	22942-43	Yellow	-	Shot
03-29-87	Dry Fork	F	3-10	150.844	WPVC	20792-93	Yellow	-	Unknown
01-12-88	Dry Fork	F	Calf	-	Red w/white 2	20720-21	Orange	-	Unknown
01-13-88	Camels Hump 4	F	6-8	-	Red w/white ▲ closed triangles	22948 23149	Orange		Unknown
01-13-88	Dry Fork	M	Calf	150.078	WPVC w/red zigzag	20717 20764	Orange	-	Unknown
01-14-88	Dry Fork	F	Calf	-	Orange w/white ■ closed rectangle	20794-5	Orange	-	Unknown
01-20-88	Tamarack 2	F	1	-	Orange w/white stars & bars ★|	20724 20800	Orange	+	Unknown

01-20-88	Dry Fork	F	6-7	-	Red w/white 3	20725 22990	Orange	+	Unknown
01-20-88	Mayo 5	F	4-5	-	Blue w/white stars & bars ★|	22991-2	Orange	+	Unknown
01-20-88	Camels Hump 4	F	3	-	Orange w/white zigzag	22988-9	Orange	+	Unknown
01-26-88	Dry Fork	F	Calf	-	Orange w/white squiggle	22995-6	Orange	-	Unknown
01-27-88	Dry Fork	F	Calf	-	Orange w/white zeros ○	22999 23000	Orange	-	Unknown
01-27-88	Camels Hump 4	F	3	-	Orange w/white □ open rectangle	22976 22977	Orange	+	Unknown
01-29-88	Dry Fork	F	1-2	-	Orange w/white M	22985 22986	Orange	+	Unknown
01-30-88	Dry Fork	F	2-3	-	Orange w/white bar & slash -/-/	22978 22979	Orange	-	Unknown
02-02-88	Dry Fork	F	3-4	-	Orange w/white stripe ——	22912 22980	Orange	+	Unknown
02-02-88	Dry Fork	F	3-4	-	Orange w/white bars |||	22983-84	Orange	-	Unknown
02-03-88	Mayo 5	F	3-4	-	Orange w/white chevrons & dots <.>	22927-28	Orange	+	Unknown
02-03-88	Camels Hump 5	F	3-10	-	Red w/white arrows →	-	Orange	-	Unknown
02-04-88	Dry Fork	M	Calf	151.720	WPVC	22931-33	Orange	-	Unknown
02-04-88	Camels Hump 4	F	3-10	-	Red w/white ØØØ	22934-35	Orange	-	Unknown

02-05-88	Mayo 5	F	3-10	-	Red w/white △ open triangle	22951-52	Orange	-	Unknown
02-06-88	Mayo 5	M	1-2	151.170	WPVC	22936 22950	Orange	-	Shot
02-09-88	Camels Hump 4	F	3-10	-	Red w/white bars & zeros ǀ0 ǀ0	22953-54	Orange	+	Unknown
02-10-88	Camels Hump 4	M	Calf	151.701	WPVC	22958-59	Orange	-	Shot
02-17-88	Camels Hump 4	F	3-10	-	Red w/white checkers	22962-63	Orange	+	Unknown
02-17-88	Dry Fork	M	Calf	151.522	WPVC	22967-68	Orange	-	Shot
02-19-88	Camels Hump 4	F	2-3	-	Red w/white equals =	22969-70	Orange	+	Unknown
02-23-88	Camels Hump 4	F	3-10	-	Red w/white T	25399	Orange	+	Unknown
02-27-88	Camels Hump 4	F	2-3	-	Red w/white Z	25397-98	Orange	-	Unknown

WPVC=white radio collar
\+ =blood sample taken
Age=age at capture
Fate=as of July 1991

Appendix 3. CAPTURE AND KNOWN FATE DATA FROM ELK TRAPPED IN HD 200, 1984-1985.

