Population ecology of Rocky Mountain bighorn sheep in the upper Yellowstone River drainage, Montana/Wyoming
by Kimberley Alan Keating

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Fish and Wildlife Management
Montana State University

Abstract:
A study was conducted in the upper Yellowstone River drainage of Montana and Wyoming between December 1979 and October 1981 to evaluate the history and possible causes related to an instance of natural recolonization of historic bighorn winter range and to provide baseline data on the current bighorn population. Seasonal ranges and movements were determined from 210 radio-relocations and 3,235 visual observations. Historical records indicated that current use of the Cinnabar Mountain winter range represents a natural recolonization, beginning about 1965, following extirpation of bighorns from that area during the late 1800's. Dispersal from the Mount Everts winter range population was postulated as the mechanism for recolonization. Census data on the Cinnabar Mountain winter range showed an exponential trend with a mean annual rate of increase per individual of 0.18 between 1967 and 1980. Census data for the Mount Everts winter range showed an exponential trend with a mean annual rate of increase per individual of 0.12 between 1965 and 1973, while numbers remained relatively stable at about 200 since 1974. Comparison of observed rates of increase per individual bighorn with estimated elk numbers on the northern Yellowstone winter range four years previously, suggested that elk numbers negatively impacted bighorn numbers on the Mount Everts winter range. Possible reasons for the observed time lag and the potential importance of this relationship to bighorn dispersal and ecesis were discussed. Bighorn winter food habits indicated a high potential for competition between elk and bighorns during conditions of severe winter weather and high elk numbers. Lamb:adult ewe ratios of 88:100 in 1979 and 71:100 in 1980, a mean suckling time of 26.4 seconds, and a log-normal mean lungworm larval output of 16 larvae per gram of dry fecal material were all suggestive of a high quality population, These factors were thought to be highly influenced by the mild weather during the study. Rapid ram maturation rates were also indicative of a high quality population and were thought to be less subject to immediate climatic conditions. Population responses following the recent mortality resulting from a Chlamydia outbreak on the Mount Everts winter range were suggested as a means of evaluating hypotheses on elk-bighorn relations.

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Approved:

Chairperson, Graduate Committee

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ABSTRACT

A study was conducted in the upper Yellowstone River drainage of Montana and Wyoming between December 1979 and October 1981 to evaluate the history and possible causes related to an instance of natural recolonization of historic bighorn winter range and to provide baseline data on the current bighorn population. Seasonal ranges and movements were determined from 210 radio-relocations and 3,235 visual observations. Historical records indicated that current use of the Cinnabar Mountain winter range represents a natural recolonization, beginning about 1965, following extirpation of bighorns from that area during the late 1800's. Dispersal from the Mount Everts winter range population was postulated as the mechanism for recolonization. Census data on the Cinnabar Mountain winter range showed an exponential trend with a mean annual rate of increase per individual of 0.18 between 1967 and 1980. Census data for the Mount Everts winter range showed an exponential trend with a mean annual rate of increase per individual of 0.12 between 1965 and 1973, while numbers remained relatively stable at about 200 since 1974. Comparison of observed rates of increase per individual bighorn with estimated elk numbers on the northern Yellowstone winter range four years previously, suggested that elk numbers negatively impacted bighorn numbers on the Mount Everts winter range. Possible reasons for the observed time lag and the potential importance of this relationship to bighorn dispersal and ecesis were discussed. Bighorn winter food habits indicated a high potential for competition between elk and bighorns during conditions of severe winter weather and high elk numbers. Lamb:adult ewe ratios of 88:100 in 1979 and 71:100 in 1980, a mean suckling time of 26.4 seconds, and a log-normal mean lungworm larval output of 16 larvae per gram of dry fecal material were all suggestive of a high quality population. These factors were thought to be highly influenced by the mild weather during the study. Rapid ram maturation rates were also indicative of a high quality population and were thought to be less subject to immediate climatic conditions. Population responses following the recent mortality resulting from a *Chlamydia* outbreak on the Mount Everts winter range were suggested as a means of evaluating hypotheses on elk-bighorn relations.

INTRODUCTION

If one applies the traditional criteria of wide geographic distribution, numerical strength, and extensive temporal distribution, the genus *Ovis* must be regarded as historically, among the most successful of the large Pleistocene mammals (Geist 1971). This characterization implies an ability to readily disperse into and colonize available habitat (Flerow 1967). Paradoxically, however, extirpation of bighorn sheep (*O. canadensis*) populations during historic times has not generally been followed by recolonization (Buechner 1960), despite the continued suitability of most historic habitat and periodic expansion of local populations (Geist 1971). The lack of documented instances of natural recolonization by bighorns has previously precluded empirical analysis of current hypotheses regarding this problem.

The purpose of this thesis is to: 1) document an instance of natural recolonization of historic bighorn range adjacent to Yellowstone National Park, 2) examine selected factors which may have been important in stimulating this recolonization, and 3) provide baseline data on current bighorn distribution and movements in the area and on current population status.

STUDY AREA

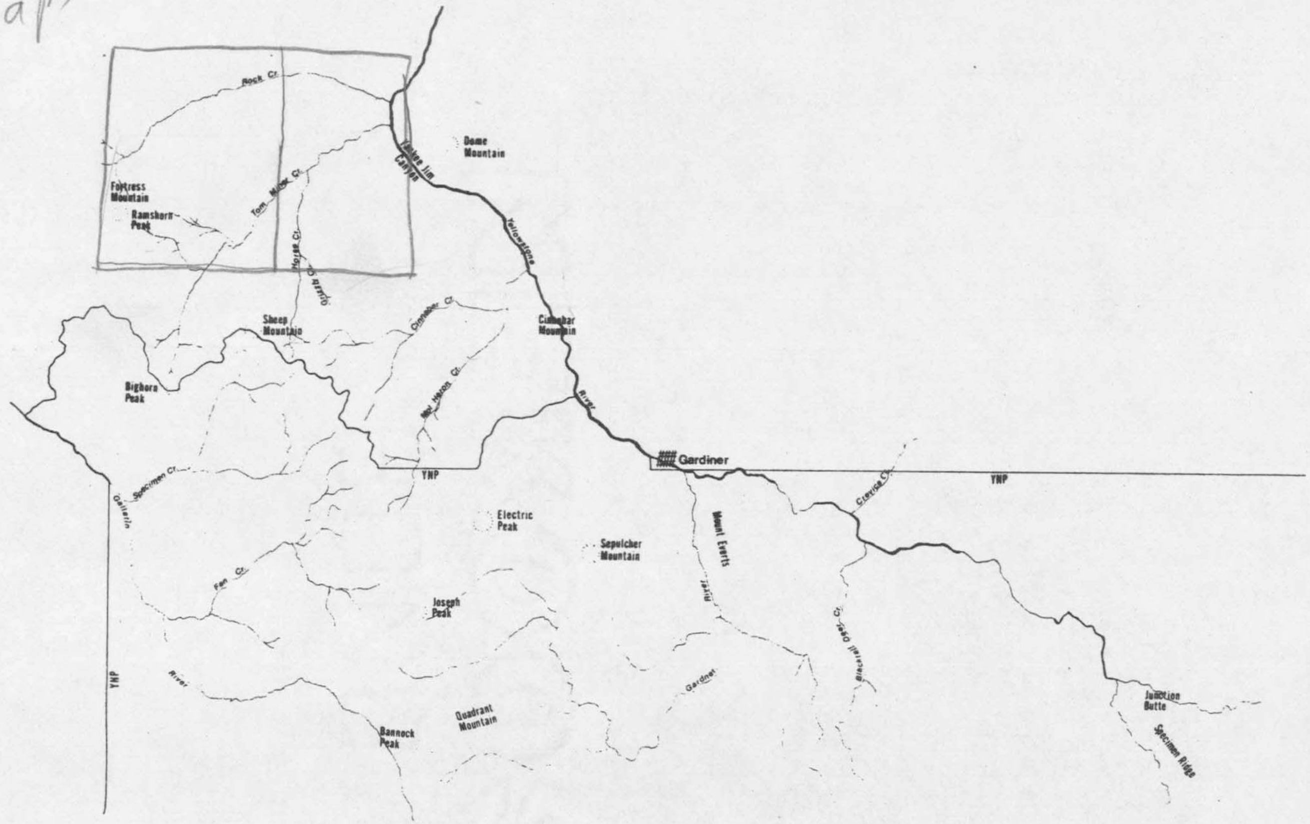
This study was conducted in the upper Yellowstone and Gallatin River drainages of Montana and Wyoming. The study area encompassed the southern portion of the Gallatin Range from Fortress Mountain south to Bighorn Pass (Figure 1). Movements of bighorns from previously known wintering areas (Figure 2) in Tom Miner Basin and on Cinnabar Mountain defined the extent of the study area. Both the Cinnabar (CWR) and Mount Everts (EWR) winter ranges are subunits of the northern Yellowstone winter range (NYWR) described by Houston (1980).

Land ownership is a mixture of National Park Service (Yellowstone National Park), U.S. Forest Service (Gallatin National Forest), and private lands, with minor areas in Tom Miner Basin controlled by the Bureau of Land Management.

Topography is characterized by a single major north-south divide which forms the crest of the Gallatin Range. Elevations in the area range from 1,575 meters at the Yellowstone River to 3,330 meters on Electric Peak.

Chester (1976) characterized the climate of the Gallatin Range as "severe with long winters, heavy snowfall, and short summers. Considerable snow usually remains on the higher portions of the area into July, while fall accumulations generally begin in October and November." During this study, winters were unseasonably warm and dry,

USGS
maps



Ramshorn pk.
Miner
Dome MT.
Bighorn pk.
Sportsman LK.
Electric pk.

Figure 1. Map of areas and features mentioned in the text.

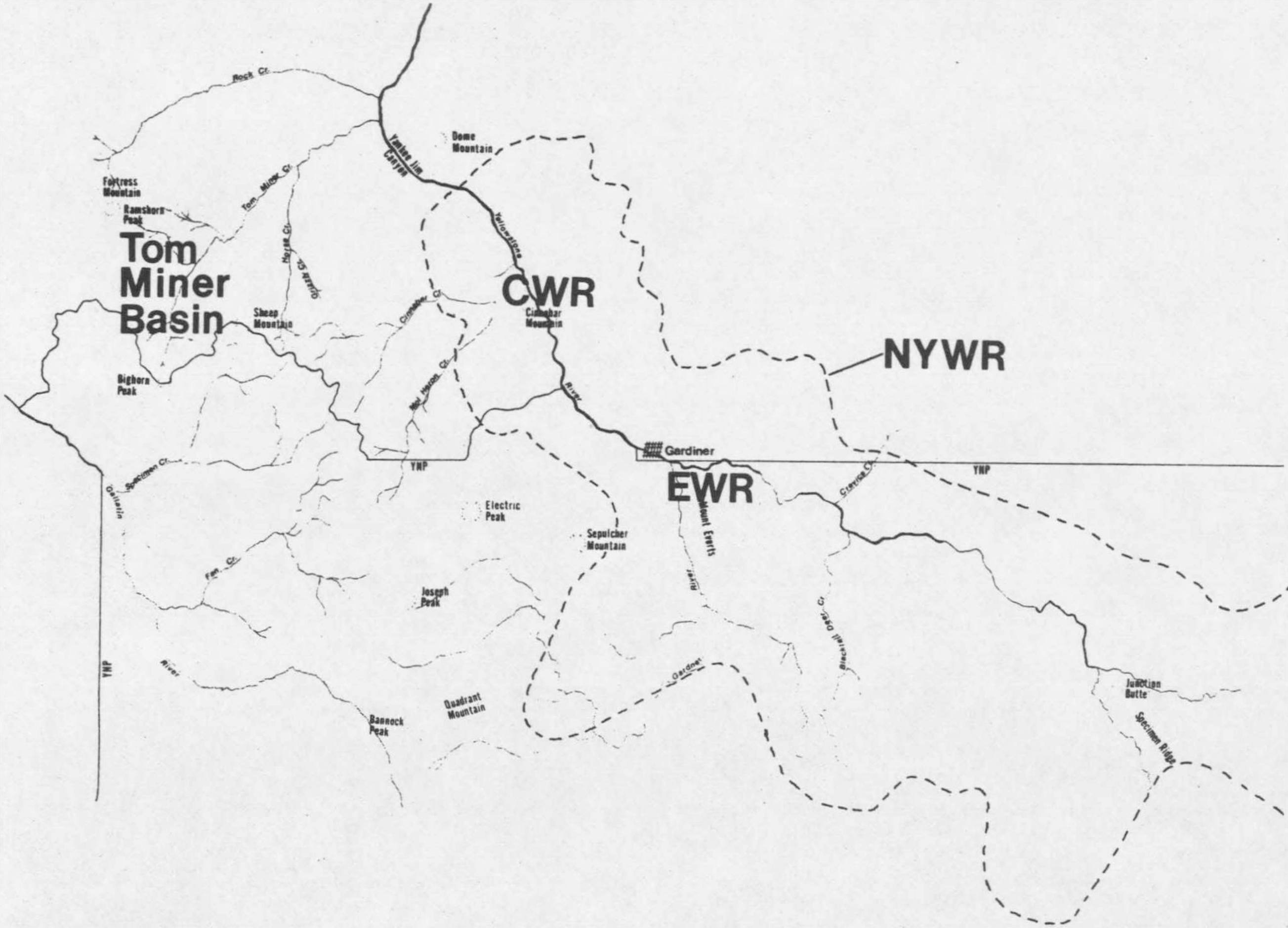


Figure 2. Previously identified wintering areas mentioned in the text,

with no substantial snow accumulations on the lower winter ranges until January in 1979-1980 and February in 1980-1981.

Vegetation zones in the area have been described previously by Despain (1973).

HISTORY

Archaeological studies indicate that aboriginal man has hunted mountain sheep in the Yellowstone area for at least 8,000 years (Lahren 1971). Aboriginal predation is thought to have had no discernible adverse impact on bighorn numbers or distribution (Geist 1971), and the abundance of mountain sheep in the upper Yellowstone as late as 1870 is believed to reflect pristine conditions (Houston 1980).

Intensive market hunting in the 1870's dramatically reduced big game populations (Houston 1980). Norris (1877) estimated that, between 1870 and 1877, 2,000 hides each of elk, deer, and bighorn sheep had been removed from Yellowstone National Park (YNP). Strong (1876) estimated that over 4,000 elk were killed in a single winter in the Mammoth Springs Basin alone. Though discrepancies exist between the kill estimates of Strong and those of Norris, it is clear that market hunting had substantial impact during the 1870's. Houston (1980) concluded that market hunting "must have reduced or eliminated accessible herd segments by the mid 1880's and 1890's". Grinnell (1876) specifically noted the extreme impact of hide hunting on big game populations between Mammoth and the mouth of Tom Miner Creek. The movement of the U.S. Army into YNP in 1886 did much to curtail market hunting within the Park's boundaries. However, this may have served to increase market hunting pressures outside the Park until market hunting subsided in the 1890's.

The degree and rapidity of settlement in the upper Yellowstone should also be reckoned as a factor in the decline of wild ungulate populations in the area. Mining began at Emmigrant in 1864. Two years later mining operations began in Bear Gulch where the town of Jardine was established in 1898. By 1883, just 3 years after its establishment, the town of Gardiner claimed a population of 200 people, though this figure belies the extent of settlement in the area. By virtue of its size, the business community in Gardiner (Whithorn and Whithorn *circa* 1977) obviously served a much larger population in the surrounding area. The chronology of settlement in the upper Yellowstone is shown in Figure 3. Of special interest is the Electric-Aldridge complex. The following historical review of that area is derived from work by Whithorn and Whithorn (*circa* 1965).

With the discovery of high grade coal in the Devil's Slide area, the towns of Horr (later changed to Electric) and Aldridge were established in 1894 and 1896, respectively (Figures 4 and 5). The Electric-Aldridge boom was rapid and substantial. Boasting a combined population of 1,500 people, the Electric-Aldridge complex was a beehive of activity until bankruptcy of the coal company brought the demise of both communities in 1910. Wagon roads connected the 2 towns and completely encircled Cinnabar Mountain. Five separate mine sites were developed between the 2 towns (Figure 6). Flumes and, later, tramways traversed the area, bringing the coal from the mines to

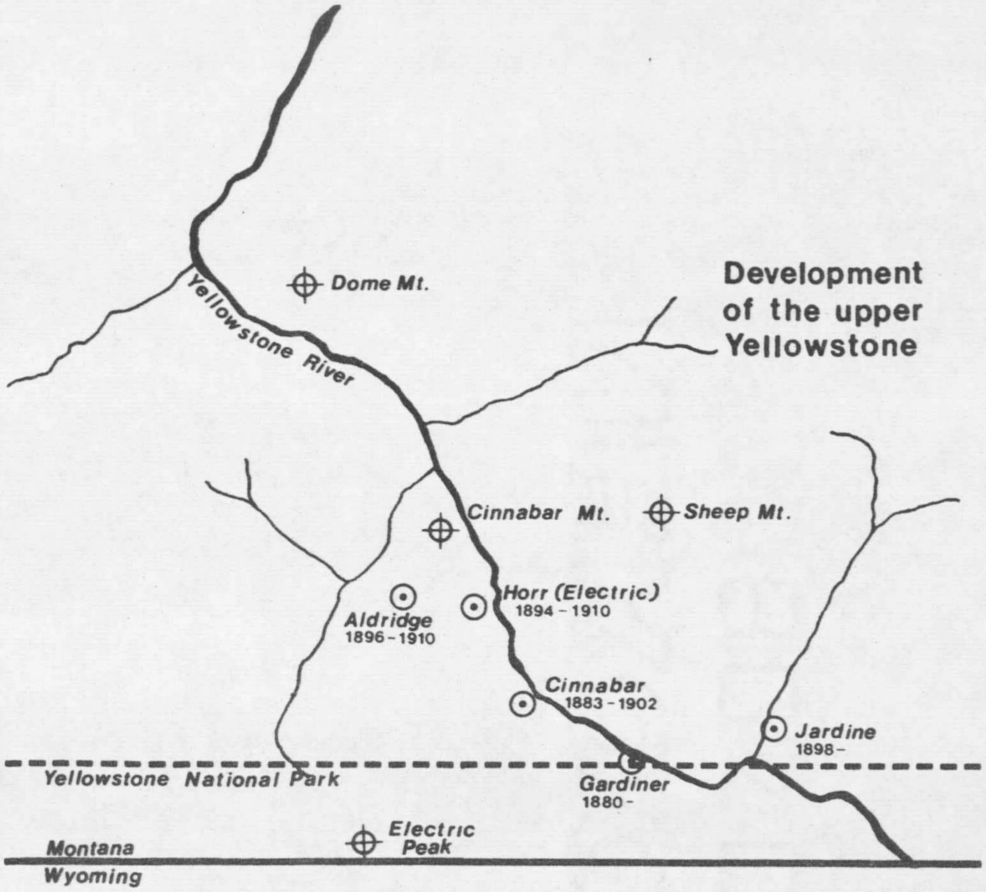


Figure 3. Chronology and spatial relationships of town site developments, 1860 to the present, in the upper Yellowstone River drainage between Yankee Jim Canyon and Gardiner, Montana.

