Seasonal locations of bighorn sheep, mountain goats, and elk on the Haystack Domestic Sheep Allotment, Montana
by Boyd Raldon Byelich

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Range Science
Montana State University

Abstract:
In response to allegations that a bighorn population along the upper Boulder River was declining in numbers due to the presence of domestic sheep each summer on the Haystack Grazing Allotment, the objective of this thesis was to describe the seasonal and spatial locations of bighorn sheep and domestic sheep, as well as elk and mountain goats, between November of 1987 and September of 1989. Ungulate locations were identified using aerial surveys between September and May followed by ground observations from June through August. Compilation of this data indicated that interactions might occur between elk and domestic sheep during July and August, between bighorns and mountain goats from September through May, and among bighorns throughout the year. Evidence of domestic sheep use on observed bighorn sheep range was also observed on two occasions. Chi-square analyses revealed that bighorns did not use the Monument and Baboon mountain complexes in proportion to suitable habitat availability during the summer ($P < .05$) and that Monument might be used significantly more during the winter ($P < .05$). People do use the area between Monument and Baboon for recreational activities throughout the year. Paired t-tests indicated that bighorn sheep locations were not dependent on domestic sheep locations ($P > .50$). In conclusion, domestic sheep are only one of many factors along the upper Boulder that might affect bighorn sheep numbers. A more detailed study would be needed to determine the relative importance of these observations.

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Boyd Raldon Byelich

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

10 Jan 1994
Date

Chairperson, Graduate Committee

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1/10/94
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Signature Boyd Colton Byelich

Date January 10, 1994

To my parents, George and Louella, who taught me to respect all living things.

VITA

Boyd Raldon Byelich was born in 1963 in Freemont, Michigan. He was raised on a beef farm near Harrisville, Michigan and graduated from Lincoln-Alcona High School in 1982. He graduated from Lake Superior State University in Sault Ste. Marie, Michigan with a bachelor of science degree in fisheries and wildlife management in 1987. His graduate career at Montana State University also began in 1987.

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ABSTRACT

In response to allegations that a bighorn population along the upper Boulder River was declining in numbers due to the presence of domestic sheep each summer on the Haystack Grazing Allotment, the objective of this thesis was to describe the seasonal and spatial locations of bighorn sheep and domestic sheep, as well as elk and mountain goats, between November of 1987 and September of 1989. Ungulate locations were identified using aerial surveys between September and May followed by ground observations from June through August. Compilation of this data indicated that interactions might occur between elk and domestic sheep during July and August, between bighorns and mountain goats from September through May, and among bighorns throughout the year. Evidence of domestic sheep use on observed bighorn sheep range was also observed on two occasions. Chi-square analyses revealed that bighorns did not use the Monument and Baboon mountain complexes in proportion to suitable habitat availability during the summer ($P < .05$) and that Monument might be used significantly more during the winter ($P < .05$). People do use the area between Monument and Baboon for recreational activities throughout the year. Paired t-tests indicated that bighorn sheep locations were not dependent on domestic sheep locations ($P > .50$). In conclusion, domestic sheep are only one of many factors along the upper Boulder that might affect bighorn sheep numbers. A more detailed study would be needed to determine the relative importance of these observations.

INTRODUCTION

The headwaters of the Boulder River, a tributary of Montana's Yellowstone River, are historic Rocky Mountain bighorn sheep (Ovis canadensis canadensis Shaw) range. In spite of gold mining activity around the turn of the century, this area has remained virtually undeveloped. Approximately half of the watershed lies within the Absaroka - Beartooth Wilderness while the remaining portions are other national forest lands administered by the Big Timber District of the Gallatin National Forest. Remoteness and immediate proximity to Yellowstone National Park mean that the upper Boulder has the potential for being very important wildlife habitat. Wildlife diversity, the opportunity for primitive recreation, and rugged mountain scenery combine to make this area attractive for backpacking, horseback camping trips, hunting, fishing, and snowmobile excursions.

In addition to recreational use, Baboon Mountain, the Independence - Monument Peak complex, and adjacent areas along the upper forks of the Boulder River are used for summer range by domestic sheep (Ovis aries) as part of the Haystack domestic sheep Allotment. Although Forest Service records indicate that as many as 2000 sheep may have grazed these portions of the upper Boulder earlier this century, the permitted numbers have been reduced over the years. Following

non-use in the late 1970's, the allowable number of domestic sheep was set and has been maintained at 640 ewe/lamb pairs. In the early 1980's, following the reinstatement of permitted domestic sheep use, there were reports of fewer bighorns in the area. This alleged decline concerned local camping and hunting outfitters, wildlife enthusiasts, and the Forest Service. Bighorn numbers from aerial winter range surveys conducted by Montana Department of Fish, Wildlife, and Parks personnel also suggested that the resident bighorn population might be declining (Figure 1).