(from Thompson and Sterling 1986)

DATE	TRAP SITE	SEX	AGE	FREQ	COLLAR COLOR/SYMBOL	EAR TAG NO.	EAR STREAMER	BLOOD SAMPLE	FATE
05-11-84	Rock Creek	M	1	151.387	Blue	11751-52	-	-	Shot
06-04-84	Rock Creek	M	1	151.344	Red/Blk.Bars	14216-17	-	-	Shot
06-29-84	Rock Creek	M	4-6	151.539	Yel/Grn.Bars	14227-28	-	-	Shot
07-14-84	Meadow Mtn.	F	1	151.211	Green	-	-	-	unknown
07-28-84	Randolf Creek	F	4-6	151.286	Red	14227	-	-	unknown
09-07-84	Meadow Mtn.	M	1/2	151.788	Yel/Blk.Bars	-	-	-	shot
05-25-85	Randolf Creek	F	2+	151.768	Wht/Blk.Stripes	-	-	-	unknown
06-18-85	Rock Creek	F	2	151.712	Wht/Blk.Blocks	20404-05	-	-	spring mort.
06-20-85	Randolf Creek	F	7-9	150.817	Wht/Blk.Bars	20407	-	-	unknown
06-27-85	Randolf Creek	F	2	151.758	Wht/Blu Checkers	20401-08	-	-	shot
06-28-85	Rock Creek	F	3	150.978	Wht/Red Checkers	20409-10	-	-	unknown
06-30-85	Randolf Creek	F	1	151.317	Wht/Blk.+ + +	20421	-	-	unknown
07-18-85	Rock Creek	M	1	151.164	Wht/Blk./ / /	20419-425	-	-	unknown
07-20-85	Meadow Mtn.	F	2+	150.942	Yellow	20414	-	-	unknown
07-21-85	Meadow Mtn.	F	1	151.110	Wht/Blk.Dots	20411	-	-	unknown
07-29-85	Rock Creek	F	1	151.584	Wht/Red X X X	20403-406	-	-	unknown
07-30-85	Meadow Mtn.	F	1	151.686	Wht/Blk Triangles	20418	-	-	unknown
07-31-85	Rock Creek	M	1	151.214	Wht/Blk & Red Diamond	20417	-	-	unknown

Appendix 4. CAPTURE AND KNOWN FATE DATA FROM ELK TRAPPED IN HD 202, 1987-88.

DATE	TRAP SITE	SEX	AGE	FREQ.	COLLAR COLOR/SYMBOL	EAR TAG NUMBER	EAR STREAMER COLOR	BLOOD SAMPLE	FATE
01-27-87	Bouchard	F	5-7	150.562	WPVC	20856-57	Yellow	+	Unknown
01-29-87	Bouchard	F	Calf	-	OB w/white triangles	20707-08	Yellow	-	Unknown
02-05-87	Bouchard	F	Calf	-	OB w/white arrows	20472-73	Yellow	-	Unknown
02-13-87	Marble	F	10+	151.834	WPVC	20786-87	Yellow	+	Unknown
02-14-87	Marble	F	2	151.126	WPVC	20778-79	Yellow	+	Unknown
02-20-87	Marble	F	3-10	151.728	WPVC	20470-71	Yellow	-	Unknown
03-31-87	Wanda's	F	8-10	151.522	WPVC	22946-47	Yellow	+	Summer Mort.
02-09-88	2-Mile	F	3-10	151.540	WPVC	22955-57	Orange	-	Unknown
02-10-88	2-Mile	F	3-10	151.798	WPVC	22960-61	Orange	+	Unknown
02-19-88	2-Mile	F	10+	151.815	WPVC	22961 22973	Orange	+	Unknown

Appendix 5. Capture Data for 88 White-tailed and Mule Deer Marked in Hunting District 123, 1986-1989.

