1989

Status and population dynamics of mountain goats in the Snake River Range Idaho

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STATUS AND POPULATION DYNAMICS

OF MOUNTAIN GOATS

IN THE SNAKE RIVER RANGE, IDAHO

by

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B.S. Penn State University, 1979

Presented in partial fulfillment of the

requirements for the degree of

Master of Science

University of Montana

1989

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June 12, 1989

Date

ABSTRACT

Hayden, James A., M.S., Spring 1989 Wildlife Biology

Status and population dynamics of mountain goats in the Snake River Range, Idaho (147 pp.).

Director: B. W. O'Gara

An introduced population of mountain goats (Oreamnos americanus) was studied between April 1982 and August 1983. Introductions occurred from 1969-1971, resulting in a population estimated at 141 goats by July 1983. Modeling suggested growth through 1983 was not affected substantially by density-dependence. This population continued to grow rapidly during the study, but density-dependent changes in the growth rate appeared imminent. A low proportion of kids in 1982, following an extremely severe winter, may have resulted from a density-dependent decrease in survival that year. The observed rate of growth ($\bar{r}$) from 1971 to 1983 was 0.22. Reproduction was high during the study, with 114 kids per 100 females 3 years of age or older. Twinning was common, with 29% of mature females observed with twins. Eighty-six percent of mature females were observed with at least 1 kid. The survival rate was estimated to be 92-94% for the population from July 1982 to July 1983. Observed kid survival was 88%, yearling survival was 95% and average sub-adult/adult survival was 93%. Palisades Creek and Big Elk Creek drainages contained the only 2 concentrations of goats during winter. During summer most goats were found at high elevations immediately adjcent to the winter ranges. Yearlong densities were high ranging from 3 to 16 goats/mi^2 (8 to 27 goats/km^2). Minor movement was detected during summer to other portions of the Snake River Range, and to the Teton Range.

ACKNOWLEDGEMENTS

I am grateful to Dr. Bart O'Gara, Chairman, and Drs. Joe Ball and Don Bedunah, my graduate committee, for their guidance. It has been 7 years since I came to them with vague ideas of what I wanted to study, and how. I thank them not only for their advice, but also for their patience in seeing me to the completion of this thesis.

Three individuals were key in bringing this project from suggestion to conception. In addition to serving as chairman of my committee, Dr. O'Gara, through his role as the Leader of the Montana Cooperative Wildlife Research Unit, provided me an office, computer space, and miscellaneous equipment and was instrumental in obtaining a teaching assistantship at the University of Montana. Tracey Trent, as Wildlife Manager for the Idaho Falls Region of the Idaho Department of Fish and Game, provided a truck, helicopter and fixed-wing survey funding, miscellaneous equipment, and financial support for fecal analysis. I thank him not only for this support, but also for helping to give me direction for the study. Michael Whitfield, then the Idaho Falls District Biologist for Targhee National Forest, was instrumental in providing housing and utilities, maps, and use of horses. As importantly, Michael provided me with a sounding board and a friendship that contributed much to the success of this endeavor. Unknowingly, he also provided me with a tremendous amount of "long-term" help. Concurrent with this project, we put together a spin-off project on mountain goat activity budgets. During 1983, Mike enlisted the help of several volunteers. One of these was Vicki Criddle, now Vicki Hayden, my wife. I'd like to thank Michael, therefore, for this lasting support.

Vicki has contributed to this project both through her help in the field and in her encouragement for me to finish my writing. She helped support me both financially and emotionally during this time, and I thank her greatly for all her time, effort, and patience.

Interactions with other graduate students, and the ensuing camaraderie, are an important part of the graduate learning process. I was fortunate to school with an excellent and diverse group. I would especially like to thank John Grant, Mark Haroldsen, Rich Harris, Rick Mace, and Randy Matchett for those many mid-day and late-night sessions.

Thanks are also due Dr. Lee Metzgar, at the University of Montana, who provided much needed help in understanding the population dynamics of big game, and in modeling of this mountain goat population. Research grants from the National Rifle Association, and the Mazamas organization were essential to this work, and are gratefully acknowledged.

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INTRODUCTION

Mountain goats (Oreamnos americanus) historically were distributed from Alaska and the Yukon south to the Snake River Plain of Idaho. Since the early 1970's, the distribution of the mountain goat has been extended to Oregon, Wyoming, South Dakota, Utah, Colorado, and Nevada (Johnson 1977). Transplants have been used to augment native populations, and to initiate populations on islands of apparently suitable, but vacant, habitat within the historic range.

Through 1987, a total of 55 mountain goats had been released at 3 locations in Idaho to establish new populations. All 3 have been successful. These locations include north of Lake Pend Oreille in northern Idaho (releases made 1960, 1968), in the Seven Devils Range of western Idaho (1962, 1974), and the Snake River Range in southeastern Idaho (1969-1971). This study focuses on the population in the Snake River Range.

The Snake River Range, located on the Idaho/Wyoming border, abuts the more rugged Teton Range to the northeast. Skinner (1926) specifically described the Teton Range as an area for which there was no conclusive evidence for the prior existence of mountain goats. There are no records of mountain goats in other adjacent ranges (Roby, pers. comm. 1982). Suitable mountain goat habitat in the Snake River Range is isolated by more than 100 miles (160 km) of desert and dry plains from the southernmost native population of goats, in the Lemhi Range of central Idaho.

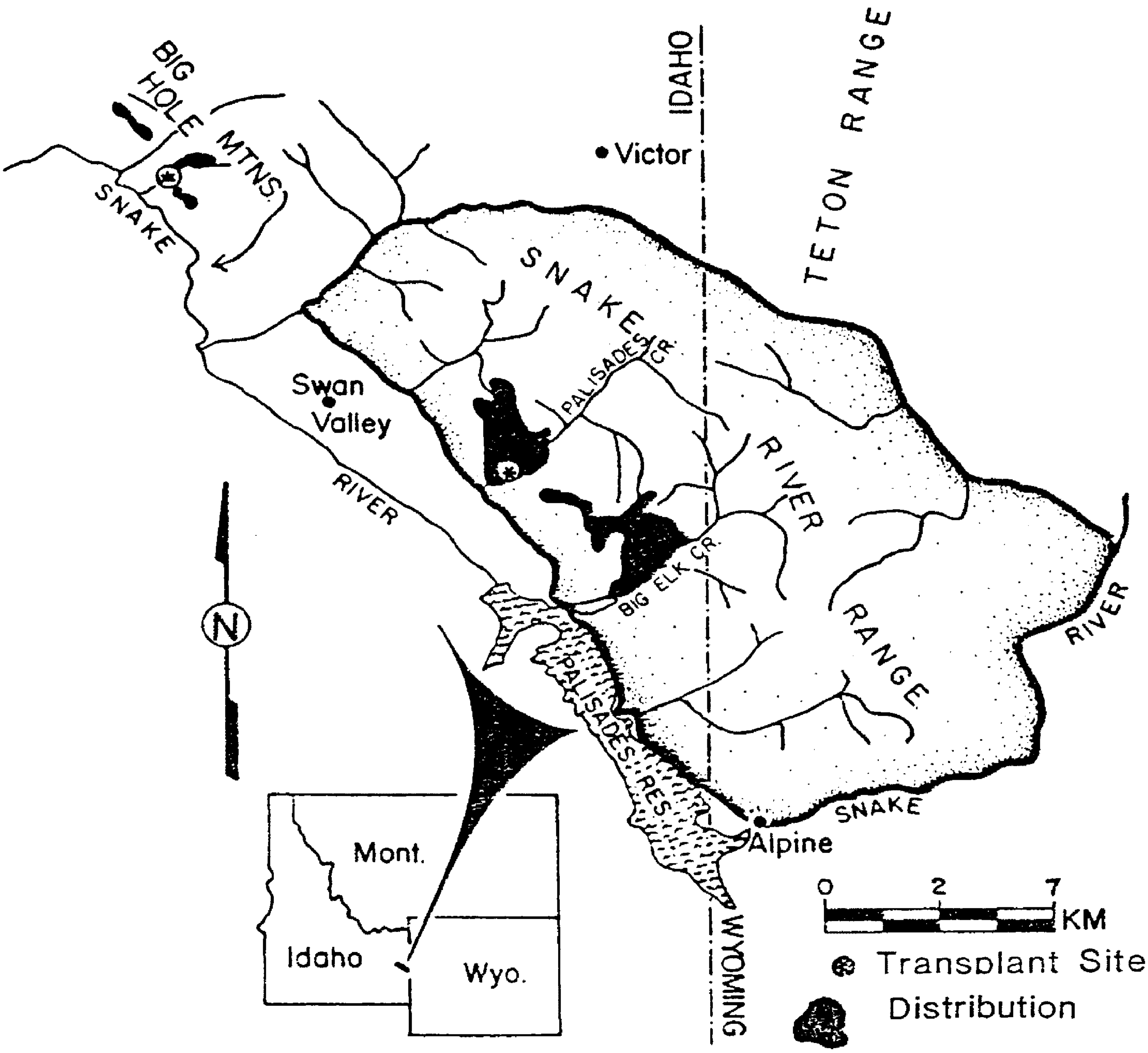
Although the Snake River Range did not historically contain mountain goats, Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*) were historically present, and still exist, in the Teton Range. Concurrent with heavy domestic sheep grazing in the late 1800's and early 1900's, the bighorn sheep population of the Snake River Range dwindled. By the 1950's only scattered sightings of individual sheep were recorded (Whitfield, pers. comm. 1982). Only 4 bighorn sheep have been observed in the Snake River Range since 1975. Two mature rams wintered at the mouth of Palisades Creek during winter 1977-78 (Jones, pers. comm., 1982), and a ewe with a lamb was observed during late summer 1982 near Alpine, Wyoming (Roby, pers. comm. 1982). These 4 sheep apparently dispersed from the Teton Range population 8 to 20 miles (13 to 32 km) to the northeast.

During early July 1969, the Idaho Department of Fish and Game initiated a mountain goat population in the Snake River Range. From 1969 through 1971, 5 female and 7 male goats were transplanted to 2 sites in the Snake River Range (Table 1, Fig. 1). Neither site was surveyed from the air to evaluate success of the transplant prior to this study. Ground observations by Idaho Conservation Officers Ken Neilson and Lynn Merrill in the late 1970's and early 1980's indicated the introductions were successful, but the extent of the success was unknown. By 1981, however, it appeared that the Snake River Range population had grown substantially, and could be at a harvestable level.

Table 1. Composition of mountain goat transplants into the Snake River Range and Big Hole Mountains, Idaho.

Date	#Gts.	Composition	Source Population	Destination
July 1969	5	2 females, 1 male (age unknown)	Snow Peak, ID	Palisades Creek (Snake River Range)
		1 male, 1 female (age unknown)	Black Mtn., ID	
July 1970	3	3 yearling males	Black Mtn., ID	Black Canyon (Big Hole Mts.)
July 1971	4	Adult female, Adult female with male kid, yearling male	Black Mtn., ID	Black Canyon (Big Hole Mts.)

Figure 1. Map of the Snake River Range study area, including transplant sites and areas of current distribution (1982-1983).


BIG HOLE MTNS.
SNAKE
IDAHO
Victor
TETON RANGE
SNAKE RIVER RANGE
PALISADES CR.
Swan Valley
RIVER
BIG ELK CR.
PALISADES RES.
RIVER
SNAKE
Alpine
N
Mont.
Idaho
Wyo.
WYOMING
0 2 7
KM
Transplant Site
Distribution

I initiated this study during fall 1981 to assess the current status and basic ecology of goats in the Snake River Range. Field work was primarily conducted from March through December 1982, and from June through September 1983. The population was also surveyed periodically between these 2 primary field seasons. Study objectives were to:

1. estimate the present size, population structure, and population dynamics of these goats;
2. determine their present distribution and use of seasonal ranges;
3. describe the winter range;
4. identify nearby vacant winter habitat; and,
5. recommend population management guidelines.

STUDY AREA

Location and Ownership

The study area included all of the Snake River Range (Fig. 1), which runs from northwest to southeast and spans the Idaho/Wyoming border. About 425 mi^2 (1,100 km^2), it is bounded on the southeast and southwest by the Snake River, on the northwest by Idaho Route 31, and on the northeast by Idaho Route 31 and Wyoming Route 22.

More than 90% of the study area is publicly owned, most of which is administered by the Targhee National Forest. The remaining public land is administered by the Bridger-Teton National Forest. The majority of work took place in Targhee National Forest Management Area 19 (USDA 1985).

Topography

Elevations of the Snake River Range vary from 5,500 to 10,040 feet (1,665 to 3,040 m). The highest 5 peaks in the range average 9,965 feet (3,020 m). Rocky, rugged areas are not extensive. High-elevation cirque basins are generally small, and confined to the southwestern half of the range. Low elevation cliffs are common in the Palisades Creek and Big Elk Creek drainages, but are only scattered elsewhere. Talus slopes, avalanche chutes, and rocky promontories are typical of both high and low elevation areas used by goats. In general, such areas are more common at elevations over 7,500 feet (2,273 m). Northerly-facing slopes are generally steeper than other slopes.

A relatively high-elevation ridge begins at Alpine, Wyoming, on Ferry Peak, connecting to the Teton Range at Teton Pass. From this central axis, several smaller, ridges lead to Bald Mountain, Sheep Creek Peak, Needle Peak, and other higher-elevation areas in the southwestern portion of the study area.

To the west of the Snake River Range lies the smaller Big Hole Mountains, and beyond them, the Snake River Plain, a high-altitude desert. The Caribou Mountains lie to the south, across the Snake River and Palisades Reservoir. In Wyoming, to the south, lie the

Salt River and Wyoming Ranges. To the east lay the Gros Ventre Range, and to the north, the Teton Range, including Grand Teton National Park.

Land Use

Sheep and cattle grazing take place on U.S. Forest Service lands within the study area, but with no concurrent use. Sheep are the primary grazing animal on areas also used by mountain goats. Big game hunting is a primary use of the Snake River Range. Part of the Idaho Department of Fish and Game's Management Unit 67, this area provides one of the few opportunities for backcountry hunting in southeastern Idaho. Hunter density during 1987 averaged $2.8/mi^2$ ($4.5/km^2$) for deer and $1.8/mi^2$ ($2.9/km^2$) for elk, with a harvest of $1.4/mi^2$ ($2.2/km^2$) and $0.3/mi^2$ ($0.5/km^2$), respectively. Logging is minimal in the Snake River Range because of low-quality timber, lack of roads, steep terrain, and fragile soils.

Geology and Soils

The Snake River Range is part of the Overthrust Belt, an area of high potential for oil and gas reserves that stretches from northern Alaska into Mexico. Oil and gas leases, and lease applications cover much of the study area (USDA 1985). Essentially the entire range has been explored by seismic crews from several companies. Three exploratory oil wells have been drilled in the Snake River Range. No announcements of commercially viable strikes have been made (Wright, pers. comm. 1988).

Most of the taller peaks of the Snake River Range are associated with the the very hard Mission Canyon limestone formation. Lodgepole limestone, a slightly softer, older formation is found at lower elevations on Baldy Mountain, providing some shallow caves among the shale-type talus (Wright, unpubl. data).

Soil surveys have been completed in the Palisades Creek drainage only. Soils on the goat winter range are cryorthents--rock outcrops with a Cryochrepts complex. Wright (unpubl. data) described the area as follows:

> "This map unit is on steep to extremely steep mountainside slopes. Parent material is loess and residual bedrock material from limestone and sandstone. The components of this unit are so intricately intermingled that it was not practical to map them separably at the scale used. Slopes are short and steep with rock outcrops commonly forming cliffs. Avalanche chutes are common in the higher elevation. Included in this unit are steep rubble lands and small level benches composed of deep soils."

The summer range on Baldy Mountain is very well defined by the boundaries of the soil type described by Wright as "Rubble land--rock outcrop with Cryorthents undifferentiated." Essentially, it is an area typified by high elevation basins with cirque head walls. Rockfall and talus slopes are frequently dissected by avalanche chutes. Soils are thin.

Vegetation

High elevation portions of the study area typically had only small, scattered pockets of Engelman spruce (Picea engelmanni), subalpine fir (Abies lasiocarpa), or limber pine (Pinus flexilis). On northerly slopes, spirea (Spirea spp.) and currant (Ribes spp.) were found. High elevation meadows commonly included mint (Mentha spp.), aster (Aster spp.), pontentilla (Potentilla spp.), fescue (Festuca idahoensis), mountain brome (Bromus carinatus), alpine timothy (Phleum alpinum), alpine bluegrass (Poa alpina), and sedge (Carex spp.). Springbeauty (Claytonia lanceolata) was abundant during spring and below snowdrifts through early summer.

Overstory at lower elevations consisted largely of lodgepole pine (Pinus contorta), with Douglas-fir (Pseudotsuga menziesii) on slopes with deeper soils, and in avalanche chutes. Mountain brush was abundant. Principal species included curl-leaf mahogany (Cercocarpus ledifolius), Rocky Mountain juniper (Juniperus scopulorum), juniper (J. osteoperma), common juniper (J. communis), chokecherry (Prunus virginiana), Rocky Mountain maple (Acer glabrum), big tooth maple (A. grandidentatum), mountain snowbrush (Ceanothus velutinus), ninebark

(*Physocarpus malvaceus*), serviceberry (*Amalanchier alnifolia*), huckleberry (*Vaccinium* spp.), mountain sagebrush (*Artemesia tridentata vaseyana*), and bitterbrush (*Purshia tridentata*). Common understory species included arrowleaf balsamroot (*Balsamorhiza sagittata*), mule's ears (*Wyethia amplexicaulis*), Heart-leaf arnica (*Arnica cordifolia*), Oregon grape (*Berberis berberis*), yarrow (*Achillea lanulosa*), bluebunch wheatgrass (*Agropyrum spicatum*), mountain brome and pinegrass (*Calamagrostis rubescens*).

Generally, south-facing slopes consisted of dry, open meadows with little coniferous overstory. Curl-leaf mahogany and juniper provided considerable overhead canopy at lower elevations. Most northerly slopes were forested.

Climate

Weather data have been recorded daily since 1957 at the Palisades dam site, at the base of the range. Mean annual temperature, 1957-1986, was 48.5^{o}F (9.2^{o}C). January is the coldest month, with a mean temperature of 20.8^{o}F (-6.2^{o}C). The warmest month is August, with a mean temperature of 68.5^{o}F (20.3^{o}C). The comparison of the median daily temperature to 65^{o} F is used to provide a general index of climate by the National Weather Service. For example, a median temperature for 1 January might be 19^{o}, which would give a value of 46 heating degree days (65-46). Median temperatures below 65^{o} yield units of heating degree days. Median temperatures above 65^{o} are known as cooling degree days. Annually, there are an average of 231 cooling degree days, and 8,021 heating degree days at the Palisades dam site. The growing season in Driggs, 8 miles (13 km) north of the study area, was 68 days for plants having a 32°F (0°C) threshold. Prevailing winds were from the southwest.

Mean annual precipitation was 19.6 inches (49.7 cm). January and June had the most precipitation, with 21% of the year's total. February and March were the driest months.

METHODS

FIELD AND LAB TECHNIQUES

Census Techniques

The Palisades and Big Elk Creek areas were surveyed about once every 3 weeks between 27 March and 15 September 1982, and between 18 June and 15 August 1983. An additional survey of both areas was made during March 1983. When a group of goats was sighted, I marked their location and age/sex composition on a 7.5 minute topographic map. The time, weather, and general behavior of the group, age/sex composition of the group, and incidental observations were recorded. Standard routes were followed during each survey, although minor deviations were necessary to assist in classification.

During this study, 138 surveys produced 2,209 mountain goat locations. Many partial drainage surveys were made. Twenty complete surveys were made of the Palisades Creek drainage, and 3 complete surveys were made in the Big Elk Creek drainage. The 949 locations from complete drainage surveys are the only data used in analysis unless otherwise noted.

The elevation, aspect, etc. of goats observed during the study should not be strictly interpreted as representative of the population. Goat locations were recorded throughout each day, thus goats observed during a cool summer morning were recorded along with other goats observed, for example, during a mid-afternoon thunderstorm. Further, no observations were made during nighttime, and it is likely that observations of goats in forested cover are not in proportion to their occurrence. Therefore, patterns in observed use of elevation, aspect, group size, group composition, and inter-goat distances indicate only gross, seasonal changes.

Ground Censuses.--Two-year-old goats could only be distinguished from older goats during ground censuses. Goats were located and identified by scanning with 8x30 binoculars and a 15-60x telescope. All drainages in the area were censused during composition counts. Additional attention was given to the Palisades and Big Elk Creek drainages, the 2 major centers of mountain goat activity.

Summer ranges were censused primarily from several prominent observation points, although goats encountered during travel between observation points were also recorded. The Big Elk Creek winter range was censused from the drainage bottom because the cliffs were nearly impassable. The Palisades Creek winter range was surveyed by traveling among the cliffs.

Surveys in the Palisades and Big Elk Creek drainages were conducted almost entirely on foot during both summer and winter. Areas of light goat concentrations were censused during the winter and spring by hiking, cross-country skiing, and to a lesser extent, by snowmobile. During the summer and fall, these areas were primarily censused from ridge tops on horseback, and on foot.

Aerial Censuses.--During 1982, 3 aerial surveys were conducted to help assess seasonal distribution and numbers of goats. A Hiller 12E helicopter with a Soloy conversion was used to survey winter ranges on 10 April and 8 December, 1982, when goats were concentrated on winter or winter/transitional ranges. A Bianca Scout plane was used to survey summer ranges on 21 and 22 July, 1982. A Cessna 182 was used to conduct surveys on 25 June, 20 July, and 21 July 1983.

During the helicopter surveys, drainages were systematically investigated for goats and goat tracks. Each drainage was divided into several segments by sub-drainage. Each segment, typically from 0.5 to 1.0 miles (0.8 to 1.6 km) in length, was flown from top to bottom at contour intervals of approximately 200 feet (61 m). During the April 1982 survey, my second week in the field, I was only able to classify goats as kids or non-kids. During the December 1982 survey, I was also able to distinguish yearlings and the sex of adults from the air.

Because the summer range was so large, and because there was little snow for tracking, the plane surveys were extensive rather than intensive, providing only general information on distribution. All drainages, including low elevation cliffs and winter ranges, were flown from top to bottom. Long, high-altitude ridge tops were flown first, in segments of approximately 1.25 miles (2.0 km). Because of the relief of the area and the reconnaissance nature of the fixed wing flights, drainages associated with each segment were flown at 500 foot (152 m) contour intervals. Narrow drainages were flown by side-slipping and slowly gliding back and forth straight down the drainage. The minimum speed of the plane was 55 miles/hour (88 km/hour), too swift for me to reliably classify goats other than as kids or non-kids.

Identification of Sex and Age

The observation of genitalia was infrequent. Sexes were primarily classified on the basis of horn curvature and basal width (Brandborg 1955, Lentfer 1955). Additional features provide clues for classification: association with a kid, general social behavior, and timing of the molt (Chadwick 1973), and coat color during the rut (Brandborg 1955). I found it difficult to distinguish the sex of yearlings before mid-summer.

When possible, goats were classified as a kid, yearling, 2-year old, or adult. Age groups were assigned on the basis of rostrum length (Smith 1976), as well as on beard and horn length (Brandborg 1955). Body size, social behavior (Chadwick 1973), pantaloon development (Smith 1976), timing of the molt, and coat color during the rut (Brandborg 1955) provided additional clues for assigning ages.

Habitat Analysis of Palisades Creek Winter Range

The presence of cliffs is a key feature among goat winter ranges (Brandborg 1955). Several researchers have noted that critical ranges are selected by mountain goats primarily on the basis of physical characteristics rather than by the vegetative association (Geist 1971, Chadwick 1973, Smith 1976, Kuck 1977). Utilization of these ranges is augmented by the plasticity of goat food habits (Saunders 1954, Hibbs 1967, Hjelford 1973). Therefore, I evaluated winter range habitat on the basis of physical characteristics, and vegetative morphology of the areas immediately surrounding the cliffs, rather than concentrating on vegetative types.

Cliff Evaluation.--Separate winter cliff complexes were identified from aerial photographs, topographic maps, and ground reconnaissance. Each cliff was assigned an identification number and correspondingly coded onto a 7.5 minute topographic map. Criteria used to evaluate cliffs included:

1. Elevation at cliff's top - estimated from the base map.

2. Height - the maximum height of the cliff at any point. Height categories were less than 50 feet, 51-200 feet, 201-400 feet, and over 400 feet (less than 15 m, 16-61 m, 62-122 m, and over 122 m).

3. Length - the maximum length of the cliff across the cliff's face, following the cliff's fall-line orientation. Length categories were less than 100 feet, 101-250 feet, 251-500 feet, and over 500 feet (less than 30 m, 31-62 m, 63-152 m, and over 152 m).

4. Primary exposure - objective evaluation of the cliff's gross exposure relative to one of the 8 compass points (i.e. N, NE, E, etc.).

5. Presence of prominent ledges - the number of abrupt changes in slope toward the horizontal for at least 12 feet (4 m). Categories were 0, 1, 2, and 3+ ledges.

6. Presence of prominent points - the number of major protrusions of at least 40 feet (12 m) away from the basic cliff configuration. Categories were 0, 1, 2, and 3+ prominent points.

7. Presence of caves or overhangs - the number of caves or overhangs at the base of, or on the ledges of, the cliff. These caves or overhangs were defined as any protrusions between 3 and 15 feet (0.9 and 4.6 m) above a roughly horizontal surface, at least

6 feet (1.8 m) long, and at least 3 feet (0.9 m) deep. Categories were 0, 1, 2, and 3+ caves or overhangs.