Some interested parties contended that the recorded high bighorn populations came during a brief period when there was no grazing by domestic sheep. However, this relationship could not be justified by the existing data base because the records on bighorn population levels and distributions within the upper Boulder were scanty and were developed from sightings by sheepherders and hunters or sporadic flights. The situation is complicated further by the lack of information on bighorn population levels during the years when domestic sheep numbers exceeded 1000. In effect, the information base on the surviving bighorns was insufficient to determine much about the effect of domestic sheep on the resident bighorn population.

In 1987, representatives of the Montana Woolgrowers Association approached the Animal and Range Sciences Department of Montana State University about the possibility

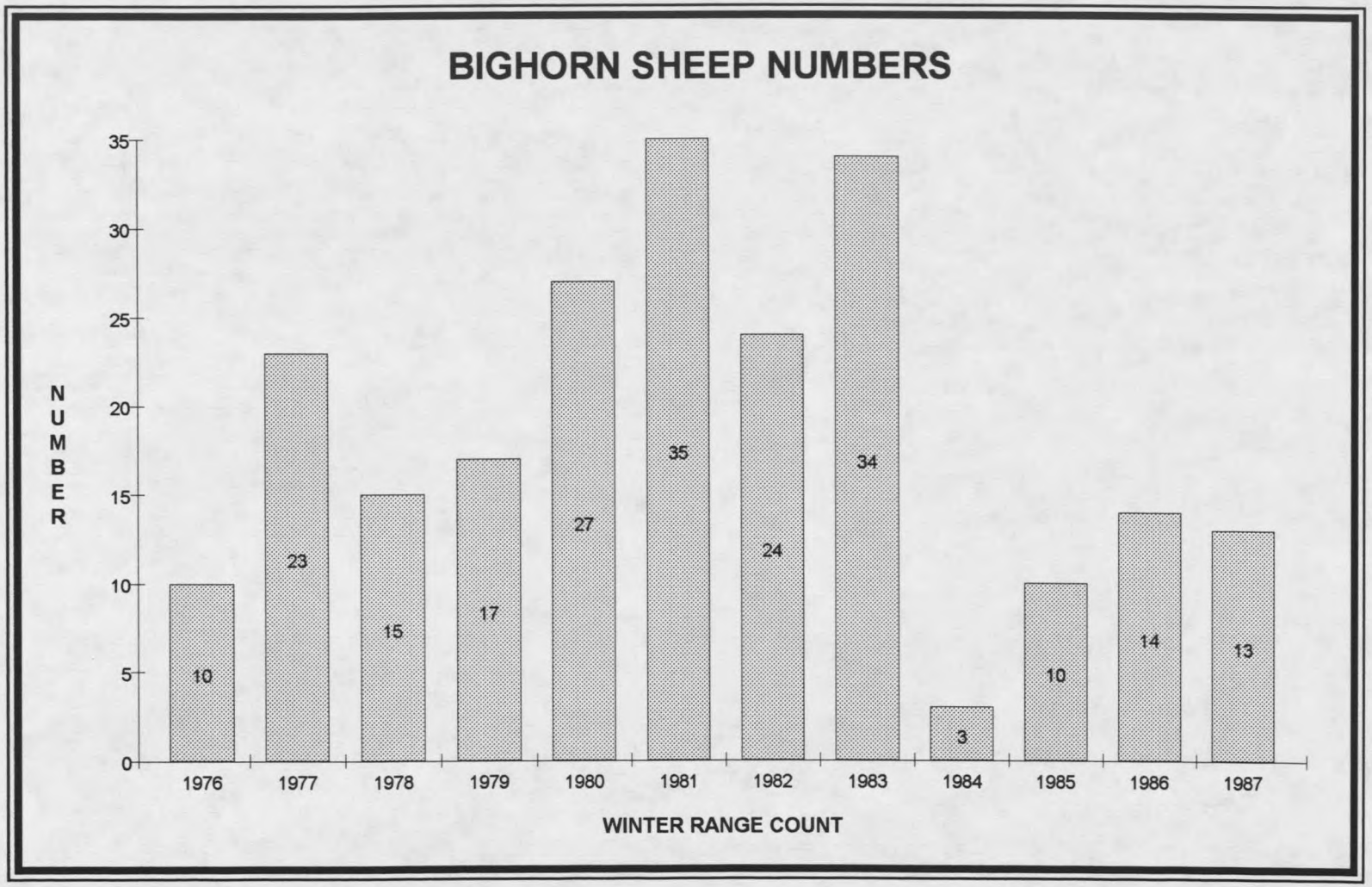

Figure 1. Annual Monument Peak bighorn sheep winter range aerial census, Montana Department of Fish, Wildlife, and Parks, 1976-1987.

of a cooperative research effort into the reported bighorn - domestic sheep conflict on the Haystack Grazing Allotment. This prompted an initial site visit in early August (1987) by Dr. Clayton B. Marlow, along with the permittee and representatives from the Big Timber Ranger District, Montana Woolgrowers Association, Montana Department of Fish, Wildlife, and Parks, and Montana Farmer-Stockman. Their subsequent observations and discussions revealed the possibility of at least two other factors that might be affecting bighorns: displacement attributed to snowmobile recreation and competition with Rocky Mountain goats (Oreamnos americanus americanus Blainville). Following this site visit, a cooperative research agreement was developed between the Montana Woolgrowers, the Montana Agricultural Experiment Station, and the Big Timber Ranger District. The intent of this partnership was to stage a thorough, unbiased investigation into the possible relationship between the domestic sheep grazing under a Forest Service permit and the observed variation in bighorn numbers.

Although the fluctuation in bighorn numbers may have been due to disease, Montana Fish, Wildlife, and Parks biologists recommended that the issue of competition be addressed first. They reasoned that if the occurrence and extent of competition could be verified, then trauma induced mortality resulting from the need to capture the surviving bighorns to obtain blood and nasal discharge samples might be avoided.

In addition, seasonal forage availability may be critical to bighorn survival because of reports that the upper Boulder population uses some of the same areas year long. The possibility of predation by coyotes (Canus latrans latrans Say) was also mentioned.