DATE	LOCATION	SPP.	SEX	AGE	COLLAR *	EAR TAGS	BLOOD
01-07-86	Swamp Creek	WTD	F	3-10	-	20601-03	-
01-07-86	Brush Gulch	MD	F	3-10	-	20602-04	-
01-07-86	Brush Gulch	MD	F	1/2	-	20605-06	-
01-07-86	Brush Gulch	MD	F	3-10	-	20607-08	-
01-08-86	Swamp Creek	WTD	F	1/2	-	20609-10	-
01-08-86	Swamp Creek	WTD	F	2	-	20611-12	-
01-08-86	Brush Gulch	MD	F	3-10	-	20613-14	-
01-08-86	Brush Gulch	MD	M	1/2	-	20615-16	-
01-08-86	Dry Creek	WTD	F	1	-	20617-18	-
01-08-86	Dry Creek	WTD	M	1/2	-	20619-20	-
01-12-86	Swamp Creek	WTD	F	3-10	-	20623-24	-
01-15-86	Brush Gulch	MD	F	3-10	-	20625-26	-
01-17-86	Brush Gulch	MD	F	3-10	-	20627-28	-
01-17-86	Brush Gulch	MD	F	1/2	-	20629-30	-
01-18-86	Swamp Creek	WTD	F	3-10	-	20631-32	-
01-20-86	Brush Creek	MD	F	1/2	-	20635-36	-
01-20-86	Swamp Creek	WTD	F	3-10	-	20637-38	-
01-23-86	Brush Gulch	MD	F	2	-	20639	-
01-30-86	Brush Gulch	MD	F	2	21/21/21	20641-42	+
01-31-86	Brush Gulch	MD	F	3-10	H2H2H2H2	20643-44	+
02-06-86	Brush Gulch	MD	F	4	freq.151.481	20648-49	+
02-06-86	Brush Gulch	MD	F	1	H9H9H9H9	51538-39	-
02-14-86	Sheep Gap	WTD	M	2	-	21540-41	-
02-15-86	Hill 7	WTD	M	10+	-	21542-43	-
02-20-86	Brush Gulch	MD	F	3-10	T2T2T2T2	21528-29	+

02-26-86	Brush Gulch	MD	F	3-10	H4H4H4H4	21526-27	-
02-28-86	Sheep Gap	WTD	F	1/2	-	21531-37	+
03-05-86	Therriault Gul.	MD	F	10+	T1T1T1T1	21512-13	+
03-05-86	Brush Gulch	MD	F	3-10	09090909	21510-11	+
03-12-86	Therriault Gul.	MD	F	3-10	80/80/80	21525-34	+
03-12-86	Therriault Gul.	MD	M	1	42/42/42	21516-50	+
03-18-86	Therriault Gul.	MD	F	3-10	12/12/12	-	+
03-18-86	Therriault Gul.	MD	F	3-10	H7H7H7H7	21521-23	+
03-19-86	Sheep Gap	WTD	M	1/2	-	21504-22	+
03-20-86	Therriault Gul.	MD	F	3-10	H1H1H1H1	20650-21501	+
03-22-86	Therriault Gul.	MD	F	3-10	A9A9A9A9	21502-03	+
03-24-86	Therriault Gul.	MD	F	3-10	E8E8E8E8	20684-85	+
03-25-86	Therriault Gul.	MD	F	3-10	Y2Y2Y2Y2	20682-83	+
03-28-86	Sheep Gap	WTD	F	1	-	20680-81	+
03-28-86	Therriault Gul.	MD	F	8-10	Y3Y3Y3Y3	20699-70	+
03-29-86	Brush Gulch	MD	M	1/2	43/43/43	20696-97	+
03-31-86	Shamrock Gul.	MD	F	1	Y1Y1Y1Y1	20693	+
04-04-86	Sheep Gap	WTD	M	1	-	20663-64	+
04-13-86	Therriault Gul.	MD	M	1/2	M2M2M2M2	20673-74	+
04-17-86	Shamrock Gul.	MD	F	1	11/11/11	20675	+
04-17-86	Therriault Gul.	MD	F	3-10	20/20/20	20661	+
04-17-86	Brush Gulch	MD	M	1	13/13/13	20651	+
04-19-86	Shamrock Gul.	MD	M	1/2	M7M7M7M7	20654	+
12-18-86	Clark Mt.	WTD	M	3-10	-	21593-94	-
12-18-86	Therriault Gul.	MD	M	1	%%%%%%	21568-69	-
12-23-86	Clark Mt.	MD	M	3-10	-	21553-54	-
12-23-86	Clark Mt.	MD	M	1	-	21555-56	-
12-29-86	Clark Mt.	MD	F	3-10	-	21557-58	-