8. Distance from the canyon mouth - straight line distance from the mouth of the canyon (which also equals the distance to the nearest road) to that point where a perpendicular line would run through the center of the cliff complex.

Cliff Area Evaluation.--The areas above and below each cliff were sampled with 0.1 acre (0.04 ha) circular plots located along a transect approximately 75 feet (22.9 m) from, and parallel to the cliff. Plots were centered every 150 feet (45.7 m) on the transect if the cliff complex was less than 500 feet (152 m) in length or every 300 feet (91.4 m) if the cliff complex was greater than 500 feet (152 m). Criteria used to evaluate these areas included:

1. Nature of the terrain - sidehill, ridge fin, or couloir.

2. Slope - the average slope, in degrees, taken from the center of the plot, both down and up the hill, to the edge of the plot (a distance of 37.2 feet (11.4 m).

3. Exposure - compass reading taken from the center of the plot, perpendicular to the hillside.

4. Percent ground cover - estimated by the step-point method (Evans and Love 1957) within the sample plot.

5. Density of woody vegetation - density of trees and shrubs, by species, in 1 of 5 canopy height categories, including 2 maximum canopy height categories: less than 6 feet and over 6 feet (0-183 cm and over 183 cm), and 3 minimum canopy height categories: less than 3 feet, 3.1-6 feet, and over 6 feet (less than 92 cm, 93-183 cm, and over 183 cm).

6. DBH - the diameter at breast height, 4.5 feet (137 cm), on the uphill side of the tree was taken for all trees over 4 inches (10.2 cm) in diameter.

Food Habits

Mountain goat diets from late winter were examined by the micro-histological analysis of fecal pellets to detect major forage items (Sparks et al. 1968). Analysis was done by the Animal Composition lab at Colorado State University in Fort Collins. Because funding was limited, food habits were analyzed from a composite sample of different pellet-groups collected from the Palisades Creek herd during late winter. The composite sample was composed of 25 pellets from 11 pellet-groups, collected between 9 and 29 April, 1982. Analysis involved 4 slides, with 10 fields evaluated per slide.

Lungworm Infestation

Between 4 April and 28 May, 32 fresh pellet groups were collected from snowbanks to be tested for lungworm (*Protostrongylus* spp.). Three additional samples were collected from bare ground between 29 June and 24 July 1982. The Baerman Technique (Baerman 1917) was used in all analyses, substituting perforated, 7 oz. Solo Cups in a cardboard box for funnels in ring stands. Each sample consisted of 20 pellets, which were suspended between 10 and 12 hours in tap water. After submersion, the liquid was placed in Petri dishes, and examined at 25x magnification with a scanning microscope. Suspicious-looking particles were further examined under 40x magnification.

ANALYTICAL TECHNIQUES

Statistical Analysis

The DECSYSTEM 20 time-sharing computer at the University of Montana was used in data analysis. Basic descriptive statistics and file manipulation were made much easier with use of the 1022 Database Management System program (Jackson 1982). Various SPSS programs (Nie et al. 1975, Hull and Nie 1981) were used for more advanced descriptive statistics and non-parametric analysis of density indices. Habitat data were analyzed with the SYSTAT package (Wilkinson 1986) on the Idaho Department of Fish and Game's Honeywell microcomputer in Pocatello, Idaho.

Delineation of Seasons

The following dates were used to delineate seasons:

Season	Period	Length
Spring	1 April-31 May	2 months
Summer	1 June-15 September	3-1/2 months
Fall	16 September-15 November	2 months
Winter	16 November-31 March	4-1/2 months

The early summer period of 1-15 June was not included in the analysis of grouping, elevation-use, and demographics because of the variability introduced by the kidding season.

Calculation of Demographics

The discrete nature of the Snake River Range population allowed application of the cohort completion method (Smith 1976) to surveys throughout each year. By this method, identifiable age/sex categories are repeatedly counted, and the highest count for any category assumed to be the closest to the true size. The summation of all age/sex categories thereby represents a calculated population size, rather than the largest observed population. The calculated population was assumed to reflect the population immediately following the kidding season. Back-calculation of age/sex categories to previous years provided additional information. All demographics reported are taken from the calculated populations resulting from the cohort completion method. A basic assumption behind this method is that goats are properly classified, and the classification to each category is equally reliable. Although this method does not assume equal observability between age/sex categories, it does assume that differences in observability are not extremely disparate.

Calculation of Population Parameters

The observed rate of increase ($\bar{r}$) for the population was estimated according to the following formula (Caughley 1977):

$$\bar{r} = \frac{\ln (N_t/N_o)}{t}$$

Where, $\bar{r}$ = estimate of the observed, expotential rate of increase,

N_t = population size at time t and;

N_o = population size at time zero;

Population birth and death rates were calculated for each segment of the population from the composite population for 1 July of each year (following the kidding season).

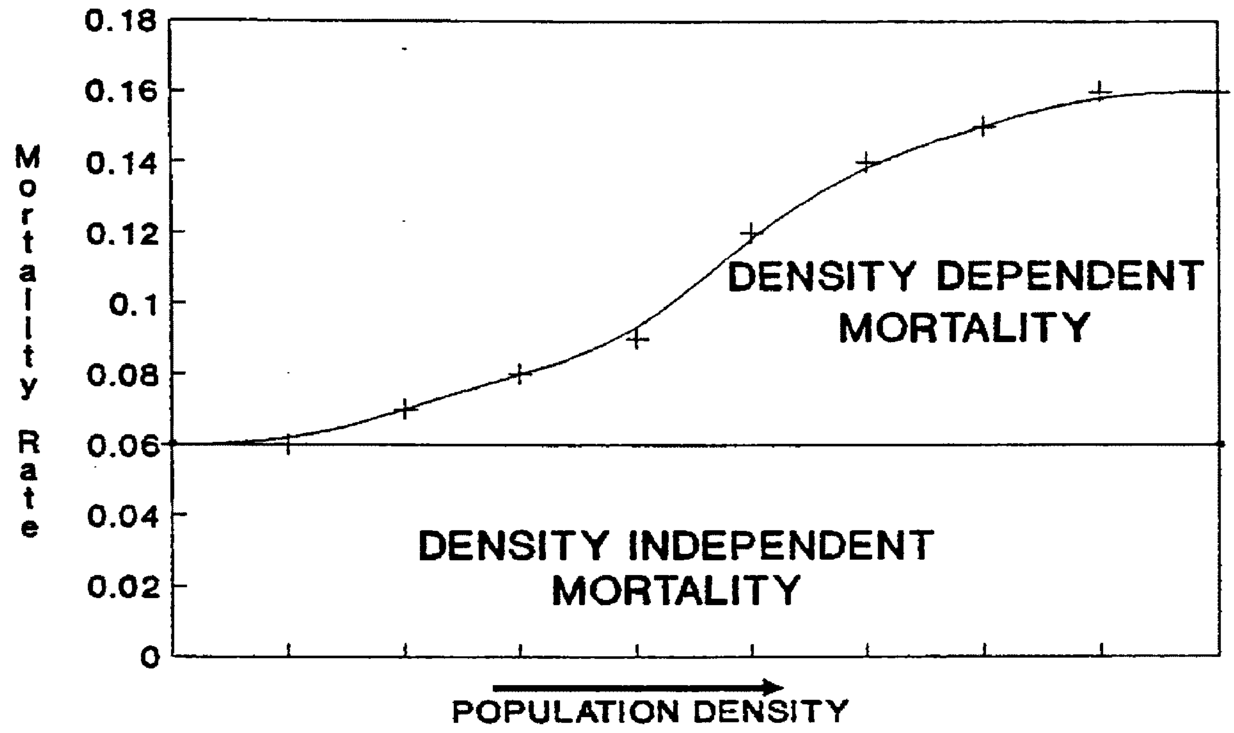
Population Modeling

My purpose in modeling was to mimic previous growth in order to better interpret the current status of the population. A deterministic population projection model, Lesmod (Metzgar, unpubl. data), was used to simulate population growth from the introduction to the study period to examine the rate of density-dependent changes in birth and death rates, and to examine the expected response of the current population to a spectrum of harvest regimes. Within the model, birth and death rates are calculated respective to the post-hunt population size relative to K (carrying capacity) using a sigmoidal curve. The functional response of the birth and death rates are changed by stretching or contracting the curve. An example of a functional response curve for mortality is illustrated in Fig. 2. The minimum value of the curve (at 0 goats) represents the density-independent rate. The difference between the overall mortality rate and this density-independent rate is the density-dependent rate.

Lesmod uses a variable Leslie matrix (Leslie 1945) for population projections. There are no parameters of pre-hunt mortality or winter severity indices. Post-birth, summer population values are input for the population at time t. The model then advances through the fall hunt, winter mortality, and summer births to form the population for year t+1. Growth of the population in Lesmod is a smooth function, including "portions" of animals in the population. Thus, if only 1 young were born, that new population, at a 100:100 sex ratio at birth, would have 0.5 females and 0.5 males.

There is no functional response of the vegetation to the previous winter's population size of animals in the model. In effect, there is full revegetation each year. Differential use of the vegetation base by various age/sex classes at different population sizes is compensated for by setting the rates differently at the start.

Figure 2. Example of a functional response curve of mortality to population density.


0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Mortality Rate
DENSITY DEPENDENT MORTALITY
DENSITY INDEPENDENT MORTALITY
POPULATION DENSITY

I made the following explicit assumptions for modeling:

1. Only females entering age-class 3 or beyond have young.
2. Fecundity first increases, then decreases with age.
3. Sex ratio at birth is 100 females:100 males.
4. No goat lives beyond 13 years of age.
5. Immigration and emigration are nonexistent.
6. Sex ratios do not affect birth rate.
7. The order for the initiation density-dependent population responses was first a reduction in birth rate (which includes neonatal mortality), second, a reduction of 2+ male survival, third, a reduction of yearling male survival, fourth, a reduction of kid survival, and fifth, a reduction of 1+ female survival.

Density Calculations

I delineated seasonal and yearlong ranges based upon initial sightings of goats during all surveys. Boundaries of the resulting polygon (Hayne 1949) were modified slightly to follow prominent topographic features. For example, when a prominent ridge wove in and out of the seasonal range boundary, I subjectively changed the boundary to include the entire ridge. The number of goats on these ranges were assumed to equal the population calculated for that area, rather than the maximum number of goats seen at any one time. This proved to be a minor difference.

Analysis of Grouping

Similar to the method employed by Chadwick (1977), a goat was considered to belong to a specific group if within 50 yards (45.7 m) and currently, or recently engaged in similar activities.

Areal goat concentrations were analyzed by examining the distance between goats. Differences in elevation, and physical obstructions between groups were ignored in calculating these distances. Measurements, therefore, were as if all animals occupied the same horizontal plane. All goats in a group were arbitrarily assigned the same location.

Goat-to-goat distances can be analyzed using both arithmetic and harmonic summations. Straight arithmetic comparisons of the distance between groups are sensitive to the dispersal of even a few individuals, but not to concentration or clustering. By transforming the distance between groups (or individuals) in a harmonic or inverse manner (DISTANCE ===> 1/DISTANCE) a statistic is obtained that is sensitive to clustering, but not to dispersion (see Neft 1966). Harmonic transformations have been used with individual animals to help describe home ranges (Dixon and Chapman 1980, Samuel et al. 1983) and have analogous applications in the analysis of spatial use by individuals in a population. The equation for this transformation is as follows:

$$H_d = \frac{n}{\sum_{i=1}^{n} \sum_{j=2}^{n} \frac{1}{M_j}}$$

where, H_d = the harmonic mean distance from any 1 "anchor" location (i) to all other locations;

n = the total number of locations; and,

M_j = the distance from the anchor location (i) to the object location (j).

The average H_d among the population of locations is known as Hp, which provides a measure of concentration. This statistic is useful for comparisons of 1 area to another, or between seasons or years in 1 area.

To establish the sensitivity of both the average arithmetic distance from 1 point to all others (AvD) and Hp, locations from the 4 full surveys of the Big Elk Creek drainage were selected randomly, with progressively larger sample sizes, with 10 to 295 goats. Graphs of AvD and Hp vs. sample size revealed that stability was reached at about 175 and 225 goats, respectively. Therefore, statistical comparisons were not attempted when samples sizes were below these thresholds.

Aspect Use

Simple vector addition was used to combine the aspect use of groups of goats into a single resultant vector. Component vectors were weighted by the number of goats in the group. The direction of the resultant vector indicates the average aspect of goats during a survey. The length of the vector indicates the dominance of that average use.

Habitat Use on the Palisades Creek Winter Range

Of 36 cliff complexes identified on the main Palisades winter range, 26 were fully evaluated. Some data (e.g. elevation, map length, distance to the canyon mouth) were available for all 36 complexes. Each complex was given a use-rating by dividing the total number of goats observed on that complex from all full surveys of the drainage during winter and spring by the length of the complex, yielding units of goats per 100 yards (91.4 m) of cliff.

Incomplete data prevented a clear filtering of variables by stepwise linear regression. Instead, Spearman rank correlation coefficients were calculated with pair-wise deletions of missing data. Proportional data were transformed before analysis with the arc-sine transformation (Sokal and Rohlf 1981).

RESULTS AND DISCUSSION

Distribution

Table 2 contains a list of areas that lacked goat sign when inspected. Palisades Creek and Big Elk Creek drainages were found to contain the only 2 major wintering areas of goats in the Snake River

Table 2. List of complete drainage surveys in the Snake River Range, outside the Palisades and Big Elk Creek winter ranges and Baldy Mountain and Mount Baird summer ranges.

Area	Date(s)	Goats Seen
Alpine to Owl Creek, in the Teton Range, along the divide	8/16 thru 9/03/83	2
Blowout Canyon/Needle Peak	5/24/82	0
	9/05/82	0
	7/17/83	0
	7/20/83	1
Chicken Springs	9/03/82	0
Indian Creek, North Fork	4/05/82	0
	7/13/82	0
Indian Creek, South Fork	7/15/81	0
	4/25/82	0
	7/03/82	0
	11/18/82	0
Mail Cabin Creek	9/21/82	0
	9/20/83	0
Pine Creek Pass	7/14/82	0
Powder Peak	5/24/82	0
	9/02/82	1
Red Creek, Wyo.	7/21/83	0
Sheep Creek	3/30/82	0
	12/10/82	0
Taylor Mountain	10/21/83	0
	9/22/83	2
Wolf Creek, Wyo.	4/02/82	0
	7/21/83	0
	9/16/83	0

Range. Five goats were detected wintering in the Black Canyon/Burns Creek area during the study. The only other known location for wintering mountain goats was for a lone billy that wintered high on Taylor Mountain, about 1 mile (1.6 km) north of the study area, during winter 1983-84 (Becker, pers. comm. 1983). Areas that were inspected but which lacked evidence of winter goat use included Pine, Rainey, Sheep, and Little Elk creeks, Blowout and Dry canyons, the North and South Forks of Indian Creek, the southern, eastern, and western faces of Ferry Peak, Wolf Creek, and Red Canyon. I did not observe goats wintering on Taylor Mountain during the study, although I observed 2 billies there during summer 1983.

During summer, the largest aggregation of goats in the Snake River Range was found on the top of Baldy Mountain. Goats also concentrated on the top of Mount Baird, commonly moving along the ridgetops to Sheep Creek Peak, Sheep Mountain, and Neeley Cove. South of Rainey Creek, all high elevation ridgetops receive at least some use by goats during summer. Outside the 2 concentration areas, use was minimal, usually involving males or immature females. A list of goat observations outside the 2 concentration areas is found in Appendix 1. Goats have also been observed in the adjacent Teton Range during summer. Whitfield (1983) compiled a list of goat observations from the Tetons prior to 1983. Since then, the number of annual goat sightings in this range has changed little (P. Hayden, pers. comm. 1988).

In the Black Canyon-Burns Creek area, "typical" mountain goat summer range is almost entirely lacking. The only summer observations (3 goats during 1982) were in the Hell Hole portion of Burns Creek.

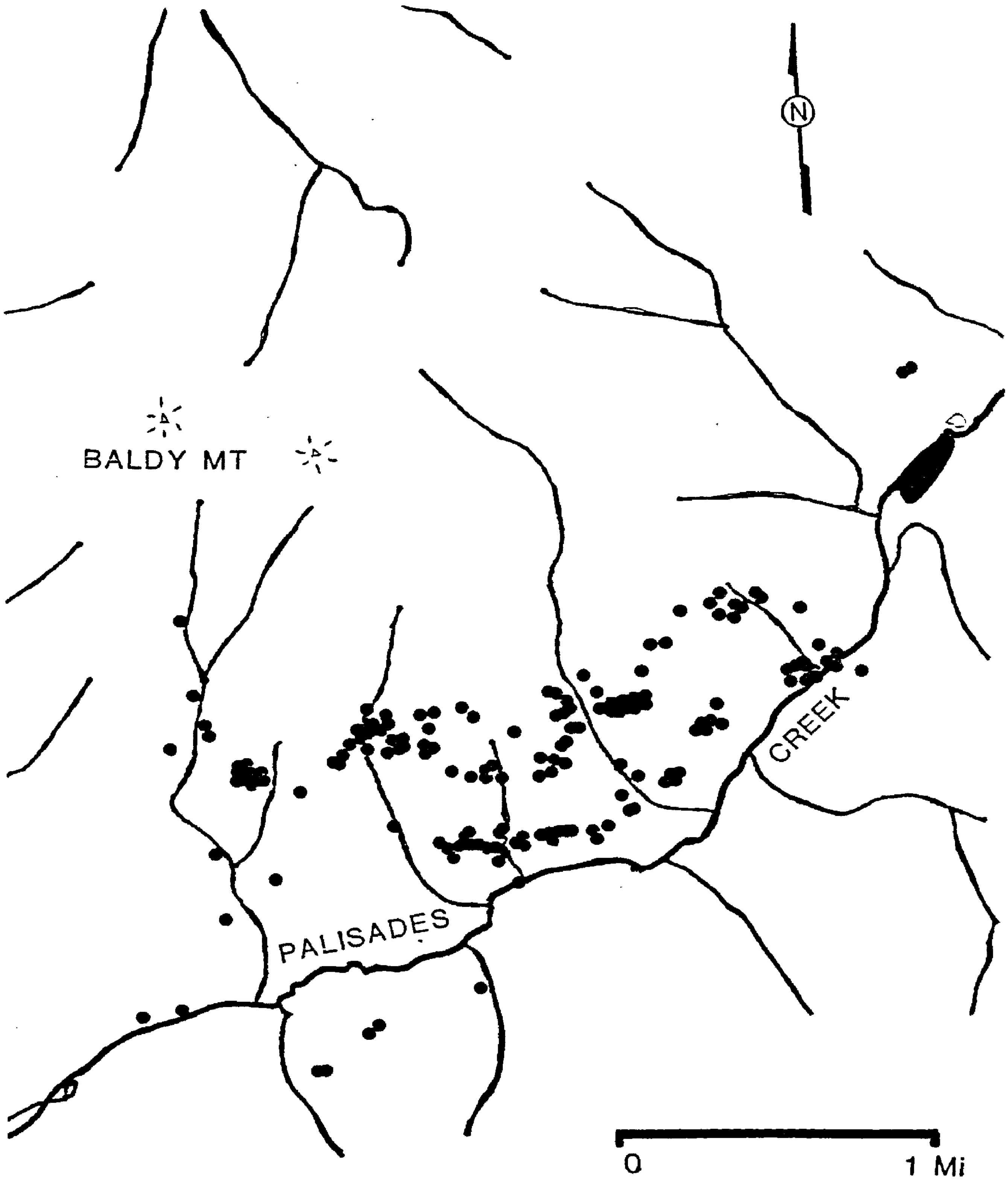
Winter Range Characteristics

Generally, the winter ranges in the Snake River Range are more broken, with more shrub and tree cover than found on many goat winter ranges. Cliffs are generally smaller, and, perhaps, more convoluted in appearance, than those of Montana's goat ranges in the Bitterroot Mountains, Beartooth, Cabinet, and Swan ranges, or of Idaho's Salmon River Range, Lemhi Range and White Cloud Mountains. Points that jut prominently away from the main cliff face appear to be an important feature of this winter range, allowing extended exposure to the sun during early morning and late afternoon/evening.

Palisades Creek Winter Range.--The Palisades Creek winter range is located on the southeastern slope of Baldy Mountain, along the lower 3 miles (4.8 km) of Palisades Creek canyon (Fig. 3). Less than 1,100 acres (445 ha) in size, this area winters between half and two-thirds of the Snake River Range population, at a 1983 density of approximately 55 goats per square mile (21 goats/km^2).

Mountain goats in the Palisades Creek drainage wintered among 36 cliff complexes averaging 6,747 feet (2,056 m) in elevation, and ranging from 5,800 to 7,600 feet (1,768 to 2,317 m). Mean aspect was 159° (N=159) surrounding the cliffs. Base slope of the winter

Figure 3. Winter distribution of mountain goat groups in the Palisades Creek drainage.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range (mean slope from the lower to upper elevation) averaged 25^{o} (C.V.=12%, N=10). Two bands of cliffs ran roughly laterally through this winter range. Measurements among these cliffs (Table 3) showed significantly more ground cover (T-test, $p<0.01$, df = 166), and more gentle slopes (T-test, $p<0.01$, df = 169) above than below the cliffs. This arrangement of cliffs on the winter range allowed a high density of goats on the winter range because of the relative abundance of vegetation on the slopes between the cliff bands.

The hillside between the upper 2 cliff bands was approximately 300 yards (274 m) wide and well-vegetated with old curl-leaf mahogany, chokecherry, and maple. Vegetation composition was largely controlled by aspect. Approximately 30% of the slope was composed of Douglas-fir stands, primarily on northern slopes and in gullies. These stands could be characterized as "old-growth", with a mean diameter at breast height of 26 inches (66 cm). Roughly 21% was composed of mixed conifer cover (mostly lodgepole pine); 47% was mixed shrub cover (largely curl-leaf mahogany), including small openings less than 2 acres (0.8 ha) in size. Openings larger than 2 acres accounted for only 2% of the slope's area.

Composition of the overstory in plots immediately adjacent to winter range cliffs was dominated by curl-leaf mahogany (48%), Douglas-fir (18%), Rocky Mountain Juniper (14%), and bigtooth maple (13%). Seventy-seven percent of the overstory plants had a minimum canopy height of greater than 6 feet (1.8 m), leaving it unavailable to

Table 3. Characteristics of selected cliff complexes of mountain goat winter range in Palisades Creek drainage. Plots for aspect, slope and ground cover were established 75 feet (22.7 m) above and below each cliff.

Characteristic	N	Mean	CV[a]	Range
Elevation	36	6747 ft.	7%	5800-7600 ft.
Aspect	154	159°	-	-
Slope				
Above Cliff[b]	88	32°	23%	0-44°
Below Cliff[b]	83	36°	15%	5-42°
Cover				
Above Cliff[c]	87	61%	42%	10-100%
Below Cliff[c]	81	47%	64%	0-90%

[a] Coefficient of variation.

[b] For differences in slope, above vs. below cliffs, $T=3.98$, $f=169$, $P<0.01$.

[c] For differences in percent herbaceous cover, above vs. below cliffs, $T=3.27$, $df=166$, $P<0.01$.

goats except during periods of deep, firm snow. Less than 1% of the overstory plants had a minimum canopy height less than 3 feet (0.9 m).

The woody understory consisted primarily of bigtooth maple (44%), Rocky Mountain maple (13%), chokecherry (10%), and serviceberry (9%). Fifty-three percent of the woody understory plants had a minimum canopy height of less than 3 feet (0.9 m). Herbaceous ground cover averaged 54%, composed mostly of grass, Oregon-grape, arrowleaf balsamroot, and mule's ears.

The northwesterly-facing side of the Palisades Creek drainage (the lower portion of Sheep Mountain) was used little during winter. Observations here usually included less than 4 goats per survey--usually males, but sometimes including yearling or 2-year-old females. This side of the drainage, although steeper than the southeasterly-facing side, is heavily covered by an extensive Douglas-fir stand, with only a few mahoganies and junipers scattered among the cliffs. Cliffs are more massive on the northwesterly facing side, and appear more convoluted than on the primary goat range. Colder temperatures and deeper snows are often present because of the relative lack of direct sunshine.

