

MOUNTAIN GOAT HOME RANGES IN  
THE SAPPHIRE MOUNTAINS OF MONTANA

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**Abstract:** Twenty-eight mountain goats (*Oreamnos americanus*) were captured in the Sapphire Mountains of Montana from 1971 to 1973; 16 were equipped with radio collars. Mean yearly home ranges (convex polygon estimates) calculated from radio locations were 48.3km<sup>2</sup> for yearlings, 31.1km<sup>2</sup> for two-year-olds, 24.0km<sup>2</sup> for adult females, and 21.5km<sup>2</sup> for adult males. The size of monthly ranges of four goats decreased from August to November of 1972 as snow accumulated at high elevations. Females were traditional in their use of summer ranges, whereas males were not seen in the study area during consecutive summers. Mean winter migration distances (measured between summer and winter activity centers) ranged from 9.2km for the severe 1971-72 winter to only 2.9km during the mild winter of 1972-73. Goats with radio collars occupied south-facing cliffs at approximately 1,700m altitude during the winter of 1971-72, but they ranged at much higher elevations (2,100 to 2,500m) in the winter of 1972-73.

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The mountain goat, because of its low populations and the remoteness of its native ranges, has been the subject of few ecological studies. Because of the broken terrain they occupy, and because of the problems involved in their capture (Rideout 1974a), still fewer of these studies have involved the marking and long term observations of individual animals. This paper on mountain goat home ranges presents a portion of a movements and ecology study of a native herd of mountain goats in western Montana (Rideout 1974b). Information obtained in this study has been utilized in land planning in the Bitterroot National Forest, and hopefully will be useful in improving the management of the species.

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#### STUDY AREA

Dome Shaped Mountain (2,640m), which served as our center of operations, is located on the divide ridge of the Sapphire Mountains (Fig. 1). Much of this top ridge is forested with whitebark pine (*Pinus albicaulis*), subalpine fir (*Picea engelmannii*) and alpine larch (*Larix lyallii*). Unlike most goat ranges there is no true alpine zone in the Sapphires, and no Krummholz stands exist. Large snowbanks form along ridges, and they do not melt completely until July or August. Lodgepole pine (*Pinus contorta*) is common between altitudes of 1,500 and 2,400m, and douglas fir (*Pseudotsuga menziesii*) reaches a maximum altitude of 1,830m. For detailed information on habitats in the Sapphires see Rideout (1974b).

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## MATERIAL AND METHODS

We captured 27 mountain goats during this study in a woven-wire pen trap on a natural salt lick on a ridge top at 2,585m (Rideout 1974a). They were marked with sheep marking paint, numbered plastic ear tags, and collared marking collars; 16 were equipped with radio collars having radio frequencies ranging from 27.570 to 27.680MHz (Rideout 1974c). Signals were received with loop antennas, a two element hand-held Yagi antenna, and two three element Yagi antennas attached to 9m masts on two mountain tops. The masts rested on swivel bases, and declination circles aligned with compass directions were used in determining directions of signals. An airplane with loop antennas attached was used to locate goats during the winter. A total of 749 goat locations was obtained by telemetry, and they were recorded in 16.2 ha (40 acre) grid squares. Home ranges were estimated by drawing lines between grid square centers and measuring the area of convex polygons (Jennrich and Turner 1969:228) with a compensating polar planimeter. Although convex polygons were always used in computing home range size, minimum polygons were used in some figures to indicate the areas of use more accurately (Figs. 2-5). This study involved 241 days in the field during a four-year period.

## RESULTS AND DISCUSSION

### Home Ranges

Home ranges were determined for 13 of the 16 goats equipped with radio collars. This included six adult females, two adult males, one female and two male two-year-olds, and two female yearlings. The average transmitter life was 144 days, and an average of 67 telemetry fixes per animal were used to determine home ranges (Table 1). Movements to lower elevations occurred in early or mid-November, and the movement back to summer ranges occurred in late May or June. Summer-fall home ranges (SFHR) were measured over the 16 May to 15 November period (the earliest actual summer-fall radio location in this study occurred on 25 June), and yearly home ranges (YHR) also included locations from the 16 November to 15 May period.