Figure 4. The pioneer community of Electric (1901-1904).

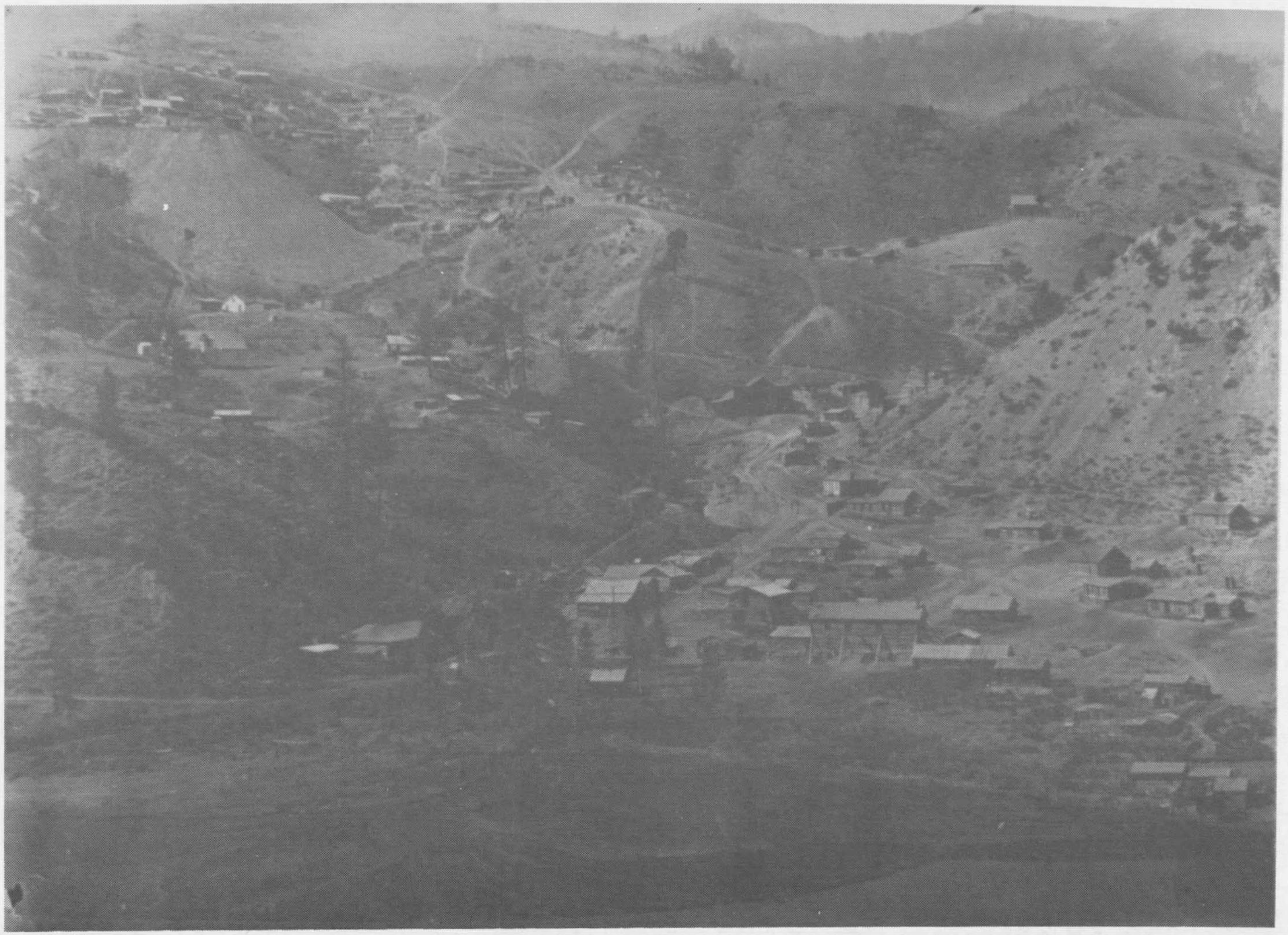


Figure 5. The pioneer community of Aldridge (1902-1904).

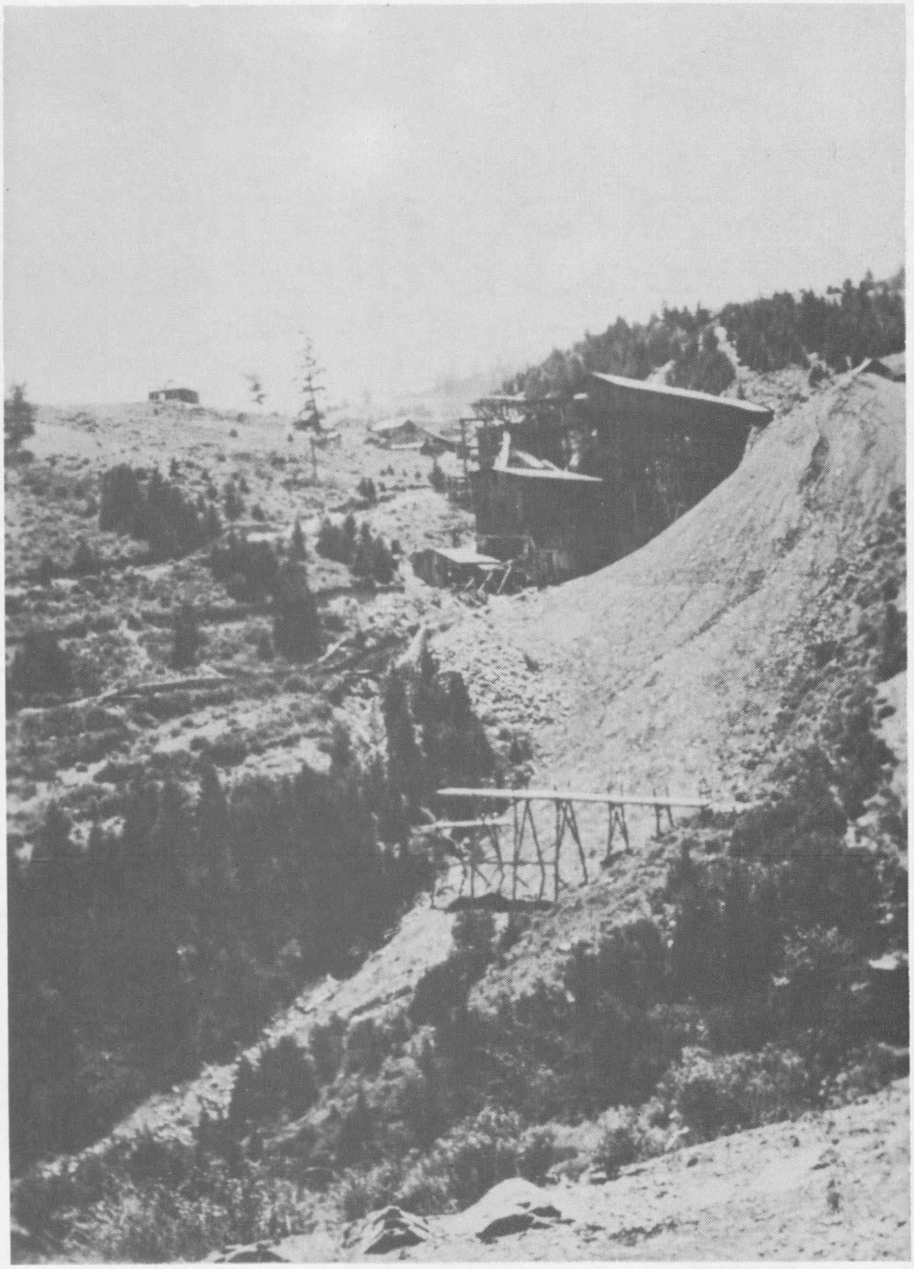


Figure 6. One of the 5 mines established between Electric and Aldridge. One of the many haul roads which laced the area is seen to the left of the mine, while a flume appears below.

storage bunkers in Electric. A railroad ran along the eastern base of Cinnabar Mountain (Figure 7).

Life may best be characterized as subsistence at the time that this development was going on, and wild game was a primary food source. Lovaas (1970) reported that venison--a term historically used to refer to meat from any large, wild herbivore--comprised a large part of early settlers' diets. Bighorns were undoubtedly part of the fare. The impact of subsistence hunting is difficult to quantify but persisted through the Depression era and was probably more severe during periods of economic hardship (Meagher pers. comm., Picton pers. comm.).

The potential impacts of livestock were also substantial, though difficult to quantify. It is not unreasonable to assume that the community's livestock overgrazed much of the area adjacent to the Electric-Aldridge complex during the boom era. Following the Electric-Aldridge boom, livestock became the dominant economic force in the area. Houston (1980) demonstrated a substantial decline in range condition at Devil's Slide between 1871 and 1972. He attributed the decline to a combination of overgrazing and fire suppression. I was unable to document the history of grazing near Cinnabar Mountain. However, it seems likely that the pressure was substantial, on gentler terrain and ridge tops, into the 1950's and, possibly, the early 1960's.

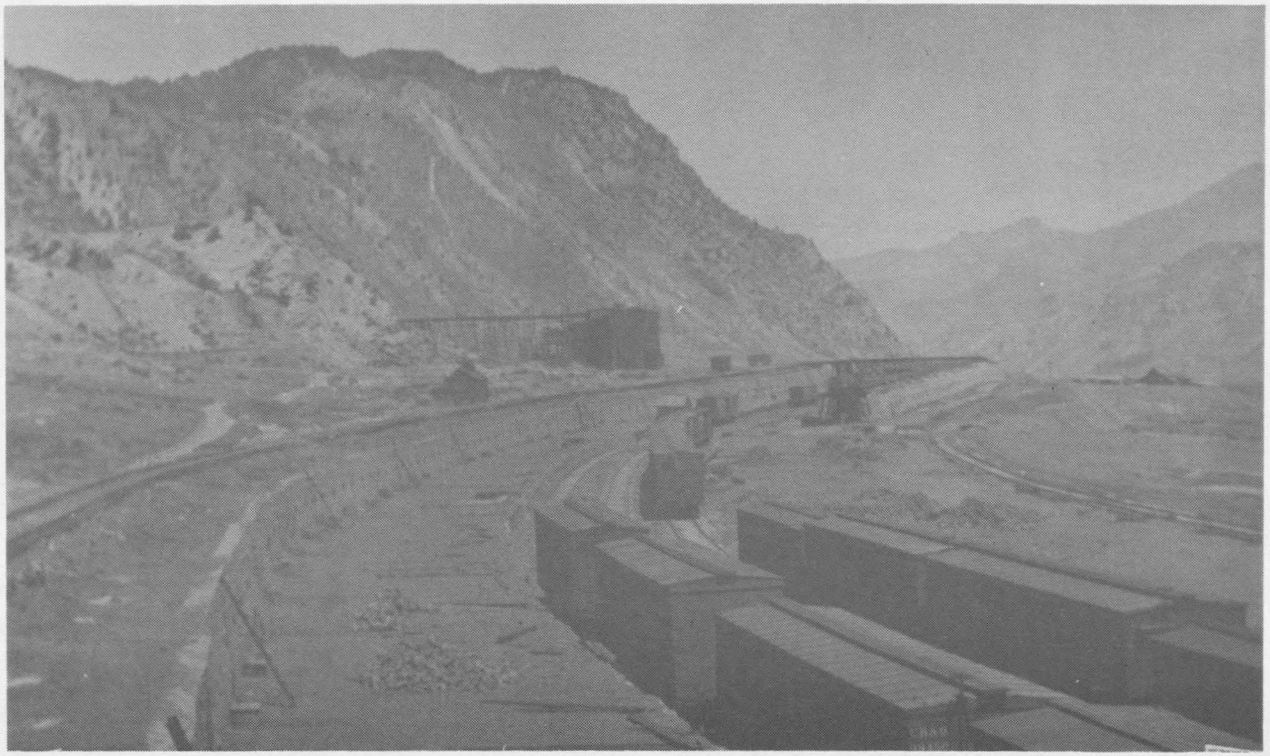


Figure 7. The railyards and coal storage bunker at Electric, Montana. Devil's Slide is seen in the background.

Grazing by domestic animals during the study period was light to nonexistent. The upper slopes of Cinnabar Mountain have probably been little used in recent decades due to the nature of the terrain and the poor forage found there (Stermitz pers. comm.). Historic livestock use on the Cinnabar Mountain area was largely restricted to cattle and horses. Domestic sheep were abundant in the Paradise Valley to the north, with numbers totaling 100,000 just after the turn of the century (Whithorn and Whithorn *circa* 1977), but apparently extended no further south than Yankee Jim Canyon. The Harvat Brothers Sheep Company (1919-1953) grazed up to 5,000 sheep on the summer range at the head of Rock Creek (Figure 8), an area which is currently used by bighorns. Early residents of the area contended that diseases contracted from domestic sheep decimated the bighorns which historically wintered in Yankee Jim Canyon (Bassett pers. comm.), though there is nothing in the written history of the area to substantiate this.

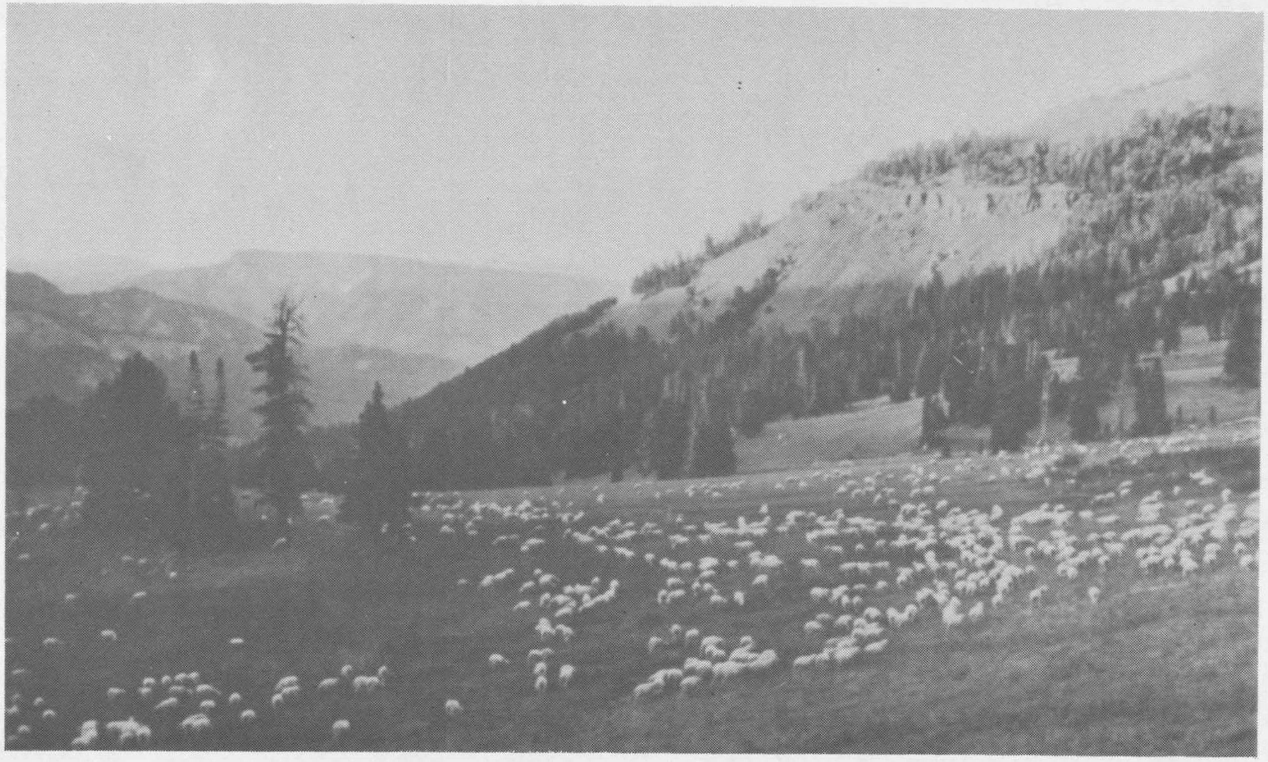


Figure 8. Upper Rock Creek drainage as it appeared from the Ramshorn Peak-Fortress Mountain col during the 1930's. Shown are a portion of the 5,000 domestic sheep which the Harvat Brothers Sheep Company annually grazed in the Rock Creek drainage during the summer season.

METHODS

Seasonal Distribution and Movements

Three bighorns in Tom Miner Basin and 8 on the CWR were immobilized with either M-99 or a Sernylen/Rompon mixture and fitted with color-coded radio-collar units. One radio-collar from a CWR ram was later replaced with a color-coded neckband following failure of the transmitter. Two additional animals on the CWR were marked with color-coded neckbands. Numbered metal ear tags were inserted in both ears of all marked individuals.

Radio-relocations were made primarily from the air. Visual observations of marked and unmarked individuals were obtained whenever possible during both aerial and ground work. Delineation of seasonal ranges and movement patterns was based on collation of radio-relocation data, visual observations, and previous observations by Constan (1975).