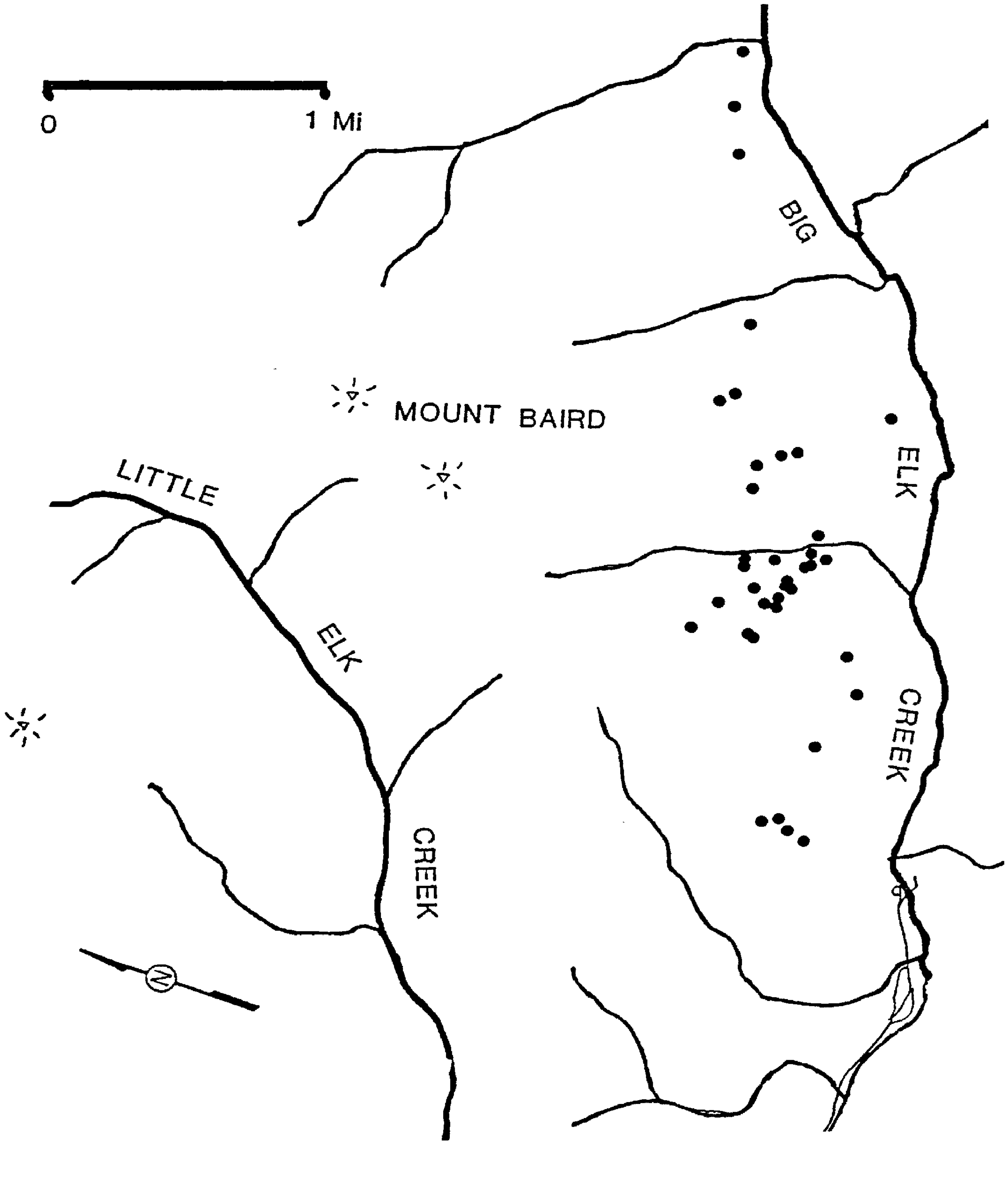
Other ungulates use portions of the Palisades Creek winter range during early winter and early spring, but this use is almost negligible relative to use by goats. Most land-use overlap occurs between goats and deer, with elk normally staying on the periphery of the goat range. During early spring, a few moose are commonly found among the cliffs on the winter range. Domestic livestock grazing does not occur on the Palisades Creek winter range (Ward, pers. comm. 1984).

There was little disturbance to wintering goats by man on the Palisades Creek winter range during the study. Approximately 360 recreation visitor days were expended between 1 December and 31 March on the trail along the bottom of Palisades Creek (Whitfield and Barnhurst, unpubl. data). Disturbance by photographers and those merely wanting to observe mountain goats was negligible during winter. Although a plowed road extends to the edge of the Palisades winter range, motorized vehicles, including snow machines, were not allowed beyond this road.

Big Elk Creek Winter Range.--Winter range in the Big Elk Creek drainage was found on the southeastern slope of Mount Baird, along the lower 4 miles (6.4 km) of the canyon (Fig. 4). This winter range covered about 1,100 acres (445 ha), about the same size as the Palisades Creek winter range. The 1983 density of goats wintering on the Big Elk Creek winter range was approximately 29 goats per square mile (11 goat/km^2), considerably less than that of the Palisades Creek winter range.

Goats were observed at approximately the same elevations during winter as on the Palisades Creek winter range. The base slope of the Big Elk Creek winter range averaged 28^{o} (C.V. = 18%, N=10). Unlike

Figure 4. Winter distribution of mountain goat groups in the Big Elk Creek drainage.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the Palisades Creek winter range, the Big Elk Creek winter range had no distinct set of cliff bands. Instead, cliff complexes were mostly continuous from lowest to highest elevations, with wide ledges scattered among the cliffs. Approximately 15% of the overstory was Douglas-fir, 25% mixed conifer, 60% mixed shrub, and 10% openings greater than 2 acres (0.8 ha).

Overstory and shrubbery understory cover appears considerably less dense on the Big Elk winter range than on the Palisades Creek winter range. Noticeably lacking are the extensive stands of old curl-leaf mahogany. However, mahogany plants between 6 and 14 inches in height (15 and 36 cm) subjectively appear much more abundant here.

Whereas the Palisades Creek canyon is relatively V-shaped, the Big Elk Creek canyon is U-shaped allowing a longer exposure to direct sunshine. Despite this, plant phenology appears to lag behind that found in the Palisades Creek drainage by about a week.

The northwesterly-facing slope of the Big Elk Creek drainage is extremely well-covered by Douglas-fir, and although the base slope appears steep, rocky outcroppings are small and few. No use by goats was observed on this slope during winter.

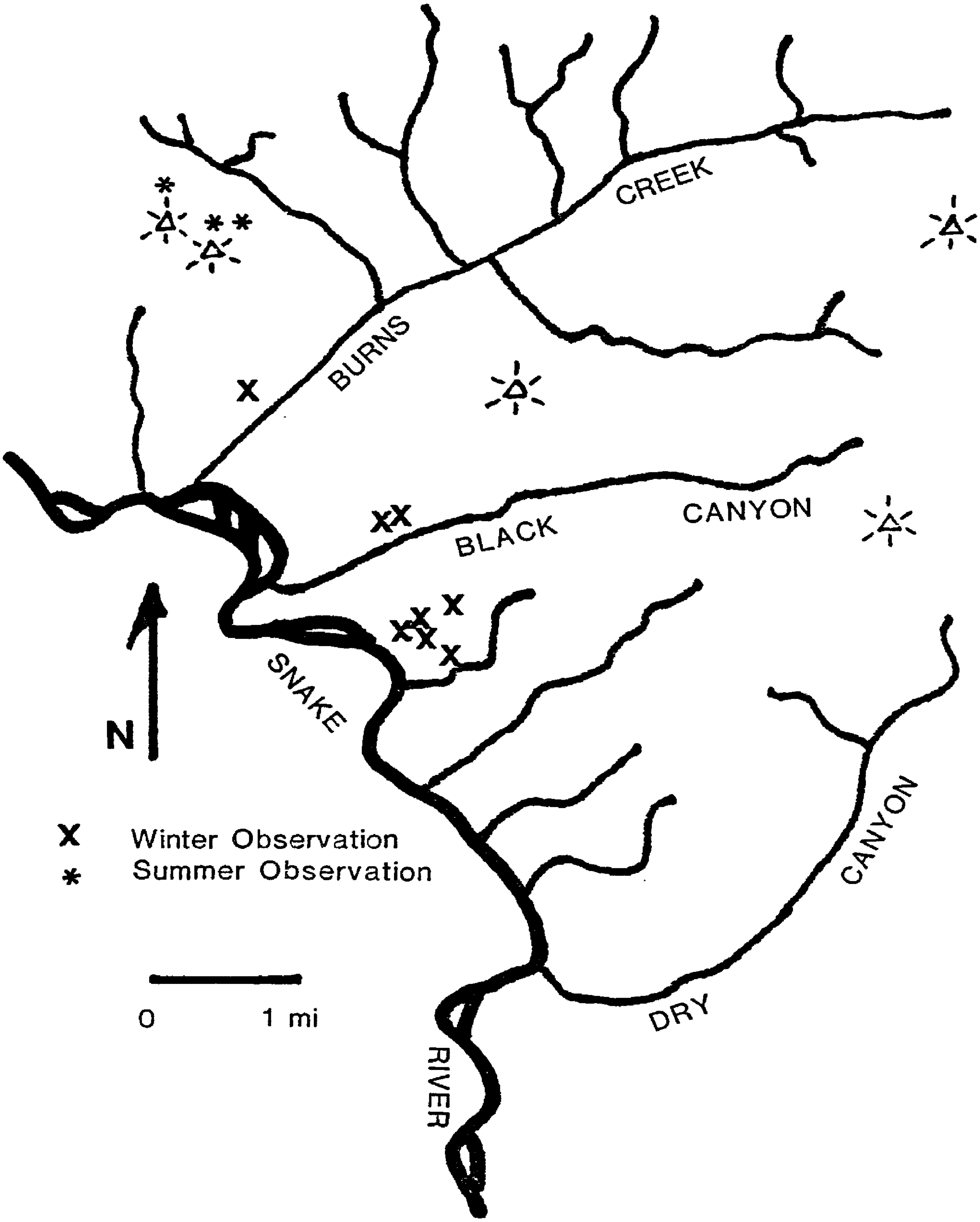
Land-use overlap between mountain goats and elk occurs to a minor extent along the alluvial ridges and along the lower elevations of this winter range, but is believed to be very minor. Overlap with deer and moose appeared negligible. Although this winter range lies within the Targhee National Forest's Elkhorn Sheep and Goat Grazing Allotment, no domestic grazing occurred on the winter range at any time of the year, largely because of the steepness of the area (Ward, pers. comm. 1984).

There was probably less disturbance to goats wintering in the Big Elk Creek drainage than the Palisades Creek drainage, although no data were available to test this. A 2.5 miles (4.0 km) gravel road extends from U.S. Route 26 to the edge of the Big Elk winter range, but because it was not plowed, it usually remained impassable between mid-November and early May. The road and adjacent areas were open to snowmobiles, but the trail at the bottom of the Big Elk Creek drainage is closed to all motorized vehicles. I estimated the use of this trail by cross-country skiers was less than 50 recreation days between 1 December and 31 March.

Black Canyon and Burns Creek Winter Ranges.--Up to 5 mountain goats were observed annually on various cliffs in the Black Canyon and Burns Creek drainages, and on the "Hole in the Wall" face above the Snake River between Black Canyon and Bear Gulch (Fig. 5). Elevations of wintering goats ranged from 5,400 to 7,000 feet (1,646 to 2,134 m). Plant phenology generally appeared 1 to 2 weeks advanced relative to the Palisades Creek winter range.

Vegetatively, these areas are somewhat similar to the Palisades Creek winter range. In particular, curl-leaf mahogany is abundant, but the stands are old, and little mahogany is within reach of a goat. Douglas-fir stands are also common in this area.

Figure 5. Distribution of mountain goat groups in the Big Hole Mountains.



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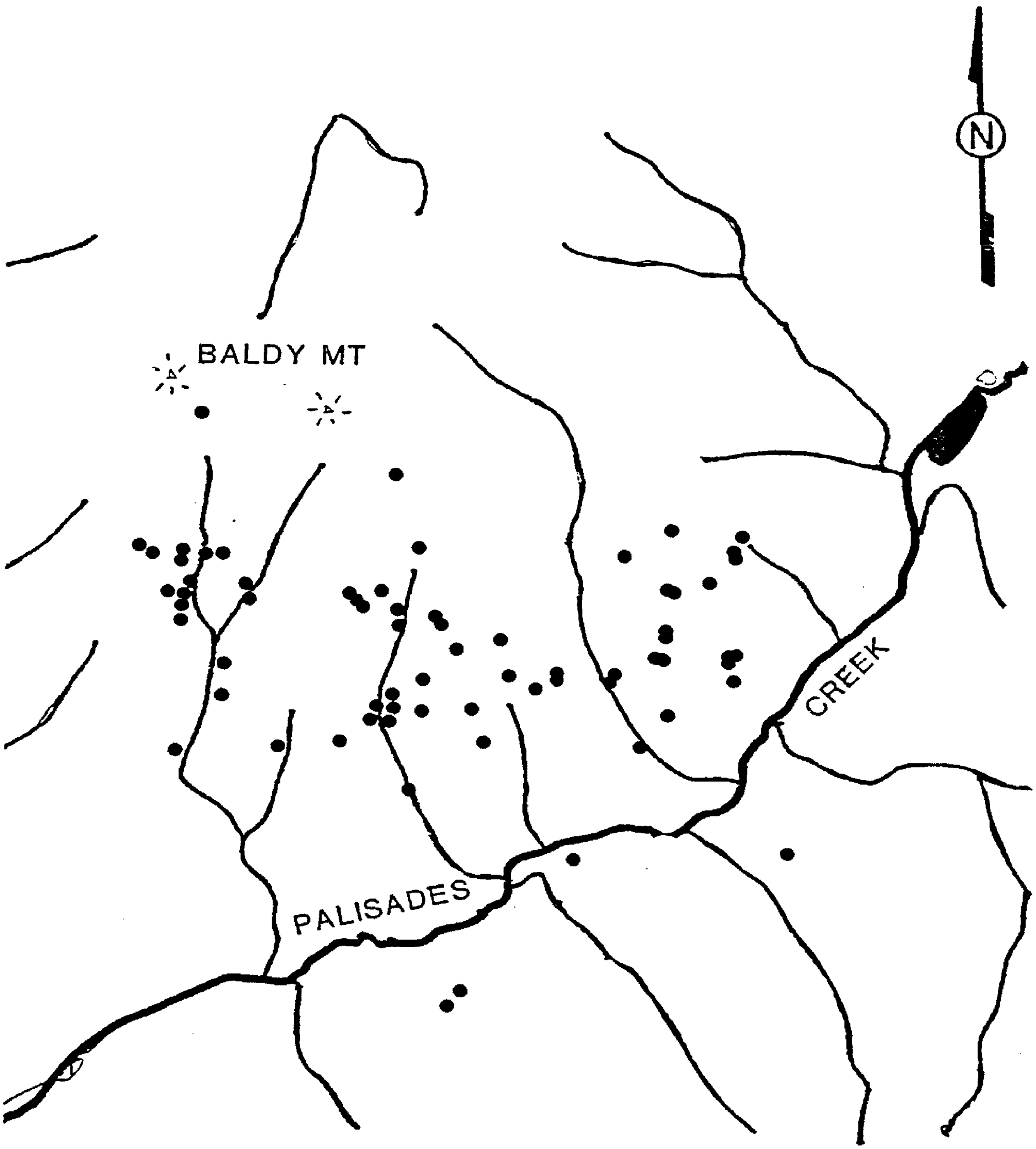
The potential for land-use overlap is heavy between goats, elk, and deer in the Burns Creek and Black Canyon areas. Inter-specific competition for forage, shelter, and space may be present. Domestic grazing within the areas used by goats is minimal because of the steep terrain. Most of the goat observations during winter have been within the Targhee National Forest Burns Creek Cattle and Horse Grazing Allotment, with current use of 154 Animal Unit Months (AUM's) per year (USDA 1985).

Disturbance of this winter range by man is currently negligible. This area is fronted by the South Fork of the Snake River, allowing access only by a road along the River that is plowed only to within 12 miles (19 km) of the winter range.

Spring Range Characteristics

As spring progressed, goats were observed with increasing frequency in the basin immediately south of the peak of Baldy Mountain. The general pattern of movement was down Palisades Creek, toward the mouth of the canyon. Spring use was spread from the upper portions of the winter range to the lower portions of the summer range (Fig. 6). A similar pattern was evident in the Mount Baird area (Fig. 7), but goats moved up Big Elk Creek, into Hell Hole, just below the Peak of Mount Baird.

Figure 6. Spring distribution of mountain goat groups in the Palisades Creek drainage.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BALDY MT
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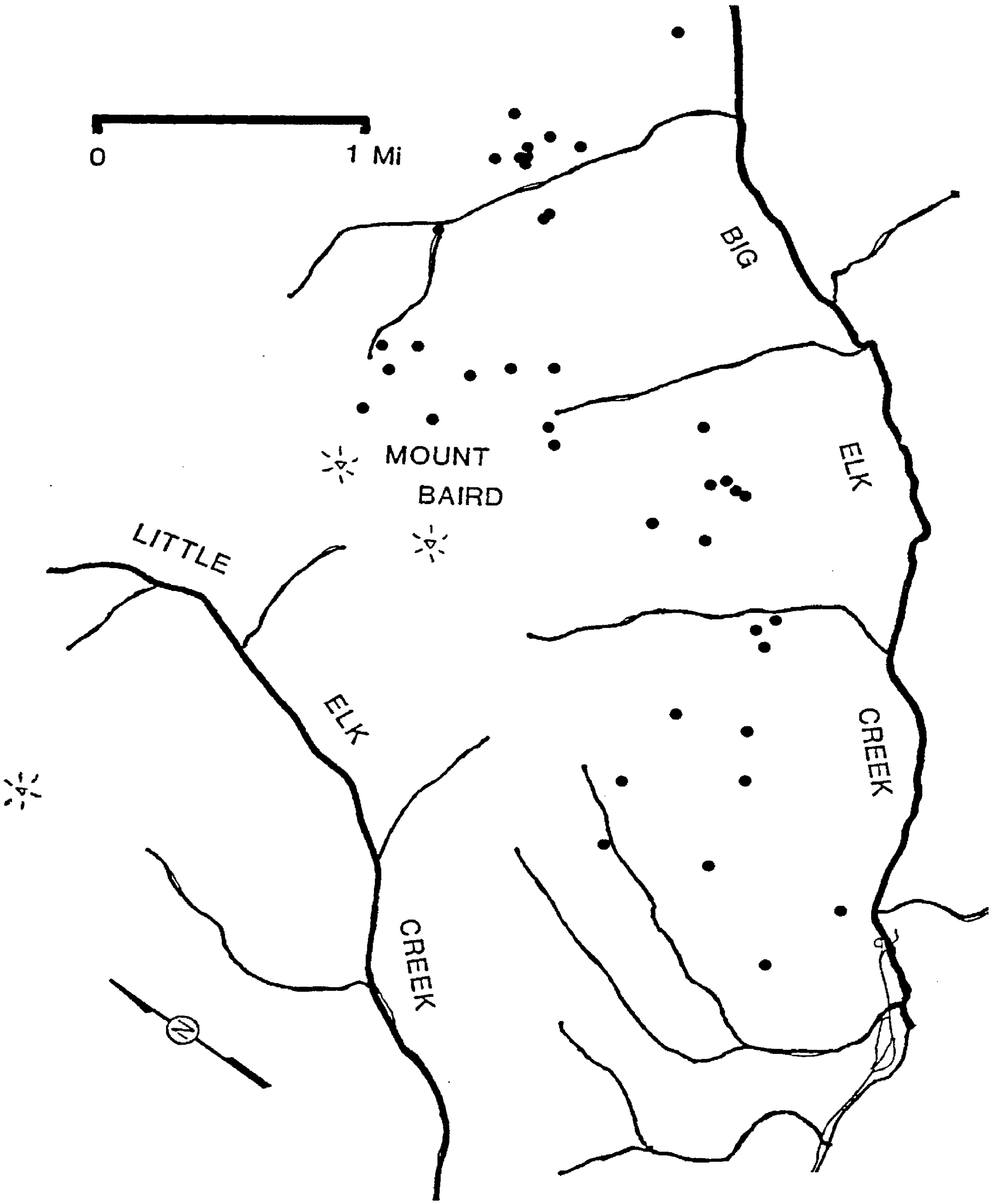
Figure 7. Spring distribution of mountain goat groups in the Big Elk Creek drainage.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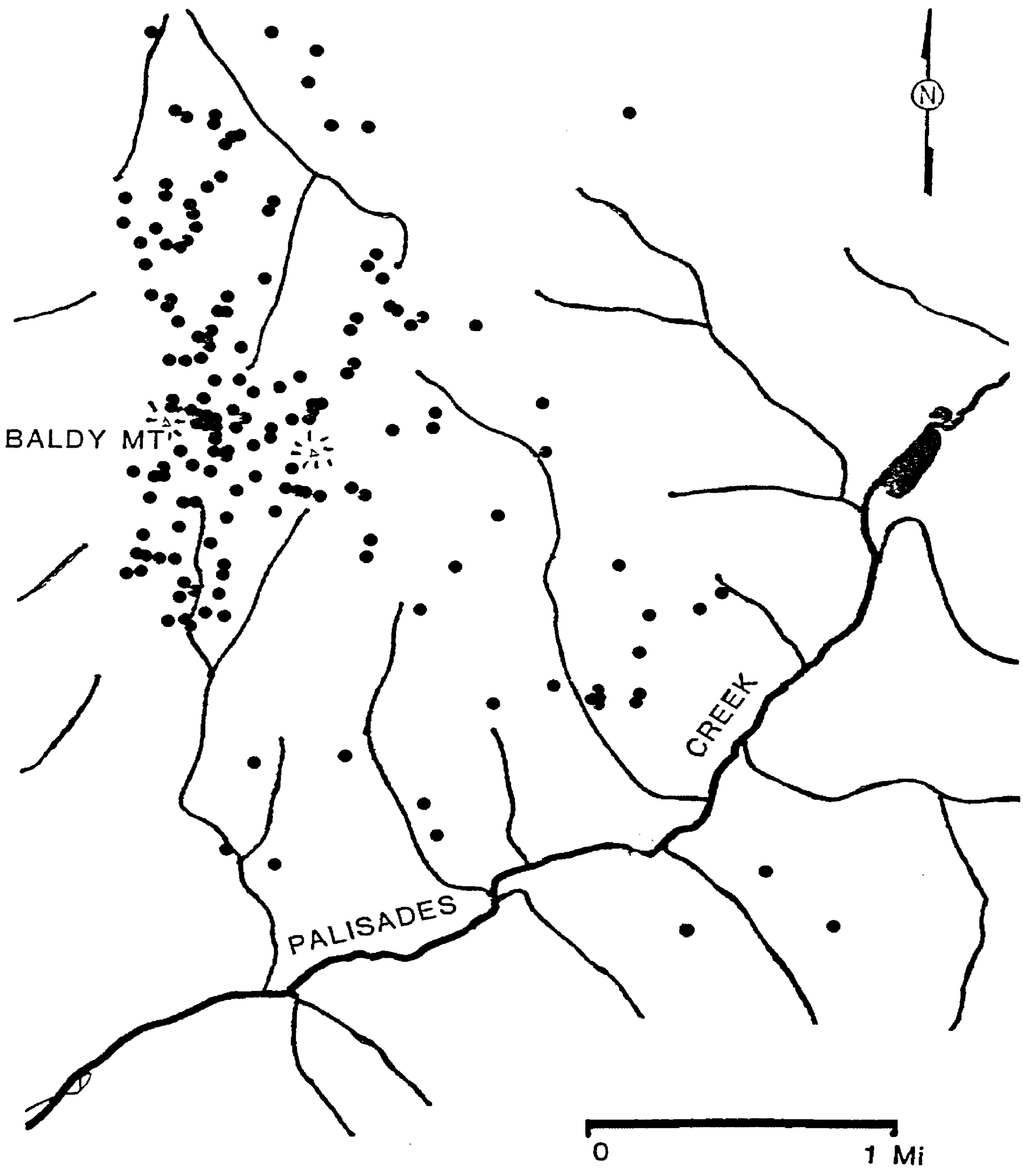
Summer Range Characteristics

Overall, summer range in the Snakes is noticeably less rugged than native summer ranges observed in the Beartooth, Bitterroot, and Swan mountains of Montana, or the Lemhi, Lochsa, and Sawtooth mountains of Idaho. Here, ridge tops and steep open hillsides, more typical of bighorn sheep summer range, characterize goat summer range. Alluvial fins are an extremely important feature of the summer range, serving both as bedding sites and travel routes. Mature Douglas-fir trees, scattered along these fins, appeared to provide important thermal cover during summer.

Baldy Mountain Summer Range.--The top of Baldy Mountain, elevation 9,835 feet (2,998 m), is the focus of summer goat activity north of Palisades Creek (Fig. 8). A ridge, extending northeasterly from Baldy to Atkinson and Thompson Peaks, had little goat habitat available, but may have acted as a travel corridor. Beyond Thompson Peak lie a series of low-elevation, semi-forested hills that separate the small Baldy Mountain ridge complex from the remainder of the high-elevation portions of the Snake River Range.

A large cirque basin on Baldy's north facing slope appears to be the dominant feature of this summer range, providing the only real high-elevation escape terrain. A snowfield usually remains in the basin through August, and sometimes through the year. Goats commonly used this snowfield for thermoregulation, and apparently as a water source. Extensive use of the basin began in early July, when slopes

Figure 8. Summer distribution of mountain goat groups in the Baldy Mountain area of the Snake River Range, Idaho.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become entirely free of snow, and succulent vegetation became available. Three smaller cirque basins, 2 on the western side and 1 on the eastern side, provide additional summer habitat.

Goats are also concentrated at high elevations on the southern exposure of Baldy Mountain during summer. Travel between the north-side cirque basins and the southerly exposure of the top of the mountain occurs daily. The southern face of Baldy Mountain is characterized by outcroppings of small bluffs across a large basin, well-dissected by chutes. This face of the mountain is very open, with Douglas-fir and limber pine mainly scattered along the small divides between debris chutes. Subalpine fir and Englemann spruce are the most common tree species.

The Baldy Mountain summer range in the Targhee National Forest lies entirely in Baldy Mountain Cattle and Horse Grazing Allotment, which was closed to protect recreation and soil values. Use during the study was limited to 48 AUM's in this 710 acre allotment (288 ha), for use by recreational horseback riders (USDA 1985).