Since there was little information on movement patterns and preferred habitats for this bighorn population, the first objective in testing the potential for competition was to identify seasonal habitat use patterns of bighorns, mountain goats, and domestic sheep. Habitat features and forage availability levels within possible seasonal ranges were to be recorded. This data would then be transferred to a common base map to determine potential overlapping use patterns by the various wild and domestic grazers.

With the Storm Creek and Hellroaring fires raging out of control nearby, a portion of the forest that included the study area was closed to the public in mid-August of 1988. This complicated the study as we were not permitted to return until the fires were extinguished, which was early October of 1988. No funds were available for a 1989 summer field season.

The objective for this thesis is to use the 1987, 1988, and 1989 aerial surveys and 1988 ground observations to describe the seasonal and spatial locations of bighorn sheep, elk (Cervus elaphus nelsoni Bailey), Rocky Mountain goats, and domestic sheep along the upper forks of the Boulder River. Attention was directed towards areas of adjacent or

overlapping use, particularly on suitable bighorn sheep habitat, to evaluate the potential for forage competition among the various large herbivores. The accumulation of bighorn sheep locations was compared with suitable habitat availability to determine if bighorns might be selecting or avoiding portions of the study area. Bighorn and domestic sheep distributions were also compared to determine if domestic sheep distribution could have influenced bighorn spatial use. Evidence of other potentially limiting factors, such as predation and human disturbance, was recorded.

LITERATURE REVIEW

Bighorn sheep were numerous and widely distributed across western North America until the late 1800's (Geist 1971). Since that time, many researchers contend that there has been a general decline in wild sheep populations (Marsh 1938, Buechner 1960, Stelfox 1971, Goodson 1982). Competition with livestock for forage on seasonal ranges, disease transmission from domestic sheep, and indiscriminate hunting have been implicated as the principle causes of these declines (Cowan 1940, Buechner 1960, Foreyt and Jessup 1982). Disease relationships and hunter induced mortality were not addressed in this study. However, other extrinsic factors which might contribute to fluctuations in bighorn populations were considered. Competition for available forage among bighorns (Wishart 1978) and with other populations of wild grazing ungulates, particularly mountain goats (Dailey et. al. 1984) and elk (Constan 1972), can limit the carrying capacity of bighorn occupied ranges. Spatial distribution may be influenced by the presence of domestic sheep (Thilenius 1975), mountain goats (Reed 1986), or elk (Goodson 1978). While human disturbance (Hicks and Elder 1979) and predation (Post 1971) can certainly effect the stability of bighorn populations, the various forms of competition may have the greatest long term impact.