Population Trends

During 1980-1981, interviews were conducted with longtime residents of the upper Yellowstone area and with people who had worked extensively in the area. Results were used to estimate historic distribution and recent population trends on the CWR and the Yankee Jim Canyon winter range (YJWR). Emphasis was placed on interviewing descendants of early homesteaders in the Electric-Aldridge area and individuals who had observed big game in the area for many years.

Those interviewed were questioned specifically about the presence of bighorns on the CWR, the approximate year in which they first observed sheep there, and their general impression of numerical trends of bighorns in that area.

Interviewees were also questioned regarding bighorn use of other areas near Yellowstone National Park. Knowledge of the historical presence of bighorns in the Tom Miner Basin area was regarded as evidence of the probable reliability of an interviewee's statements concerning the CWR population since Tom Miner Basin is, and historically has been, further removed from human activity and less observable than the CWR.

Quantitative analysis of recent population trends on the CWR was based on counts conducted from 1967-1981 (Montana Department of Fish, Wildlife and Parks unpubl., YNP unpubl., Constan 1975). A similar analysis for the EWR was based on records of bighorn sheep counts on the NYWR during 1965-1981 (YNP unpubl.). Data for the EWR were separated from the NYWR data by referring to the original flight reports. Boundaries used in separating the EWR data from the larger data set are delineated in Figure 9. Crevice and Blacktail Deer Creeks defined the eastern boundary of the EWR, while the eastern base of Sepulcher Mountain formed the western boundary.

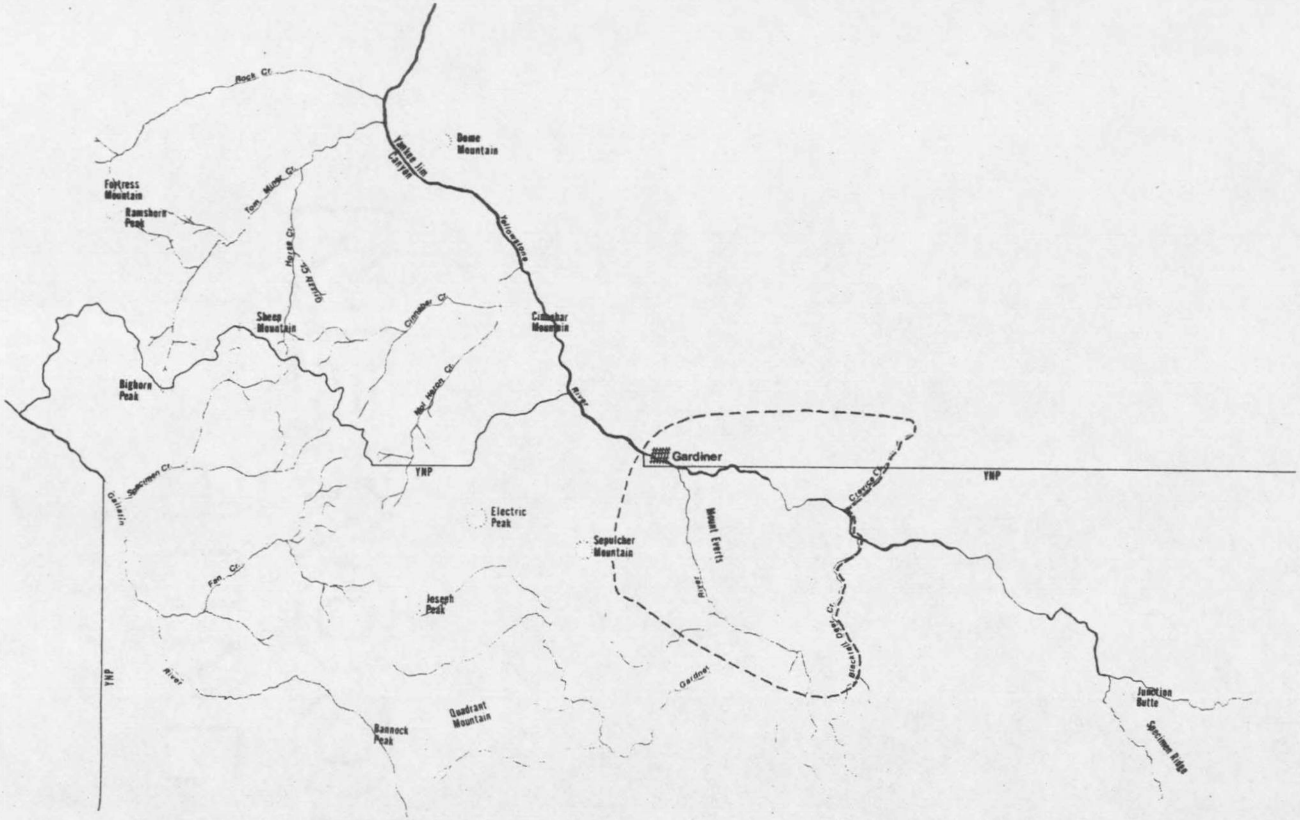


Figure 9. Map of the boundaries used in extracting census data for the Mount Everts winter range from census data for the entire northern Yellowstone winter range.

Two points should be emphasized regarding these data. First, the 1968-1970 data, collected by Barmore (YNP unpubl.), are included here, despite the incidental manner in which they were collected (Houston 1980), because: 1) Barmore's more intensive study of the EWR makes it likely that the EWR data were comparable to later counts, even though his counts for the entire NYWR may not have been, and 2) data for 1970 included one of the most intensive bighorn surveys conducted on the NYWR (Houston 1980). Second, the EWR sheep were treated as an autonomous population in this analysis, despite some known interchange with populations wintering further upriver along the Yellowstone (Houston 1980). Linear regression analysis indicated a significant positive correlation ($P<0.05$) between the number of sheep wintering on the EWR and those wintering east of the Crevice-Blacktail Deer Creek boundary to the Junction Butte and Specimen Ridge areas. Therefore, while there may have been sufficient interchange to maintain a single gene pool, it appears that interchange was not likely to have been a significant factor in the population dynamics of either area.

Annual rates of increase per individual for bighorns on the EWR were calculated from 2-year moving means derived from census data for the EWR. These values were compared with 2-year moving means of population estimates for elk on the NYWR (Houston 1980) using standard linear regression techniques (Snedecor and Cochran 1980).

Results were used to evaluate the relationship of elk numbers to bighorn reproduction and population size.

Indicators of Population Quality

Based on work by Geist (1971), Shackleton (1973), and Stelfox (1976), lamb:ewe ratios, duration of suckling periods, maturation rates in rams, and lungworm larval output were selected as possible indicators of population quality in the CWR and EWR populations. Data were compared with similar information from studies of other populations.

Population composition on the CWR was determined from periodic classification of sheep along a standardized transect which followed the county road from Cinnabar Mountain south to include the north ridge of Sepulcher Mountain. This information was combined with estimates of lamb:ewe ratios provided by the annual survey of the Montana Department of Fish, Wildlife and Parks (MDFWP) to produce an estimate of the lamb:adult ewe ratio. Data for the EWR were derived from reports of the MDFWP and the YNP biologist's office. Yearling ewe:adult ewe ratios, necessary for estimating the lamb: adult ewe ratio, were unavailable for the EWR sheep.

Duration of suckling period was recorded whenever possible during the course of summer field work. Times were recorded to the nearest second. The "tail-wagging" behavior associated with suckling was used as an indicator to determine onset and termination of suckling so that accurate observations were possible at distances of approximately 2 kilometers.

Age/ram class relationships were assessed to provide an indicator of maturation rates in rams. Rams were aged and assigned to a ram class according to Geist (1966, 1971).

Fecal samples were analyzed for the presence of lungworm (*Protostrongylus* spp.) larvae according to the technique described by Baermann (1917). Samples were collected monthly from November 1980 to September 1981 from the CWR population. For the EWR group, samples were collected monthly from November 1980 to March 1981 and in October 1981. Incidence of infection was determined and mean infection levels were analyzed using logarithmic transformations to normalize the data (Snedecor and Cochran 1980).

Food Habits

Food habits were determined using standard microhistological techniques (Sparks and Malechek 1968). Ten samples per month per area were analyzed for the November 1980 to March 1981 period on both the EWR and CWR.

RESULTS AND DISCUSSION

Seasonal Distribution and Movements

Nine radio-collared bighorns (4 rams, 5 ewes) yielded 210 radio-relocations between February 1980 and October 1981 (Appendix Table 3). These data were supplemented with 3,235 visual observations (Appendix Table 4) and previous work by Constan (1975) to provide a description of seasonal distribution and movement patterns for bighorns in the southern Gallatin Range (Figure 10).

Evidence indicated that some interchange occurred between the EWR, CWR, and Cinnabar Basin/Tom Miner Basin groups. The extent of this interchange is unknown due to the small number of marked animals. A single young ram was observed to move from the CWR to summer range on Bighorn Peak in 1980 and 1981. Known interchange between the EWR and CWR consisted of a single observation of an adult ewe with a lamb wintering on the EWR in 1980-1981. This same ewe wintered on the CWR during 1979-1980. She was apparently accompanied onto the EWR by approximately 10 other ewes and lambs. There is no evidence that movements between areas has a substantial impact on the population dynamics of any of the areas.

Population Trends

Cinnabar Mountain Winter Range

Interviews with long-time residents of the area indicated that bighorns occurred on the EWR and in the Cinnabar and Tom Miner Basins

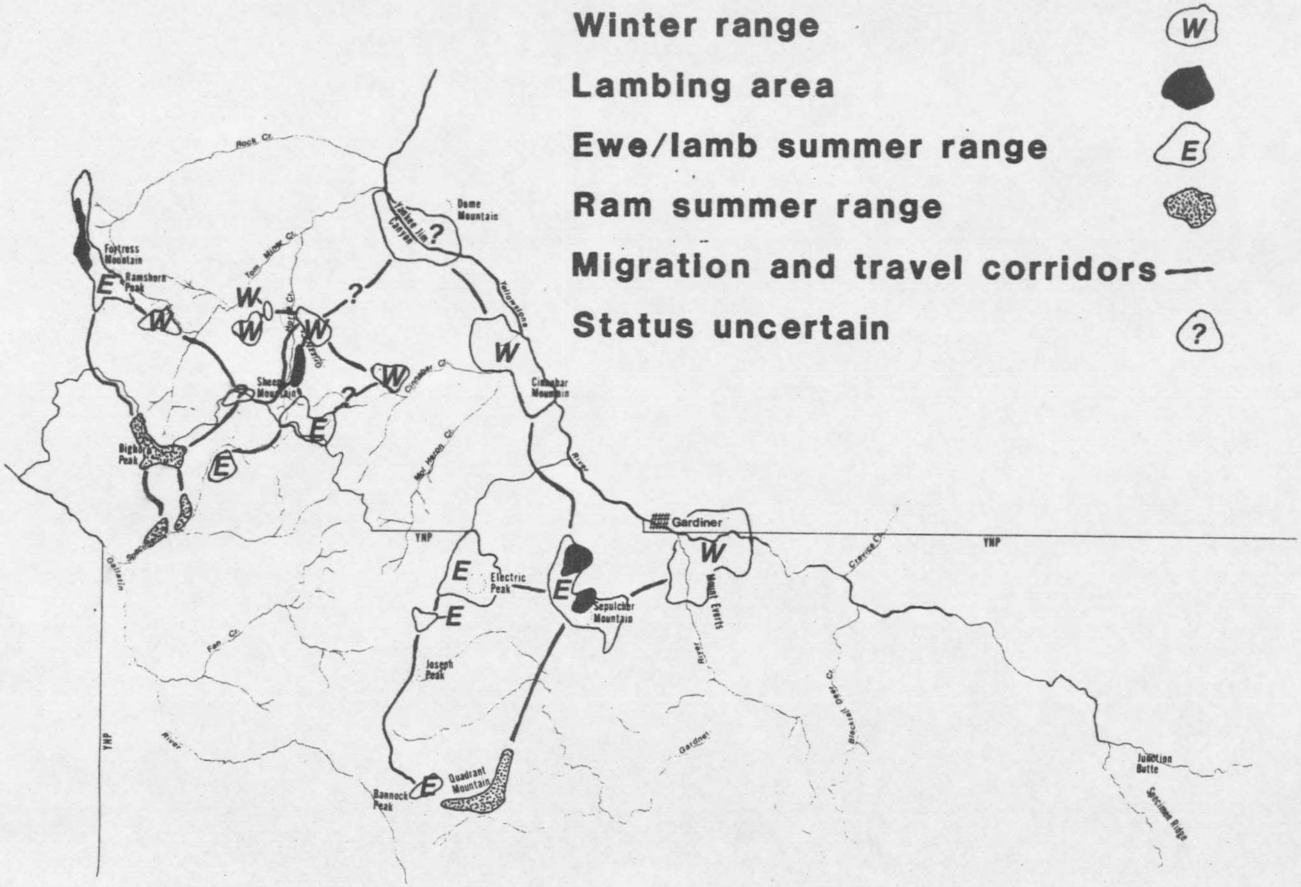


Figure 10. Seasonal distribution and major travel routes of bighorn sheep in the southern Gallatin Range, Montana as determined from 210 radio-relocations, 3,235 visual observations, and previous work by Constan (1975).

but not on the CWR during the Electric-Aldridge era. Interviewees generally agreed that bighorns first appeared on the CWR *circa* 1965. This was also supported by: 1) observations of MDFWP officials who worked in the area from 1946 to 1968 (McLucas pers. comm.), 2) YNP personnel who lived and worked in the area (Armstrong pers. comm., Chapman pers. comm.), 3) experienced observers of big game in the area (J. Stradley pers. comm.), 4) Couey (1950), who described bighorn distributions in the area, and 5) Buechner (1960), who thoroughly censused sheep populations in the upper Yellowstone in 1955. Interviewees who had reliable knowledge of bighorns on the CWR were unanimous in their belief that a substantial increase in bighorn numbers had occurred during the last 10± years.

Records of recent population trends on the CWR during 1967-1981 are summarized in Table 1. These data indicate an increase in the number of bighorns wintering on the CWR, from 11 in 1967 to a maximum of 103 in 1980. Poor censusing conditions in 1976 and 1981 probably resulted in underestimates for those years. Calculated annual rates of increase per individual (r_a) for 1977-1978 (r_a=0.69) and 1979-1980 (r_a=0.57) indicated that the 1977 and 1979 censuses also were underestimates, since the calculated values for r_a were much higher than the maximum of 0.392 calculated by Buechner (1960). This assumes that there was no substantial impact resulting from immigration or emmigration, an assumption which is reasonable in light of the

Table 1. Summary of maximum bighorn counts on the Cinnabar Mountain winter ranges, 1967-1981 (Montana Department of Fish, Wildlife and Parks unpubl., Yellowstone National Park unpubl.).

Year	Maximum Number Observed
1966-1967	11
1969-1970	14
1970-1971	21
1971-1972	21
1972-1973	31
1973-1974	39
1974-1975	40
1975-1976	16
1976-1977	37
1977-1978	74
1978-1979	58
1979-1980	103
1980-1981	83

movements data. Data for 1976, 1977, 1979, and 1981 were, therefore, disregarded and a growth curve was constructed based on the remaining minimum population estimates (Figure 11). Curvilinear regression indicated that the data corresponded closely (r=0.99) to the exponential growth model (Andrewartha and Birch 1954), with a mean annual rate of increase per individual of 0.18.

Mount Everts Winter Range

YNP records indicated an apparent increase in the EWR population, from 63 in 1965 to a maximum of 222 in 1978 (Figure 12). Curvilinear regression indicated that the 1965-1973 data corresponded closely

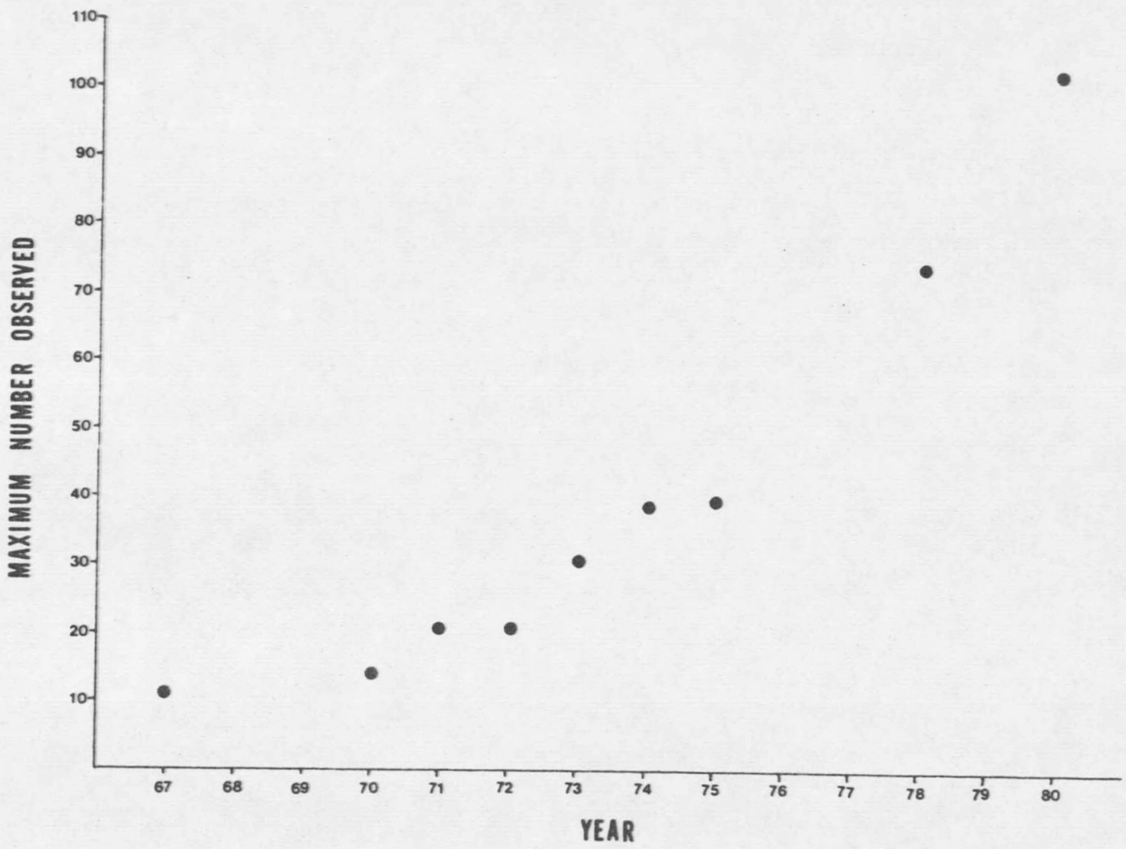


Figure 11. Population trends for bighorns on the Cinnabar Mountain winter range, 1967-1980, as determined from unpublished data supplied by the Montana Department of Fish, Wildlife and Parks, and the Yellowstone National Park biologists office.