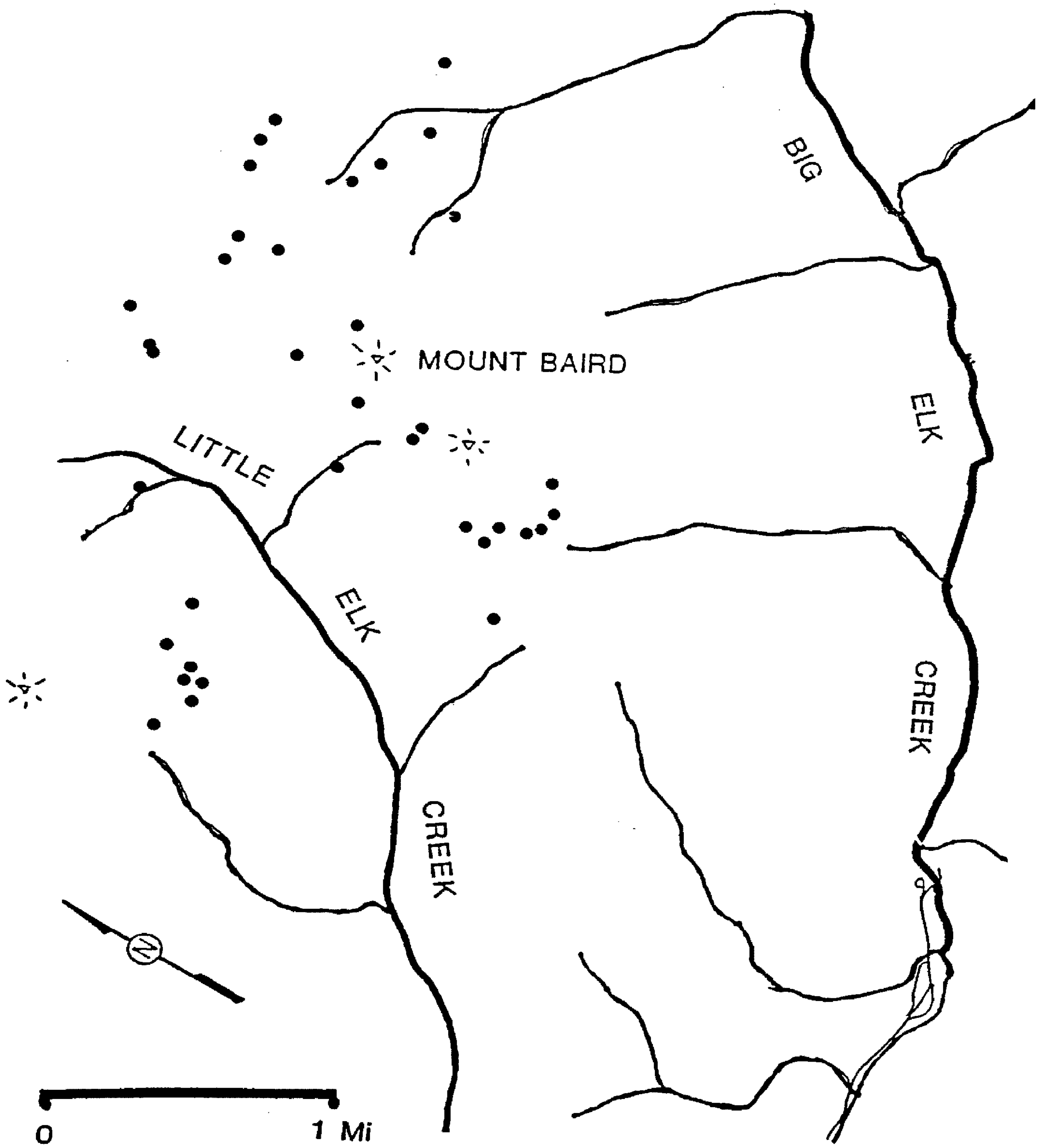
At the onset of this study, disturbance to the goats on the Baldy Mountain summer range was low, probably involving less than 50 recreational vehicle days per year. As this study progressed, and a goat activity study was initiated (Whitfield and Hayden, unpubl. data), the public became more aware of the goats and a slight increase in disturbance was noticed.

All motorized vehicles were restricted from the Baldy Mountain summer range to protect recreation and soil values beginning during 1984 (USDA 1985). Access to this summer range is relatively limited, requiring a hike of at least 2 miles, gaining more than 2,000 feet (610 m) in elevation, or riding horses at least 6 miles. One infrequently used trail ends inside the summer range. Should traffic on this trail increase substantially, disturbance to the goats could become very detrimental to the goat population especially in light of the extreme limitation of space, and a very high goat density in the area.

Mount Baird Summer Range.--Mount Baird provided a second focus of mountain goat activity observed during summer (Fig. 9). However, the Mount Baird summer range is considerably larger, allowing goats to spread out along several high-elevation, open ridges that connect with most of the peaks in the Snake River Range. The ridge *FIG 9 HERE9Bconnecting Sheep Mountain (adjacent to Palisades Creek), Sheep Creek Peak, and Mount Baird received the heaviest observed use.

Vegetation is similar between the 2 summer concentration areas, but more lush meadows occur near Mount Baird. Tree cover is roughly comparable. Hell Hole is a large cirque basin to the east of Mount Baird. This area receives heavy use throughout the year, and is physiographically similar to the southeastern-facing portion of the Baldy Mountain summer range. Vegetation in Hell Hole is sparse, however, and during very hot weather, goats moved to the periphery, or out of this basin.

Figure 9. Summer distribution of mountain goat groups in the Mount Baird area of the Snake River Range, Idaho.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Most of the Mount Baird summer range is within the Elkhorn/Dry Canyon Sheep and Goat Grazing Allotment. Livestock use in this 5,300 acre area (2,145 ha) was 360 AUM's, mostly in Dry Canyon (USDA 1985). Elkhorn Peak itself (part of Mount Baird) was closed to grazing on 2,500 acres because of steep terrain and soil instability. Although domestic sheep and mountain goats used some of the same ridge top meadows near Mt. Baird, herders did a good job of moving the sheep through the area, and it is unlikely that there was substantial competition for either space or forage during the study.

Disturbance to goats on the Mount Baird summer range was negligible at the start of this study (1982), with only an occasional hiker or horse-rider coming to specifically look for goats. As the study progressed, people became more aware of the goats' presence here too, but no real increase in human activity was noticed.

Motorized vehicles are excluded from the Mount Baird summer range, because of the high recreation value of the area and unstable soils. The nearest motorized access is only about 2 miles (3.2 km) from the summer range, but there is also a $2,000^{+}$ foot (610^{+} m) difference in elevation. Trails pass through this summer range in several areas, but current use of these trails is largely confined to hunters during fall.

<u>Summer Range in the Burns Creek/Black Mountain Vicinity</u>.--Summer range for mountain goats wintering in the Black Canyon/Burns Canyon area is extremely limited. The elevation of the 6 peaks nearest to

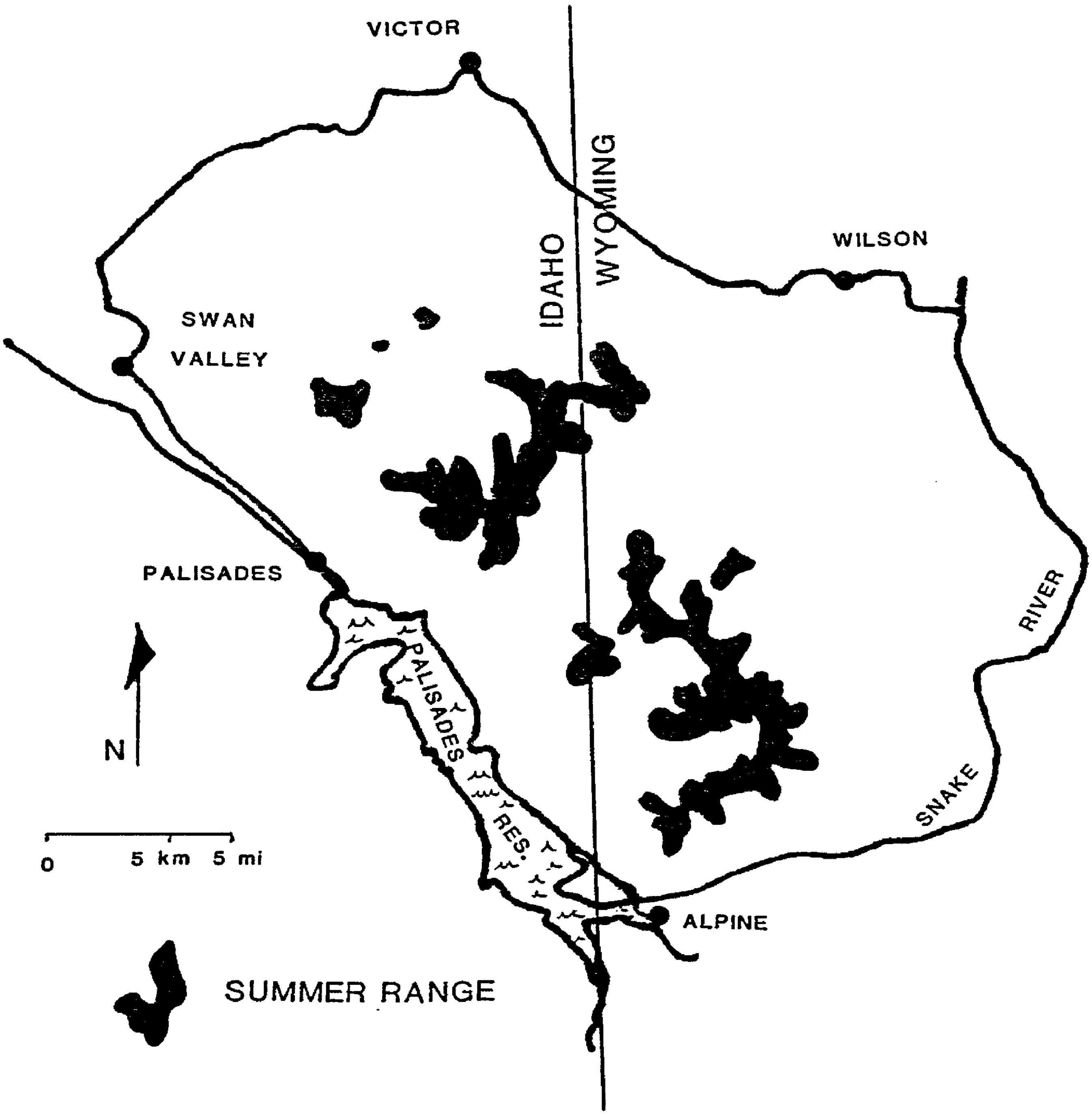
the winter range averages only 8,363 feet (2,549 m). No area lies above 9,000 feet (2,727 m) elevation. The gentle terrain and heavy timber cover on these peaks was not conducive for goats. I only observed 3 goats during summer in this area (Fig. 5). These were found on Twin Peaks, in Hell Hole at an elevation of only 7,200 feet (2,196 m). Goats were observed on other nearby peaks during summer by Targhee National Forest personnel, but inspection of these areas revealed only small areas of marginal goat habitat. I feel that the lack of adequate summer range was severe enough to preclude any large population build-up of goats in this area.

Habitat Availability

There is relatively little good habitat for mountain goats in the Snake River Range, either for summer or winter. Of approximately 15,000 acres (6,070 ha) above 9,000 feet (2,727 m) in the range (Fig. 10), only 5,370 acres (2,173 ha) appear likely summer habitat because of heavy vegetative cover or gentle terrain. During the study, use was concentrated on about 2,230 (42%) of the likely-appearing summer habitat. However, a few wandering goats probably used all portions of potential summer range at some time.

Summer habitat in the Big Hole Mountains was severly lacking. Less than 10 acres (4 ha) of this range are above 9,000 feet (2,727 m), with no cliffs available at elevations greater than 8,600 feet (3,474 m).

Figure 10. Ridge area above 9,000 feet (2,727 m) in the Snake River Range.


VICTOR
IDAHO
WYOMING
WILSON
SWAN
VALLEY
PALISADES
PALISADES
RES.
N
0
5 km 5 mi
ALPINE
RIVER
SNAKE
SUMMER RANGE

Winter range is also limited, with only 4,460 acres (1,805 ha) apparently suitable for wintering goats (Fig. 11, Table 4). Only 2,110 acres (854 ha) can be classified as "good" winter range, with the remainder being of poorer value because of more gentle terrain, small, and/or isolated cliff complexes, or continuous forest cover. Of the "good" winter range acres, about 1,800 (728 ha) were used during the study, accounting for about 78% occupancy. I documented no use of areas outside the Palisades and Big Elk Creek drainages during winter.

The Big Hole Mountains contain about 560 acres (227 ha) of "good" winter range, 110 acres (45 ha) of "fair" winter range (Fig. 12, Table 5). In light of the unavailability of summer range, it is obvious that winter range is not limiting in this area.

General Patterns of Seasonal Behavior

Nanny-kid associations began to break up on the winter range during late March. It appeared that kids, rather than nannies, most often terminated the nanny/kid bond in the Snake River Range. As winter ended and spring green-up began, kids and yearlings appeared more and more inquisitive - exploring further and further from the rest of the group. The snowpack became firm with the warmer temperatures of late March and April, allowing adult males and some subadults to advance to the higher elevations. Puzzlingly, this advance was well ahead of spring green-up. By late April groups composed solely of juvenile goats were common on transitional range. Adult females began to

11. Potential winter range in the Snake River Range.

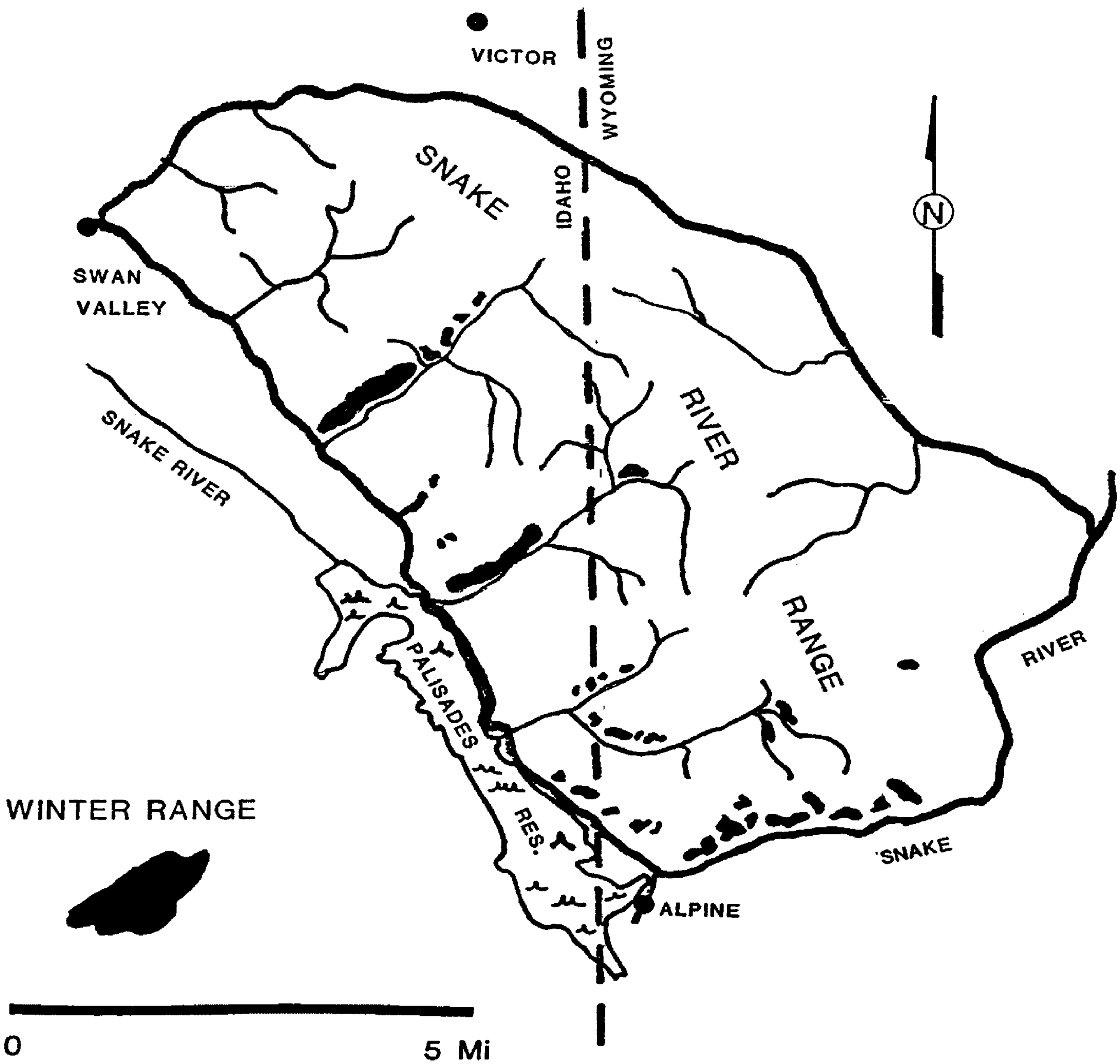

VICTOR
WYOMING
IDAHO
SNAKE
RIVER
RANGE
SWAN
VALLEY
SNAKE RIVER
PALISADES
RES.
ALPINE
SNAKE
RIVER
WINTER RANGE
0
5 Mi
N

Table 4. Location of apparent winter range areas in the Snake River Range.

Area	Acreage	Quality
Above Alpine, Wyo.	330	Fair
Big Elk Creek	1,090	Good
Coburn Creek	50	Poor
Dog Creek	10	Poor
Dry Canyon, Big Elk Creek	140	Fair
Fall Creek	20	Poor
Indian Creek, North Fork	200	Fair
Indian Creek, South Fork	280	Fair
Little Elk Creek	30	Fair
Palisades Creek	1,020	Good
Sheep Creek	30	Fair
Snake River Canyon, Wyo.	1,260	Fair
TOTAL	4,460	

Figure 12. Potential winter range in the Big Hole Mountains.

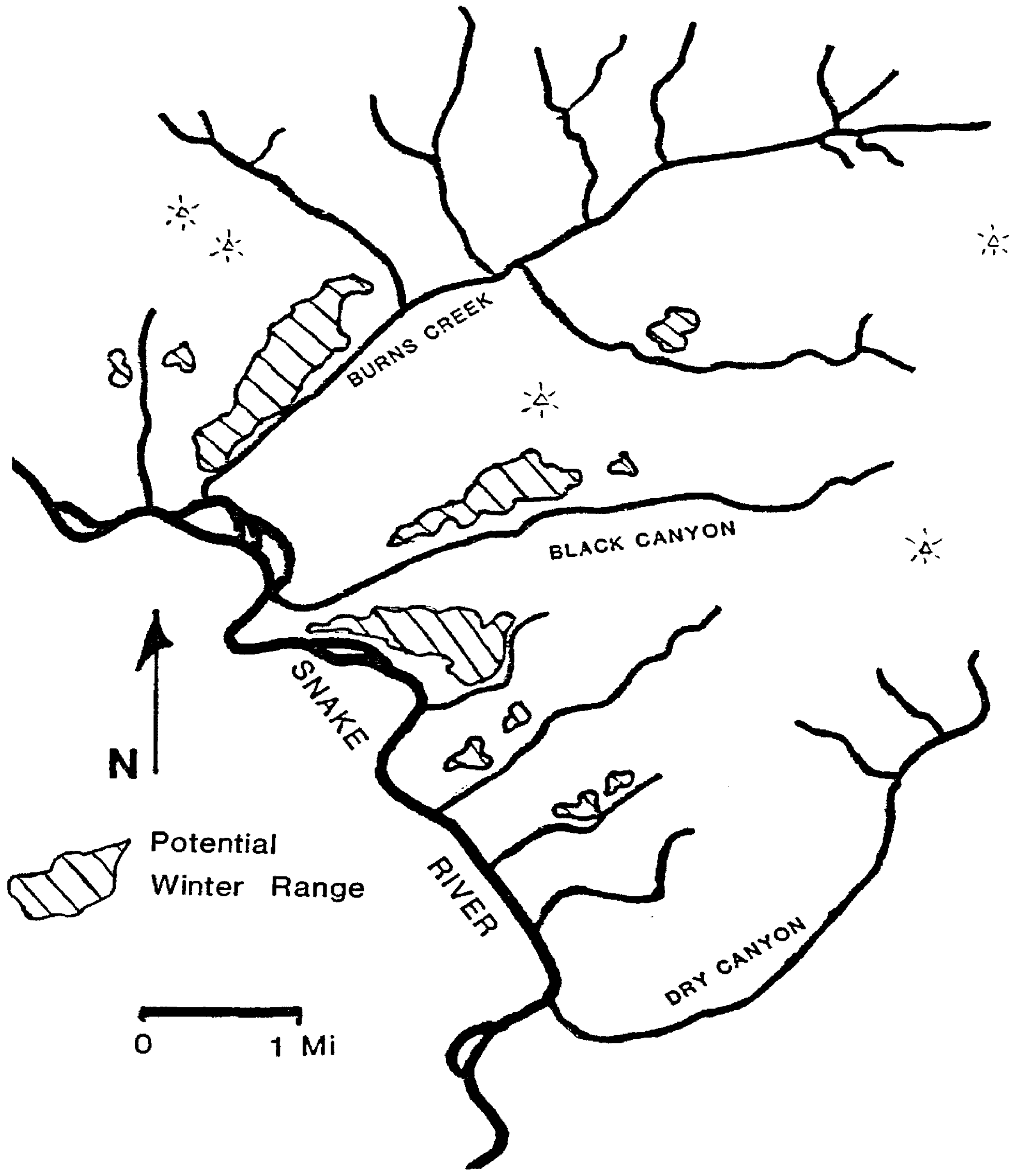

BURNS CREEK
BLACK CANYON
SNAKE
RIVER
DRY CANYON
N
Potential
Winter Range
0
1 Mi

Table 5. Location of apparent winter range acreage in the Big Hole Mountains.

Area	Acreage	Quality
Bear Gulch	180	Good
Black Canyon	90	Good
Burns Creek	250	Good
Gormer Canyon	40	Good
Ladder Canyon	20	Fair
Little Burns Creek	50	Fair
Woods Canyon	40	Fair
TOTAL	670	

disassociate from other goats during early May, possibly in preparation for kidding.

I am uncertain whether or not weather was a major factor in determining where nannies kidded during the end of May and early June. All observations of nannies with neonates occurred on the winter range, or on the lower reaches of transitional range. Subjectively, visual obstructions appeared to be important factors in habitat use by adult females during the kidding period as virtually all sightings occurred in the trees or in the most broken, cliffy terrain.

Nannies with kids began to re-associate with other goats almost immediately post-partum. These new, early summer groups included other nanny-kid groups, juveniles, and even 2-year-old males. Little agonism was evident from nannies "protecting" their kids from the intrusions of other goats.

Soils in southeastern Idaho have an abundance of salts (Wright, pers. comm. 1988). Perhaps as a consequence, there were no noticeable long-distance movements to lick sites as found in other areas (Brandborg 1955, Thompson 1980, Adams 1981).

Micro-climate was obviously important in habitat selection during summer. This seemed especially true prior to mid-July, when adult females were yet largely unshed. A measurement during mid-June 1982 indicated a difference of $30^{o}F$ ($17^{o}C$) between a thermometer shaded by a solitary tree, and 1 in an adjacent sunlit area. Use of mature Douglas-fir and limber pine trees for shade was heavy throughout summer, with trees at the edge of a steep hillside apparently preferred locations. Bedding at the bases of cliffs, out of the sun, also seemed a response to temperature stress. Remnants of snowdrifts were used heavily until their disappearance.

Severe summer thunderstorms also moved goats to shelter. Often moving to lower elevations during storms, goats could be found on the more moderate slopes, with ample tree cover. I also noted consistant use of shallow caves and rocky overhangs during severe thunderstorms. Within a few hours following a storm, goats generally returned to the more open, higher-elevation areas.

Snowstorms generally began during early October on goat summer ranges. With the snows began the shift to transitional range, and by late October, much of the shift from summer to winter range had commenced. Signs of the oncoming rut began around the first of October, with swollen crescent glands, some digging of rutting pits, and limited displays. During October, adult males were found on the same ranges as other goats, but they remained in the company of other males or were found alone.

Active rutting did not take place prior to 1 November, with most activity in late November. Rutting pits were most often dug in the deeper soils of north-facing aspects adjacent to upper winter range cliffs. Rutting males appeared to monitor the females of individual groups for up to a week, checking juvenile and adult females frequently. All mounts between adult goats were observed during the period of 1 November through 10 December.

As rutting activity diminished and snow depths increased, group sizes gradually grew smaller. Adult males remained on the primary winter range with, but not in, the female/young groups. By late winter, partial range segregation was noticeable between the sexes, with some males moving to the steeper north-facing slopes, and also remaining at slightly higher elevations.

Late Winter Food Habits

Fresh pellets collected on the Palisades Creek winter range during April 1982 showed about 88% of the late-winter diet was composed of browse species. Curl-leaf mahogany comprised 43% of the diet. Juniper (Juniperus spp.) comprised 30%, Douglas-fir, 15%; Oregon grape, 8%; and other species combined, 4%.

Habitat Use

In general, mountain goats in the Snake River Range gathered in large groups at high elevations during summer, and small groups at low elevations during winter. Aspect use was southerly throughout the year, but summer aspect vectors were weak.

Elevation.--Goats were observed over the entire range of available elevations, from 5,600 to 10,025 feet (1,707 to 3,056 m). During any given day, goats were found in a relatively narrow band. The coefficient of variation of mean daily elevation ranged between 3% and 20% of the available elevatinal range. However, substantial shifts in this elevational band occurred commonly. Nine comparisons of major surveys of the Baldy Mountain subpopulation were conducted within a 2-week period. Differences in mean elevation were significant in 4 (T-test, $P<0.10$) with a fifth comparison nearly significant ($P=0.12$).