Competition occurs when different organisms seek a common, limited resource. Interspecific competition occurs among two or more species and intraspecific among two or more individuals of the same species (Smith 1980). Either form of competition can be further described as exploitative or interference (Miller 1967). Exploitative competition refers to the effectiveness of competitors to utilize a common resource. Interference competition occurs when one competitor either directly or indirectly denies or limits another competitor access to a resource. Selection of identical forages by two different ungulates is an example of exploitative competition. The presence or activity of one species or individual that results in the displacement of another from suitable habitat that would otherwise be occupied is a form of interference.

The occurrence and degree of forage competition can be ascertained by examining the following components: (1) overlaps in distribution, (2) sympatric habitat use, (3) similarities in food habits, and (4) extent to which mutually-used forages limit the productivity of at least one species (McCollough et. al. 1980). Assessing interference would involve a comparison of observed differences in distribution or habitat use which could be attributed to the presence or activities of potential competitors (Miller 1967). Either form of competition could impact bighorn sheep habitat selection and distribution patterns.

Bighorn sheep seasonal distribution patterns are dominated by a predator-evasion strategy made apparent by their tendency to select high visibility habitats with forage in close proximity to escape cover (Geist 1971, Shannon et. al. 1975, Risenhoover and Bailey 1980, Fairbanks et. al. 1987). While both rams and ewes may exhibit strong fidelity to several seasonal home ranges (Geist 1971, Becker et. al. 1978), precipitous, rocky terrain is probably the predominant habitat feature selected by mountain sheep in all seasons (Tilton and Willard 1982, Risenhoover and Bailey 1985, Cooperrider et. al. 1986, Wakelyn 1987). The onset of winter causes migration to either lower elevation ranges or to portions of their summer habitats where favorable aspect and wind can minimize snow accumulation (Geist 1971, Berger 1979).

Bighorn populations inhabiting interior mountain ranges often do not have the option of migrating to lower elevation winter ranges that satisfy their habitat requirements. Instead, they implement behavioral adaptations to avoid deep or crusting snow (Stelfox 1975). When snow depth or hardness impairs foraging on open, grass covered slopes, they move up to windswept ridges (Shannon et. al. 1975, Schuerholz 1984) and prefer southerly exposures (Hudson et. al. 1976, Tilton and Willard 1982). Cliffs may be used in late winter (Geist 1971) when the effects of wind and sun enhance forage availability. Consequently, competition may be for landscape features as well as foraging opportunities.

While the selectivity of bighorns indicates that plant phenology is important in determining habitat use patterns (Hobbs et. al. 1983, Schuerholz 1984, Goodson and Stevens 1988), the influence of the bighorn predator-evasion strategy dictates that dietary intake may be predicated by forage availability rather than quality (Cooperrider et. al. 1980, Adams et. al. 1982, Festa-Bianchet 1988). Like other grazing ungulates, bighorns will select actively growing plants and plant-parts in early stages of phenological development (Johnson and Smith 1980, Cooperrider and Hansen 1982, Cooperrider et. al. 1986), which correlates to the most palatable, nutritious forage available. Consequently, forbs generally make their greatest contribution to bighorn diets during spring and summer (Andryk and Irby 1986, Brown and Yde 1988) and may be preferred (Pitt and Wikeem 1978, Cooperrider et. al. 1980, Johnson and Smith 1980).

Many researchers concur that graminoids dominate the diets of the northern races of bighorns in all seasons due to their greater year-round availability on alpine and subalpine rangelands (Capp 1967, Todd 1972, Stelfox 1975, Wishart 1978, Schuerholz 1984, Andryk and Irby 1986, Brown and Yde 1988). Browse is generally recognized as an important winter range forage (Shallenberger 1966, Stelfox 1975, Keating et. al. 1985). However, there are inconsistencies in the literature. Hobbs et. al. (1983) reported that forbs were the major component of bighorn winter diets. Shrubs have been

identified as important summer forage (Rominger et. al. 1988), and not necessarily in proportion to availability (Cooperrider and Hansen 1982). Summarizing the available literature leads one to conclude that bighorn food habits vary from season to season, year to year, and site to site. It appears that they are selective grazers as long as preferred forages are snow-free and abundant proximal to escape cover. They become opportunistic under heavy snow conditions and when forage close to escape terrain is less than optimal.