01-08-87	Therriault Gul.	MD	F	3-10		21561-62	-
01-08-87	Therriault Gul.	MD	F	1/2	0 0 0	21570-71	-
01-10-87	Therriault Gul.	MD	M	1		21574-75	-
01-12-87	Therriault Gul.	MD	F	1/2		21599-600	-
01-13-87	Therriault Gul.	MD	F	3-10	o o o	20565-66	-
01-13-87	Clark Mt.	MD	F	3-10	-	20567-68	-
01-14-87	Therriault Gul.	MD	F	1/2	SSSSSSSSS	20569-70	-
01-17-87	Clark Mt.	MD	F	3-10	-	20574-75	-
01-24-87	Clark Mt.	MD	F	2	-	20557-58	-
01-29-87	Clark Mt.	MD	F	1/2	-	20555-56	-
02-01-87	Clark Mt.	MD	F	3-10	-	21580-81	-
02-02-87	W.Fk.Dry Cr.	WTD	M	1/2	-	21584-85	-
02-14-87	Therriault Gul.	MD	M	1/2		20526-27	-
02-20-87	Clark Mt.	WTD	F	2	-	20549-50	-
02-21-87	Therriault Gul.	MD	F	3-10	XXXXXXXXX	20545-46	-
02-22-87	Therriault Gul.	MD	M	1/2		20543-44	-
02-25-87	Clark Mt.	WTD	F	1/2	-	20541-none	-
03-03-87	Swamp Creek	WTD	F	3-10	-	20539-40	-
03-03-87	Clark Mt.	MD	F	1/2	-	20519-20	-
03-08-87	Therriault Gul.	MD	F	3-10	333333333	20523-24	-
03-11-87	Eddy Cr.	MD	M	3-10	-	20501-02	-
03-11-87	Therriault Gul.	MD	F	1	o o o o	20503-25	-
03-11-87	Therriault Gul.	MD	F	3-10		20504-05	-
03-12-87	Therriault Gul.	MD	M	1/2	orange	20506-38	-
03-13-87	Therriault Gul.	MD	M	1/2	o o o	20507-08	-
03-15-87	Therriault Gul.	MD	F	1/2		20509-10	-
03-30-87	Therriault Gul.	MD	F	1		21434-35	-
04-01-87	Therriault Gul.	MD	F	1/2		21432-33	-
01-07-88	Wilkes Creek	WTD	M	1	-	21474-75	-

01-19-88	Brush Gulch	MD	F	2	-	21440-41	-
02/05/88	Clear Creek	MD	M	3-10	-	21457-58	-
02/18/88	Clear Creek	MD	M	3-10	-	21565-66	-
02/28/88	Miller Creek	MD	F	1	-	21588-90	-
01-26-89	Miller Creek	WTD	F	3-10	-	21424-25	-
02-07-89	Miller Creek	MD	F	3-10	-	21422-23	-

* From Jan. - April 1986 deer were fitted with white neckbands with black markings. From December 1986 - April 1987 deer were marked with orange vinyl neckbands with black or white markings.

Appendix 6. Capture data from 51 white-tailed and mule deer marked in HD 200, 1986-1987.

DATE	LOCATION	SPP.	SEX	AGE	COLLAR *	EAR TAGS	BLOOD
01-17-86	Mullan 1	WT	F	1/2	-	20820-21	-
01-25-86	Keith	WT	F	9	-	20818-25	-
01-28-86	Mullan 2	WT	F	8	-	20816	-
01-28-86	Tamarack 2	WT	M	1	-	20824	+
01-29-86	Tamarack Hill	WT	F	2	-	20809	Died
01-30-86	Keith	WT	F	8	-	20817	-
01-31-86	Keith	WT	F	6	-	20807	-
02-06-86	Keith	WT	F	1/2	-	20834	+
02-12-86	Tamarack 2	WT	M	2	-	20833	+
02-14-86	Tamarack 2	WT	M	3	-	20881	+
02-21-86	Mayo 2	WT	F	1/2	-	28841	+
02-22-86	Mayo 2	WT	M	5	-	20850	-
02-22-86	Keith	WT	F	9	-	-	-
02-23-86	Tamarack 2	WT	F	1/2	-	20848	+ +
03-04-86	Keith	WT	M	6	-	20844	+
03-11-86	Dry Fork	WT	F	6-8	-	20853	+
03-18-86	Mayo 3	WT	F	4	-	20899	+
03-18-86	Keith	WT	M	1/2	-	20854	-
03-21-86	Dry Fork	WT	F	3	-	20864	+
03-22-86	Mayo 3	WT	M	5	-	20875	+
03-26-86	Mayo 3	WT	F	7	-	20870	+
01-06-87	Mayo 4	WT	F	6+	-	20450-51	-
01-07-87	Mayo 4	WT	F	8	-	20438-39	-
01-08-87	Mayo 4	WT	F	1/2	-	20480	-
01-08-87	Keith	WT	F	3+	-	20858	-
01-04-87	Tamarack 2	WT	M	3+	-	20495	-