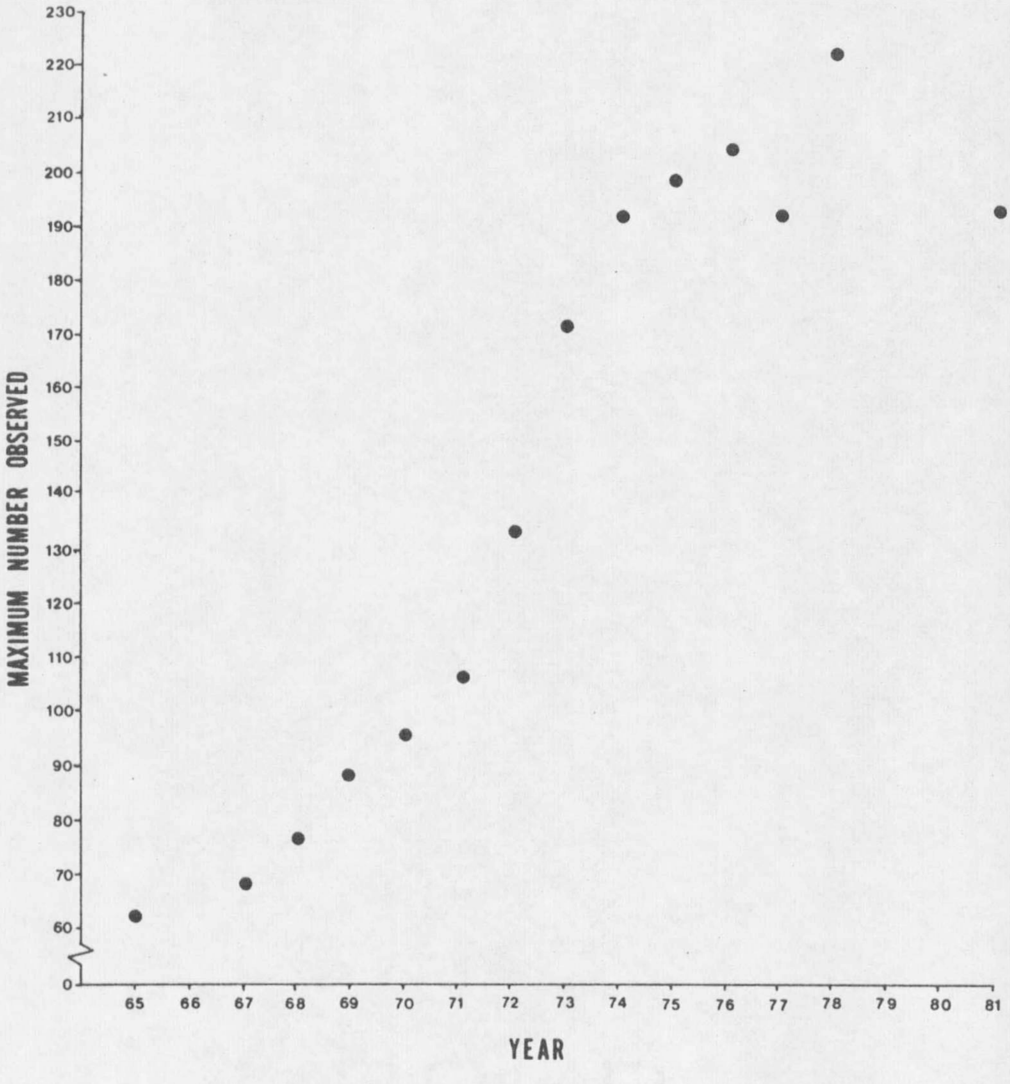


Figure 12. Population trends for bighorns on the Mount Everts winter range, 1963-1981, as determined from flight reports for bighorn censuses on the northern Yellowstone winter range (Yellowstone National Park unpubl.).

(r=0.96) to the exponential growth model (Andrewartha and Birch 1954), with a mean annual rate of increase per individual of 0.12. Numbers appear to have stabilized at approximately 200 since 1974.

The apparent trends observed here generally agree with the conclusions of Barmore (1980) but directly contradict those of Houston (1980). Houston noted a similar increasing trend in census data for the entire NYWR but concluded that the apparent trend was the result of both increased coverage and selection for progressively more optimal censusing conditions rather than a real increase in numbers.

Due to the visible nature of the EWR and past history of human activity in that area, bias resulting from increased coverage was probably minimal, with respect to the data examined here. However, the EWR data were subject to potential bias due to selection for progressively more optimal censusing conditions between 1965 and 1981. Because of this, the data were analyzed with respect to Houston's postulates regarding the effects of temperature on observability. Although the census data used in the following analysis were not the same as those used by Houston, they exhibited a similar positive correlation with temperature (r^2=0.47 versus r^2=0.52), indicating that any difference in findings was not likely to be a result of differing data sets.

Using linear regression analysis, Houston found that the number of sheep observed was positively and significantly associated with mean daily ground temperature at Mammoth on the day of the census flight (r^2=0.52, P<0.001), up to 7° Celsius (C.). Beyond 7° C, bighorns were observed to migrate off the winter range, thereby violating the assumptions of the regression model. He postulated that the observed temperature-observability relationship was primarily the result of: 1) changing habitat use and foraging patterns in response to warmer temperatures and vegetation growth, and/or 2) improved observability with time as the faded, white, spring pelage of sheep becomes more conspicuous against brown and green backgrounds. The regression relationship was somewhat improved by the addition of a "greenup" factor (r^2=0.62). The fact that "greenup" added little to the correlation may have been due to the intercorrelation of "greenup" and temperature (Houston 1980).

Temperature alone was considered in my analysis since "greenup" added very little to the model, and no data on plant phenology were available for the 1968-1970 counts. It is important to recognize that temperature cannot be a proximal cause in the observed relationship, since temperature cannot make an animal appear or disappear. Rather, temperature is an indicator of the proximal causes postulated by Houston. In the following analysis I have attempted to evaluate the nature of the temperature relationship underlying Houston's postulates. The upper threshold of 7° C, observed by Houston is incorporated as an assumption in this analysis. Another assumption in this analysis is that mean daily ground temperature is a reasonable indicator of seasonal temperature trends.

The strict linearity of the temperature-observability relationship is an *a priori* assumption of Houston's. Implicit within his postulated proximal causes, however, is the possibility of a bipartite relationship, formalized here as: 1) daily effect, and 2) seasonal effect. The mechanisms of these two effects need not be the same. The seasonal effect would be a result of snowmelt. The daily effect would be the result of differences in habitat use in response to short-term temperature changes. This implies that the daily effect may be observed throughout the temperature spectrum, while the seasonal effect would be observed only at temperatures above 0° C., when snowmelt would presumably occur. It also suggests that the temperature-observability relationship may be significantly different at temperatures above and below 0°C.

My analysis of temperature/census data for the EWR showed that the relationship between temperature and numbers observed at temperatures between 0° and 7° C. differed significantly ($P<0.001$) from that for temperatures less than 0° C. (Figure 13). This indicates that daily and seasonal temperature effects are substantially different. It would be premature, however, to conclude that the actual temperature-observability relationship is defined by the regressions in Figure 13. Assumptions of the regression model require that

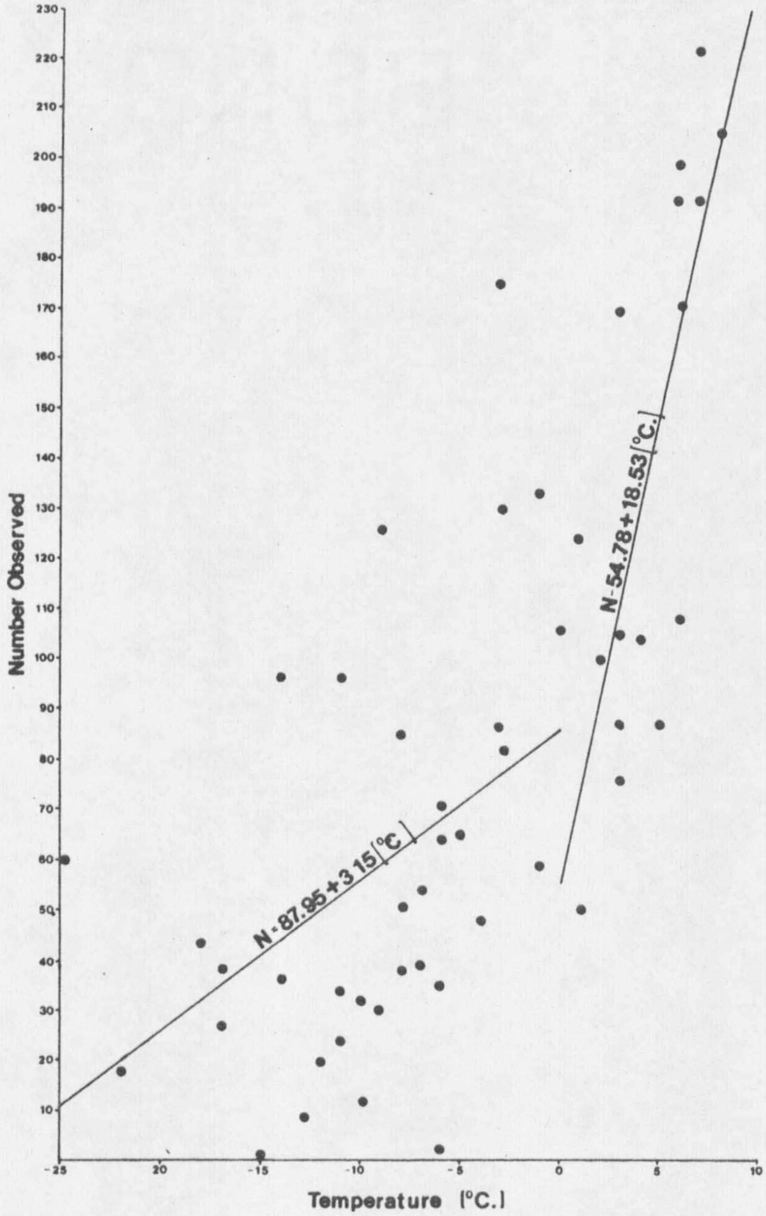


Figure 13. The relationship between mean daily ground temperatures at Mammoth, Wyoming and the number of bighorns observed on the Mount Everts winter range for temperatures less than 0° C. and between 0° and 7° C.

population size be held constant during the period when data were collected. It is not evident that this assumption has been met (Figure 12).

To test the constancy of population size between 1968 and 1978, apparent low and high population years were grouped (1968-1972 and 1973-1978, respectively), and the residuals from the temperature/census regressions were tested for equal distribution about the regression lines. For temperatures less than 0° C., residuals for 1968-1972 and 1973-1978 were found to be distributed equally about the regression (Figure 14). For temperatures between 0° and 7° C., residuals for both 1968-1972 and 1973-1978 were found to be unequally distributed about the regression (P=0.12 and P=0.04, respectively), with counts from 1968-1972 and 1973-1978 clustered below and above the regression line, respectively (Figure 15). This pattern strongly suggests that the regression equation for temperatures between 0° and 7° C. was artificially derived from 2 different data clusters and does not reflect a true regression relationship.

These findings indicated that: 1) observability increased with temperature up to 0° C., 2) census data collected at temperatures of 0° to 7° C. are of equal quality (i.e. no temperature-observability relationship existed for temperatures in this range), and 3) there was a real increase in bighorn numbers on the EWR between 1968-1972 and 1973-1978. The rationalization for the bipartite temperature-

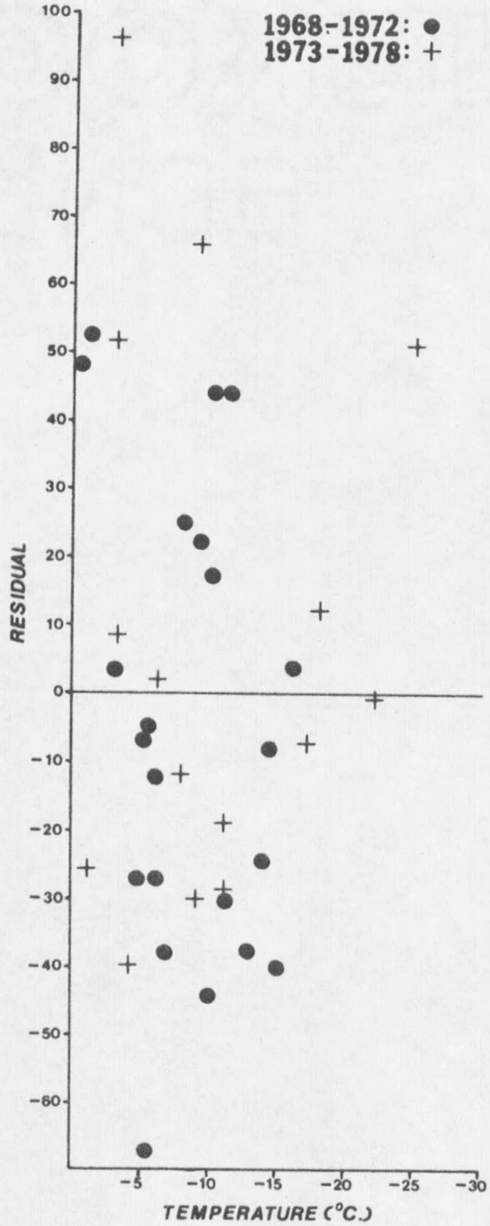


Figure 14. Residuals of the temperature-census regression (Figure 13) in relation to the regression line for temperatures less than 0° C.

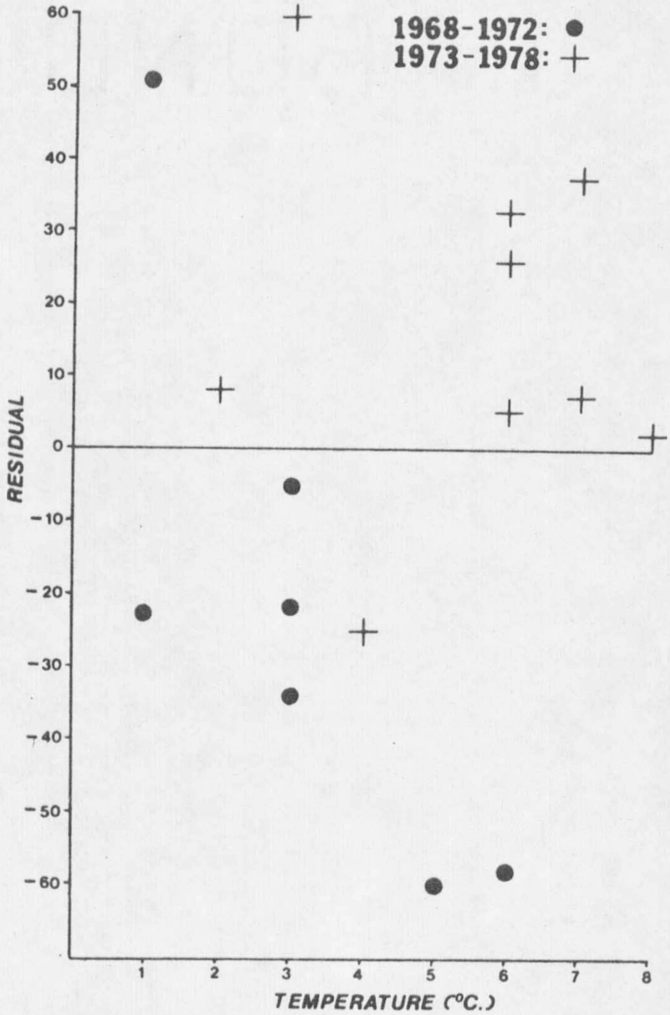


Figure 15. Residuals of the temperature-census regression (Figure 13) in relation to the regression line for temperatures between 0° and 7° C.

observability model presented here is readily acceptable and demonstrates the strength of Houston's postulated proximal causes. According to the model, counts are maximized at the time that snowmelt and "greenup" are effected. Therefore, there was no detectable increase in the efficiency of census counts beyond that point.

Relationship to Elk Numbers

Observed rates of increase per individual bighorn on the EWR during a given year (time t-1 to t) were found to be significantly, negatively, and exponentially correlated (r=-0.81) with elk numbers censused on the NYWR 4 years earlier (time t-4) (Figure 16). The regression predicts that elk numbers above 3,000 will reduce the rate of population increase in bighorns on the EWR and that EWR bighorns will stabilize or decline in numbers when elk numbers on the NYWR exceed 9,500.