### Adult Females

Six adult females were equipped with radio collars; home ranges were calculated for five, omitting goat 36, a female captured in October and providing only 21 locations (Fig. 2). The mean SFHR for the five females was 19.8km<sup>2</sup>, and the mean YHR value was 24.0km<sup>2</sup> (Table 1). Females 23 and 21 were observed during the two years following their capture; 23 was always seen within her 1971 SFHR, but goat 21 was observed two km east of her 1971 SFHR in September of 1972.

### Adult Males

Three adult males had radio collars, but only two (27 and 31) provided enough locations for home range calculation. Male 33 was captured on 14 November 1972, two weeks before we left the study area, and only five locations were obtained. The mean SFHR values for males 27 and 31 was 17.6km<sup>2</sup>; the mean yearly home range was 21.5km<sup>2</sup> (Fig. 3, Table 1). Male 31's SFHR was probably much larger than indicated since we were frequently unable to locate him by triangulation.

Goat 27 was a six-year-old male of unusually small size (54.9kg). Like male 31, he was often found in suboptimal habitat (less escape terrain, more forest) during summer. His body was found on 20 May 1973 in river bottom habitat at 1,648m below the confluence of Stony and Little Stony Creeks; the cause of death was not determined. Males 31 and 33 were not seen during the years following their capture.

### Two-Year-Olds

Three two-year-olds were radio-collared in 1971, two males (24 and 25) and a female (22) (Fig. 4). All three of them were captured on 22 July 1971; winter locations were obtained for 22 and 24, but we only received signals from goat 25 for 27 days. The mean SFHR for 22 and 24 was 15.9km<sup>2</sup>, and the mean YHR 31.1km<sup>2</sup> (Table 1). Males 24 and 25 were not seen in later years, whereas 22 was seen frequently during the summer and fall of 1972 and 1973, always within her 1971 SFHR. Goat 22 was shot on 15 September 1974 at the head of Little Stony Creek, again within her 1971 SFHR.

### Yearlings

Two female yearlings, 29 and 30, were trapped and radio-collared on 7 August 1972, and yearlings 34 (female) and 35 (male) were equipped with radio collars on 31 July 1973. Home ranges were not determined for 34 and 35 due to the small number of locations, but the mean SFHR (41.2km<sup>2</sup>) and YHR (48.3km<sup>2</sup>) values for female yearlings 29 and 30 were much larger than any other age group (Fig. 5).

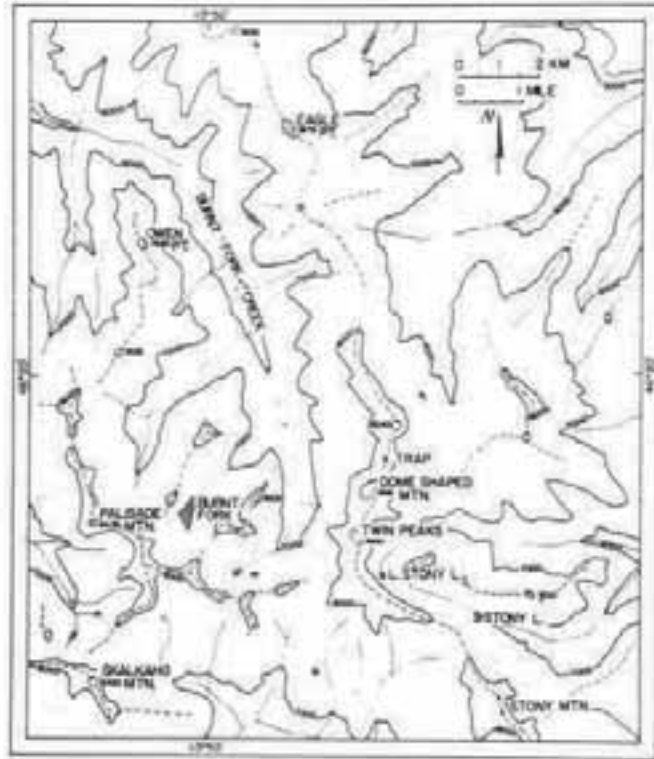


Figure 1. Habitat map of the study area in the Sapphire Mountains. Map prepared from Sapphire Quadrangle Map. U.S.G.S.