01-14-87	Dry Fork 1	WT	M	3+	-	20497	-
01-14-87	Keith	WT	F	3+	-	20500	-
01-14-87	Mayo 4	WT	M	1/2	-	20481	-
01-17-87	Dry Fork 1	WT	F	3+	-	20862	-
01-17-87	Mayo 4	WT	M	1/2	-	20431	-
01-20-87	Wolf	MD	F	8+	-	20486	-
01-20-87	Long	WT	M	8+	-	20430-863	-
01-21-87	Wolf	MD	F	6+	-	20448	-
01-21-87	Keith	WT	F	8+	-	20426-27	-
01-27-87	Tamarack	WT	M	6+	-	20715-16	-
01-28-87	Wolf	MD	F	8+	-	20709-10	-
01-29-87	Wolf 2	MD	F	4	-	20433	-
02-03-87	Wolf 2	MD	F	5	-	20711-12	-
02-03-87	Wolf 1	MD	F	1/2	-	20449 20713	-
02-05-87	Wolf 1	MD	M	1/2	-	20429	-
02-13-87	Wolf 2	MD	F	1	-	20776-77	-
02-21-87	Wolf 1	MD	M	1/2	-	20453	-
03-19-87	Camels Hump 1	WT	F	8+	-	20790-91	-
01-20-87	Wolf	MD	F	3-10	-	20486	-
01-21-87	Wolf	MD	F	3-10	-	20448	-
01-28-87	Wolf	MD	F	3-10	-	20709-10	-
01-29-87	Wolf	MD	F	3-10	-	20433	-
02-03-87	Wolf	MD	F	3-10	-	20711-12	-
02-03-87	Wolf	MD	F	1/2	-	20713 20449	-
02-05-87	Wolf	MD	M	1/2	-	20429	-
02-13-87	Wolf	MD	F	1/2	-	20776-77	-
02-21-87	Wolf	MD	M	1/2	-	20453	-

	OBSERVED VALUES			EXPECTED VALUES	
	SURVIVED	HARVESTED	TOTAL	SURVIVED	HARVESTED
HD 123	5	8	13	7.7	5.3
HD 200	17	7	24	14.3	9.7
TOTAL	22	15	37	22.0	15.0

X^2=3.58, df=1, .10>p>.05

Appendix 7. Comparison of harvest rates for pooled samples of radio-tagged bulls in HD 123 and HD 200 during the 1984-1990 hunting seasons. Observed and expected values.

AGE CLASS (YRS)	OBSERVED VALUES		TOTAL	EXPECTED VALUES	
	SURVIVED	HARVESTED		SURVIVED	HARVESTED
1.5	12	3	15	8.9	6.1
2^+	10	12	22	13.1	8.9
TOTAL	22	15	37	22	15

X^2 4.41, df=1, .05>p>.025

Appendix 8. Comparison of harvest rates for 3 age-classes of radio-tagged bulls in the study area during 1984-1990 hunting seasons. Observed and expected values.