These results are in agreement with Picton (unpubl.) who observed that elk numbers were negatively correlated with lamb survival among bighorns in the Sun River area of Montana. The fact that high elk populations may influence lamb survival, but not necessarily adult mortality, provides an explanation for the apparent stabilization in bighorn numbers on the EWR since 1974, despite high elk numbers. Implicit within this explanation is the possibility that bighorn numbers could decline to pre-elk reduction levels as older animals

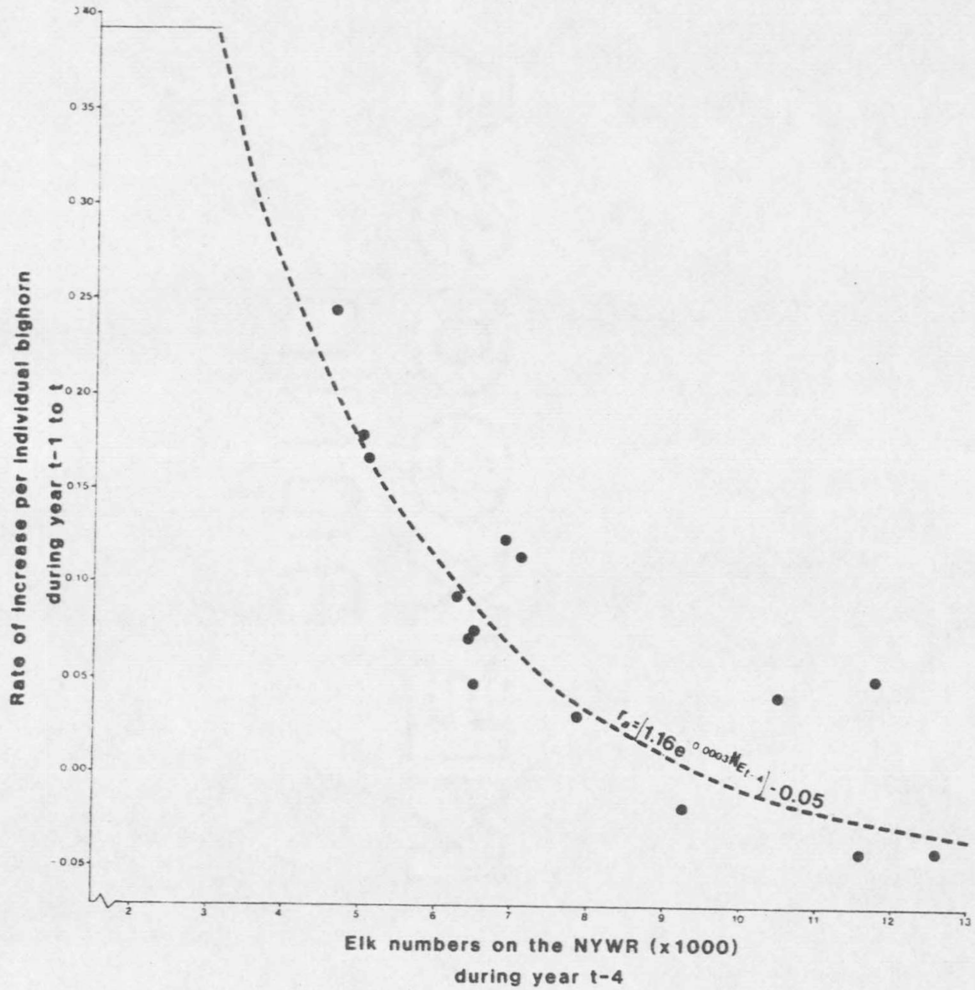


Figure 16. The relationship between elk numbers at time t-4 and annual rates of increase per individual bighorn on the Mount Everts winter range between t-1 and t.

die and are not replaced. Given a life span of approximately 10 years, this decline would be expected by about 1984. Picton also found that the impacts of climate became more severe as bighorn populations approached ecological carrying capacity (K). This might provide an explanation for the apparently greater residuals observed in Figure 16 for elk populations above 9,500.

Reasons for the observed 4-year time lag between elk numbers and bighorn population responses are unknown. This lag may be due to: 1) delayed vegetational responses, and/or 2) delayed responses within the bighorn population itself. Ewes born in the t-4 cohort would be bred in the fall of t-2 and would lamb in the spring of t-1. Thus, it might be speculated that lambs born to the t-4 cohort would be counted on the winter range during the winter of year t, thereby influencing the observed rate of increase between t-1 and t.

Population Quality

Lamb:Ewe Ratios

Lamb:ewe ratios observed on the CWR during December 1979 and 1980 were 58:100 (number classified=75) and 52:100 (N=148), respectively (MDFWP unpubl.), suggesting good reproduction and a healthy, possibly expanding, population. December yearling ewe:adult ewe ratios of 34:100 in 1979 (N=92) and 27:100 in 1980 (N=61) similarly indicated good survival to reproductive age. Since the lamb:ewe ratios were based on total ewes (both yearling and adult), the actual numbers of lambs per adult ewe were higher than indicated. When yearlings were eliminated, the December lamb:adult ewe ratios were 88:100 for 1979 and 71:100 for 1980.

Comparison with similar data for populations of known quality (Figure 17) indicated that the observed lamb:adult ewe ratios were characteristic of a high quality population. Since lamb survival may be dramatically influenced by climatic conditions (Picton unpubl.), these ratios may be an artifact of the unusually mild winters during 1979 and 1980 rather than an indication of the population level relative to the long-term carrying capacity of the CWR.

Duration of Suckling Periods

Mean suckling times of 26.9 and 25.1 seconds were calculated for 17 and 7 suckling bouts on the Sepulcher Mountain and Fortress Mountain lambing areas, respectively, during June 1980. No significant difference was found in mean suckling times between the two areas at the 0.05 level of significance (P=0.78). Data were pooled and a mean suckling time of 26.4 seconds was calculated. Comparison with similar data for populations of known quality (Figure 18) indicated that the observed suckling times were characteristic of a high quality population.

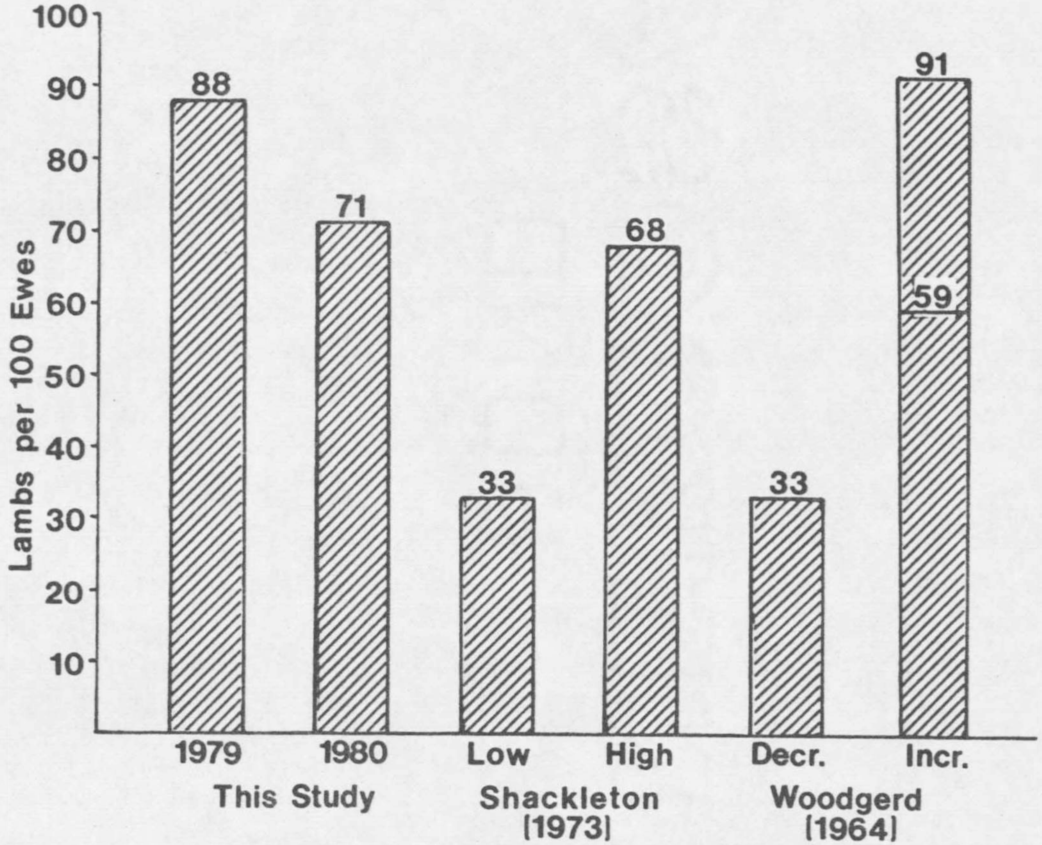


Figure 17. Comparison of observed lamb:adult ewe ratios for the study population with similar data for other populations of known quality.

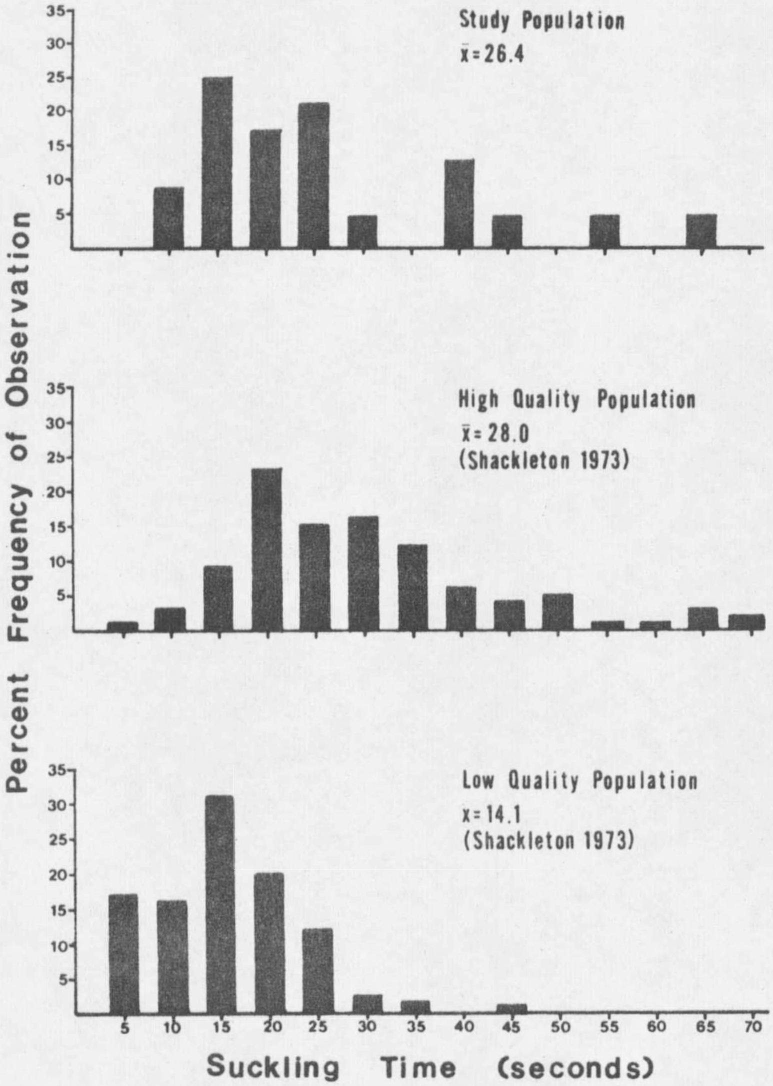


Figure 18. Comparison of observed suckling durations for the study population with similar data for populations of known quality.

Suckling times are a reflection of the overall energy balance of the lactating ewe, with longer suckles being observed when ewes are in low stress situations and on a high nutritional plane (Shackleton 1973). The long suckling times observed may, therefore, have been influenced by the mild conditions of the previous winter.

Maturation Rates in Rams

Age and ram class were recorded for 75 observations of rams on the EWR and CWR between April 1979 and December 1980. Comparable data for 25 observations on the same areas were reported by the MDFWP (unpubl.) for December/January 1979-1980 and December 1980.

Mean age was calculated for each ram class (I-IV) on both the EWR and CWR. Means for the respective ram classes on the two areas were tested for equality. Although mean ages were consistently lower for ram classes II-IV on the CWR, analysis revealed no significant difference ($P<0.05$) between the two areas for any ram class. Pooled age and class data are summarized in Table 2.

The range of ages which may be expected for any given ram class is listed by Geist (1971). Comparisons of the respective ram classes (Figure 19) indicated that the mean age for any given ram class on the EWR and CWR was quite near the theoretical minimum. These theoretical minima may not be absolute, however, as evidenced by the fact that the observed age ranges for classes III and IV extended

Table 2. Summary of age/class data for 100 observations of rams on the Mount Everts and Cinnabar Mountain winter ranges.

	Ram Class			
	I	II	III	IV
Sample size	14	23	27	36
Mean age (years)	2.5	3.6	5.4	8.2
Standard deviation	0	0.29	0.93	1.60
Range	2.5	3.5-4.5	4.5-7.5	5.5-12.5

below those observed by Geist. In the case of class III rams, the difference was only 6 months and was not significant since no growth would be expected between 6.5 and 7.0 years of age. The 18-month difference noted for class IV rams, however, indicated that rams may reach full maturity a full year earlier than was previously thought possible. Both means and ranges indicated the rapid maturity and shorter life expectancy characteristic of a high quality population.

Lungworm Larval Output

Incidence of infection was found to be 94% and 91% for the EWR (N=95) and CWR (N=143) populations, respectively. There was no significant difference between the two areas ($P<.05$). An incidence of 92% was calculated for the pooled data.

Mean levels of infection were found to be 13 and 18 larvae per gram of dry fecal material for the EWR and CWR bighorns, respectively, based on logarithmically normalized data. No significant difference

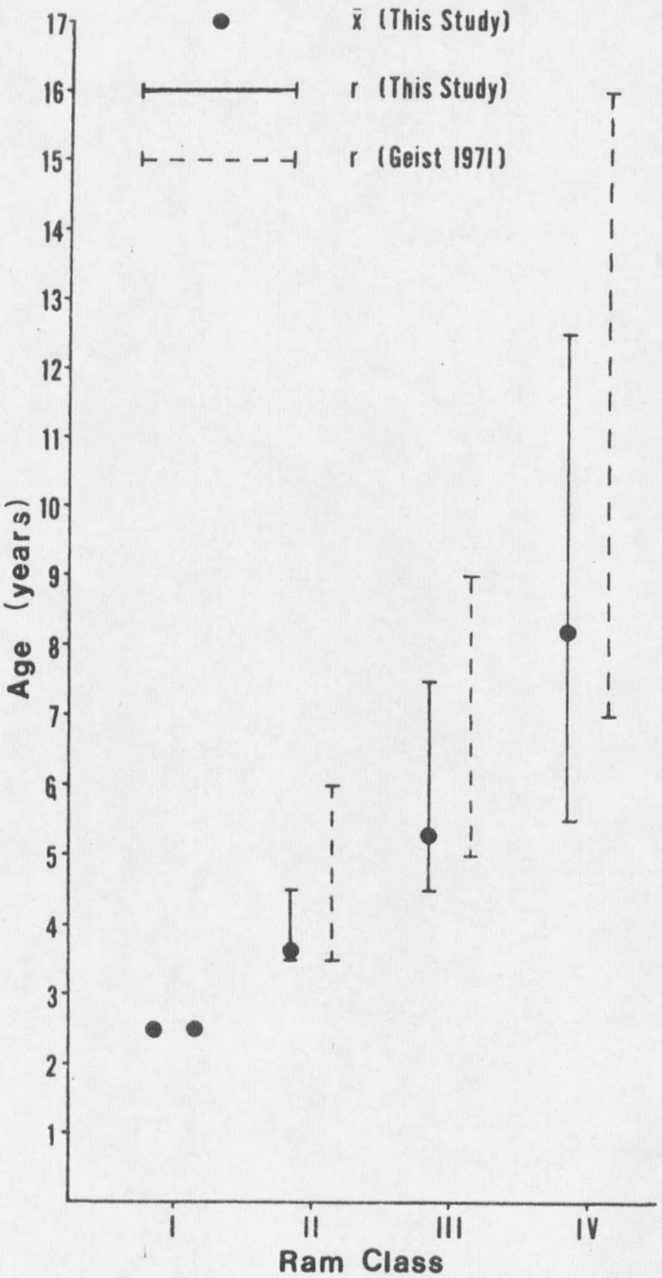


Figure 19. Comparison of observed age means and ranges for rams in the study population with possible age ranges for the respective ram classes.

between the log-normal means of the two groups was found at the 0.05 level of significance. A log-normal mean of 16 larvae per gram of dry fecal material was calculated for the pooled data.

Uhazy et al. (1973) indicated that mean lungworm larval outputs of 157±98 per gram of dry fecal material corresponded to light infection levels in the lungs. Though the data presented here were not entirely comparable to those of Uhazy et al., the observed levels of lungworm larval output on the CWR and EWR were relatively very low and indicative of a healthy high quality population existing on a high nutritional plane (Stelfox 1976). Stelfox found that lungworm burdens may be substantially reduced during mild winters, however, suggesting that the observed larval outputs may be indicative of short-term climatic impacts rather than the populations relationship to the long-term carrying capacity of the habitat.

Food Habits

Winter food habits on the EWR and CWR were determined from 100 fecal samples collected between November 1980 and March 1981 (Appendix Tables 5-7). Monthly variation, with respect to use of major forage classes, is shown in Figure 20. Monthly variation, with respect to utilization of major forage items (items individually comprising at least 4% of the winter diet on either area), is shown in Figures 21 and 22.