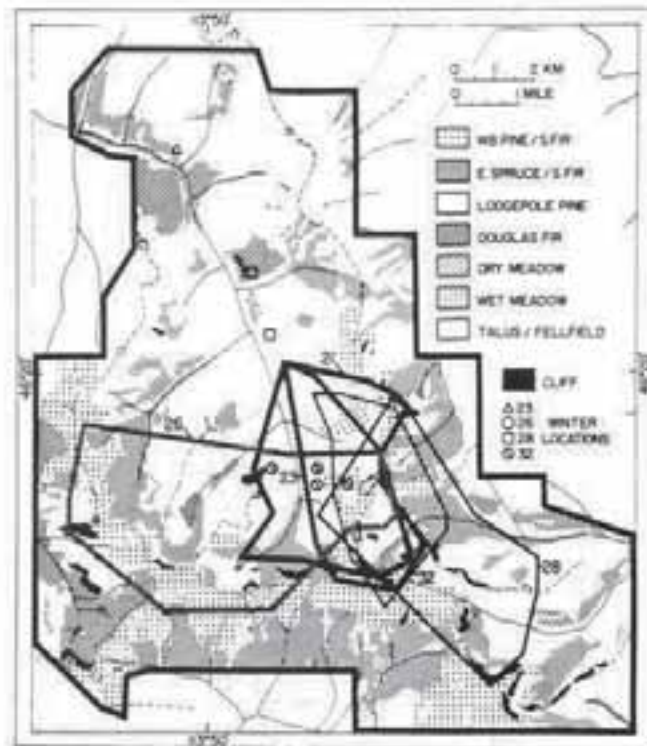


Figure 2. Summer-fall home ranges and winter locations for five adult female mountain goats.

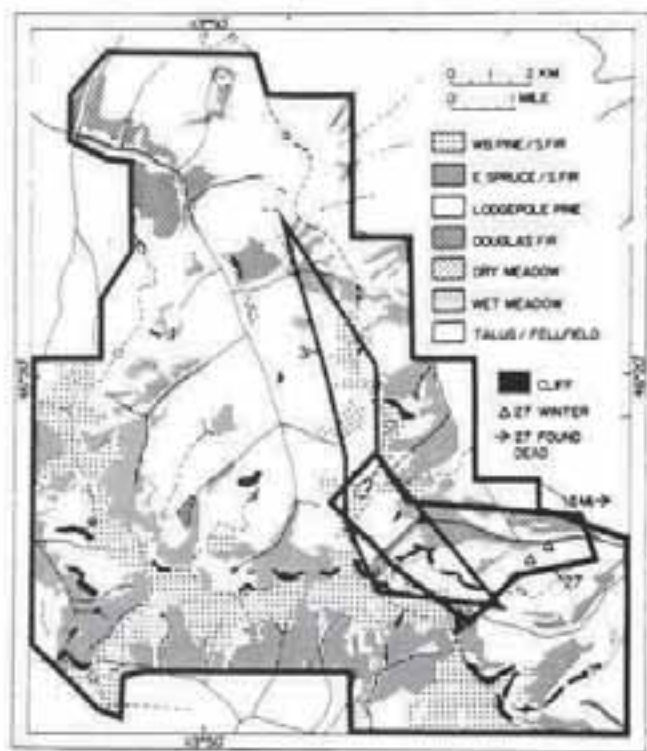


Figure 3. Summer-fall home ranges and winter locations of two adult male mountain goats. Male 27 found dead 2.4km (1.5 mi) east of arrow.