Domestic sheep exhibit food habits similar to those of bighorn sheep and are capable of exploiting steep, high elevation rangelands (Bowns 1971, Goodson 1982). Like their wild cousins, domestics are selective (Weir and Torell 1959) yet opportunistic (Cook et. al. 1965). Much evidence exists supporting domestic sheep preferences for grasses, sedges, and forbs on higher elevation spring and summer ranges (Stevens 1966, MacCracken and Hansen 1981, Thilenius and Brown 1987). The relative amounts of graminoids and forbs in their diet varies with location, with the tendency being to consume more forbs subject to availability (Pickford and Reid 1943, Schwartz and Nagy 1976). Some studies have demonstrated the importance of shrubs as summer forage for domestic sheep (Smith and Julander 1953, Jensen et. al. 1972).

The distribution of domestic sheep on public summer range depends to a great extent on the experience and willingness of the herder to follow the recommended grazing schedule imposed

by the corresponding administrative agency (Thilenius and Brown 1987). The similarities in diet suggest that any lapse from the predetermined grazing plan could perpetuate interspecific competition for available forages between domestic and wild sheep.

While individual bighorns (almost exclusively males) have been observed to associate with domestic sheep, social avoidance is the rule (Thilenius 1975, Goodson 1982). This could lead to the displacement of bighorns from any one of their home ranges or discourage them from occupying suitable habitats. Stevens (1982) reported that historic bighorn ranges were not recolonized following the removal of domestics, even after forage was available. Skiba and Schmidt (1982) hypothesized that dispersal patterns are genetically controlled. They contended that competition with livestock limited bighorn movements at a critical stage of range establishment and facilitated inbreeding. After the livestock were removed, bighorns did not disperse into the vacated suitable habitat. However, others have reported that bighorns will expand their range into areas previously used by domestic sheep (Bear and Jones 1973, Thilenius 1975).

While mountain goats prefer habitats resembling those considered ideal by bighorns, they tend to make greater use of cliff topography (Rideout 1978, Smith and Raedeke 1982). Since high visibility is not a requirement (Adams et. al. 1982), some mountain goat populations inhabit heavily forested

habitats (Smith 1982). Desirable habitat is generally a function of forage availability, escape terrain, and thermoregulatory opportunities within the landscape during summer (Michalovic 1984) and winter (Fox 1983). Summer movement patterns correspond to melting snow and green-up of vegetation (Adams et. al. 1982). Ranges are constricted in the winter and increasing snow depth may cause movement to either lower or higher elevations (Lentfer 1955, Adams and Bailey 1980, Fox et. al. 1989). South-facing aspects (Brandborg 1955) and windswept ridges (Hjeljord 1973, Cooperrider et. al. 1986) are preferred at the higher elevations. Female and nursery groups tend to be oriented towards the more optimal habitats while males and male groups occupy the more marginal range (Michalovic 1984).

Mountain goats have general food habits, apparently due to their relatively narrow habitat preferences (Geist 1971). Graminoids (Hibbs 1966, Johnson et. al. 1978), forbs (Hjeljord 1973), and shrubs (Casebeer 1948) have all been reported as primary summer forages. The winter diet appears even more variable. Dailey et. al. (1984) found that goats ate more shrubs and forbs than grass throughout winter. Saunders (1955) and Hibbs (1967) reported graminoids as important winter forage. Peck (1972) indicated that shrubs were the major component of winter diets. Fox and Smith (1988) stated that when preferred forage is limited due to heavy snow, goats rely on the most abundant plants available, including

conifers, ferns, lichens, and mosses. One might speculate that their plastic food habits and demonstrated ability to forage successfully in deeper snow (Adams 1981) could potentially transcend any competitive advantage sympatrically occurring bighorns may have over mountain goats. Interspecific social contacts may complicate this level of competition. Reed (1986) observed that nearly half (41%) of all direct interactions between bighorns and goats resulted in the displacement of the bighorns.