During summer, goats on Baldy Mountain became concentrated, possibly because too little high elevation habitat was available. Surveys during mid-August of 1982 showed an average elevation of 9,291 feet (2,815 m, N=82), yet less than 4% of Baldy Mountain summer range was above this elevation. By comparison, the lowest mean elevation of goats was 6,542 feet (1,982 m, N=39) on 31 March 1983. About 12% of the winter range was below this elevation.

The elevational shifts between summer and winter ranges during spring and fall were abrupt. While mature females remained on winter ranges, subadult females and all males began to make extensive use of higher elevations and different sub-drainages during late March and early April. These initial movements were not related to plant phenology, as new plant emergence had not yet occurred. Instead, goats seemed to take advantage of the firm snowpack to feed on previously unavailable plants. Most new plant emergence took place during late April and early May, when most goats fed at low elevations.

During spring 1982, adult females remained on the winter range well into the kidding period (about 30 May through 15 June), moving higher between late May and mid-June. The cool spring and previous harsh winter probably were contributing factors, although the direct influence of kidding itself could be important. After a less severe winter and a relatively normal spring in 1983, this difference seemed less pronounced - more adult females used the higher elevations prior to the kidding period.

Few observations were made during fall, but drops in elevation began during late September and early October 1982, concurrent with the onset of cooler nights and high-elevation snowstorms. The influence of the rut was not determined, but rutting did take place on the winter range during fall 1982.

Aspect.--Southerly aspects dominated use by goats year-round, although resultant use vectors (Table 6) were shorter, at high elevations during summer. This reflects the increased use of other exposures. Within the area used by goats during summer, the mean aspect was west-southwest (244^{o}, r=1.2, N=28). The winter range had a mean aspect vector of south-southeast (142^{o}, r=10.3, N=21). Combined, the year-long range generally faced south-southeast (148^{o}, r=10.1, N=49).

Table 6. Summary of mean elevation and aspect of mountain goat sightings from full drainage surveys, 1982-83.

Date	Elevation (Feet)			Aspect		
	Mean	St. Dev.	No. Goats	Direction (Degrees)	Vector Length	No. Goats
Palisades Creek Area						
1982						
4-27	7115	236	23	214	0.74	23
4-29	7029	428	41	137	0.83	41
5-17	7615	515	23	146	0.68	23
5-21	7694	567	27	154	0.47	32
6-07	7606	812	38	163	0.56	37
6-21	7780	619	36	159	0.76	36
8-11	9234	151	41	162	0.65	39
9-3	8811	409	31	166	0.35	17
11-15	7396	124	25	190	0.74	25
12-08[a]	6807	415	55	172	0.85	49
12-10	7178	364	44	178	0.77	43
12-11	7196	181	27	169	0.84	27
1983:						
2-18	6973	480	17	201	0.71	12
2-19	6921	371	35	187	0.69	35
3-17	6746	467	48	177	0.84	48
3-31	6542	428	40	151	0.79	39
4-30	6866	391	31	164	0.77	31
6-18	7748	807	60	152	0.58	60
7-01	7887	442	97	176	0.46	97
Big Elk Creek Area						
1982:						
6-13	7497	463	36	134	0.69	36
2-08[a]	7079	382	46	166	0.45	46
1983:						
3-26	6939	502	14	158	0.92	14
7-26	9067	358	42	147	0.68	41

[a] Helicopter survey.

Weather influenced use of aspect as it did use of elevation, with winter use of southerly exposures apparently influenced by snow accumulation, and summer use of northerly exposures apparently influenced by hot temperatures. Tree cover on southerly-exposed colluvial fins masked this relationship, as there was also a tendency for goats to seek nearby shade during summer.

Slope.--Only gross measures of slope were available for mapped locations, and the mapping itself was not precise enough to provide good information on slope. Therefore, only a general slope was calculated for the area defined by goat observations.

The summer range on Baldy Mountain averaged 27^{o} in slope (C.V.=37% N=28), which is not significantly different than the 31^{o} slope (C.V.=32%, N=21) of the winter range (T-test, P>0.10).

Habitat Use on the Palisades Creek Winter Range

Twenty-nine of the 36 identified cliff complexes were evaluated during late August 1983 (App. 4). Observations of mountain goats on individual cliffs were used for correlations only when all cliffs were surveyed for use. The best single predictor for the total number of goats observed on a given cliff was the number of prominent cliff protrusions (stepwise linear regression, r^2=0.43). Several variables were significantly correlated with use of specific cliffs by wintering goats (Table 7). The most important of these appears to be the distance to the nearest road (which equals the distance to the

Table 7. Spearman's correlation coefficient matrix for use of specific cliffs by mountain goats in the Palisades Creek drainage during winter. Significance probability = 0.10.

Cliff Variable	Total Goats	Adult Females	Adult Males	Yearlings	Kids
Distance to a road[a]	Yes	Yes	Yes	Yes	Yes
Slope below the cliff	Yes	Yes	Yes	Yes	Yes
Prominent protrusions	Yes	Yes	Yes	No	No
Cliff length	Yes	No	No	No	No
Angular deviation	Yes	No	No	No	No
Elevation	No	No	Yes	No	No

[a] This also equals the distance to the canyon mouth.

canyon mouth), slope below the cliff, and number of prominent cliff protrusions. Variables examined for which there was no significant correlation with use of specific cliffs by mountain goats, included the number of caves and overhangs, cliff height, herbaceous ground cover above or below the cliff, slope above the cliff, and tree basal area above or below the cliff.

Land Use Overlap

The principle large mammals involved in land-use overlap with mountain goats in the Snake River Range include mule deer, elk, moose, and domestic sheep. Most overlap with other wild animals occurred on the winter range during late winter and early spring. Deer, elk, and moose were observed both years on both winter ranges feeding between the cliffs, apparently taking advantage of the more shallow snow depths available below the cliffs. I do not believe that use was severe enough to initiate major competition between any of these species. Similarly, distribution of all 4 of these species overlapped on summer ranges, but this overlap appeared less common, and was likely of a lesser impact than that on winter ranges.

Although the potential existed for mountain goats to compete with domestic sheep on portions of the summer range, this was not observed during the study. Because of the concentrated nature of domestic sheep bands, a strong likelihood exists that sheep may exclude mountain goats near Mount Baird via their physical presence (and associated herder and dogs) and through short-term impacts to the vegetation in the high meadows between Mount Baird and Sheep Mountain. The land-use overlap in this area is of concern for 2 reasons, utilization of the area by sheep to the exclusion of goats because of space and forage conflicts, and disease transmission.

As this goat population continues to grow, summer range will play a more important part in year-long energetics. The availability of a few lush summer meadows near escape terrain will become increasingly important to the ability of these goats to overwinter. The high densities here are indicative that the summer range is probably a critical part of their survival.

Both goats in the Snake River Range, and bighorns in the Teton Range are at risk from disease transmission from domestic sheep. Although goats are relatively resistant to many of the diseases carried by sheep, bighorn/domestic sheep interactions are frequently fatal for bighorns (Bunch pers. comm. 1988, Foreyt pers. comm. 1988).

Population Size and Structure

The calculated population size for the Snake River Range was 104 goats during summer 1982, and 141 goats during summer 1983. Five to ten additional goats were believed to inhabit the Black Canyon/Burns Creek area in the Big Hole Mountains during the study. Limited observations, and back-calculations of 1982 and 1983 cohorts indicate a minimum of 81 goats were present in the Snake River Range during 1981. The Baldy Mountain area supported 56% of the summer 1982 population, and 65% of the 1983 population. The remaining goats were spread between Sheep Creek Peak and Neeley Cove, with the center of activity on Mount Baird.

Little change was noted in age structure between 1982 and 1983 with the observed rapid growth (Table 8). Adult age-classes (3+ years) comprised 38% of the 1982 population and 39% of the 1983 population. Sex ratios of adults were significantly biased toward females, with 31 males per 100 females during 1982, and 51 males per 100 females during 1983 (G-test; 1982: $P=0.02$, $N=38$; 1983: $P=0.09$, $N=53$).

Subadult goats (age-class 2) comprised 13% of the 1982 population, and 15% of the 1983 population. Sex ratios of subadults were biased toward males, with 140 males per 100 females during 1982, and 125 males per 100 females during 1983 (G-test, $p<0.01$).

Combined, subadult and adult cohorts accounted for 55% of the 1982 population and 54% of the 1983 population. The resulting sex ratio was 56 males per 100 females during 1982 ($N=58$), and 67 males per 100 females during 1983 ($N=72$). The impact of the age-class 2 cohort was large, resulting in sex ratios without significant differences with either a 1:1 ratio (G-test; 1982: $P=0.17$; 1983: $P=0.25$) or the adult ratios (G-test; 1982: $P=0.13$; $P=0.46$). Thus, although it may be possible to use adult sex ratios as a monitoring technique for evaluating relative harvest of sexes, inclusion of age-class 2 goats will make this a useless technique except for detecting extremely gross differences.

Table 8. Composition of mountain goats in the Snake River Range. The cohort completion method (Smith 1976), and back-calculations of known age-classes to prior years were used to calculate composition.

		Classification[a]														
Year	Location	AF	AM	AU	2F	2M	2U	2+F	2+M	2+U	YF	YM	YU	K	U	TOTAL
1981[b]	Palisades	0	0	0	0	0	0	23	5	0	4	3	2	17	0	52
	Big Elk	0	0	0	0	0	0	12	4	1	1	2	0	7	2	29
	Other	0	0	0	0	0	0	1	1	0	1	1	0	0	0	4
	Total	0	0	0	0	0	0	36	10	1	6	6	2	24	2	85
1982	Palisades	15	4	0	4	5	0	0	1	0	5	6	2	12	4	58
	Big Elk	13	4	0	1	2	0	1	3	1	2	1	5	13	0	46
	Other	1	1	0	1	1	0	0	0	0	0	0	0	1	0	5
	Total	29	9	0	6	8	0	1	4	1	7	7	8	26	4	109
1983	Palisades	23	7	0	7	9	1	0	0	0	4	4	11	24	2	92
	Big Elk	12	11	0	1	1	2	0	1	0	1	2	1	16	1	49
	Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	35	18	0	8	10	3	0	1	0	5	6	13	40	3	141

a A=adult; 2=age class 2; 2+=2 years or older; Y=yearling; K=kid; U=unknown; M=male; F=female.

b This is a minimum estimate as mortalities prior to 4/01 could not be taken into account.

Yearlings comprised 20% of the 1982 population, and 17% of the 1983 population. The yearling sex ratio was 100:100 during 1982 (N=14), and 120 males per 100 females during 1983 (N=11). Inclusion of the yearling cohort with older cohorts further increased the proportion of males to females to 63 males per 100 females for 1982 (N=67), and 73 males per 100 females for 1983 (N=83). Adult age-classes made up only 54% of the yearling and older segment of the population during 1982, and 64% of the 1983 population.

Kids comprised 25% of the 1982 population, and 29% of the 1983 population. Sexes were not assigned to kids as they were generally indistinguishable.

Density

The number of goats present per unit of available resources would be an important measure of habitat quality and/or population status if the measure could be applied uniformly between studies. Unfortunately, severe problems exist in defining resource requirements, whether a given piece of habitat is available, and even in how to measure a given land area (because of problems of slope and topographical features). Consequently, the interpretation of density figures can lead only to rather general conclusions.

Observed seasonal densities ranged from 11.1 to 53.8 goats/mi^2 (4.3 to 20.8 goats/km^2) within seasonal ranges (Table 9). The highest goat densities were found on the Palisades Creek winter range, and

Table 9 Density of goats on the Palisades and Big Elk Creek seasonal ranges.

Area	Season	Density	
		Goats/mi^2	Goats/km^2
Palisades Creek	Winter 81-82	26.6[a]	10.3[a]
	Summer 82	34.0	13.1
	Winter 82-83	34.3	13.2
	Summer 83	53.8	20.8
	Winter 83-84	54.4[b]	21.0[b]
	Year-long 83-84	27.1[b]	10.4[b]
Big Elk Creek	Winter 81-82	20.0[a]	7.7[a]
	Summer 82	11.1	4.3
	Winter 82-83	27.9	10.8
	Summer 83	11.8	4.6
	Winter 83-84	29.7[b]	11.46[b]
	Year-long 83-84	8.5[b]	3.3[b]

[a] This is a minimum density, assuming the same area was used as during the 1982-83 winter.

[b] Projection, assuming the same area was used as during the 1982-83 winter.

the adjacent Baldy Mountain summer range. Densities on the Big Elk Creek winter range were only slightly lower than on the Palisades Creek winter range. Densities on the Mount Baird summer range were considerably lower than on the Baldy Mountain summer range.

The lack of a high elevation ridge system connecting with Baldy Mountain may be locally limiting for large goat herds in this area on an extended basis. The limiting factor may be either space of forage, although ample forage exists on the more gentle, adjacent slopes nearby. Thus far, habitat conditions on the Baldy Mountain summer range have apparently been sufficient as no widespread dispersal to larger complexes in the range were apparent. If summer goat densities on the Baldy Mountain summer range continue to increase, dispersal to the large adjacent ridge complexes should increase.

Most density calculation methods vary between studies to some degree. Nonetheless, goat densities calculated for this population were considerably higher than those reported elsewhere (Table 10), supporting the argument that this population was in an eruptive phase. High mountain goat densities were not present in the Snake River Range for an extended period of time prior to this study. Consequently, the browse-based winter ranges had not yet reached the zootic disclimax typical of that for well established populations. Although it is possible that habitat conditions in the Snake River Range were considerably more conducive to mountain goats than were conditions elsewhere, it seems more likely that this population will

Table 10. Density of various goat populations on year-long ranges.

Location	Density (Goats/km^2)	Source
Alaska		
Chilkat	0.5	Streveler and Smith (1980)[a]
Lituya Bay	0.7	Streveler and Smith (1980)[a]
Herbert Glacier	1.4	Streveler and Smith (1980)[a]
Dixon Harbor	2.1	Streveler and Smith (1980)[a]
Kodiak Island	7.7	Hjelford (1973)
Southeastern	0.5-4.7	Fox (1984)
British Columbia		
Knight Inlet	0.2	Hebert and Turnbull (1977)
Yoho Park	1.5	McCrory, et al. (1977)
	13	Foster (1978)[b]
Montana		
Glacier N.P.	0.5	Singer (1975)[c]
Swan Mts.	1.2	Chadwick (1973)
Glacier N.P.[d]	2.8	Chadwick (1973)
Glacier N.P.[e]	15.4	Singer and Doherty (1985)
Washington		
Olympic N.P.	0.6-14.0	Stevens (1983)
Idaho		
Palisades Cr.	10.4	This study
Big Elk Cr.	3.3	This study

[a] As cited by Fox and Streveler (1986).
[b] As cited by Fox (1984).
[c] As cited by Chadwick (1977).
[d] "Central" portion.
[e] Running Rabbit area.

soon incur density-dependent reductions in birth and survival, bringing these statistics more in line with those for established populations.

Grouping

Analysis of the mean distance between goats is another method to measure concentration of use in an area. One advantage this method has over analysis of densities is that there is no need to define how much area is available, or used by goats. In the analysis of inter-goat distances, both group size, and the scattering of groups are incorporated.

A simple arithmetic mean of the distance between animals (AvD) is sensitive to the wide scattering of groups, and small group sizes. The harmonic transformation of this measure (H_p) yields a mean distance that is sensitive to the clustering of groups, and large group sizes. Both measures are needed to provide sensitivity at both ends of this spectrum.

Summer groups of goats were roughly twice the size of winter groups, with the smallest mean groups found during late spring. With no change in inter-group distance, summer AvD and H_p values should be considerably smaller than those of winter. However, the similarity between summer and winter AvD's, and Hp's (Table 11), indicate the change in group size was offset entirely by changes in inter-group distances. During summer, goats were in large groups, but with large

Table 11. Harmonic (H_p) and arithmetic (AvD) mean distances between goats on the Palisades Creek seasonal ranges. H_p is sensitive to clustering (group size); AvD is sensitive to large distances (e.g. between groups of goats).

Season	H_p (Feet)	AvD (Feet)	Number of Goats
Winter	1480	4240	264
Spring	1800	5060	269
Summer	1640	4220	210
Combined[a]	2420	5720	768

[a] Also includes 25 goats observed during a fall survey.

distances between groups, and during winter, goats were in small groups, but the small groups were close to one another. These measures reinforce the hypothesis that there is relatively little difference in use of winter range vs. summer range in the Baldy Mountain area.

The increase of H_p from winter to summer implies a decrease in clustering during summer. I believe this is related to the shape of these ranges. The winter range is slightly more linear in shape than is the summer range. It is probably most desirable to make comparisons only within a season to allow more reliable conclusions.

Spring AvD and H_p values were significantly larger than those for either winter or summer (Mann-Whitney Test, $P>0.10$). Goats used a much larger area during spring, dispersing to higher elevations across the hard snowpack. At the same time, many adult females remained on the low-elevation winter range for kidding.

The interpretation of grouping patterns is difficult because of various, sometimes-subtle environmental influences and a variety of individual study biases. Such biases include differential observability of the variously sized groups in several cover types, differential effort expended examining different habitat types, weather conditions, and even the definition of a "group". Thus only general conclusions can be made from group size information.

Mountain goats in the Snake River Range demonstrate a seasonal grouping pattern consistant with that identified by Adams and Bailey (1980) for goats wintering on rough, low-elevation ranges, groups during winter were consistantly smaller than those during summer. This pattern was more strongly reflected by maximum observed group size than mean group size (Table 12). Considerable variation in group size was seen during any given survey. Coefficients of variation ranged from 48% to 107%, averaging 80%. During winter, the coefficient of variation averaged 70% (N=9), 18% less than the summer average of 85% (N=9). Considerable differences in mean groups size were noted for surveys conducted within 4 days.

Significant differences in groups sizes were noted between groups that included males or females 2 years of age or older, yearlings, and kids during winter, spring, and summer (Tables 13,14). Generally, groups with males were the smallest, and groups with yearlings were the largest. Many of these differences were significant (Table 15). Composition of the population studied is obviously another factor confusing the analysis of grouping patterns.

Chadwick (1973) first documented the negative correlation between agonistic levels and group size. Adams and Bailey (1980) later speculated that relatively large groups could be expected in recently-introduced goat populations. Despite the very high densities of goats in the Snake River Range, groups of goats were relatively large, leading to the conclusion that resources were not severely limited during the study.

Table 12. Grouping summary for goats observed in the Palisades and Big Elk Creek areas during complete surveys.

Date	Groups	Goats	Mean Group Size	CV[a]	Group Size 1	2	3	4	5	6	7	8	9	Other
Palisades Creek Area														
1982:														
4-27	14	23	1.6	81%	9	4	0	0	0	1				
4-29	18	40	2.2	65%	8	3	4	2	0	1				
5-17	14	23	1.6	85%	10	2	1	0	0	1				
5-21	20	29	1.3	94%	18	0	1	0	0	1				
6-07	21	40	1.9	97%	13	4	2	1	0	0	0	0	1	
6-21	10	36	3.6	67%	2	1	3	2	0	1	0	0	1	
8-11	11	41	3.7	73%	4	3	1	0	1	0	0	0	0	10, 13
9-03	10	31	3.1	75%	3	3	0	1	2	0	0	1		
11-15	12	25	2.1	80%	6	4	0	0	1	1				
12-08[b]	18	54	3.0	74%	7	3	1	3	0	2				
12-10	20	35	2.2	89%	10	5	3	0	0	0	1	1		
12-11	10	26	2.6	83%	4	2	2	1	0	0	0	1		
1983:														
2-18	10	17	1.7	48%	5	3	2							
2-19	14	29	2.1	48%	5	4	4	1						
3-17	20	48	2.4	80%	7	8	2	1	0	0	1	1		
3-31	17	40	2.4	84%	10	2	0	1	2	2				
4-30	15	31	2.1	107%	10	2	1	0	1	0	0	0	1	
6-18	20	58	2.9	72%	6	5	3	1	4	0	0	0	1	
7-01	21	97	4.6	107%	6	3	2	3	2	1	0	0	2	11, 22
Big Elk Creek Area														
1982:														
6-13	13	36	2.8	80%	5	3	1	2	0	1	0	1		
2-08[b]	14	46	3.3	76%	6	1	0	3	1	1	1	1		
1983:														
3-26	10	14	1.4	50%	7	2	1							
7-26	10	48	4.8	94%	3	2	0	1	0	2	0	0	0	12, 13

a Coefficient of variation.
b Helicopter survey.

Table 13. Seasonal differences in mean number of goats associated with selected group types observed in the Palisades Creek area. Sample sizes in parentheses.

Season	Year	Type of Goat Found in Group				All Groups
		Kids	Yearlings	Older Females	Older Males	
Spring	1982	3.1 (18)	1.7 (9)	2.5 (21)	1.1 (7)	1.9 (46)
Summer	1982	4.1 (36)	5.1 (18)	4.1 (31)	3.1 (18)	3.3 (73)
Fall	1982	3.8 (4)	3.5 (2)	3.0 (6)	1.5 (4)	2.1 (12)
Winter	82/83	4.2 (35)	3.9 (31)	3.1 (65)	2.8 (43)	2.4 (110)
Spring	1983	5.7 (3)	3.7 (3)	2.5 (10)	2.3 (6)	2.1 (15)
Summer	1983	4.1 (12)	5.1 (9)	4.3 (15)	2.3 (15)	2.9 (32)

Table 14. Seasonal differences in mean number of yearling and older goats associated with selected group types observed in the Palisades Creek area. Sample sizes in parentheses.

Season	Year	Type of Goat Found in Group				All Groups
		Kids	Yearlings	Older Females	Older Males	
Spring	1982	1.1 (18)	1.3 (9)	1.3 (21)	1.1 (7)	1.1 (46)
Summer	1982	2.6 (36)	4.1 (18)	2.8 (31)	2.7 (18)	2.5 (73)
Fall	1982	2.3 (4)	2.5 (2)	2.0 (6)	1.5 (4)	1.6 (12)
Winter	82/83	2.7 (35)	2.7 (31)	2.3 (65)	2.4 (43)	1.9 (110)
Spring	1983	3.3 (3)	2.7 (3)	1.8 (10)	1.7 (6)	1.6 (15)
Summer	1983	2.5 (12)	4.0 (9)	3.1 (15)	2.2 (15)	2.3 (32)

Table 15. Mann-Whitney test results of group size comparisons by various group types.

Season	Group Types Compared					
	$2^+M/2^+F$	$2^+M/Y$	$2^+M/K$	$2^+F/Y$	$2^+F/K$	Y/K
<u>Winter</u>						
Probability	0.35	0.02	<0.01	0.05	<0.01	0.50
No. Groups	43/65	43/31	43/35	65/31	65/35	31/35
Relationship	(<)	>	<	>	>	(<)
<u>Spring</u>						
Probability	0.03	0.18	<0.01	0.84	0.04	0.13
No. Groups	30/59	30/27	30/39	59/27	59/39	27/39
Relationship	<	(<)	<	(>)	>	(<)
<u>Summer</u>						
Probability	0.03	0.16	0.02	0.92	0.75	0.95
No. Groups	8/14	8/9	8/22	14/19	14/22	9/22
Relationship	<	(<)	<	(>)	(<)	(<)

Population Dynamics

Fecundity.--When a mountain goat population is classified to age-class 2, and the sexes of adults are also broken out, it is possible to determine the number of kids relative to the number of mature females, and thus derive an index to fecundity. This is normally possible only in the more intensive research projects, where ample samples of the population are classified from the ground.

Caughley (1977) noted that the age of fecundity is often lower in rapidly-growing populations than those without positive growth. Stevens and Driver (1978) observed "several" 2-year-old nannies accompanied by kids in the introduced population of the Olympic Peninsula, Washington, thus implying some goats bred as yearlings. They also reported that no adult female observed during their study was seen without a kid. Two yearling mountain goats, on somewhat atypical habitat on the National Bison Range, Montana, were confirmed as pregnant (O'Gara, pers. comm.). No goats younger than age-class 2 bred in the Snake River Range population. However, during the rut, only a few age-class 2 males showed signs of breeding behavior (dirty pelage, use of rutting pits, etc.), and most of the breeding was believed to have been by older males. Several times during late summer of 1982, I observed what appeared to be a 2-year-old female with a kid, indicating that she bred at 1.5 years. Confirmation of the nanny's age was not possible, and she may have been a "low-quality" goat in age-class 3.

The onset of the kidding season, examined only during 1982, occurred during the last of May. Through 28 May 1982, I had not observed any new kids, but a severe snowstorm on that date severely hindered visibility. On 30 May, I observed 5 kids (including 2 sets of twins) among 6 older goats in the same area. By 21 June, and possibly as early as 14 June, the kid crop was apparently complete.

Kid:adult female ratios in the Snake River Range were high during both years of the study relative to other goat populations (Table 16). Fecundity and neonatal survival were likely higher in the Snake River Range during the study than in the other populations, but this was untested.

The Mount Baird herd had higher kid:adult female ratios than the Baldy Mountain herd during both years. Although the 1982 twinning rate was largest in the Baldy Mountain herd, the percentage of adult females with kids was much smaller (Table 17), accounting for the discrepancy in kid:adult female ratios between that and the Mount Baird herd. During 1983, the proportion of adult females with kids in the Baldy Mountain herd was about equal to that of the Mount Baird herd during 1982. Little change was seen in the twinning rate. At the same time, the proportion of adult females with kids further increased in the Mount Baird herd, and the twinning rate went up dramatically.