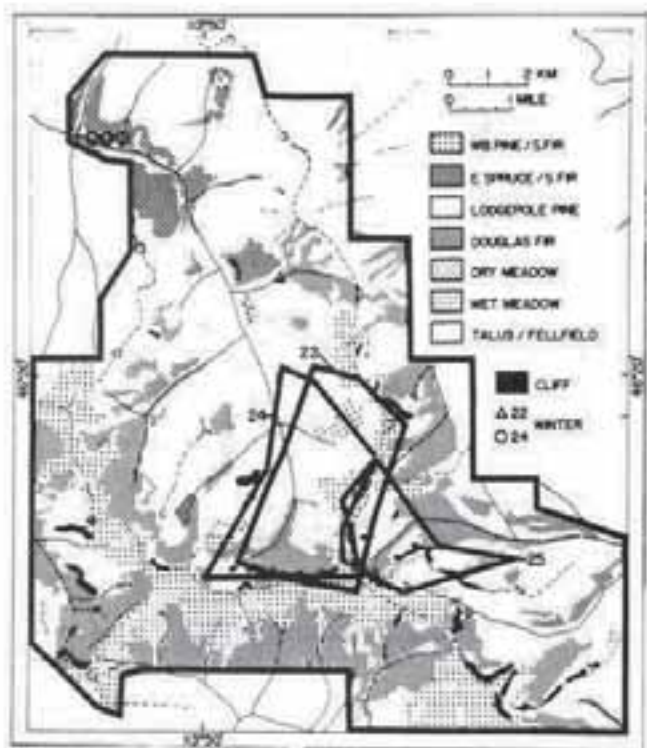


Figure 4. Summer-fall home ranges and winter locations of three 2-year-olds; males 24,25 and female 22.

Table 1. Home ranges of radio-collared goats (in km<sup>2</sup>) from maximum polygon estimates. Dates of collar operation refer to time from capture to reception of last signal. Summer-fall home ranges (SFHR) is the area used from the time of capture until 25 November; yearly home range (YHR) is the area used during the entire period of collar operation.

Age Group	Sex	#	SF Fixes	Winter Fixes	Date of Capture	Collar Operation	SFHR	YHR
<b>YEARLINGS</b>								
	F	29	36	41	7 Aug. 72	226 days	38.7	38.7
	F	30	38	62	7 Aug. 72	226 days	43.8	57.9
	F	34	3	3	31 July 73		- *	- *
	M	33	3	3	31 July 73		- *	- *
Mean Home Range Values:							41.2	48.3
<b>TWO-YEAR-OLDS</b>								
	F	22	51	52	22 July 71	164 days	15.6	21.9
	M	24	30	34	22 July 71	287 days	16.2	40.3
	M	25	41	41	22 July 71	27 days	8.1*	8.1*
Mean Home Range Values:							15.9	31.1
<b>ADULT</b>								
	F	21	40	40	7 July 71	39 days	20.1	20.1
	F	23	49	50	25 July 71	193 days	11.1	18.5
	F	26	63	69	16 July 72	248 days	31.0	31.0
	F	28	117	124	27 July 72	175 days	25.6	34.8
	F	32	68	74	4 Sept. 72	85 days	11.2	15.7
	F	36	16	21	23 Oct. 72	149 days	5.6*	7.1*
Mean Home Range Values:							19.8	24.0
<b>ADULT</b>								
	M	27	72	76	1 Aug. 72	117 days	16.3	24.1
	M	31	41	41	25 June 72	56 days	18.9	18.9
	M	33	4	5	14 Nov. 72	24 days	- *	- *
Mean Home Range Values:							17.6	21.3

\*Not included in calculation of mean values.

Yearlings of other ungulate species tend to have large home ranges as well. Houston (1968) reported large home ranges in yearling moose (*Alces alces*) in Jackson Hole; Bayless (1969) found that yearling pronghorns (*Antilocapra americana*) have the largest winter home ranges of 16 marked animals; and Martinka (1969) found that radio-collared male yearling elk (*Cervus canadensis*) have the largest summer home ranges, followed by adults and female yearlings. Adult female mountain goats frequently threaten yearlings; the greater mobility of yearlings may be due in part to their forced movement from one female-kid group to another.

#### Monthly Ranges

The monthly ranges of five goats were determined from the time of capture (July or August,