Interference or exploitative competition could also occur if elk are present on bighorn ranges. Elk tend to migrate to higher elevation grasslands in the spring and early summer in search of lush, green forage (Murie 1951). Seclusion is important, made evident by their selection of summer range away from human activity (Grover and Thompson 1986). They prefer smaller openings (Lyon and Jensen 1980), especially in late summer due to the decreased palatability of forage in larger, open areas (Edge et. al. 1988). Like many northern bighorn populations, elk prefer graminoids and forbs throughout spring and summer (Pickford and Reid 1943, Morris and Schwartz 1957, Stevens 1966, Constan 1972, Edge et. al. 1988), and into autumn (Kufeld 1973). Elk have also been observed to displace bighorns from summer ranges above tree line (Goodson 1978).

Investigations into intraspecific competition among bighorn sheep appear quite limited. Constan (1972) and

Wishart (1978) imply that intraspecific competition can be a concern when bighorns occupy only a small portion of their available habitat. Bighorn lambs learn traditional migration routes from older ewes and rams so the loss of mature, experienced individuals could alter traditional movement patterns and perpetuate intraspecific competition among bighorns. Low status individuals and juveniles may be forced onto poor quality ranges as well (Van Horne 1983).

Bighorn sheep have been known to habituate to human activity (Geist 1971, Stelfox 1975) and may tolerate controlled human visitation (Hicks and Elder 1979). However, there are recorded incidents of passive human disturbance affecting bighorns. Several researchers have observed bighorns altering behavior patterns in the presence of humans. Packard (1946) noted that bighorns vacated suitable habitat because they were annoyed by camera enthusiasts. Horejsi (1976) and Stevens (1982) reported that parts of traditional ranges were abandoned when human recreation interrupted bighorn activity and distribution patterns. Leslie and Douglas (1980) believe disturbances near critical resources, such as watering sites, may amplify behavioral response patterns. Distance from human disturbance (Etchberger et. al. 1989), herd size (Hicks and Elder 1979), and elevational position of approaching humans (MacArthur et. al. 1982) are also important in determining the reactions of bighorns to the presence of people. However, the threat of predation probably

alters bighorn sheep behavior patterns to a greater extent, as evidenced by their apparent evolutionary predator-evasion strategy relating to habitat selection (Adams et. al. 1982).

Coyotes are one of many predators with the ability to pursue and capture bighorn sheep (Post 1971), and are among the most opportunistic predators (Toweill and Anthony 1988). They may consume carrion (Grater 1943) or change their diet as different prey species become more vulnerable (Gese et. al. 1988), making adult ungulates more susceptible when snow is deep. However, indirect effects can be just as significant as an actual incidence of predation. Foraging behavior may be influenced when the threat of predation prevents bighorns from grazing the choicest ranges (Festa-Bianchet 1988). Bighorn ewes in groups of ten or less appear to exhibit a decreased foraging efficiency because they spend more time alert for predators and less time foraging than bighorns in larger groups (Risenhoover and Bailey 1985). Smaller nursery bands tend to select more precipitous escape cover and do not range as far from escape terrain (Gionfriddo and Krausman 1986), which means forage selection would be limited to available instead of preferred plants. The presence of canids has also been associated with increased heart rates, indicating a higher level of stress (MacArthur et. al. 1982).

Habitat loss may be the most serious threat to bighorn sheep (Wakelyn 1987) because survival is uncertain without spatial and habitat resources (Wilcox and Murphy 1985). While

loss of habitat resulting from agricultural, industrial, and recreational development has been well documented (Buechner 1960, Bear and Jones 1973, Campbell and Remington 1981), recent work indicates that the encroachment of tall, dense shrubland and forest can result in the fragmentation and reduction of high-visibility habitats used by bighorn sheep in some areas (Wakelyn 1987).

STUDY AREA

General Description

The study area is located approximately 80 km (50 mi) south of Big Timber, Montana, and 19 km (12 mi) north of the Montana - Wyoming state boundary (Figure 2), near the head of the Boulder River. The entire 6634 ha (16392 ac) study area can be found on the 1987 edition of the USGS Haystack Peak quadrangle 7.5-minute series topographical map.

Physiographically, the study area can be subdivided into three distinct mountain complexes. The Baboon Mountain complex (Figure 3) marks the northern limit of the study area and is near the confluence of the East Fork and Main Boulder Rivers. Lying to the south, respectively, are the Monument and Sheepherder Peak complexes (Figure 4). Independence and Haystack Peaks are included in the Monument Peak complex. Baboon and Monument form the divide separating the East Fork and Main Boulder rivers while the north facing cirque basins of Sheepherder serve as the rivers' headwaters.