No attempt was made to ascertain the cause of the differences in productivity observed between the 2 herds. Both age-structure

Table 16. Comparison of kid:adult ratios between selected studies. Females 3 years of age or older were assumed to be mature.

Location	Source	Year	Kids per 100 Mature Females	Population Size
Alaska	Nichols 1980	1977[a]	108	45
		1977[b]	70	58
		1978[a]	79	41
		1978[b]	54	59
		1979[a]	77	42
		1979[b]	82	37
British Columbia	Dane 1977	1968	13	36
		1969	27	18
		1970	35	36
		1971	50	32
		1972	50	37
	McFetridge 1977	1974[c]	75	32
		1974[d]	27	23
		1975[c]	69	39-42
		1975[d]	80	31-33
Colorado	Risenhoover and Bailey 1982	1981	100	118
Idaho	This study	1982	90	104
		1983	114	141
Montana	Chadwick 1973	1971	44	25
		1972	73	29
		1973	89	31
	Smith 1976	1974	40	132
		1975	39	110
	Chadwick 1977	1974	56	314
		1975	55	300
		1976	57	232

[a] Ptarmigan Lake population.
[b] King's Bay population.
[c] Mt Hamill population.
[d] Goat Cliffs population.

Table 17. Summary of productivity indices for goats in the Snake River Range.

Productivity Index	1982 Palisades	1982 Big Elk	1982 Total	1983 Palisades	1983 Big Elk	1983 Total
AF's with no kids	6	2	8	4	1	5
AF's with 1 kid	6	9	15	14	6	20
AF's with 2 kids	3	2	5	5	5	10
Kids per 100 Mature Females	87	100	90	104	133	114
Proportion of Mature Females Without Kids	0.40	0.15	0.28	0.17	0.08	0.14
Proportion of Mature Females With Twins	0.20	0.15	0.18	0.22	0.42	0.29
Proportion of Productive, Mature Females With Twins	0.33	0.18	0.25	0.26	0.45	0.33

differences and range quality seem plausible explanations.

Physical maturation of young goats appeared to continue through the winter, but at a slower rate than during the remainder of the year. Most age-class 2 goats were distinguishable from other age-classes through mid-winter, and a few individuals were distinguishable through early spring. Although age-class 3 goats were not readily identifiable during early summer, behavioral cues and impressions of slightly smaller sizes, rostrum lengths, and horn size often hinted that certain animals were likely 3 years of age.

I was not able to reliably classify age-class 3 goats during either year of the study. However, of those nannies that I felt were likely to be 3-year-olds, none had twins. I suspect that the twinning rate (and by inference, parturition rate) among 3-year-old females was lower than that of older females. This would be in agreement with Fowler et al. (1980), describing a "hump-shaped" birth curve.

During the collection of activity data during late June 1983, a nanny with what appeared to be a set of triplets was observed for extended periods of time during a 4-day period (Whitfield, pers. comm. 1983). Suspected triplets were not observed during any full census and are not included in the productivity summary. Lentfer (1955) reported the only other suspected cases of triplets, in the rapidly-growing, introduced population of the Crazy Mountains of Montana. Of 311 kids observed during the 2 years of his study, Lentfer classified 3 sibling groups as triplets and suspected 3 additional sets.

Caution is necessary, however, in the interpretation of multiple birth statistics. On 19 August 1982, I witnessed 2 kids to leave a nanny in 1 group and join a different group. Disturbed by my presence, a group of 9 goats had slowly crossed the hillside away from me. One kid became separated from the rest of the group and began bleating loudly, whereupon the second kid broke from the group and ran back to the first. Neither the nanny or any other goats in the original group showed concern over the absence of the 2 kids, continuing across the hill and out of sight, more than 400 yards (364 m) away. Meanwhile, both kids began bleating loudly and were answered by a kid in a group that included a nanny and a 2-year-old male. The 2 kids then joined the new group, and after a 10-15 minute period of acquaintance and play, bedded next to the nanny. I observed this new group for the next 40 minutes, and the kids appeared to be well accepted into the new group.

Survival.--Survival estimates were influenced by dispersal as well as mortality as they could not be seperated. The survival rate for the entire population was 94% between 1982 and 1983. Survival was estimated at 92% for the classified portion of the population for this period, with no significant differences between kid, yearling, and average subadult/adult rates (G-test, $P>0.95$). Observed kid survival was 88%, yearling survival was 95%, and the average subadult/adult survival was 93%.

As indicated by growth rate, density-dependent regulation has apparently been minimal or absent to this point. The mortality incurred should, therefore, be composed almost entirely of density-independent mortality. Although I am not comfortable with estimating the level of density-independent mortality for the subadult/adult segments of the population, it seems reasonable to suppose a 5-7% density-independent rate of mortality existed during this time for the population as a whole, based on observed cohort changes from 1982 to 1983. Roughly a 12% density-independent mortality rate was estimated for kids (excluding the neonatal period), and a 5% rate for yearlings.

Density-independent mortality for this population is likely to be slightly less when compared to most mountain goat populations. Accidents, believed to be a major cause of mountain goat mortality (Chadwick 1973, 1977, 1983, Smith 1976), may not be as apt to occur as much here as elsewhere because of the cliffs and relatively low prevalence of avalanches.

Weather conditions may play an important role in density-independent mortality of kids in mountain goat populations. In terms of local winter precipitation, the winter preceding the 1982 kid crop was the most severe in the previous 26 years. This may have weakened at least the smaller, and presumably younger, nannies, and weakened those fetuses. On 28 May 1982, a heavy, wet snow fell and the weather remained very cold and wet through 7 June. This is the first and perhaps most crucial part of the kidding season in the Snake River Range. The combination of a harsh winter and a cold, wet kidding season probably contributed to high neonatal mortality.

The importance of predation on the population dynamics of mountain goats is unknown across their distribution. The largest potential predator for mountain goats, the grizzly bear (Ursus arctos) was not detected in the Snake River Range since the initial introduction (DeShon, pers. comm., 1982). Black bears (U. americanus) have been observed hunting in goat habitat (Foss 1962), but the black bear population in the Snake River Range is small. Black bear harvest in the Snake River Range was negligible well before the goat introduction, a reflection of relatively low population densities. Therefore, predation by bears likely has had a negligible effect on this goat population.

Coyotes (Canis latrans) are common on the Snake River Range and have been observed stalking goats, although the goats chased the coyotes away (Whitfield, pers. comm. 1983). At least 1 mountain lion (Felis concolor) resided in the Palisades Creek drainage throughout this study. Although lion tracks were encountered almost daily during late winter and early spring, no predation nor scavenging on mountain goats was detected. The low population death rate indicates that predation must be low despite high goat (potential prey) densities.

No legal hunting took place on this population prior to, or during this study. However, poaching has apparently affected this population. On 27 March 1982, during the first survey of the study, I found the headless carcass of a large adult billy. Apparently left within the previous 3 weeks, the carcass had been caped and left on a hiking trail below a winter range cliff. The caped carcass of another adult billy was found in the southeastern part of the range during a Wyoming elk hunt during September 1983 (Roby, pers. comm. 1983). Hunting was not allowed on this population until fall 1983. Casual reports from local residents indicate that 1 resident may have taken up to 4 illegal goats from this population, and there are rumors of illegal guided hunts. How much poaching has affected the growth of the Snake River Range population remains unknown. My presence in the range may have decreased the effect of poaching on the goat population during the study.

The survivability of a kid following it's nanny's death is unknown, but should be considered in evaluating the population dynamics of any goat population when any type of harvest is present. Foster and Rahs (1982) postulated that the separation of a nanny and her kid was not an uncommon phenomenon, and that orphaned kids will often join a foster group. They also supported Rideout's conclusion (1974, as cited by Foster and Rahs) that nanny/kid separations do not always lead to the kid's death, and noted that metabolic dependency on nursing is probably complete before mid-August under normal circumstances. Steven's (1983) observed an orphaned kid that joined foster groups, and survived the winter.

Logically, the probability of an orphaned kid successfully joining a foster group (or groups) is a function of goat density. In the Snake River Range, then, orphaned kids are likely to be less of a factor in population dynamics than in most populations because goat densities are high enough, and agonism levels low enough, to allow a good chance for an orphaned kid to "adopt" another group of goats.

Parasitism seems to be at a very low level in the Snake River Range population, and not an important mortality factor in current population dynamics. None of the 30 valid fecal samples collected during spring 1982 showed the presence of lungworms or any other parasite identifiable by the Baerman technique.

Potential for a major die-off from a parasite/disease complex clearly exists in the Snake River Range. Land-use overlap between goats and domestic sheep provides a vector for transmission of parasites and diseases.

Population Growth.--The observed rate of increase ($\bar{r}$) between 1 July 1982 and 1 July 1983 was 0.30 for the Snake River Range population. The observed rate of increase for the period from 1971 to 1983 was 0.22. By comparison, the maximum $\bar{r}$ attainable between 1982 and 1983 is 0.49, based on 1 kid/age-class 2 female, and 2 kids/older female. The observed rates of growth, 1971-1983, for the adult female, subadult/adult female, and the yearling/subadult/adult female segments of the population were all 0.19.

Fowler (1981) notes that $\bar{r}$ will increase as the mature age-classes make up a progressively large proportion of the population (and the population has not yet reached the threshold for density-dependence). As such, that the observed rate of growth during the study was greater than that since the transplant was expected. However, the 1982 population could have been underestimated, and $\bar{r}$ for 1982 to 1983 might be slightly less than 0.30. Still, these rates of growth are all very rapid, with the population doubling about every 3 years. Growth of the Snake River Range population presently appears similar to that calculated for the Gore Range, Colorado, and Crazy Mountains, Montana, transplants (Guenzel 1980) during the initial growth phase.

At $\bar{r}$ = 0.19, the summer 1986 population would be 260 goats and the summer 1989 population would be roughly 460 goats. Clearly, density-dependent decreases in fecundity and juvenile survival must occur very soon. Most introduced goat populations peak in less than 20 years, then stabilize at a lower level. The same can be expected in the Snake River Range, with the peak population likely to occur prior to 1989. The high densities of goats in the Snake River Range imply that the current population level is likely above the eventual stabilization point.

Dispersal.--Herd identity was generally maintained throughout the year, with no movement observed between the Baldy Mountain and Mount Baird herds during March and April 1982, between 1 December 1982 and 31 March 1983, or between 1 December 1983 and 31 March 1984. Demographic changes between herds from 1982 to 1983 and observations of goats between the 2 concentration areas indicate at least a partial mixing during summer and fall.

Extensive seasonal migrations were not detected during this study. A considerable amount of apparently suitable, but yet little-used summer range exists in the Snake River Range. Rough calculations of available habitat indicate summer densities could be reduced by up to 70% if all summer range was used. This would bring summer densities more into line with those of long-established populations. Colonization of new winter range is much more limited here, with approximately 85% of available low-elevation winter range currently occupied. Thus, although the establishment of a migration to new summer range seems possible, the lack of winter range appears to be more limiting.

In some areas, mountain goats winter on high-elevation ridges (Brandborg 1955, Lentfer 1955, Hjelford 1973, Hebert and Turnbull 1977, Rideout 1978, Adams and Bailey 1980, Adams 1981). This is also true for Rocky Mountain bighorn sheep in the adjacent Teton Range (Whitfield 1983). If goats in the Snake River Range adopt this strategy for overwinter survival, then winter densities too, could be reduced. The likelihood of this possibility is unknown.

Three avenues of dispersal from the Snake River Range could lead to vacant habitat. The Teton Range, to the northwest, is connected by a 7,072 foot (2,143 m) pass to the Snake River Range. The extent to which colonization of the Tetons has begun is unknown. Proliferation of mountain goats in the Tetons may lead to land-use and forage competition between the exotic mountain goats and the relict bighorn population.

The second and third avenues of dispersal involve crossing the South Fork of the Snake River above Palisades Dam. Flow of the river normally varies between 2,000 and 14,000 cubic feet per second with peak flows normally occurring during June (Nelson et al. 1976). Assuming the river is negotiable, mountain goats could move into the Salt River Range or the Gray's River Range in Wyoming. Gross inspection reveals that summer range is ample in both areas, but a lack of low-elevation cliffs could be limiting to a goat population in those areas. The Wyoming Department of Game and Fish verified 1 goat in the Gray's River Range during summer 1988 (Lockman pers. comm. 1989).

Stevens (1983) calculated dispersal rates for goats from the high-density Kluhane Ridge subpopulation in the Olympic Mountains of Washington. She found a 5-6% dispersal of 4+ females, a 20% dispersal of 4+ males, and an 18% dispersal of juveniles. Extrapolating these data to the Snake River population, a maximum 15% annual reduction could be expected given the 1983 age structure. Because densities are lower here than on Kluhane Ridge, a 10% rate may be a better estimate. Neither dispersal rate would overcome the current growth rate of the population (21-35%). Consequently, dispersal alone cannot be expected to reduce the density of goats on either summer or winter ranges.

Population Modeling.--Through experimentation, I derived a set of model parameters (App. 2) that tracked the observed growth of the Snake River Range population, and mirrored the 1983 population reasonably well (Table 18). I found achieving the 1983 population in 14 years of simulated growth was not possible using only the Palisades Creek transplant with realistic birth and survival rates. Consequently, I used all 12 goats introduced as my starting population, even though I had doubts this was completely accurate.

Stochastic variation may have allowed a sex ratio at birth weighted towards females, thus allowing more rapid growth with a smaller initial population than modeled. Likewise, the difference between observed, and modeled growth using only the Palisades Creek transplant, could be attributed to the step-function of true population growth, rather than the smooth growth function of the model, which uses "portions" of animals. A third argument could be made that either yearling females bred successfully in the early years, or that the birth rate of age-class 3 goats was severely underestimated. No evidence for these arguments exists however. A fourth explanation is that 1 or more females from the Black Canyon transplant dispersed to the Palisades Creek drainage. I chose this explanation as the easiest to model, resulting in a model more general than originally planned. Note that this model is not appropriate for population projections. Its sole function is to mirror prior growth.

Modeling efforts suggest that growth from 1969 to 1983 was essentially density-independent. Density-independent rates for mortality used in the model are listed in Appendix 2 under the

Table 18. Modeled and observed population characteristics. Modeling parameters are contained in Appendix 2.

Parameter	Observed Population	Modeled Population
Population size - 1983	141	143
Kids per 100 older goats (1+)	32	39
Yearlings per 100 older goats (2+)	39	39
Two year olds per 100 older goats (3+)	40	38
Adult males per 100 adult females	51	59
Kids per 100 2+ females	93	89
Kids per 100 3+ females	114	118

heading "minimum". Density-independent birth rates, which also incorporated neonatal mortality, are listed under the heading "maximum".

Calculations with kid and yearling cohorts suggest that the kid mortality rate was relatively high during the 1981-1982 winter. The summer 1982 yearling cohort included 22 goats. Applying the observed 1982-83 kid survival rate to this, the 1981 kid crop would be roughly back-calculated at 24. During 1982, 26 kids were born. By comparison, the observed 1983 kid crop was 40.

The lack of a large difference between the 1981 and 1982 kid crops, and the large difference between the 1982 and 1983 kid crops could feasibly be the result of an anomaly in the age structure. However, this seems unlikely. In terms of precipitation, this winter ranked 20th wettest since 1914, when records were first kept at the Aberdeen Experimental Station, approximately 90 miles (144 km) to the southwest. In terms of minimum monthly mean temperatures, that winter ranked 26th coldest. A harsh snowstorm also hit the area on 28 May, at the beginning of the kidding period. Cold, wet weather associated with this storm persisted for 9 days. Although it appears that increased kid mortality was experienced during this period, it is impossible to determint if this was due to density-dependent, or density-independent factors, or a combination of both. Because twinning was apparent during 1982, I suspect that much of the increased mortality was density-independent.

A weakness of a non-stochastic model like Lesmod is that the annual carrying capacity does not change. In actuality, K changes from season to season as well as year to year, and can increase or decrease in time as an average for several years. This has important implications for any population that can grow rapidly, because of the possibility of radically overshooting an annual K.

Growth of an introduced species often involves an initial period of rapid (often assumed to be logistic) growth, an overshooting of K, and the eventual stabilization at a somewhat lower K (Caughley 1977). For ease of reference, I will use K_a as the annually-determined carrying capacity. Changes in K_a from year to year are a function of precipitation, length of growing season, plant vigor, etc. K_s is the carrying capacity at stabilization, the carrying capacity for established populations over a longer period of time. Essentially K_s is the average of several K_a's.

The traditionally stated goal in managing introduced species is to maintain the population at the highest K_s. This, however, is difficult to achieve. Annual changes in K_a are extremely important to population growth rates as density-dependent changes in birth and death rates begin to take place. The young age structure of a population previously growing at a rapid, density-independent rate greatly exaggerates the effect of K_a on a population because environmental stress will affect the large, young age-classes first (Fowler et al. 1980).

If the population is rapidly approaching K_s, and even a single K_a is very much higher than K_s, the population will severely overshoot K_s. If the next K_a is near or below K_s, there will be far too few resources available per individual, and dramatic density-dependent changes will occur. This is even more pronounced in species that breed as yearlings rather than 2-year-olds. Based on this modeling, goat densities elsewhere, and the possible initiation of density-dependent mortality during the 1981-82 winter, I believe that the Snake River Range population was near K_s during 1983.

MANAGEMENT RECOMMENDATIONS

1. Maintain less than about 125 goats each in the Palisades Creek and Big Elk Creek drainages. This level keeps densities at levels closer to that of established populations. I doubt that either winter range could support a higher density for an extended period of time. The density problem could be as severe on transitional and summer ranges on Baldy Mountain.

   This population size above would also help minimize the chance of adversely affecting the relict sheep population of Grand Teton National Park. It is a valid concern that permanent colonization of the park by goats could easily lead to the reduction or elimination of the native bighorn population. These bighorns are cut off from their traditional winter range on the east side of Jackson Hole by development in the valley. Presently they winter on ridges above 10,000 feet (3,030 m) in the Tetons, moving to high elevation cliffs during the early spring melt-freeze cycles (Whitfield 1983). These areas, critical to the sheep, are more typical of goat habitat than sheep habitat, and it is probable that goats would better compete for these sites.

2. Conduct an interagency meeting once every 5 years to update everyone on current status, and provide informed management. The Idaho Fish and Game Department should provide the lead, with meetings held prior to drafting that agency's 5-year mountain goat management plan. Other agencies should include the Targhee National Forest, the Bridger-Teton National Forest, the Wyoming Department of Game and Fish, and Grand Teton National Park. Each agency has a valid interest in the management of this population, and the different perspectives and goals should be considered in its management.

3. Remove by hunting or trapping, 15-20% of the actual population annually during the eruption phase. If monitoring indicates birth and/or survival rates have declined to rates comparable for other, nearby populations, reduce harvest to approximate that for those populations. Removal at the 15-20% rate should not be weighted toward males; it is absolutely necessary to remove 15-20% of the females. While in the initial harvest phase, I recommend the "female-with-young-at-her-side" role be eliminated for these hunts. This removal will allow the population to reach a more gradual equilibrium with the browse on the core winter ranges. It may, however, also slow colonization of vacant habitat.

4. Monitor population size; observed twinning rate; and kid, yearling, adult female, and adult male population proportions on an annual basis. Change in the twinning rates may be the best measure of population status in the absence of data on population size and distribution. Summer ground surveys, conducted by a minimum of 5 persons, should be used exclusively. All surveys should take place between 15 July and 15 August. Standard routes and instructions are included in Appendix 3.

5. Monitor winter distribution on a 5-year basis. Helicopter surveys should be used exclusively, with the survey taking place between 15 January and 15 February. This will allow distribution to stabilize following the rut, and prevent redistribution from unusual weather conditions. No attempt should be made to classify goats, but all goats observed and goat tracks should be mapped. It is also extremely important to record areas surveyed, but where no goats were found. Standard search units should be flown to help ensure continuity of coverage. I re-emphasize the need to count nearby search units presently devoid of goats, but which appear to have the potential to harbor goats in future years. It is imperative that some time be spent in each drainage between Rainey Creek and Indian Creek (inclusive).

6. Ensure that access is not increased for any of the 4 major seasonal ranges. Motorized access to the seasonal ranges was relatively limited during the study, and should remain so to protect this population. Non-motorized access is also a

concern. Current road standards should be maintained in the Palisades Creek and Big Elk Creek drainages to ensure minimal disturbance for these extremely critical areas. The road along Rainey Creek should not extend beyond the NW quarter of Section 25, Township 2 North, Range 44 East, where the bridge is currently washed out. Backcountry use between Rainey Creek and Palisades Creek, southwest of the Water Canyon/Chicken Springs trail (U.S. Forest Service No. 092) should not be encouraged. Overnite use should be prohibited in this area. Under no circumstances should a trail be blazed from the pass at Paradise Basin to Baldy Mountain, as this would increase disturbance in this small area. Recreationists may have a major impact on goats on the Baldy Mountain summer range.

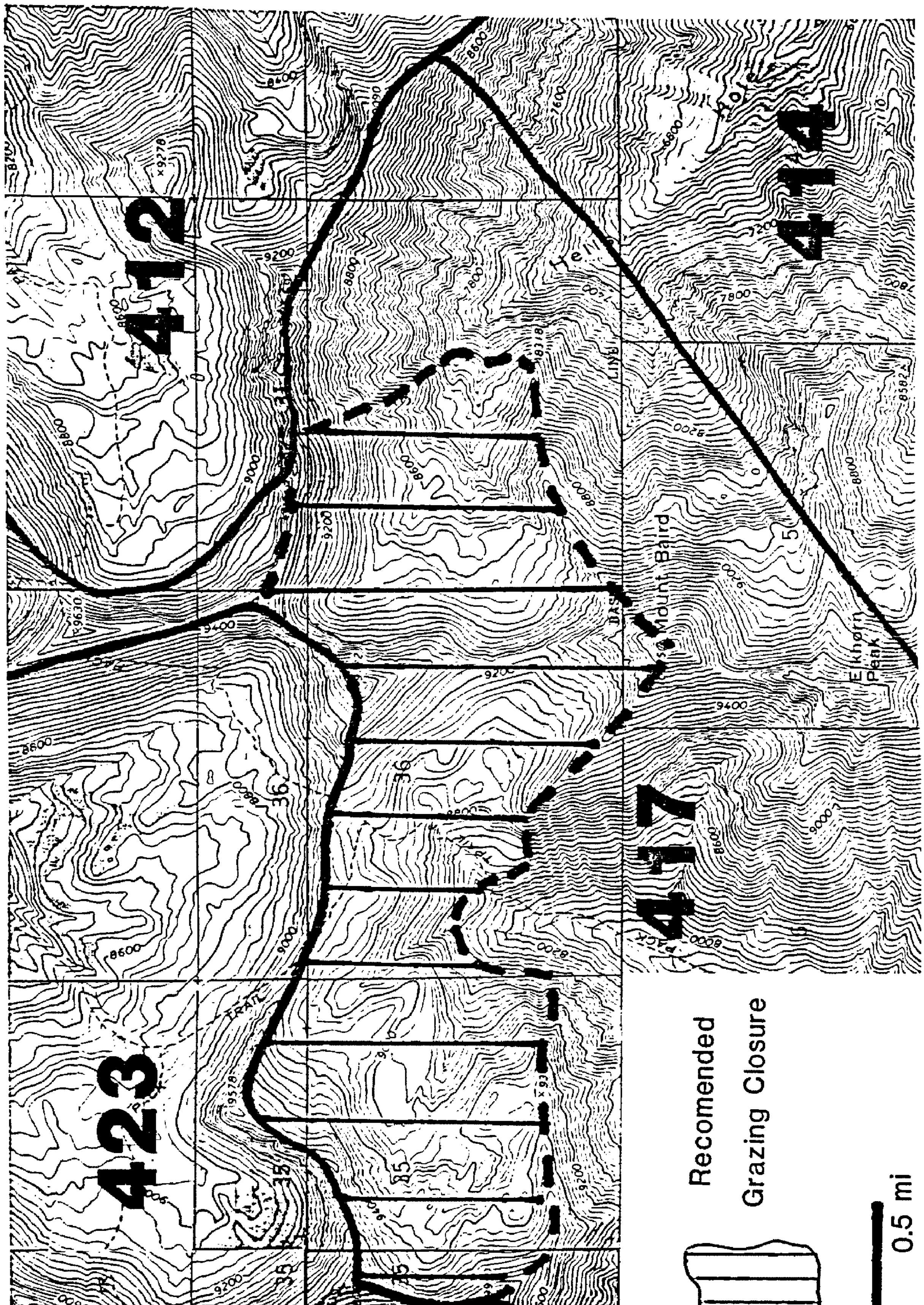
Protection from disturbance during summer may be as important in the Baldy Mountain area as protection on winter ranges. Access to the eastern rim of the Baldy Mountain cirque is relatively easy. This area receives the most overnight and day use. Merely walking this half of the rim, will disturb up to a third of the entire Baldy Mountain herd (60-75 goats), moving them to cover out of sight. Overnight use is more critical, precluding use of an important summer foraging area on the east rim, and reducing use on the west rim during the early morning and late evening feeding periods.

Recreational use of this summer range could reduce the habitat available to where the population is affected even at relatively low recreational levels. No unoccupied summer range is available in this area, and goats displaced from a portion of the summer range must either concentrate on other portions of this summer range, move to adjacent marginal habitat, or entirely disperse from the area.