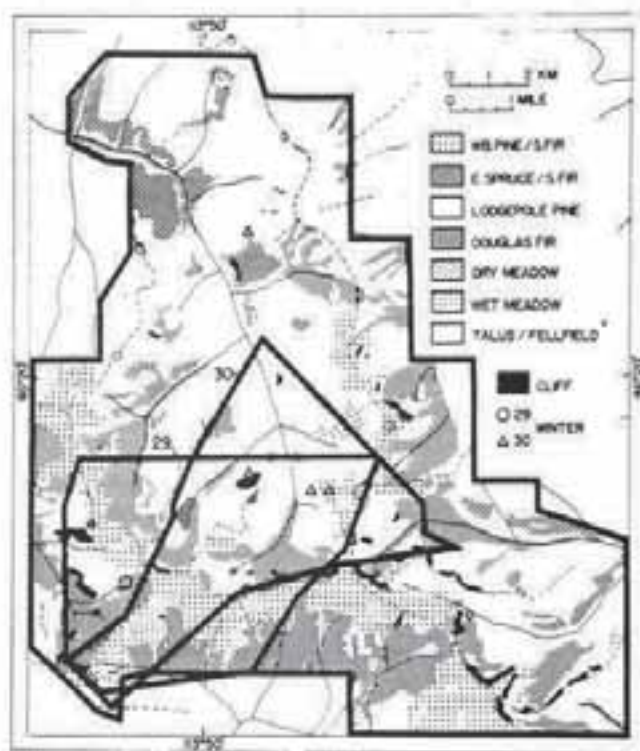


Figure 5. Summer-fall home ranges and winter locations of yearling females; 29 and 30.

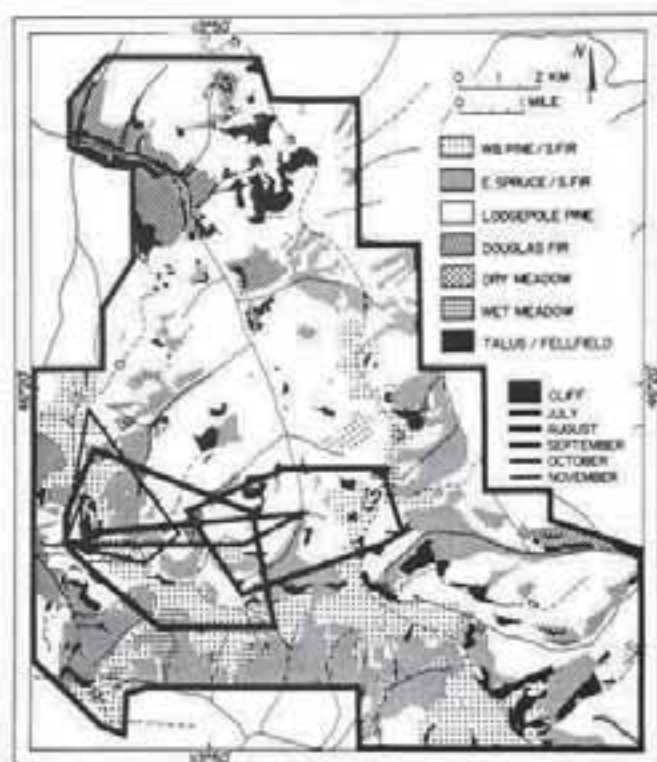


Figure 6. Monthly ranges for adult female 26.

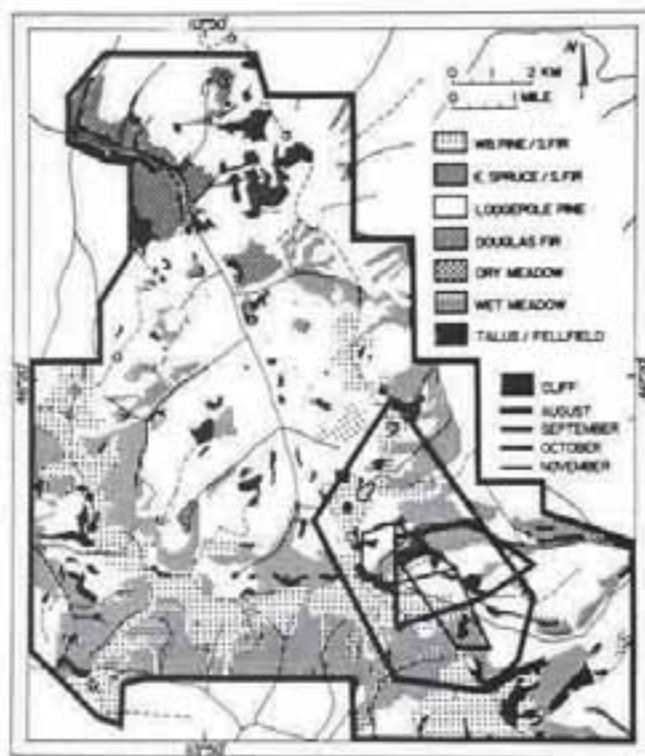


Figure 7. Monthly ranges for adult female 26.