	OBSERVED VALUES		TOTAL	EXPECTED VALUES	
	SURVIVED	HARVESTED		SURVIVED	HARVESTED
HD 123(ALL)	78	17	95	79.8	15.2
HD 200	74	12	86	72.2	13.8
TOTAL	152	29	181	152.0	29
HD 123(WEST)	42	10	52	43.7	8.3
HD 200	74	12	86	72.3	13.7
TOTAL	116	22	138	116	22

HD 123(ALL) vs. HD 200-X^2=0.52, df=1, .50>p>.10
HD 123(WEST) vs. HD 200-X^2=0.67, df=1, .50>p>.10

Appendix 9. Comparisons of harvest rates of cows radio-tagged in HD 123 and HD 200 during the 1984-1990 hunting seasons. Observed and expected values.

	OBSERVED VALUES		TOTAL	EXPECTED VALUES	
	SURVIVED	HARVESTED		SURVIVED	HARVESTED
EAST	36	7	43	35.3	7.7
WEST	42	10	52	42.7	9.3
TOTAL	78	17	95	78	17

X^2=0.13, df=1, .90>p>.50

Appendix 10. Comparison of harvest rates for pooled samples of cows radio-tagged in permitted (East) and in either-sex (West) portions of HD 123 during the 1984-1990 hunting seasons.

DECISION NOTICE
AND
FINDING OF NO SIGNIFICANT IMPACT
MOUNT BUSHNELL

USDA, FOREST SERVICE
PLAINS/THOMPSON FALLS AND SUPERIOR RANGER DISTRICTS
LOLO NATIONAL FOREST

It is my decision during the next 10 year period to construct up to 81 miles of road, reconstruct approximately 9 miles of existing road and initiate timber management activities on an estimated 3,200 acres.

Based upon an analysis of cumulative effects by an Interdisciplinary Team composed of Lolo Forest Officials and Wildlife Biologists from the Montana Department of Fish, Wildlife and Parks (DFW&P), this decision implements the Lolo National Forest Plan on National Forest lands both north and south of the Cabinet-Couer'd Alene Divide from Gold Rush Creek to the East Fork of Crow Creek on the Plains/Thompson Falls Ranger District and from Twin Creeks to Packer Creek on the Superior Ranger District.

The Interdisciplinary Teams' analysis encompassed approximately 50,330 acres. This decision addresses actions connected with timber harvest activities on approximately 3,200 acres which will be programed for transportation systems and a variety of harvest treatments including clearcut, seedtree, shelterwood and selection silvicultural systems during the next 10 year period. This area will provide a variety of forest products for local use.

The Management Areas contained within the study area, as defined by the Lolo National Forest Plan, include those available for commercial timber harvest such as Management Areas 13,16,17,18 and 21 through 26. In addition, Management Areas 1,10,19 and 27 are represented which reflect resource values other than commercial timber production. As a result of habitat inventories, areas identified as critical elk summer range were refined and mapped to reflect the existing resource condition. This decision is tiered to the Lolo National Forest Plan and Forest EIS of April 1986. The proposed actions implement the standards and guidelines of the Forest Plan.

PUBLIC ISSUES AND CONCERNS

As a result of the major forest fires of 1904, 1910 and 1919, the vegetative cover of the study area has been changing from open expanses to the present condition where the area has nearly a complete canopy coverage of 80 to 100 year old trees. Due to the essentially unroaded nature of the study area and the diversity of vegetation, terrain and wildlife, the hunting and recreational opportunities provided are generally perceived to be of high quality.

The analysis area includes portions of Region 1 and 2 of the Montana Department of Fish, Wildlife and Parks. At the present time, hunting season regulations vary between the two Regions. There are also a number of commercial outfitters and guides active within the study area which provide service to residents and non-residents for a variety of uses.

A significant potential exists for large scale value and volume loss due to the southerly migration of the mountain pine beetle epidemic in northwestern Montana.

Some of the public issues and management concerns identified in the Mt. Bushnell analysis are listed below:

1. How will the cumulative impacts of timber management activities in the area affect security cover and long term harvest rates of elk?

2. How will timber management activities in the area affect the productivity of elk summer and winter range?

3. How will road construction and timber harvest within the area affect traditional regional values, community feelings and local lifestyles?