7. Avoid any domestic grazing on key ranges. There should be no domestic grazing on the Baldy Mountain/Palisades Creek summer or winter range. This is similiar to what is planned in the Targhee National Forest Land Management Plan (USDA 1985). Three changes should be made, however, in the Mount Baird area. Grazing should be eliminated on a portion of sheep allotment 417 between Elkhorn Peak, Hell Hole, and Sheep Creek Peak (Fig. 13). No sheep grazing should occur west of Big Elk Creek in Allotment 414. No trailing of sheep should be allowed on the Sheep Mountain/Elkhorn Peak ridge complex. These grazing changes are highly desireable to maintain health of this goat population.

8. Avoid large-scale treatment of curl-leaf mahogany should be done on any winter range until test plots have been evaluated for at least 3 years. Soils on south-facing slopes are thin in many places, and reproduction will be slow. Mortality rather than sprouting should be expected from mahogany treatments, especially because the curl-leaf mahogany in this area is so old (especially on the Palisades Creek winter range). Treatment may, indeed, be highly desirable, but care should be taken to proceed slowly.

Figure 13. Area recommended for domestic grazing withdrawal because of high value to mountain goats.


412
414
417
423
Mount Baird
Elkhorn Peak
Sheep Creek Peak
Recomended
Grazing Closure
0
0.5 mi
N

9. <u>Bank blood serum at appropriate locations, and through blood analysis, monitor current incidence of exposure to pasteurellosis, para-influenza, and para-tuberculosis.</u> This population will not grow indefinitely, and may be expected to go through a corrective decline phase in the near future. Because of the very high goat densities, and an exposure to domestic sheep, disease (and parasites) may very well be the agent for a major decline. In the future, it may be important to be able to identify the source of any casual disease.

RESEARCH RECOMMENDATIONS

Potentially, the greatest value of the Snake River Range population of mountain goats lies in research. Because of this populations position on the growth curve, its isolation, and its relative accessibility, answers may be sought regarding dispersal, the importance of social behavior, habitat requirements, and, most importantly, population dynamics.

The most basic question that needs to be answered before mountain goat populations can be managed is "How do the various population attributes change with respect to resource allocations?" Current goat management is crude, based primarily on past mistakes and successes - a trial-and-error approach made necessary by the lack of reliable knowledge.

Recently, 2 hypotheses have evolved concerning how the population dynamics of mountain goats react to resource allocation, usually indexed as population density. These hypotheses (Kuck 1977, Swenson 1985), which attempt only a very general answer to the question, are somewhat contradictory and both remain untested. Testing such hypotheses requires a tremendous intensity of monitoring of social behavior, physical condition, and distribution as well as birth and survival rates (by sex and age cohorts).

To test hypotheses for density dependency, 3 approaches are obvious: 1. manipulate an established population; 2. compare various populations at different resource allocation levels; and, 3. monitor a single, newly-introduced population as it naturally progresses through various resource allocation levels. The monitoring is the same in all 3 instances. Kuck (1977) concluded there was no compensatory response in mountain goats after studying an established population in the Pahsimeroi's of central Idaho. Swenson (1985) concluded there was a compensatory response following an analysis of historical data from an introduced goat population in the Absorka's of southern Montana. However, in neither case was monitoring at a level that could do anything but suggest hypotheses. My only research recommendation is a major one: a 10-year comparison of the various population attributes of the Snake River Range population to those of other populations at different population densities. Logically, a comparison between the Snake River Range, Pahsimeroi, and Pend Oreille populations would provide information from several population densities. These 3 populations have the advantage of prior population information (this study, Kuck 1977, Naylor unpubl. data) that would be invaluable in analysis. Specific goals of such a study might include how various levels of space or forage affect birth rate, death rate, dispersal, physical condition (e.g. N_2 and DAPA levels), distribution, habitat use, grouping, horn growth, activity/energy budgets, agonism, and social heirarchy.

Commitment to a large-scale study such as this would provide the only reliable management basis for this species anywhere in its distribution.

In lieu of such a study, it is my recommendation that a graduate student, preferably a PhD candidate, be given the task of addressing social behavior differences between this population and the Pahsimeroi Range population. Done properly, such a study could provide insight into the affect of density on other population attributes. Cost of such a social behavior study would be relatively inexpensive as no trapping, radio-collars, or collar monitoring would be required. The value of the Snake River Range population for research is in answering questions of density-dependence - a value that is predicated on the population being at a relatively density-independent level.

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APPENDICES

Appendix 1. List of mountain goats observed outside the major concentration areas.

Date	Group Composition	Location
4/3/82	1 unknown	Hughies Gulch, 1 mi. S. of Black Canyon, B.H.
4/18/82	4 unknown	Hughies Gulch, 1 mi. S. of Black Canyon, B.H.
7/21/82	1 unknown	Twin Peaks, east side B.H.
7/22/82	3 unknown	Twin Peaks, east side B.H.
7/30/82	1 unknown	South side Black Canyon, S.17
9/9/82	2 adult males	Twin Peaks east side B.H.
9/22/82	1 adult male, 1 yearling male	Mosquito Pass
3/20/83	2 adults	N. side Barn's Cr., S.1
3/26/83	1 kid, 1 adult, 1 unknown	Bear Gulch, B.H.
7/20/83	1 unknown	Blowout Canyon
8/21/83	2 adult males	Ferry Peak
8/26/83	2 adult males	Taylor Mountain, Teton Range

Appendix 2. Parameters used in Lesmod (Metzgar, Unpubl. data) to model growth of the Snake River Range mountain goat population.

Female Birth Rates

Age Class	Minimum	Maximum	P50P	P95P	Rate at K
0	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00
3	0.30	0.54	0.96	1.26	0.39
4	0.31	0.65	0.96	1.26	0.44
5	0.31	0.65	0.96	1.26	0.44
6	0.31	0.65	0.96	1.26	0.44
7	0.30	0.60	0.96	1.26	0.42
8	0.28	0.55	0.96	1.26	0.39
9	0.26	0.50	0.90	1.26	0.32
10	0.26	0.50	0.90	1.26	0.32
11	0.26	0.50	0.90	1.26	0.32
12	0.26	0.50	0.90	1.26	0.32
13	0.26	0.50	0.90	1.26	0.32

Female Death Rates

Age Class	Minimum	Maximum	P50P	P95P	Rate at K
0	0.12	0.75	1.09	1.40	0.29
1	0.09	0.50	1.10	1.67	0.23
2	0.09	0.35	1.10	1.67	0.18
3	0.05	0.25	1.10	1.67	0.12
4	0.05	0.25	1.10	1.67	0.12
5	0.05	0.25	1.10	1.67	0.12
6	0.05	0.25	1.10	1.67	0.12
7	0.10	0.30	1.10	1.67	0.17
8	0.15	0.35	1.10	1.67	0.22
9	0.20	0.40	1.00	1.57	0.30
10	0.25	0.45	1.00	1.57	0.35
11	0.30	0.50	1.00	1.57	0.40
12	0.50	0.75	1.00	1.57	0.63
13	0.75	1.00	1.00	1.57	0.88

Appendix 2 (Continued)

Male Death Rates

Age Class	Minimum	Maximum	P50P	P95P	Rate at K
0	0.15	0.75	1.09	1.40	0.29
1	0.18	0.50	1.05	1.50	0.31
2	0.18	0.40	0.98	1.60	0.30
3	0.20	0.35	0.98	1.60	0.28
4	0.15	0.30	0.98	1.60	0.23
5	0.15	0.30	0.98	1.60	0.23
6	0.15	0.30	0.98	1.60	0.23
7	0.20	0.35	0.98	1.60	0.28
8	0.22	0.37	0.98	1.60	0.30
9	0.25	0.40	0.98	1.60	0.33
10	0.30	0.45	0.98	1.60	0.38
11	0.35	0.50	0.98	1.60	0.43
12	0.50	0.75	0.98	1.60	0.63
13	0.75	1.00	0.98	1.60	0.88

Appendix 3. Standard survey procedures for assessing population status of mountain goats in the Snake River Range.

Overnite camping is required for surveying either the Baldy Mountain, or Mount Baird summer range. Water is sometimes difficult to obtain during mid-August, so plan accordingly. Frequently, sufficient water can be obtained from snowpack runoff through late July. In both cases, plan a day to hike in, a day for the survey, and a day to hike out.

Essential equipment includes a good spotting scope with tripod, binoculars, topographic map(s), data form, pencils, and a watch. A compass is helpful in plotting locations in some instances. Some areas are difficult to hike; horses are inappropriate except to get to the survey routes.

Summer surveys should be done during the first 2 weeks of August to allow snow to recede, yet allow sufficient snow for drinking water. Group sizes are greatest during this period, allowing better sightability.

The route should be started as early after daybreak as possible to take advantage of early morning activity. During summer, goats normally are inactive for much of the day, bedding under trees, behind rocks, or in eaves. Use this period for travel or a siesta, rather than spending too much effort trying to locate goats. During other seasons, goats appear more active during midday.

I strongly emphasize the need to go slowly and glass frequently. Look at all areas possible, and don't forget to look in brushy areas and areas with considerable cover. Glass distant areas also, especially ahead of you, to locate goats that would be hidden by terrain or cover if you were closer. During hot summer days, be certain to search out areas under individual trees in the shade, and in the shadows at the base of cliffs. When you come across a goat bed, notice the surrounding area, and search out similar areas.

Even after you've watched a group of goats, marked them down, and go on to new groups, be sure to glass the previously-located groups again to see if you can pick up a goat or 2 that was not sighted earlier. This will also help you keep track of these groups so you don't inadvertedly count them twice simply because they've changed location.

When looking for goats, and especially when trying to get close enough to classify a group of goats, try to approach from uphill. Not only will classification be easier because they are more visible, but you can usually approach closer because they don't look uphill as often as downhill.

When a group of goats is observed, accurately map their location with a letter to be referenced on the data form, which can usually be copied onto the back of the map. On the data form, fill in the sex/age composition of the group, and the time. This will come in handy for eliminating duplicate sightings from different observers. Be sure to classify goats at least to the kid or older goat level. If possible, record the number of females with no kids, a single kid, or twins. Mark your route of travel on the map, with the time at hourly or 2-hour intervals.

Baldy Mountain Summer Range

The best access to this summer range is by driving up Rainey Creek to the end of the road (where the bridge washed out). This is a 4-6 hour climb to camp. You'll need a day up, a day for the survey, and a day for the trip back. Hike up Spring Creek, then Water Canyon to the ridgetop above Chicken Springs. Head south up the ridge about 1.5 miles to the area marked camp on Figure 14. Water can be found dripping off drifts in the contours through late July, often into mid-August. It is possible to do this route with 1 person, however, 2 are preferred.

Route A, the east rim route (next to camp) requires relatively little travel, but considerable glassing. Most goats will be observable from this route. Glass all areas repeatedly. During the mid-day sun, and during storms, goats can commonly be found in the several shallow caves in the southwestern corner of Section 6. Look in basins on all aspects. The large basin south of Baldy often has as many goats as the cirque to the north. I suggest staying at observation point A or B during the very early morning hours (looking into the south basin) and observation C during the late evening (looking into the cirque).

Route B, the west rim route, is more strenuous. From camp, some will find it easier to climb down into the cirque, crossing, and climbing up the west side. Others may prefer crossing the south rim of the cirque and climbing Baldy Mountain from that side. Crossing the cirque is safer. (This observer should definately have a flashlite in case it gets dark before the return trip.) Again, the route is not exceedingly long, and careful glassing is necessary. Care should be taken not to move goats out of the basin so the route A observer will not become confused. I suggest starting at the southern end of the route and moving northward down the ridge. In the evening, the cirque can be crossed without disturbing goats too much.

Mount Baird Summer Range

The best access to this summer range is via Little Elk Creek, camping in the basin on the northwest side of Mount Baird. It is also a 4-6 hour hike. The water situation is similar to the Baldy Mountain area, so plan accordingly.A minimum of 3 observers, preferably more, are needed for this survey. There are 3 separate routes (Fig. 15) that can be done on successive days by a single person, but accuracy will be sacrificed. None of the routes are appropriate for horses.

Figure 14. Survey routes for the Baldy Mountain summer range.

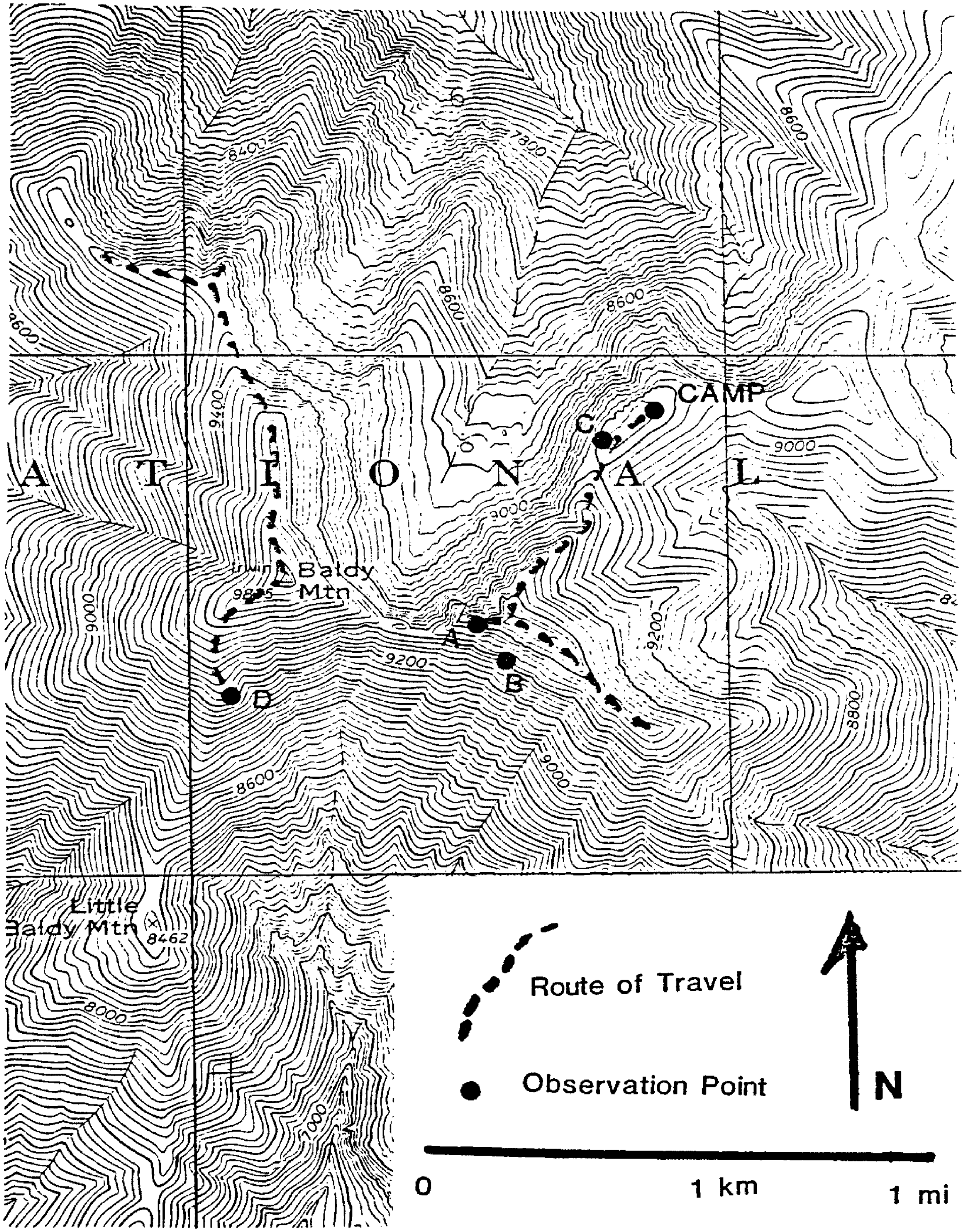
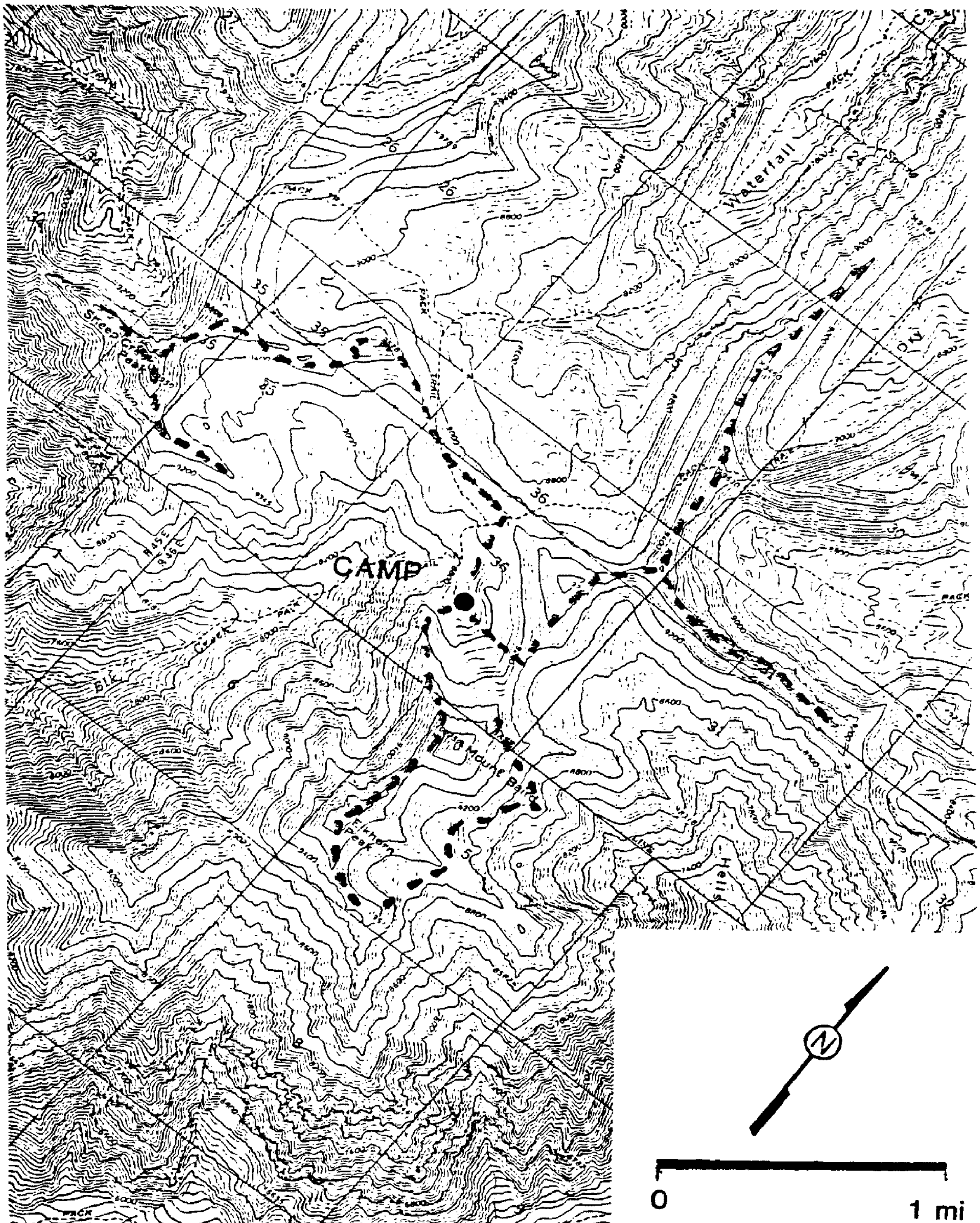

6
8400
7800
8600
8600
8600
8600
CAMP
C
9000
9400
A T I O N A L
9000
Baldy
Mtn
9825
A
9200
9200
B
D
9000
8800
8600
9000
Little
Baldy Mtn
8462
8000
Route of Travel
Observation Point
N
0
1 km
1 mi

Figure 15. Survey routes for the Mount Baird summer range.


CAMP
Waterfall
N
0
1 mi

Route A, the Elkhorn Route (Fig. 16), is by far the most difficult route of the 3. Because of the steep nature of the terrain around Mount Baird on Elkhorn Peak, 2 observers are preferred for this portion of the route. Good boots are a must. From camp, observers should climb the northwest ridge to about 9,600 feet, just below the peak. Then hike south along the sidehill to the saddle between Mount Baird and Elkhorn Peak. During this hike, pay particular attention to the Little Elk Creek drainage to the west on Sheep Creek Peak. Take some time in the saddle area to look also to the east, moving around to get views of different areas. Hiking south and easterly will bring you to observation points A and B, where you should spend additional time glassing. The return route is difficult, dropping you into several basins below Elkhorn and Mount Baird peaks. Plan to reach observation point C in time to leave yourself an hour of evening glassing, and a half hour to cross to the saddle to the north of Mount Baird. Observers on this route should have a flashlite for emergencies. Most of the goats should be observable from this route.

Route B, the Sheep Creek Peak route (Fig. 17), involves a little more hiking, but the terrain is much less severe than the Elkhorn Route. This observer will need to spend time looking into Waterfall Canyon and Sheep Creek as well as concentrating on Sheep Creek Peak. Three observation points (D, E, and F) should allow viewing of most goats on this route.

Route C, the Dry Canyon Route (Fig. 18), is the most extensive of the 3 routes. The terrain is relatively easy. The primary area of observation is Hell Hole (at least partially covered by route A). This observer should also glass Austin Canyon, Waterfall Canyon, and Dry Canyon. In the past, I've used the ridge between Dry Canyon and Austin Canyon, but it may be advisable to use the ridge betwen Dry Canyon and Waterfall Canyon instead, looking across Dry Canyon to the east. The early morning hours should be spent at observation points G and H, looking into Hell Hole and onto Mount Baird. Return to point G by evening for the final viewing of the day.

Palisades Creek Winter Range

This survey route is accessed via Palisades Creek. March is the best time to do this survey because the goats have usually established trails by this time. Glass both sides of Palisades Creek throughout the route. It will be very difficult to classify goats across the drainage, but numbers and locations of goats observed will make for a better survey.

For efficiency, this survey is divided into 2 routes (Fig. 19). Route A is the high cliff band route, route B is the low cliff band route. Although I recommend a person for each route, 1 person can do both routes successively in a long day. Moreso than other surveys, these routes require climbing among the goats, usually along the tops of the cliffs. During March, temperatures have usually warmed enough to settle the snowpack and allow goats to form good paths along the cliff bands. Observation point A is the most critical if goats are found at all in the upper cliff band (7,000-7,600 feet in elevation).

Figure 16. Survey route for the Elkhorn Peak portion of the Mount Baird survey.

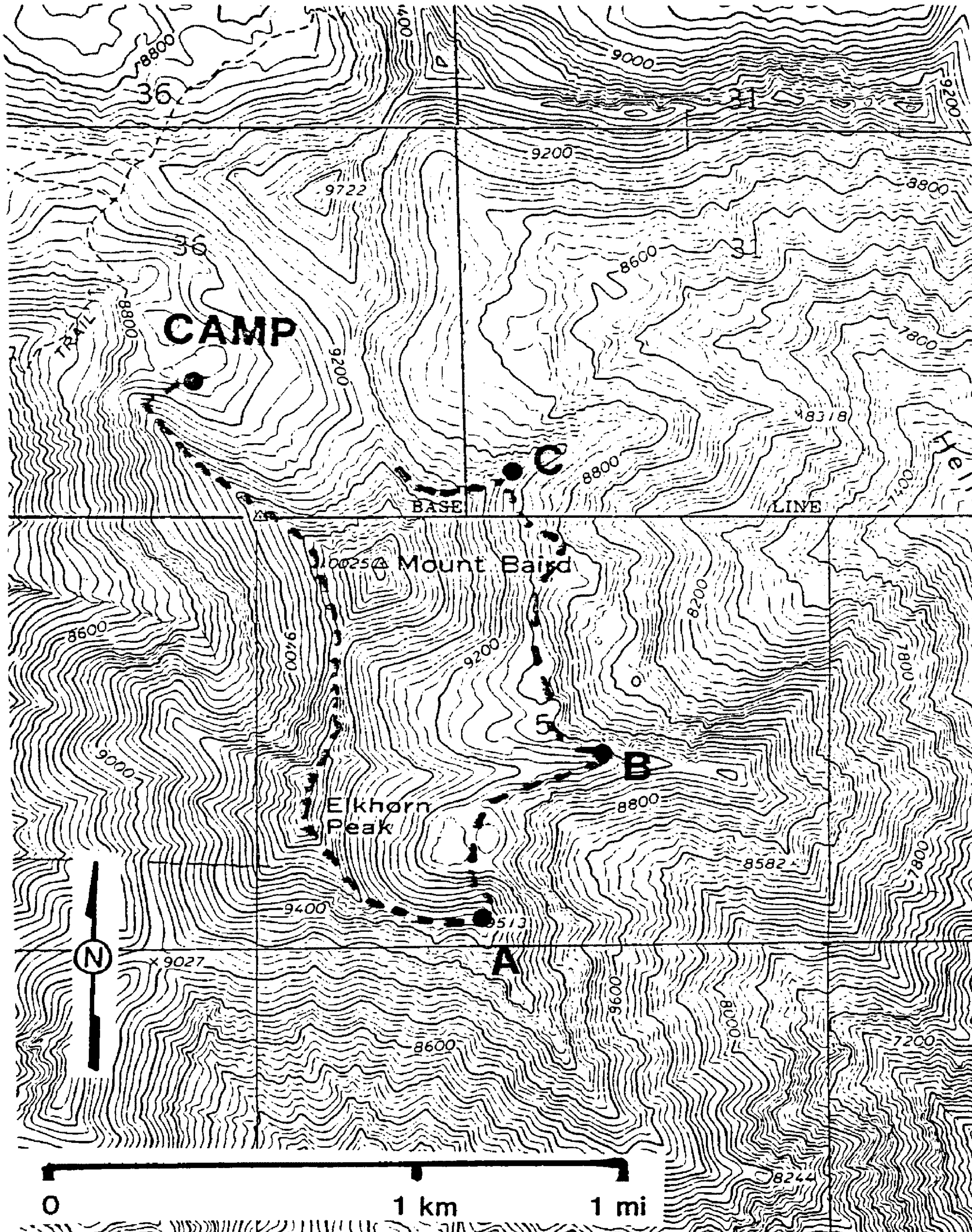

CAMP
C
B
A
Mount Baird
Elkhorn Peak
BASE
LINE
TRAIL
9722
9200
9000
8800
8600
8318
7800
9400
9027
8582
8244
7200
36
31
5
0
1 km
1 mi

Figure 17. Survey route for the Sheep Creek Peak portion of the Mount Baird survey.