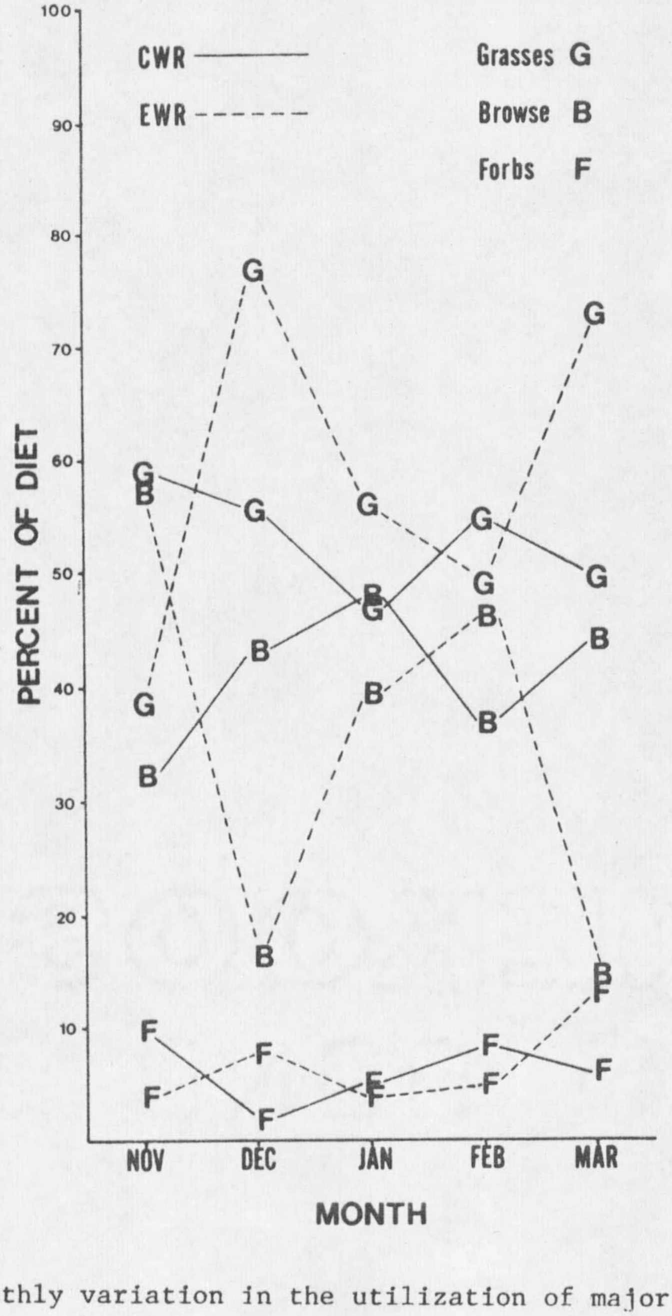


Figure 20. Monthly variation in the utilization of major forage classes by bighorns on the Mount Everts (N=50) and Cinnabar Mountain (N=50) winter ranges, as determined from microhistological analysis of fecal samples.

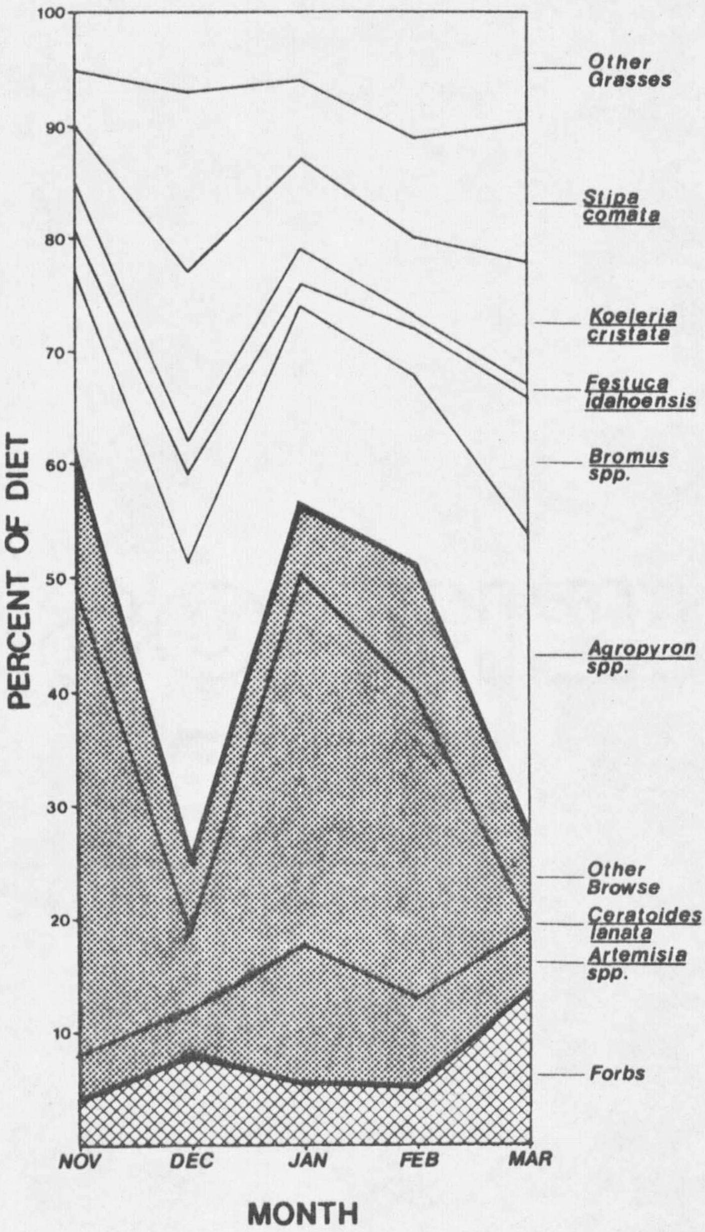


Figure 21. Monthly variation in the utilization of major forage items by bighorns on the Mount Everts winter range, as determined by microhistological analysis of 50 fecal samples.

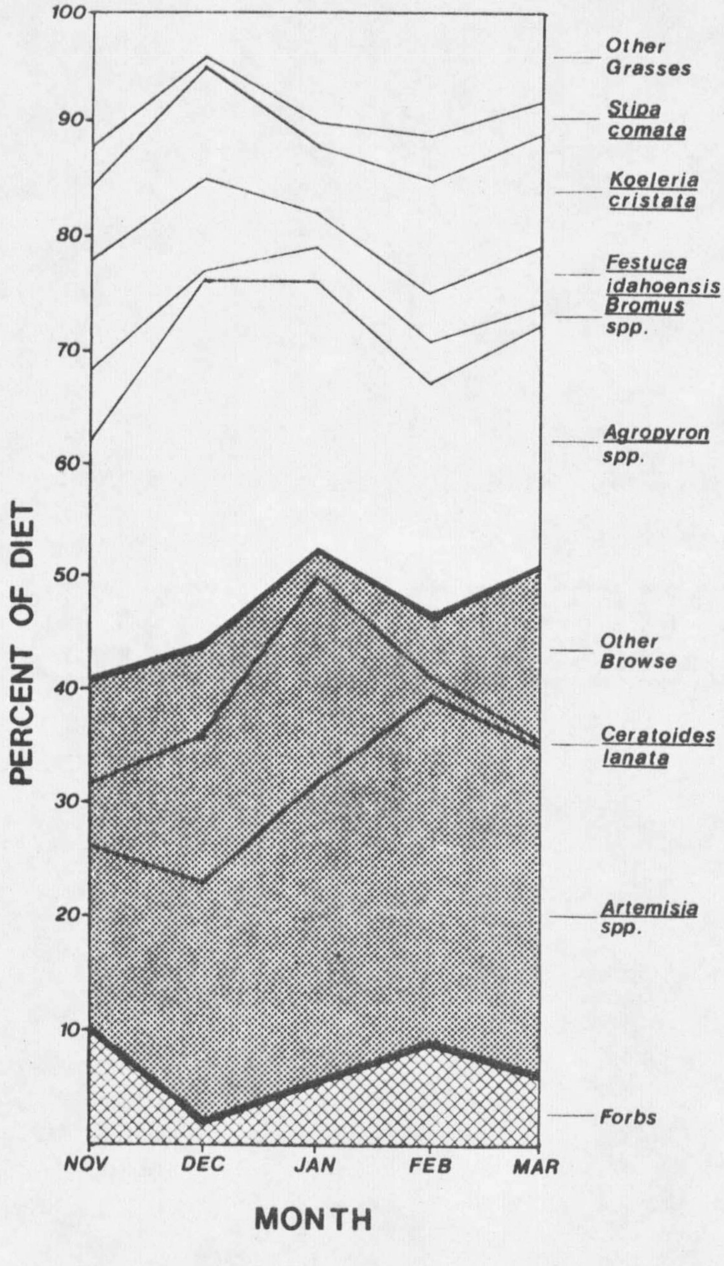


Figure 22. Monthly variation in the utilization of major forage items by bighorns on the Cinnabar Mountain winter range, as determined from microhistological analysis of 50 fecal samples.

Dietary composition in the sample, by forage class, was not substantially different between the two areas for the 5-month period. However, the EWR sample showed dramatic monthly fluctuations, with sharp increases in grass utilization and corresponding declines in browse utilization for the months of December and March. Utilization of grasses and shrubs was relatively stable throughout the 5-month period on the CWR. This difference may have been due to greater availability of grasses on the EWR combined with the unseasonable abundance of green grass shoots associated with the mild weather conditions in December 1980. A similar pattern was noted for the March sample, when "greenup" would normally be expected. Forb use was minimal and relatively constant on both areas.

Dietary composition by major forage item was generally the same on both areas, with the exception of browse species. *Artemisia* spp. comprised 7% and 22%, and *Eurotia lanata* 25% and 8%, of the diets on the EWR and CWR, respectively. The importance of these two items appeared to be essentially reversed between the two areas. Visual evaluation of the two areas indicated that this difference was probably a function of availability.

Given the high utilization of browse, and the browse species utilized, the potential for bighorn competition with mule deer and pronghorns should not be discounted. However, due to the observed relationship of elk numbers to bighorn populations, it is the potential for forage competition between elk and bighorns which is of special interest here. Greer et al. (1970) reported that, under conditions of low population levels (5,000) or mild weather, elk winter diets within YNP generally consist of 80-90% grasses and 8-14% browse (including conifers), with forb use being minimal. Under high population conditions (10,000) in severe winters, however, Greer et al. reported that elk diets consisted of 56% grasses and 43% browse (including conifers). This would be quite similar to the 56% grasses and 38% browse observed for bighorn diets on the EWR and CWR. Because of restricted availability, differential selection for plant species would probably do little to mitigate competition for forage in severe winters, particularly during periods of high elk numbers. Competition between elk and sheep is, therefore, likely to be extreme in severe winters. This is consistent with Oldemeyer et al. (1971) and Constan (1972) who concluded that severe competition between elk and sheep may result if the 2 are forced onto the same area for extended periods of time. Presumably, this condition would be met during severe winters and might be unusually severe on areas such as the EWR where hunter pressure may lead to artificially high concentrations of elk immediately within the YNP boundary. During mild winters competitive interaction is most likely to be intraspecific (Oldemeyer 1971, Constan 1972), though levels of competition from all sources are likely to be minimized under these conditions.

CONCLUSIONS

The results of this study suggested the following history of occurrence for bighorn sheep in the southern Gallatin Range of Montana and Wyoming during the period 1860-1981.

By 1890-1910, mountain sheep were apparently extirpated from winter ranges along the Yellowstone River, north of the YNP boundary, through the combined pressures of market hunting and mining development. Diseases contracted from domestic sheep may have been a complicating factor in the decline of the Yankee Jim Canyon population. Protection afforded by the creation of YNP was the apparent salvation of the EWR group, while the Cinnabar Basin-Tom Miner Basin group was apparently protected by the inaccessible nature of that area. Forty years of market hunting and/or mining development (1870-1910) led to the extirpation of bighorns from the CWR.

The fact that traditional migration patterns from YNP to the CWR could not have endured becomes apparent when one compares current bighorn movement patterns against the historic distribution of human activity in the Electric-Aldridge complex (Figure 23). The severity and duration of these activities makes it likely that learned movement behavior (see Geist 1971), with respect to the CWR, was lost from the population.

Current use of the CWR is thought to be the result of dispersal and recolonization from adjacent areas beginning about 1965.

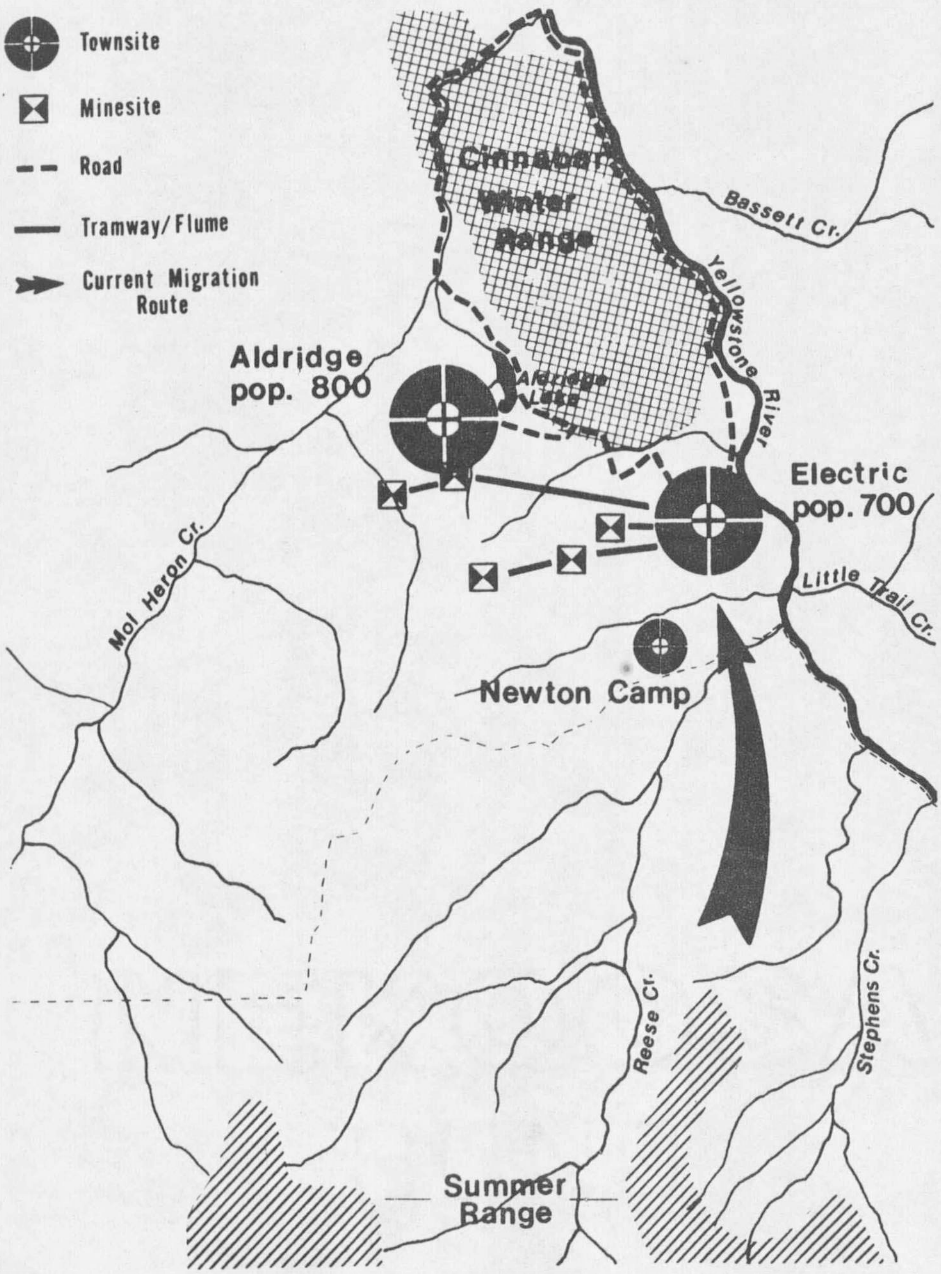


Figure 23. Schematic reconstruction of major sources of human disturbance in the historic Electric-Aldridge complex in relation to current bighorn distribution and movements.

Movements of radio-collared individuals suggested that bighorns which summered in the southern Gallatin Range of YNP and wintered on the EWR were the probable source for this dispersal. Recent irregular use of the historic YJWR is believed to be a continuation of this dispersal, though it would be difficult to justify labeling the YJWR as a traditional winter range at this time.

The time span necessary to effect ecesis on the CWR is uncertain. Though factors which led to the extirpation of bighorns from the CWR were largely removed by 1910, other factors continued to impose pressures on the sheep. Subsistence hunting and/or livestock pressures, while difficult to document, probably made the area unsuitable for recolonization until the late 1950's or early 1960's. Therefore, a period of at least 5 to 10 years elapsed from the time that pressures were essentially removed until the time that bighorns successfully recolonized the area. This does not imply that bighorns failed to disperse onto the CWR prior to that time. Rather, it implies that: 1) the size of dispersing groups was insufficiently large to form a viable propagule, given the social nature of bighorns, or 2) propagules dispersing onto the CWR entered a habitat where both the carrying capacity and the ratio of birth rate to death rate were low. Given the latter condition, the probability for rapid extinction of the propagule would be quite high (MacArthur and Wilson 1963).

At the same time that pressures were relieved on the CWR, interspecific competition was apparently being reduced within YNP, and possibly on the CWR, via the elk reduction program. A corollary to the resulting increase in the EWR bighorn population was a greater proportion of young animals in the population and, therefore, a greater number of young bighorns on the EWR. Since younger animals are thought to constitute the dispersing segment of bighorn populations (Geist 1971), this would: 1) increase group size during pioneering movements, and 2) increase numbers of potentially pioneering groups. Both would, theoretically, increase the probability of dispersal and subsequent ecesis.

Data for the CWR indicated that the population was increasing by 1973, 1 year following the period of maximum growth on the EWR and the period with, theoretically, the youngest age structure. The EWR population entered an exponential growth phase in the mid 1960's and stabilized approximately 10 years later. If a similar pattern holds for the CWR, which entered an exponential growth phase about 1970, then one would expect numbers to have stabilized by about 1980. Too few data are available to evaluate this possibility at present.

The observed recolonization of historic winter ranges does not imply reestablishment of historic migration routes. Much of the historic use of the YJWR may have been by bighorns summering to the east in the Absaroka Range.

Data on population quality, which indicated high quality and possibly expanding populations, are in apparent contradiction to the conclusion that both the CWR and EWR populations may be stable or declining. Since data were collected during 2 years with exceptionally mild winters, these indicators are believed to reflect short-term responses to more immediate conditions rather than the long-term status of the 2 groups under the current conditions of high elk numbers. Data regarding maturation rates in rams are an apparent exception to this, since these data should reflect cumulative responses over several years.