4. How can the area be managed to maintain the current quality of recreational use?

5. How can the area be managed to accommodate the full range of DFW&P objectives?

6. How will resource development impact the currently established commercial interests in the area?

7. How can the lodgepole pine stands be managed to reduce the impacts of large scale mountain pine beetle epidemics?

Alternatives Considered:

Should the mountain pine beetle epidemic enter the study area, analysis and recent history of the epidemic indicate that the volume and value loss cannot be avoided. Accelerated harvest and road construction schedules that could salvage this material would create cumulative impacts on watershed, elk productivity and recreation that would violate Forest Plan standards.

Based upon the issues and concerns identified through a public involvement process, the Interdisciplinary Team developed a range of alternative management strategies that were responsive to each. Each alternative addressed the issues and concerns and meets the objectives of the Lolo National Forest Plan and those defined by the team specific to the Mt. Bushnell study area.
During the analysis process, alternatives that were developed which did not meet Forest Plan standards were eliminated and received no further consideration.

Following is a descriptive list of the alternatives considered, but not selected:

Alternative 1 maintains recreational use in its present condition as long as possible. Harvest units will be selected to reduce risk of mountain pine beetle loss but with minimum impacts to recreation and commercial interests. Reentry into initial project areas will be on a 15 year frequency.

Alternative 2 has an objective to maintain security/cover and productivity for elk. Rate of timber harvest is commensurate with the Lolo National Forest assigned sell quantity (ASQ).

Alternative 2B is the same as alternative 2 except the rate of harvest is reduced by 25% to reflect the current situation on the Forest.

Alternative 2N defers timber resource development activities for the 10 year decision period. This alternative is the No Action alternative.

Alternative 6 places an emphasis on treatment of lodgepole stands with harvest rates accelerated in the near term for mountain pine beetle risk reduction. Dispersed recreation and elk productivity are provided for at minimal levels. However, escape cover of each herd unit will be maintained.

Alternative 6B has the same objective as alternative 6 with a scheduled rate of harvest on a even-flow basis throughout the planning period.

Alternative 11 schedules timber harvest at a rate similar to 6B while emphasizing the need for long term elk security/cover.

RATIONAL FOR THE DECISION

I chose to implement alternative 12 because recreational opportunities, cover/forage ratios and substantial amounts of security cover are maintained or enhanced in every drainage of the analysis area.

Road management provides for adequate big game security needs by incorporating a closed system to motorized vehicles. Road systems are designed for within drainage flow patterns to minimize disturbance levels and impacts to adjacent security cover areas.

Impacts on commercial Outfitters and Guides are minimized during the 10 year period of this decision.

This alternative maintains the full range of herd management options within the analysis area and allows for changing conditions and DFW&P's input.

While significant loss of lodgepole pine to the beetle is unavoidable, this alternative will initiate harvest activities in moderate and high hazard areas along the perimeter of the study area.

Under Alternative 12, resource development in the Mt. Bushnell area reflects the management standards and goals of the Lolo National Forest Plan. The cumulative effects expected by implementation of this alternative will not significantly impact the existing resource values in the analysis area. This alternative accepts additional loss of lodgepole pine value and results in a moderate reduction in total planned harvest volume during the 10 year decision period. However, expected benefits include improvement of cover/forage ratios, enhancement of elk productivity, incorporation of DFW&P objectives and maintaining quality recreational opportunities.

Within the 10 year decision time-frame, development activities in project areas are scheduled in two 5 year periods. The following table and attached map identify project area locations.

Project Area	5 Yr. Period	Est.Acres Treatment	Est.MBF Volume	Est.Mi. Const.	Est.Mi.Rd. Reconst.
I	1	182	2,184	3.3	*
II	1	305	3,355	6.8	
III	2	452	4,972	11.5	2.0
IV	2	294	3,234	5.7	
V	1	228	2,964	11.1	
VI	1	400	6,223	12.5	*
VII	2	309	3,708	7.4	
VIII	1	309	3,984	8.2	3.5
IX	2	244	2,960	5.9	3.0
X	2	360	4,866	8.6	