The topography of the area is diverse, ranging from gently sloped, meandering stream bottoms to high plateaus. Near-vertical cliffs and steep talus slides characterize the northern and western faces of each complex. Convex and concave shaped grassy slopes adjacent to rock outcrops typify the southern and eastern aspects. Elevations increase from 2280m (7478 ft) along the lower East Fork of the Boulder to

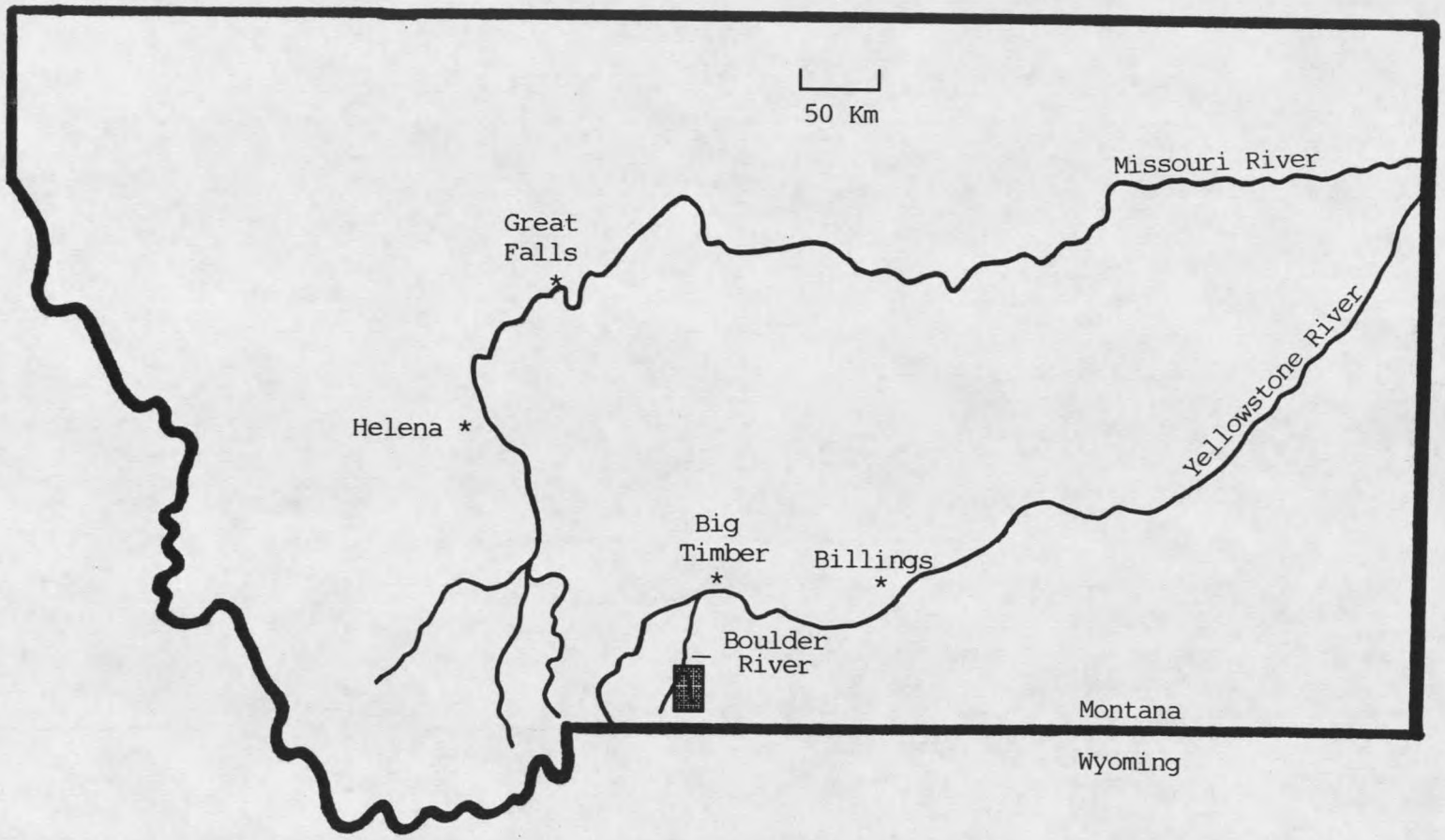

Figure 2. Location of the study area relative to the state of Montana.