The conclusions presented here regarding bighorn population trends and elk-bighorn relationships are directly contradictory to recent work by Houston (1980). This difference is based almost entirely on differing interpretations of the effects of temperature on census counts. While the exact nature of the temperature-observability relationship may not be resolved without further carefully controlled observations, the recent population decline among bighorns due to a *Chlamydia* outbreak (Meagher unpubl.) on the EWR may prove useful in evaluating the opposing interpretations of the elk-sheep relationship. Provided environmental conditions remain relatively stable, three possible eventualities are postulated: 1) sheep numbers will rebound to former levels (approximately 200) within an estimated 2-3 years, indicating that elk numbers, currently estimated at 17,000 for the NYWR (Meagher pers. comm.), have no substantial impact on sheep populations, 2) sheep numbers will continue to decline, despite the recovery from the current *Chlamydia* infection, until they reach their pre-elk reduction level of approximately 60 individuals (indicating that elk numbers have a negative influence on sheep populations), or 3) following the *Chlamydia* outbreak, sheep numbers will stabilize at some new, intermediate, level indicating that elk-sheep interactions may result in multiple equilibria. If the regression described in Figure 16 is valid, any continued decline in sheep numbers will be gradual (r_a=-0.03 to -0.04 when elk numbers are 12,000-17,000), taking many years to manifest itself, and will probably be highly subject to climatic variations. Should the population return to its pre-infection level of 200 sheep, it is expected that this increase would occur with little influence from climatic conditions. Due to the gradual nature of any expected decline, it may not be possible to ascertain between postulates 2 and 3 until some time in the future.

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LITERATURE CITED

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APPENDIX

Table 3. List of radio-relocations, February 1980 to October 1981.

		UTM Coordinates	
Date	Radio[1/]	Longitude	Latitude
2-28-80	2-08	5150	49950
"	2-10	5155	49953
"	4-11	5155	49951
4-4-80	2-03	5038	49972
"	2-04	5154	49957
"	2-06	5155	49960
"	2-07	5160	49947
"	2-08	5156	49954
"	2-10	5156	49952
"	2-11	4943	49982
"	2-12	5170	49887
"	4-11	5093	50016
4-17-80	2-03	5034	49981
"	2-04	5155	49946
"	2-06	5164	49908
"	2-07	5159	49946
"	2-08	5142	49954
"	2-10	5166	49910
"	2-11	4942	49976
"	2-12	5163	49905
"	4-11	5095	50016
5-5-80	2-03	5057	49936
"	2-04	5130	49951
"	2-06	5137	49985
"	2-07	5161	49944
"	2-08	5165	49915
"	2-10	5172	49886
"	2-11	4943	49983
"	2-12	5148	49907
5-13-80	2-03	5066	49932
"	2-04	5155	49939
"	2-06	5178	49874
"	2-07	5161	49927
"	2-08	5138	49960
"	2-10	5177	49870
"	2-11	4947	49980
"	2-12	5160	49944
5-21-80	2-03	4968	49866
"	2-04	5164	49836

Table 3 (Continued).

Date	Radio[1/]	UTM Coordinates Longitude	Latitude
5-21-80	2-06	5175	49870
"	2-07	5174	49826
"	2-08	5128	49878
"	2-10	5180	49830
"	2-11	4952	49977
"	2-12	5128	49878
"	4-11	4952	49870
6-9-80	2-03	4972	49874
"	2-04	5152	49740
"	2-06	5171	49857
"	2-07	5105	50011
"	2-08	5144	50048
"	2-10	5184	49833
"	2-11	4912	50014
"	2-12	5162	49837
"	4-11	4948	49867
6-17-80	2-03	4954	49862
"	2-04	5125	49721
"	2-06	5171	49857
"	2-07	5128	49854
"	2-08	5143	50050
"	2-10	5182	49836
"	2-11	4912	50012
"	2-12	5166	49863
"	4-11	4952	49862
7-1-80	2-03	4972	49872
"	2-04	5145	49716
"	2-06	5162	49842
"	2-07	5155	49935
"	2-08	5155	49936
"	2-10	5188	49822
"	2-11	4931	49995
"	2-12	5180	49835
"	4-11	4954	49888
7-18-80	2-03	4940	49898
"	2-04	5121	49722
"	2-06	5122	49844
"	2-07	5122	49844
"	2-08	5129	49845
"	2-10	5243	49838

Table 3 (Continued).

Date	Radio[1/]	UTM Coordinates Longitude	Latitude
7-18-80	2-11	4919	50009
"	2-12	5122	49844
"	4-11	4940	49898
8-5-80	2-03	4956	49890 Big Horn
"	2-04	5140	49716
"	2-06	5133	49846
"	2-07	5183	49822
"	2-08	5117	49834
"	2-10	5243	49838
"	2-12	5121	49830
"	4-11	4956	49890 Big Horn
8-21-80	2-03	4973	49900
"	2-04	5144	49716
"	2-06	5123	49845
"	2-07	5184	49821
"	2-08	5107	50025
"	2-10	5193	49820
"	2-11	4925	49996 Rams Horn
"	4-11	4962	49898 Big Horn
9-4-80	2-03	4967	49898 Big
"	2-04	5137	49721
"	2-06	5162	49839
"	2-07	5119	49845
"	2-08	5120	50020
"	2-10	5199	49821
"	4-11	4967	49898 Big
9-25-80	2-03	4971	49870
"	2-04	5138	49717
"	2-06	5120	49845
"	2-07	5120	49845
"	2-10	5180	49834
"	4-11	4972	49870
10-8-80	2-03	4962	49898 Big
"	2-04	5138	49721
"	2-06	5121	49849
"	2-07	5168	49862
"	2-08	5168	49862
"	4-11	4962	49898 Big
10-28-80	2-03	4986	49911

Table 3 (Continued).

Date	Radio[1/]	UTM Coordinates Longitude	Latitude
10-28-80	2-04	5150	49745
"	2-06	5171	49875
"	2-07	5140	49895
"	2-08	5160	49936
"	2-10	5243	49840
"	2-11	4923	49997
"	4-11	4954	49888
11-15-80	2-03	4997	49923
"	2-04	5170	49889
"	2-06	5171	49889
"	2-07	5155	49961
"	2-10	5239	49840
"	2-11	4931	49942
"	4-11	4960	49860
1-5-81	2-04	5172	49860
"	2-06	5150	49956
"	2-07	5157	49955
"	2-08	5157	49947
"	2-10	5174	49854
"	2-11	4937	49983
"	4-11	5139	49966
1-20-81	2-04	5174	49880
"	2-10	5187	49838
"	2-11	5001	49942
"	4-11	5137	49975
2-4-81	2-04	5168	49933
"	2-06	5170	49942
"	2-07	5170	49942
"	2-08	5170	49942
"	2-10	5173	49881
"	4-11	5140	49975
3-3-81	2-04	5153	49955
"	2-06	5160	49946
"	2-07	5157	49929
"	2-08	5160	49946
"	2-10	5167	49853
"	4-11	5151	49954
3-24-81	2-04	5153	49952
"	2-06	5153	49952

Table 3 (Continued).

Date	Radio[1/]	UTM Coordinates Longitude	Latitude
3-24-81	2-07	5163	49910
"	2-08	5153	49952
"	2-10	5171	49876
"	4-11	5154	49935
4-8-81	2-04	5152	49934
"	2-06	5154	49937
"	2-07	5163	49914
"	2-08	5163	49914
"	2-10	5174	49877
"	4-11	5145	49948
5-3-81	2-04	5159	49929
"	2-06	5172	49873
"	2-07	5172	49873
"	2-10	5174	49864
"	3-01	5032	49965
"	4-11	5128	49954
5-25-81	2-04	5158	49928
"	2-06	5164	49838
"	2-07	5164	49838
"	2-08	5164	49838
"	2-10	5170	49864
"	3-01	5021	49963
6-11-81	2-04	5140	49717
"	2-06	5163	49932
"	2-07	5183	49832
"	2-08	5163	49932
"	2-10	5171	49858
7-19-81	2-04	5132	49717
"	2-06	5132	49830
"	2-07	5120	49839
"	2-08	5120	49839
"	3-01	4990	49912
7-30-81	2-04	5126	49721
"	2-06	5121	49838
"	2-07	5121	49838
"	2-08	5121	49838
"	3-01	5048	49928
8-17-81	2-04	5130	49718
"	2-06	5115	49835

Table 3 (Continued).

Date	Radio[1/]	UTM Coordinates Longitude	Latitude
8-17-81	2-07	5115	49835
"	2-08	5115	49835
"	3-01	5028	49926
8-31-81	2-06	5181	49834
"	2-07	5126	49827
"	2-08	5181	49834
"	3-01	4987	49897
9-23-81	2-06	5183	49825
"	2-07	5093	49799
"	2-08	5183	49825
"	3-01	5009	49908
10-22-81	2-06	5164	49837
"	2-07	5150	49949
"	3-01	5030	49949

[1/] Band-channel.

Table 4. Locations of visual observations made on the study area during both aerial and ground work, December 1979 to October 1981.

Date	Area	UTM Coordinates Longitude	Latitude	Number Observed
12- ?-79	Cinnabar Mtn.	--	--	11
	" "	--	--	11
	" "	--	--	10
	" "	--	--	29
	Coke Ovens	--	--	2
12-15-79	Cinnabar Mtn.	--	--	6
	" "	--	--	2
	" "	--	--	21
1-19-80	Cinnabar Mtn.	--	--	13
	" "	--	--	3
	" "	--	--	23
	" "	--	--	45
	Coke Ovens	--	--	4
	Sepulcher Mtn.	--	--	3
1-25-80	Cinnabar Mtn.	--	--	7
	" "	--	--	5
	" "	--	--	7
	" "	--	--	11
	" "	--	--	8
	" "	--	--	12
	" "	--	--	3
	" "	--	--	2
	" "	--	--	15
	" "	--	--	15
2-16-80	Cinnabar Mtn.	--	--	25
3-18-80	Cinnabar Mtn.	--	--	8
	" "	--	--	6
	" "	--	--	13
	" "	--	--	4
	" "	--	--	6
	Coke Ovens	--	--	17
	Sepulcher Mtn.	--	--	2
3-22-80	Cinnabar Mtn.	--	--	14
	" "	--	--	1
	Coke Ovens	--	--	2
	Sepulcher Mtn.	--	--	1
4- 1-80	Yankee Jim Canyon	--	--	2

Table 4. (Continued).

Date	Area	UTM Coordinates Longitude	UTM Coordinates Latitude	Number Observed
4- 4-80	Cinnabar Mtn.	5154	49957	5
	" "	5156	49954	4
	Grizzly Cr.	5038	49972	3
4- 6-80	Cinnabar Mtn.	--	--	5
	" "	--	--	5
	" "	--	--	1
	" "	--	--	5
	" "	--	--	3
	" "	--	--	5
	" "	--	--	7
	" "	--	--	3
	Sepulcher Mtn.	--	--	8
	" "	--	--	1
4-16-80	Cinnabar Mtn.	--	--	7
	" "	--	--	4
	Coke Ovens	--	--	1
	Sepulcher Mtn.	--	--	3
4-17-80	Coke Ovens	5163	49905	1
	Grizzly Cr.	5034	49981	9
	Ramshorn Pk.	4942	49976	17
5- 3-80	Cinnabar Mtn.	--	--	2
	" "	--	--	2
	" "	--	--	7
5- 5-80	Cinnabar Mtn.	5130	49951	5
	" "	5137	49985	9
	" "	5161	49944	3
	Coke Ovens	5148	49907	1
	" "	5158	49907	4
	Sepulcher Mtn.	5772	49886	20
	Mol Heron Cr.	5130	49951	4
	Ramshorn Pk.	4943	49983	14
	Horse Cr.	5039	49946	5
	" "	5030	49984	13
	Sawtooth Mtn.	5016	49989	6
	" "	5021	49982	6
	" "	5004	49988	10
5-13-80	Cinnabar Mtn.	5161	49927	20
	" "	5160	49944	1
	" "	--	--	3

Table 4. (Continued).

Date	Area	UTM Coordinates Longitude	Latitude	Number Observed
5-13-80	Cinnabar Mtn.	5138	49960	2
	Coke Ovens	--	--	4
	Sepulcher Mtn.	5178	49874	7
	" "	5177	49870	4
	" "	--	--	3
	Ramshorn Pk.	4947	49780	12
	Lion Cr.	--	--	6
5-21-80	Specimen Cr.	4968	49866	1
	" "	4952	49870	6
	Sepulcher Mtn.	5164	49836	33
	" "	5175	49870	16
	" "	5174	49826	4
	" "	5180	49830	3
	Electric Pk.	5128	49878	3
	Ramshorn Pk.	4952	49987	24
6- 9-80	Quadrant Mtn.	5152	49740	7
	Sepulcher Mtn.	5171	49857	2
	" "	5184	49833	4
	" "	5162	49837	1
	Red Mtn.	5144	50048	2
	Specimen Cr.	4948	49867	7
6-11-80	Sepulcher Mtn.	--	--	8
	" "	--	--	1
	" "	--	--	3
6-12-80	Sepulcher Mtn.	--	--	4
	" "	--	--	11
6-17-80	Specimen Cr.	4954	49862	8
	Quadrant Mtn.	5125	49721	2
	Sepulcher Mtn.	5171	49857	9
	" "	5182	49836	2
	" "	5166	49863	1
	" "	5185	49836	1
	" "	5182	49833	8
	" "	5177	49833	2
	Electric Pk.	5128	49854	7
	Fortress Mtn.	4912	50012	4
	" "	4915	50012	10
6-20-80	Fortress Mtn.	--	--	22
6-21-80	Fortress Mtn.	--	--	4
6-23-80	Ramshorn Pk.	--	--	17

Table 4. (Continued).

Date	Area	UTM Coordinates Longitude	Latitude	Number Observed
7- 1-80	Quadrant Mtn.	5145	49716	9
	Sepulcher Mtn.	5162	49842	17
	" "	--	--	8
	Cinnabar Mtn.	5155	49935	6
	Ramshorn Pk.	4931	49995	4
	Bighorn Pk.	4954	49888	4
7-12-80	Ramshorn Pk.	--	--	5
7-18-80	Black Butte Cr.	4940	49898	8
	Electric Pk.	5122	49844	10
	" "	5121	49839	1
	" "	5123	49846	6
	" "	5129	49845	13
	Fortress Mtn.	4919	50009	9
	Daly Cr.	4942	49908	13
	Quadrant Mtn.	5143	49729	2
7-23-80	Electric Pk.	--	--	6
	" "	--	--	6
8- 5-80	Bighorn Pk.	4956	49890	10
	" "	4958	49894	2
	Quadrant Mtn.	5140	49716	6
	Sepulcher Mtn.	5183	49822	6
	Ramshorn Pk.	--	--	15
	Electric Pk.	5114	49827	1
	" "	5122	49833	7
	" "	5120	49839	25
	" "	5123	49839	11
8-21-80	Quadrant Mtn.	5144	49716	12
	Electric Pk.	5123	49845	26
	" "	5120	49831	4
	Sepulcher Mtn.	5184	49821	7
	" "	5193	49820	9
	Dome Mtn.	5107	50025	1
	Ramshorn Pk.	4925	49996	12
	" "	4928	49995	7
8-23-80	Cinnabar Mtn.	--	--	1
9- 4-80	Bighorn Pk.	4967	49898	8
	" "	4953	49899	3
	Quadrant Mtn.	5137	49721	17
	Sepulcher Mtn.	5162	49839	10

Table 4. (Continued).

Date	Area	UTM Coordinates Longitude	Latitude	Number Observed
9- 4-80	Sepulcher Mtn.	5202	49810	5
	" "	5201	49818	2
	" "	5167	49850	4
	Electric Pk.	5119	49845	25
	" "	5119	49839	10
	Ramshorn Pk.	4926	49998	7
	Fortress Mtn.	4915	50010	5
	Quadrant Mtn.	5114	49739	15
9- 7-80	Bighorn Pk.	--	--	1
	" "	--	--	2
9-25-80	Quadrant Mtn.	5138	49717	5
	Electric Pk.	5120	49845	23
	" "	5120	49831	12
	Sepulcher Mtn.	5180	49834	3
	Ramshorn Pk.	4932	49974	6
	Specimen Cr.	4958	49873	7
	Quadrant Mtn.	5131	49720	2
10- 6-80	Mt. Everts	--	--	79
10- 8-80	Sepulcher Mtn.	5168	49862	5
	" "	5203	49800	5
	Electric Pk.	5115	49835	11
	" "	5126	49848	4
	" "	5121	49849	28
	Quadrant Mtn.	5138	49721	20
	Ramshorn Pk.	4944	49982	12
10-28-80	Sepulcher Mtn.	5171	49875	5
	Mt. Everts	5243	49840	12
	" "	--	--	102
	Ramshorn Pk.	4923	49997	6
	Bighorn Pk.	4954	49888	3
	Quadrant Mtn.	5155	49755	11
	Coke Ovens	5161	49909	6
11-15-80	Sepulcher Mtn.	5171	49889	5
	Cinnabar Mtn.	5155	49961	26
	" "	5153	49956	2
	Daly Cr.	4921	49942	12
	" "	4916	49945	2
	Grizzly Cr.	5035	49983	15
	"	5041	49977	1

Table 4. (Continued).

Date	Area	UTM Coordinates Longitude	Latitude	Number Observed
11-19-80	Cinnabar Mtn.	--	--	36
	" "	--	--	10
	" "	--	--	5
11-24-80	Coke Ovens	--	--	1
	" "	--	--	1
12- 6-80	Sepulcher Mtn.	--	--	2
	" "	--	--	1
	Cinnabar Mtn.	--	--	21
	" "	--	--	9
	" "	--	--	3
	" "	--	--	28
1- 5-80	Cinnabar Mtn.	5150	49956	25
	" "	5157	49955	19
	" "	5148	49949	14
	" "	5160	49944	2
	" "	5139	49966	1
	Sepulcher Mtn.	5174	49853	2
	Fortress Mtn.	4914	50014	1
1- 7-80	Cinnabar Mtn.	--	--	21
1- 9-80	Cinnabar Mtn.	--	--	30
1-20-80	Mol Heron G.	5137	49975	11
	Sheep Mtn.	5001	49742	24
	" "	5000	49938	3
	Grizzly Cr.	--	--	3
1-28-31	Sepulcher Mtn.	--	--	6
	Coke Ovens	--	--	3
	" "	--	--	1
	" "	--	--	1
	" "	--	--	1
	Cinnabar Mtn.	--	--	1
	" "	--	--	15
2- 1-81	Sepulcher Mtn.	--	--	1
2- 4-81	Cinnabar Mtn.	5170	49942	11
	" "	--	--	9
	Sheep Mtn.	--	--	15
	" "	--	--	15
	Grizzly Cr.	--	--	17
3- 3-81	Cinnabar Mtn.	5153	49955	10
	" "	5160	49946	6

Table 4. (Continued).