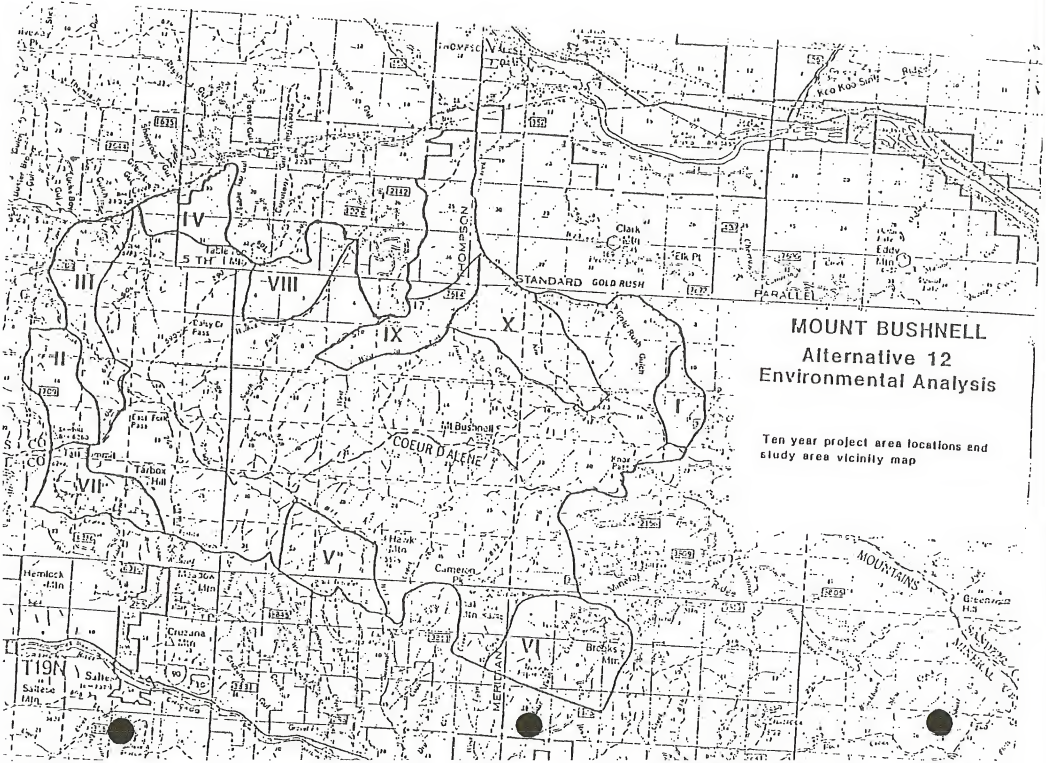
* Reconstruction needs for these project areas are outside analysis boundary.

Considering the above analysis, I have found this to be a non-significant action and not requiring a environmental impact statement. This decision will have no effect on flood plains, wetlands, threatened or endangered species. Cultural resource inventories and evaluation will be conducted prior to any project disturbance activity. Proper protection or mitigation actions will be taken should cultural resources be found. The project will have no significant impacts on the quality of the human environment.

The project file may be reviewed at the Plains/Thompson Falls Ranger District, Plains, MT 59859 or the Superior Ranger District, Box 460, Superior, MT 59872. Implementation of this project may take place upon the date of this Decision Notice. This decision is subject to a 45 day review period pursuant to 36 CFR 211.18. Questions concerning this project may be addressed to the Forest Supervisor, Lolo National Forest, Building 24, Fort Missoula, Missoula, MT 59801

ORVILLE L. DANIELS
Forest Supervisor

10/25/88
DATE


MOUNT BUSHNELL
Alternative 12
Environmental Analysis
Ten year project area locations end study area vicinity map
I
II
III
IV
V
VI
VII
VIII
IX
X
STANDARD GOLD RUSH
PARALLEL
THOMPSON
MERIDIAN
COEUR D'ALENE
MOUNTAINS
Mt Bushnell
Clark Mtn
Elk Pt
Eddy Mtn
Tarbox Hill
Hawk Mtn
Cameron Pk
Brooks Mtn
Cruzana Mtn
Hemlock Mtn
Saltese Mtn
Saltese
T19N
Kno Koo Sint
Gold Rush Gulch
Daisy Cr Pass
East Fork Pass
Knox Pass
Mineral Ridge
Greenrock Hill
5 TH
Table