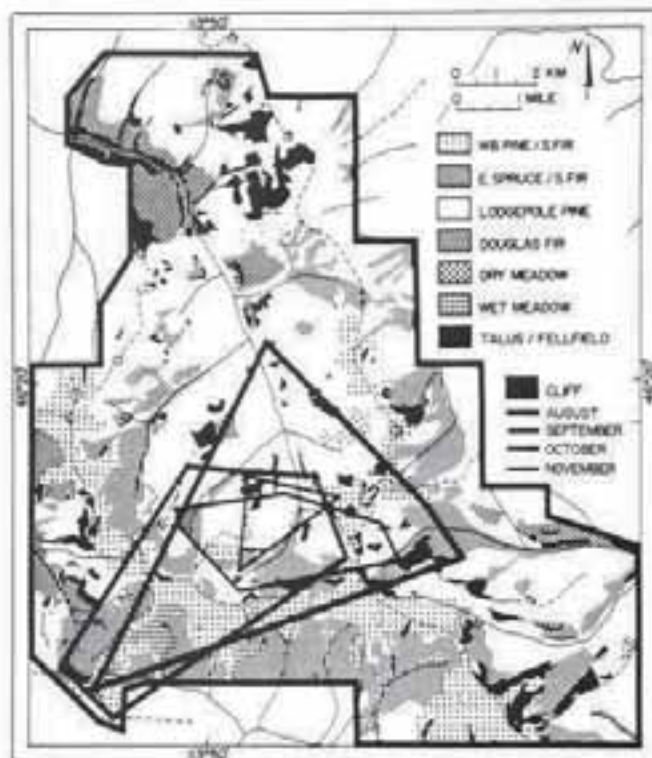


Figure 8. Monthly ranges for yearling female 30.

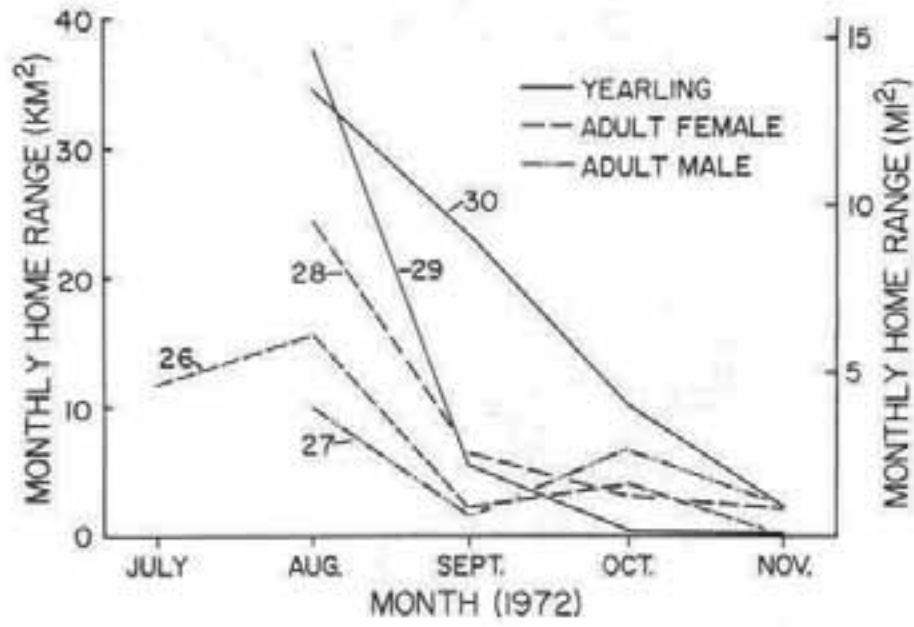


Figure 9: Monthly range size for five goats during 1972.



1972) until November 1972. These included adult male 27, adult females 26 and 28 (Figs. 6 and 7), and female yearlings 30 (Fig. 8) and 29. Goat 25 was captured on 16 July 1972, so the July value refers to only half of the month; the other goats were captured in late July or early August. In all cases, the largest monthly ranges occurred in August, and the smallest in November (Fig. 9). Male 27 and female 26 had greater monthly ranges in October than in September, possibly due to greater movement during the pre-rut.