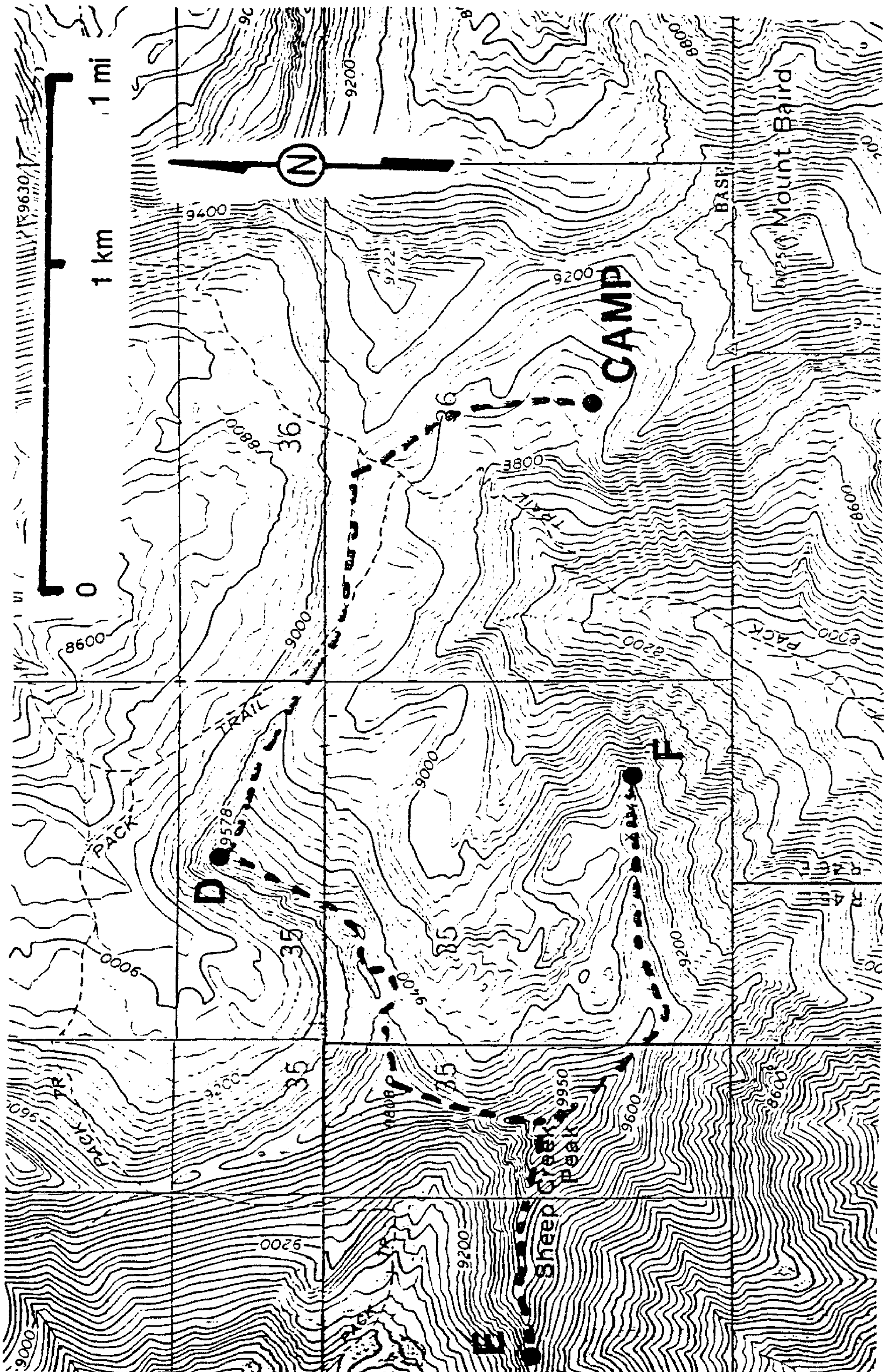

0
1 km
1 mi
N
CAMP
D
E
F
9578
Sheep Creek Peak
9950
Mount Baird
BASE
PACK TRAIL
9200
9000
9400
9600
8600
8800
9722
35
36

Figure 18. Survey route for the Dry Canyon portion of the Mount Baird survey.

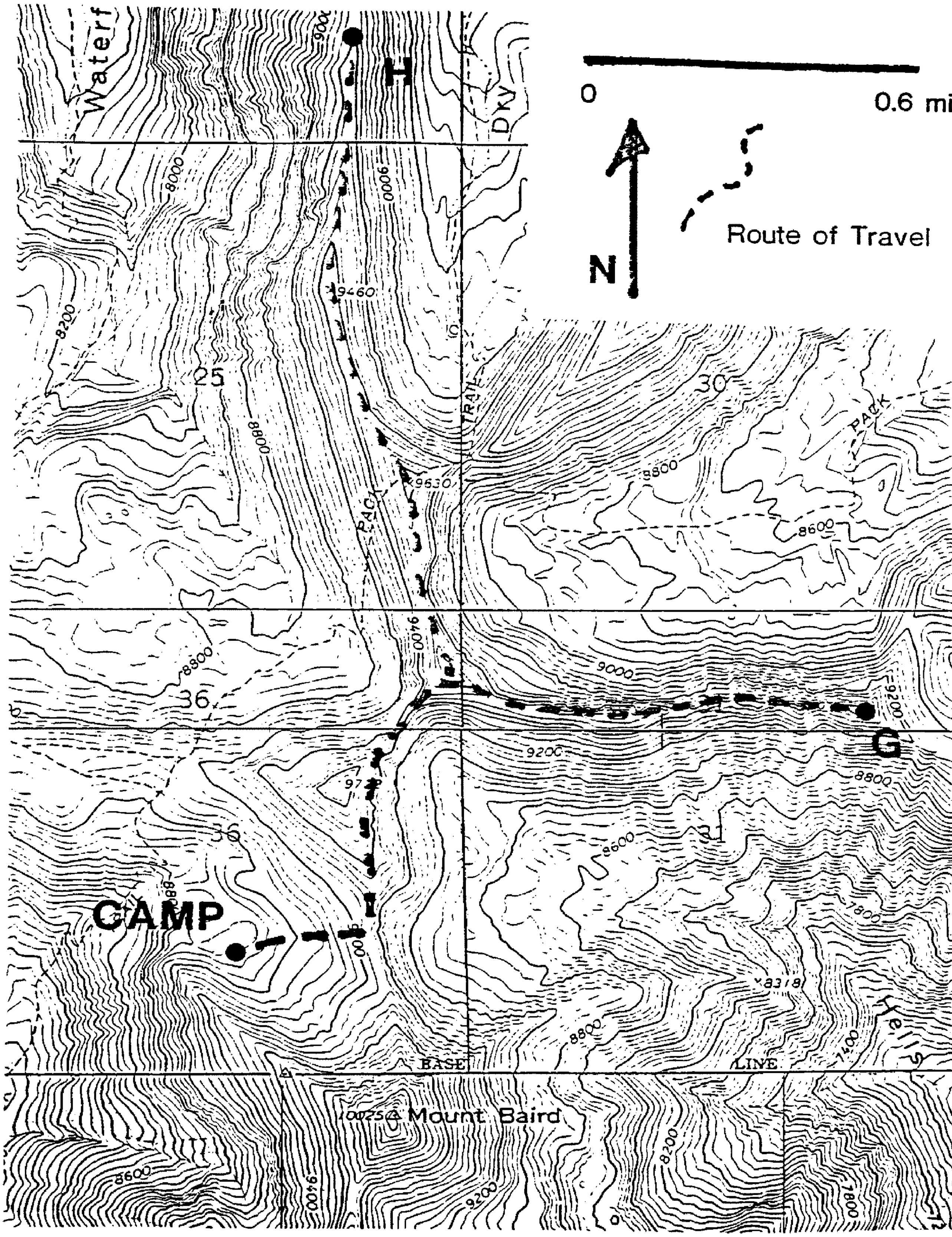
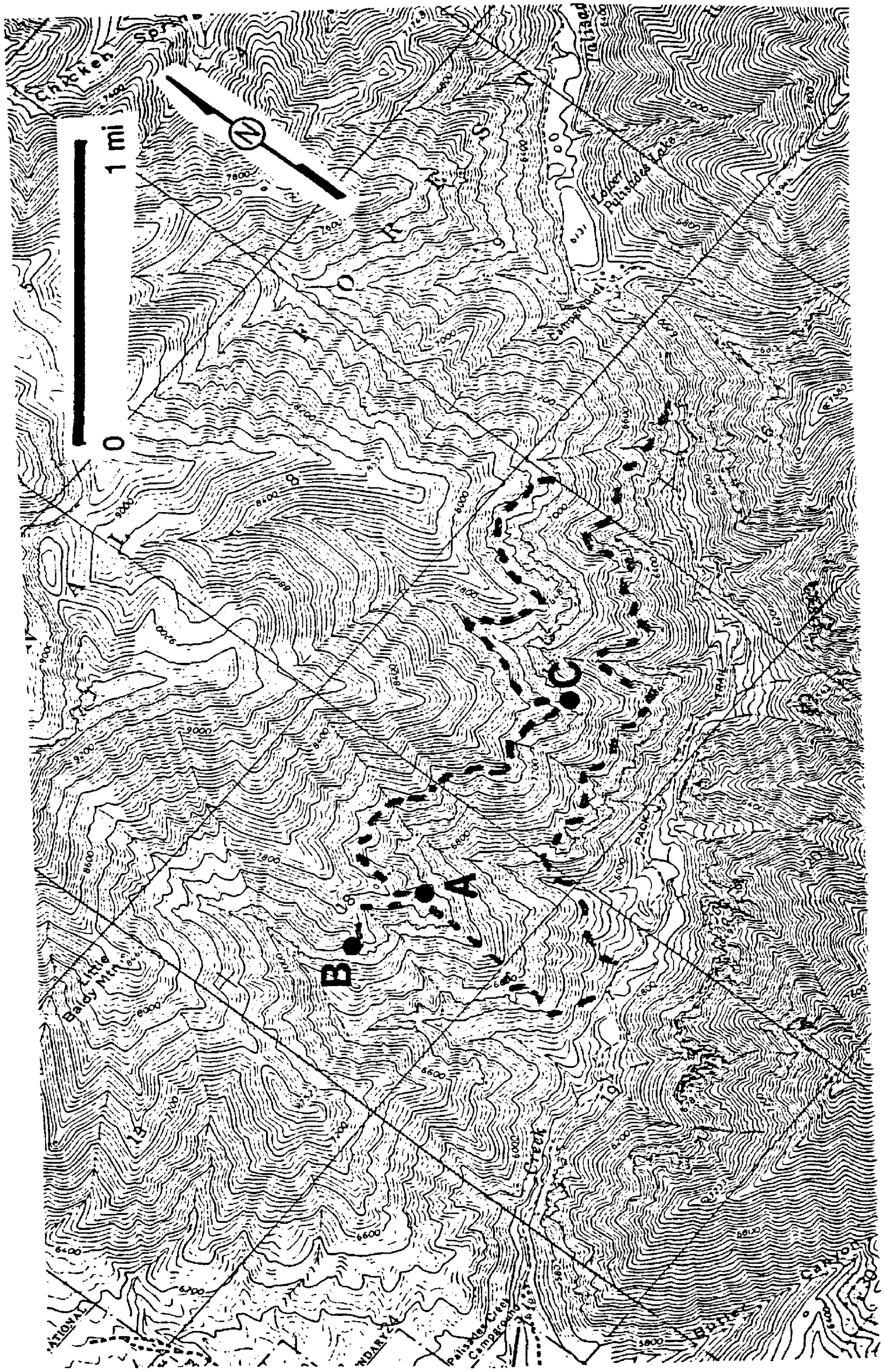

0
0.6 mi
N
Route of Travel
H
G
CAMP
Mount Baird
BASE
LINE
TRAIL
PACK
25
30
36
31
9460
9630
8800
8600
9000
9200
8200
8000
8318

Figure 19. Survey route for the Palisades Creek winter range.


0
1 mi
N
A
B
C
Little Baldy Mtn
Lower Palisades Lake
Campground
Creek
Canyon

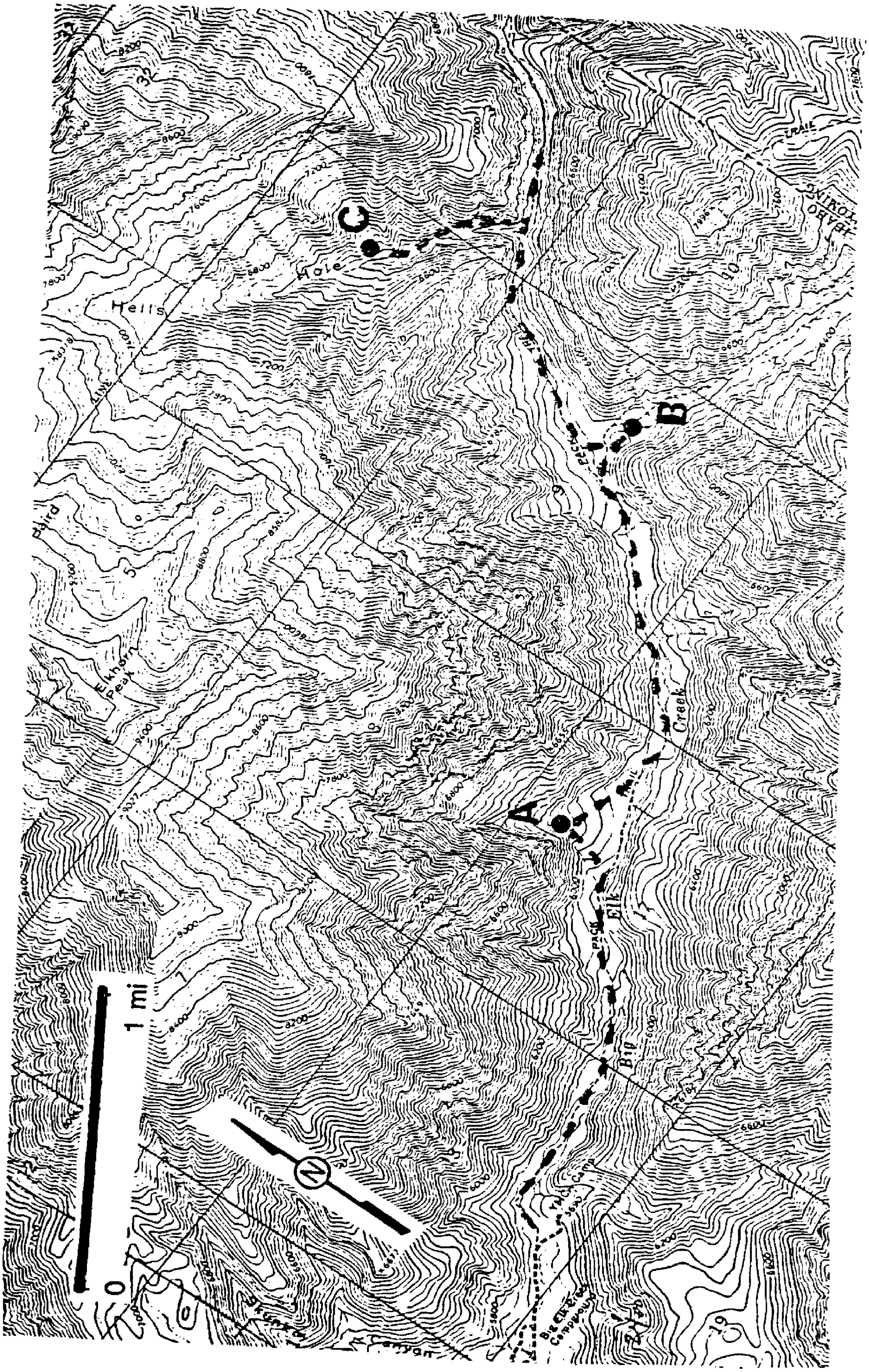
Observation point B is important for lacating goats in the first basin. Travelling along the cliff tops to observation point C usually reveals goats not visible from either observation point. There are no obvious observation points on the lower cliff band route (6,200-6,600 feet elevation), and most goats will be encountered at relatively close range. The observer for this route should also pay attention to the cliffs on the southern side of Palisades Creek, especially during late March.

Big Elk Creek Winter Range

The road from the highway to the YMCA camp is not normally plowed. The best solution is to snowmobile to the camp, then cross-country ski the route. This route (Fig. 20) is run almost entirely from the bottom of the hill. As such, goats are much more difficult to observe. The cliff configuration makes it almost impossible to move through the cliffs from basin to basin. The only solution would be for 4 (or more) individuals to climb into individual basins to observe goats within those cliffs, then return to the bottom at the end of the day. This would provide the best estimate of the population in this drainage.

Time should be spent at the base of each small basin, repeatedly glassing the entire area. Skiing into Dry Creek for about 200 yards facilitates viewing the south-facing slope. The south-facing slope of Dry Creek should be glassed also. The cliffs at the mouth of Hell Hole on the north side should be viewed as the end of the route. Travel into Hell Hole itself is especially important during spring, as goats frequently begin moving into this area during late March and early April. Observation points located on the map are the best viewing locations.

Figure 20. Survey route for the Big Elk Creek winter range.


C
Hells
Hole
B
Elkhorn Peak
A
Big
Elk
Creek
0
1 mi

Appendix 4. Tables 19 and 20 are a summary of information collected from maps and inspections during late August 1983. The cliff number references the individual cliff in Figure 21.

Table 19. Selected characteristics for cliffs on the Palisades Creek winter range. See METHODS for coding of ledges, points, shelter, and cliff height.

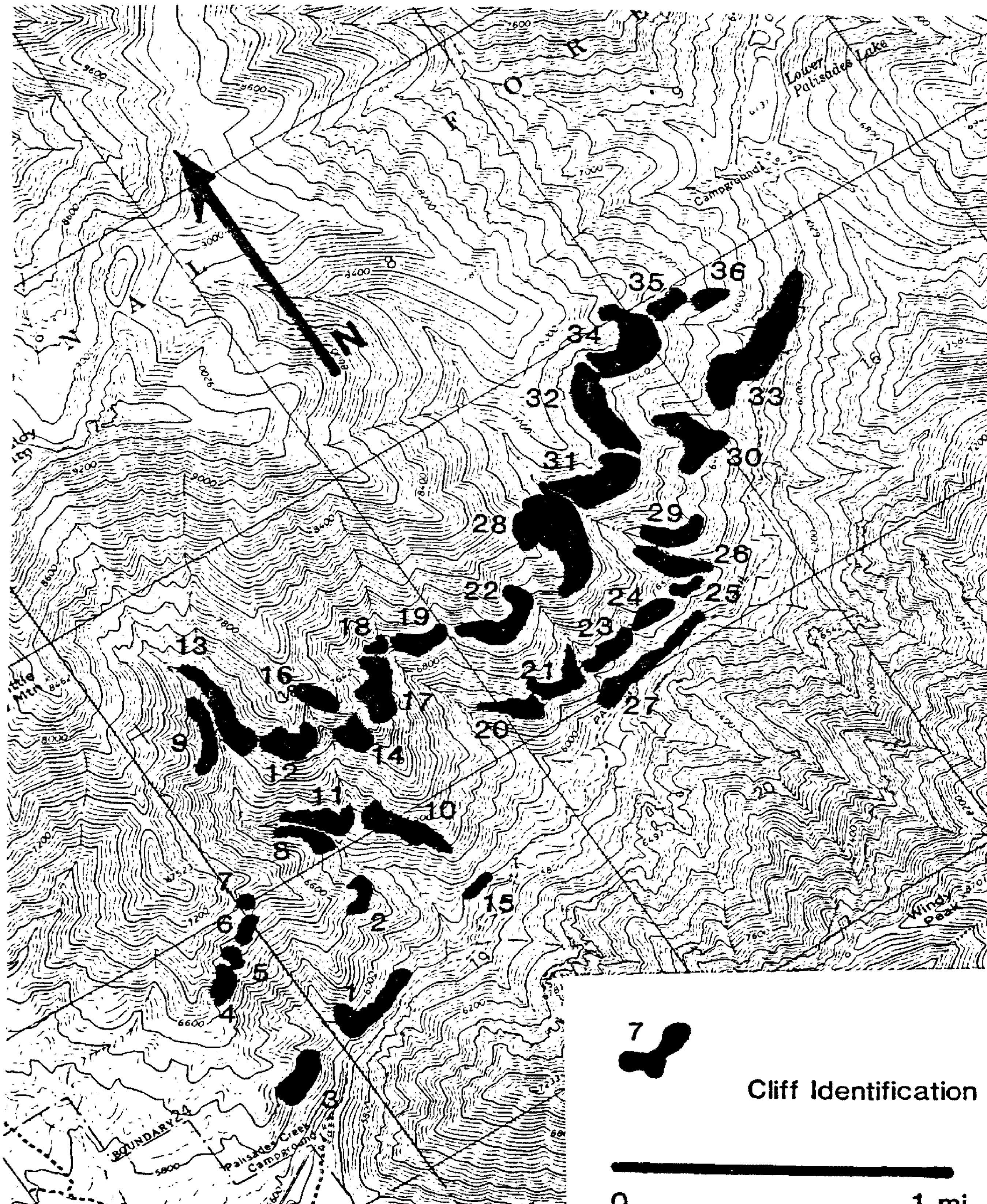
Cliff Number	Elevation at Top (feet)	L[a]	P[b]	S[c]	Height	Length (feet)	Distance to Road (Yards)	Angular Deviation (degrees)
1	5,800	2	2	2	4	168	720	
2	6,400	2	2	2	4	144	1,280	51
3	6,000	2	1	2	1	48	360	23
4	6,700	4	4	4	4	44	453	
5	6,800	2	4	4	4	120	600	29
6	6,740	2	2	2	2	96	733	14
7	6,740	2	1	1	3	96	880	12
8	6,400	3	3	4		168	1,443	16
9	7,100					288	1,600	
10	6,400	1	3	3	3	456	1,747	18
11	6,400	3	3	3	3	264	1,533	12
12	7,200	4	4	3	3	240	1,747	33
13	7,100	4	3	4	3	480	1,747	17
14	7,200	1	2	1	3	144	1,987	13
15	5,800	3	2	1	3	120	1,720	15
16	7,600					192	2,080	
17	7,200	4	2	2	2	336	2,267	43
18	7,200	2	2	2	3	96	2,467	23
19	7,200	3	4	2	4	264	2,640	34
20	6,600	3	4	2	3	216	2,680	40
21	6,500	4	4	2		264	2,933	40
22	7,200	4	3	2		504	2,933	26
23	6,300	4	4	3	4	216	3,227	27
24	6,300	4	4	3	4	144	3,573	46
25	6,400					120	3,760	
26	6,600					192	3,813	
27	6,000					600	3,307	
28	7,200	4	3	2		648	3,533	22
29	6,600					240	3,880	
30	6,600					312	4,707	
31	7,400	4	3	2		408	3,867	42
32	7,400	4	3	2	3	480	4,773	37
33	6,300					384	5,280	
34	6,300					408	5,200	28
35	7,200					192	5,373	
36	6,900	1	1	1	2	120	5,507	39

[a] Ledges.
[b] Points.
[c] Caves and overhangs (shelter).

Table 20. Additional characteristics for cliffs on the Palisades Creek winter range.

Cliff	Cover (%)		Slope (degrees)		Basal Area (ft^2)	
	Above	Below	Above	Below	Above	Below
1	73	45	28	35	303	0
2	13	48	28	35	654	1,088
3	90	80	34	39	796	67
4	60	90	28	36	750	129
5	67	90	28	29		
6	53	86	33	34		
7	54	70	34	33	0	0
8	60	20	39	29	145	553
9						
10	43	37	27	35	314	162
11	80	40	31	23	404	932
12	20	75	17	36	1,980	202
13	60	60	27	36	349	232
14	50		30	37	1,255	
15	47		37		787	
16						
17	88	55	32	38	419	185
18	90	80	32	37	37	1
19	70	43	34	38	140	63
20	40	53	32	34	129	204
21	70	10	27	37	210	1,557
22	48	50	35	36	217	171
23	63	35	34	35	0	277
24	58	46	30	36	188	333
25						
26						
27						
28	70		35		558	
29						
30						
31	56	23	37	37	484	423
32	87	40	31	39	357	633
33						
34						
35						
36	78	60	31	39	431	67

Figure 21. Identification of cliffs evaluated on the Palisades Creek winter range.


N
Lower Palisades Lake
Campground
Windy Peak
Palisades Creek Campground
BOUNDARY
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
7
Cliff Identification
0
1 mi