Date	Area	UTM Coordinates Longitude	Latitude	Number Observed
3- 3-81	Cinnabar Mtn.	5157	49929	6
	" "	5151	49954	3
	" "	5144	49957	10
	" "	5152	49958	5
	" "	5154	49959	15
	Sepulcher Mtn.	5171	49876	6
	Grizzly Cr.	5034	49981	4
	Ramshorn Pk.	4950	49977	2
3-24-81	Cinnabar Mtn.	5153	49952	8
	" "	—	—	18
	" "	—	—	3
	" "	—	—	13
	" "	—	—	4
	" "	—	—	2
	" "	—	—	5
	" "	5154	49935	5
	Sepulcher Mtn.	5171	49876	1
	Coke Ovens	5163	49910	5
	Grizzly Cr.	5040	49966	7
	Sheep Cr.	4994	49970	41
	Ramshorn Pk.	4956	49975	3
4- 3-81	Sheep Mtn.	—	—	50
4- 8-81	Cinnabar Mtn.	5152	49934	4
	" "	5154	49937	8
	" "	5145	49948	2
	" "	5150	49935	9
	" "	5153	49934	9
	" "	5159	49934	9
	" "	5159	49949	9
	" "	5160	49946	1
	Coke Ovens	5163	49914	14
5- 4-81	Cinnabar Mtn.	5159	49929	2
	" "	5128	49954	14
	" "	5157	49930	11
	" "	5152	49955	3
	" "	5124	49966	7
	Sepulcher Mtn.	5172	49873	2
	" "	5174	49864	2
	" "	5172	49866	6

Table 4. (Continued).

Date	Area	UTM Coordinates Longitude	Latitude	Number Observed
5- 4-81	Sepulcher Mtn.	5173	59864	1
	" "	5174	49865	2
	" "	5179	49865	4
	" "	5166	49838	6
	" "	5184	49838	3
	Sawtooth Mtn.	5013	49988	5
	" "	5015	49987	5
	" "	5004	49974	4
	" "	5000	49983	26
	Ramshorn Pk.	4949	49986	2
5-25-81	Cinnabar Mtn.	5158	49928	1
	" "	5132	49974	6
	Sepulcher Mtn.	5164	49838	20
	" "	5170	49864	1
	" "	5171	49855	2
	" "	5166	49839	4
	" "	5163	49838	5
	" "	5184	49832	1
	" "	5202	49826	1
	" "	5201	49813	8
	Ramshorn Pk.	4951	49979	5
	" "	4920	49993	10
	" "	4949	49979	7
	" "	4950	49978	5
	Sawtooth Mtn.	5022	49960	1
	Specimen Cr.	4951	49812	7
5-27-81	Sepulcher Mtn.	--	--	9
	" "	--	--	19
	" "	--	--	4
	" "	--	--	9
6- 1-81	Ramshorn Pk.	--	--	3
	" "	--	--	2
	" "	--	--	3
	" "	--	--	2
	" "	--	--	5
	" "	--	--	3
	" "	--	--	5
	" "	--	--	6
	" "	--	--	2
	" "	--	--	1

Table 4. (Continued).

Date	Area	UTM Coordinates Longitude	Latitude	Number Observed
6- 8-81	Sepulcher Mtn.	--	--	8
6- 9-81	Sepulcher Mtn.	--	--	5
6-11-81	Sepulcher Mtn.	5183	49832	4
	" "	5171	49858	2
	" "	--	--	12
	" "	5170	49829	1
	" "	5165	49838	11
	" "	5176	49810	1
	" "	5201	49812	6
	Ramshorn Pk.	4927	49994	18
	Fortress Mtn.	4912	50021	1
	" "	4915	50005	2
	Walsh Cr.	4996	49955	13
6-20-81	Sepulcher Mtn.	--	--	21
6-24-81	Sepulcher Mtn.	--	--	2
	" "	--	--	13
	" "	--	--	2
	" "	--	--	8
6-29-81	Electric Pk.	--	--	7
	" "	--	--	8
	" "	--	--	46
7-19-81	Electric Pk.	5120	49839	52
	Specimen Cr.	4990	49912	9
	Sepulcher Mtn.	5163	49838	4
	" "	5183	49817	3
	Sawtooth Mtn.	5018	49945	4
	Bighorn Pk.	4966	49898	2
	" "	4356	49900	9
	Fortress Mtn.	4911	50017	4
	" "	4912	50019	7
7-30-81	Electric Pk.	5121	49838	40+
8-17-81	Electric Pk.	5115	49835	70+
	" "	--	--	11
	Specimen Cr.	4949	49889	7
	" "	4981	49915	7
	Fortress Mtn.	4912	50014	26
	Quadrant Mtn.	5140	49721	3
8-27-81	Electric Pk.	--	--	5
	" "	--	--	27
8-31-81	Quadrant Mtn.	5142	49715	4

Table 4. (Continued).

Date	Area	UTM Coordinates Longitude	Latitude	Number Observed
8-31-81	Quadrant Mtn.	5133	49714	2
	" "	5120	49730	3
	Electric Pk.	5122	49845	6
	Lion Cr.	5046	49909	3
9-23-81	Pk. 10207 (N. of Joseph Pk.)	5093	49799	2
	Electric Pk.	--	--	2
10-22-81	Sepulcher Mtn.	5164	49837	9
	" "	5171	49869	3
	" "	5171	49886	9
	Cinnabar Mtn.	5150	49949	3
	" "	5145	49954	4
	Horse Cr.	5030	49949	2
10-21-81	Fortress Mtn.	4912	50040	3

Table 5. Summary of food habits data for the Mt. Everts group, based on microhistological analysis of 50 fecal samples.

Food Item	Nov. n=10	Dec. n=10	Jan. n=10	Feb. n=10	Mar. n=10	Cum. n=50
	Percent of Diet					
Grasses and Grass-like Plants						
Agropyron spp.	14.9	25.5	17.8	16.9	26.9	20.4
Bromus spp.	4.2	7.9	1.8	4.1	11.9	6.0
Carex spp.	0.2	2.1	11.5	4.9	4.9	4.7
Calamagrostis rubescens	0.0	0.0	0.0	0.0	0.0	0.0
Elymus cinereus	0.0	0.0	0.0	0.2	0.0	0.0(T)[1/]
Festuca idahoensis	4.0	2.5	3.4	1.4	1.2	2.5
Koeleria cristata	5.2	15.2	8.2	6.9	10.5	9.2
Oryzopsis hymenoides	0.0	0.2	0.0	0.5	0.0	0.1
Poa spp.	0.0	0.2	0.0	0.0	0.2	0.1
Stipa spp.	5.1	15.9	6.8	8.6	12.3	9.7
Unknown grasses	5.5	7.6	7.0	5.8	5.3	6.2
Total grasses	39.1	77.1	56.5	49.3	73.2	59.3
Forbs						
Achillea millefolium	0.4	0.2	0.1	0.4	0.0	0.2
Arenaria spp.	0.0	0.0	0.0	0.2	0.0	0.0(T)
Astragalus spp.	0.0	0.0	0.0	0.0	0.2	0.0(T)
Balsamorhiza sagittata	0.0	0.0	0.0	0.0	1.3	0.3
Compositae	0.2	0.0	0.1	0.6	0.0	0.2
Commandra umbellata	0.0	0.0	0.2	0.2	0.0	0.1
Cruciferae	0.0	0.2	0.0	0.0	0.0	0.0(T)
Equisetum spp.	0.0	0.0	0.0	0.0	0.0	0.0
Eriogonum spp.	0.0	0.5	0.2	0.0	0.0	0.1
Lupinus spp.	0.5	0.0	0.2	0.1	0.4	0.2
Phlox spp.	1.2	4.5	1.8	1.2	2.0	2.1
Unknown forbs	1.9	2.5	2.0	2.4	9.4	3.6
Total forbs	4.2	7.9	4.6	5.1	13.3	7.0
Browse						
Amelanchier alnifolia	0.0	0.0	0.0	0.0	0.0	0.0
Arctostaphylos uva-ursi	0.0	0.0	0.0	0.0	0.0	0.0
Artemisia frigida	0.8	0.4	0.0	1.0	0.0	0.4
Artemisia spp.[2/]	3.6	3.7	11.0	7.6	6.2	6.4
Artriplex conifertifolia	0.4	1.0	0.2	0.3	0.0	0.4
Artriplex nuttallii	0.0	0.0	0.0	0.0	0.0	0.0
Chrysothamnus nauseosus	5.3	3.2	0.0	7.3	3.6	3.9
Chrysothamnus viscidiflorus	0.0	0.0	0.0	0.0	0.0	0.0
Eurotia lanata	40.8	6.8	25.6	28.0	0.9	20.4
Juniperus spp.	0.0	0.2	0.7	0.0	0.4	0.3
Pinus flexilis	0.2	0.0	0.2	0.0	0.0	0.1
Prunus spp.	0.0	0.2	0.0	0.0	0.2	0.1
Pseudotsuga menziesii	2.4	0.5	0.7	0.7	2.2	1.3
Sarcobatus vermiculatus	0.0	0.2	0.0	0.2	0.0	0.1
Symphoricarpos spp.	0.0	0.0	0.0	0.0	0.0	0.0
Unknown shrubs	4.8	1.0	1.5	1.0	0.6	1.8
Total browse	58.3	17.2	39.9	46.3	14.1	35.2
Total[3/]	101.6	102.2	101.0	100.7	100.6	101.2

[1/] T = <0.1%.

[2/] Includes all *Artemisia* spp. except *A. frigida*.

[3/] May not sum to 100% due to rounding.

Table 6. Summary of food habits data for the Cinnabar Mountain group, based on microhistological analysis of 50 fecal samples.

Food Item	Percent of Diet Nov. n=10	Dec. n=10	Jan. n=10	Feb. n=10	Mar. n=10	Cum. n=50
Grasses and Grass-like Plants						
Agropyron spp.	21.3	31.8	24.0	22.0	21.4	24.1
Bromus spp.	6.3	1.1	2.8	4.1	2.0	3.3
Carex spp.	1.1	0.0	4.6	3.5	1.1	2.1
Calamagrostis rubescens	0.0	0.1	0.0	0.0	0.0	0.0(T)[1]
Elymus cinereus	0.0	0.1	0.0	0.0	0.0	0.0(T)
Festuca idahoensis	10.2	7.7	3.1	4.2	5.4	6.1
Koeleria cristata	7.3	10.2	6.3	9.9	10.4	8.8
Oryzopsis hymenoides	0.2	0.1	0.0	0.0	0.0	0.1
Poa spp.	1.0	0.1	0.1	0.2	0.5	0.4
Stipa spp.	2.9	0.7	2.0	3.8	2.5	2.4
Unknown grasses	8.3	3.7	4.7	8.0	6.8	6.3
Total grasses	58.6	55.6	47.6	55.7	50.1	53.5
Forbs						
Achillea millefolium	0.0	0.4	0.2	0.0	0.3	0.2
Arenaria spp.	0.0	0.0	0.0	0.0	0.0	0.0
Astragalus spp.	0.0	0.0	0.0	0.0	0.0	0.0
Balsamorhiza sagittata	0.2	0.4	0.4	0.4	0.0	0.3
Compositae	0.0	0.0	0.3	0.2	0.2	0.1
Commandra umbellata	0.0	0.0	0.0	0.0	0.0	0.0
Cruciferae	0.0	0.0	0.0	0.2	0.0	0.0(T)
Equisetum spp.	0.0	0.0	0.0	0.0	0.0	0.0
Eriogonum spp.	0.0	0.3	0.1	1.2	0.5	0.4
Lupinus spp.	0.0	0.0	0.1	0.2	0.1	0.1
Phlox spp.	1.6	0.4	0.9	2.1	2.5	1.5
Unknown forbs	8.4	0.3	2.7	4.6	2.4	3.7
Total forbs	10.2	1.8	4.7	8.9	6.0	6.3
Browse						
Amelanchier alnifolia	0.2	0.1	0.1	0.0	0.0	0.1
Arctostaphylos uva-ursi	0.0	0.1	0.1	0.0	0.0	0.0(T)
Artemisia frigida	0.0	0.1	0.0	0.6	0.0	0.1
Artemisia spp.[2]	16.4	20.6	26.8	30.2	28.8	24.6
Atriplex confertifolia	0.0	0.4	0.0	0.0	0.0	0.1
Atriplex nuttallii	0.0	0.2	0.1	0.0	0.0	0.1
Chrysothamnus nauseosus	3.7	1.3	0.0	2.4	9.5	3.4
Chrysothamnus viscidiflorus	0.2	0.0	0.0	0.0	0.6	0.2
Eurotia lanata	6.3	12.6	18.2	2.1	0.2	7.9
Juniperus spp.	0.6	0.8	0.2	0.4	3.7	1.1
Pinus flexilis	0.0	1.8	0.0	0.2	0.0	0.4
Prunus spp.	0.2	0.0	0.0	0.2	0.2	0.1
Pseudotsuga menziesii	0.6	1.9	1.4	0.6	0.7	1.0
Ribes spp.	0.0	0.4	0.0	0.0	0.0	0.1
Sarcobatus vermiculatus	0.0	0.0	0.0	0.0	0.0	0.0
Symphoricarpos spp.	0.0	0.1	0.0	0.0	0.0	0.0(T)
Unknown shrubs	2.9	1.8	0.7	1.2	0.8	1.5
Total browse	31.1	42.2	47.6	37.9	44.5	40.7
Total[3]	99.9	99.6	99.9	102.5	100.6	100.5

[1] T = <0.1%.

[2] Includes all *Artemisia* spp. except *A. frigida*.

[3] May not sum to 100% due to rounding.

Table 7. Summary of food habits data for both the Cinnabar Mountain and Mt. Everts groups, based on microhistological analysis of 100 fecal samples.

Food Item	Nov. n=20	Dec. n=20	Jan. n=20	Feb. n=20	Mar. n=20	Cum. n=100
	Percent of Diet					
Grasses and Grass-like Plants						
Agropyron spp.	18.1	28.6	20.9	19.4	24.1	22.3
Bromus spp.	5.3	4.5	2.3	4.1	7.0	4.6
Carex spp.	0.7	1.1	8.1	4.2	3.0	3.4
Calamagrostis rubescens	0.0	0.1	0.0	0.0	0.0	0.0(T)[1/]
Elymus cinereus	0.0	0.1	0.0	0.1	0.0	0.0(T)
Festuca idahoensis	7.1	5.1	3.3	2.8	3.3	4.3
Koeleria cristata	6.3	12.7	7.3	8.4	10.4	9.0
Oryzopsis hymenoides	0.1	0.2	0.0	0.3	0.0	0.1
Poa spp.	0.5	0.2	0.1	0.1	0.4	0.2
Stipa spp.	4.0	8.3	4.4	6.2	7.4	6.1
Unknown grasses	6.9	5.7	5.9	6.9	6.1	6.3
Total grasses	48.8	66.3	52.0	52.5	61.7	56.3
Forbs						
Achillea millefolium	0.2	0.3	0.2	0.2	0.2	0.2
Arenaria spp.	0.0	0.0	0.0	0.1	0.0	0.0(T)
Astragalus spp.	0.0	0.0	0.0	0.0	0.1	0.0(T)
Balsamorhiza sagittata	0.1	0.2	0.2	0.2	0.7	0.3
Compositae	0.1	0.0	0.2	0.4	0.1	0.2
Commandra umbellata	0.0	0.0	0.1	0.1	0.0	0.0(T)
Cruciferae	0.0	0.1	0.0	0.1	0.0	0.0(T)
Equisetum spp.	0.0	0.0	0.0	0.0	0.0	0.0
Eriogonum spp.	0.0	0.4	0.2	0.6	0.3	0.3
Lupinus spp.	0.3	0.0	0.2	0.2	0.3	0.2
Phlox spp.	1.4	2.5	1.4	1.7	2.3	1.8
Unknown forbs	5.2	1.4	2.4	3.5	5.9	3.7
Total forbs	7.2	4.9	4.7	7.0	9.7	6.7
Browse						
Amelanchier alnifolia	0.1	0.1	0.1	0.0	0.0	0.0(T)
Arctostaphylos uva-ursi	0.0	0.1	0.1	0.0	0.0	0.0(T)
Artemisia frigida	0.4	0.3	0.0	0.8	0.0	0.3
Artemisia spp.[2/]	10.0	12.1	18.9	18.9	17.5	15.5
Atriplex conifertifolia	0.2	0.7	0.1	0.2	0.0	0.2
Atriplex nuttallii	0.0	0.1	0.1	0.0	0.0	0.0(T)
Chrysothamnus nauseosus	4.5	2.3	0.0	4.9	6.6	3.6
Chrysothamnus viscidiflorus	0.1	0.0	0.0	0.0	0.3	0.1
Eurotia lanata	23.5	9.7	21.9	15.0	0.6	14.1
Juniperus spp.	0.3	0.5	0.5	0.2	2.1	0.7
Pinus flexilis	0.1	0.9	0.1	0.1	0.0	0.2
Prunus spp.	0.1	0.1	0.0	0.1	0.2	0.1
Pseudotsuga menziesii	1.5	1.2	1.1	0.8	1.5	1.2
Sarcobatus vermiculatus	0.0	0.1	0.0	0.1	0.0	0.0(T)
Symphoricarpos spp.	0.0	0.1	0.0	0.0	0.0	0.0(T)
Unknown shrubs	3.9	1.4	1.1	1.1	0.7	1.6
Total shrubs	44.7	29.7	43.8	42.1	29.3	37.9
Total[3/]	100.7	100.9	100.5	101.6	100.7	100.9

[1/] T = <0.1%.

[2/] Includes all *Artemisia* spp. except *A. frigida*.

[3/] May not sum to 100% due to rounding.