Large monthly ranges in August are probably due to one or more of the following factors:

- 1) There is a greater ease of movement due to the lack of snow.
- 2) August is the warmest month; snowbanks and north-facing cliffs, which are popular during warm periods, are widely separated.
- 3) Flies are most common during August, and cause the goats considerable irritation; they may stimulate movements to areas having more snow or greater exposure to wind.
- 4) The Sapphire salt lick is used primarily during July and August, and goats captured in August (27, 29, and 30) have the travel to the licks included in their August monthly range.

As snow levels increase during fall, goat mobility decreases. November monthly ranges varied from 16 to 251 ha. Smith (1976) showed similar results in the Bitterroot Mountains of Montana from January through May; he reported a seasonal home range value for adult females for this period of 42 ha. Petocz (1973) noted that winter storms are extremely common in January and February in Alberta, and both he and Chadwick (1973) reported minimum daily movements during those months.

#### Winter Ranges

The total area occupied by radio-collared goats during the summer-fall period (summer-fall composite home range) is shown in Fig. 10. Locations for the severe winter of 1971-72 (six locations) are more widely separated from the summer-fall composite home range than are those of the mild winter of 1972-73 (15 locations). The seasonal movement of nine mountain goats was determined by calculating the distance from the summer-fall activity center of each goat (Fig. 10) to its corresponding winter activity centers for three goats during the severe winter of 1971-72 was 9.2km (six winter locations), whereas the mean distance between activity centers for six goats in the mild winter of 1972-73 was only 2.9km (15 winter locations).

Some areas used during the winter by the goats of the Sapphires were probably not located by radio telemetry. A female and her kid were observed on a west-facing rock outcrop near the confluence of Stony and Rocky Creeks, 14.8km east of Dome Shaped Mountain in February 1974 (D. McCleerey, pers. comm.). The goats were not marked, but they were probably from my study area since it is the closest goat range.

Table 2. Distance from summer-fall activity center to winter activity center for nine mountain goats (see text).

----- WINTER 1971 - 72 -----				----- WINTER 1972 - 73 -----			
Sex	#	Age	Distance	Sex	#	Age	Distance
F	22	2	6.1km	F	29	1	3.0km
F	23	3	10.4km	F	30	1	3.0km
F	24	2	11.1km	F	28	5	4.0km
Mean:			9.2km	F	32	5	2.4km
				F	26	6	3.1km
				F	27	6	1.7km
				Mean:			2.9km

McCleerey also saw a male two-year-old from my study area, which was marked with radio collar as a yearling (35) in July of 1974, near the head of Little Hogback Creek at 2,347m elevation. This location is 19.3km SNE of Dome Shaped Mountain on the other side of Rock Creek, and 35 was accompanied at the time by four other goats.

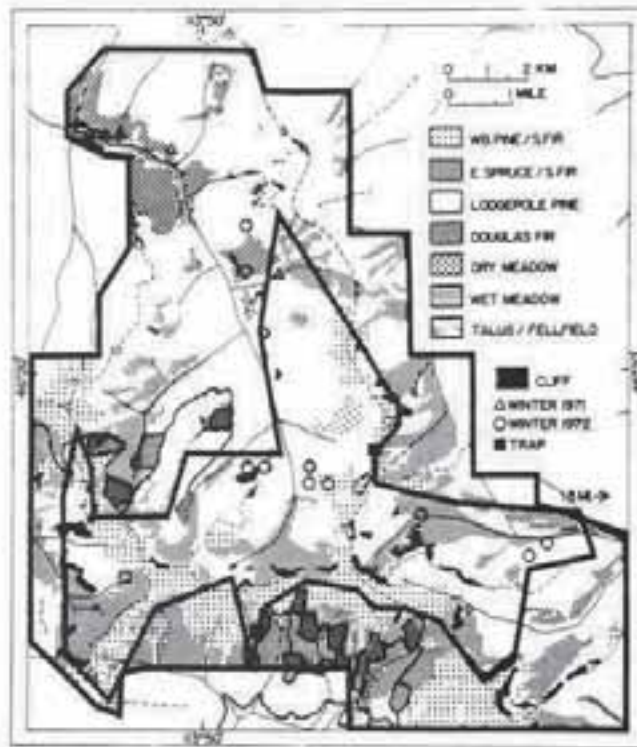


Figure 10. The summer-fall composite home range for all radio collared goats. Clear-cut logging indicated by cross hatch.

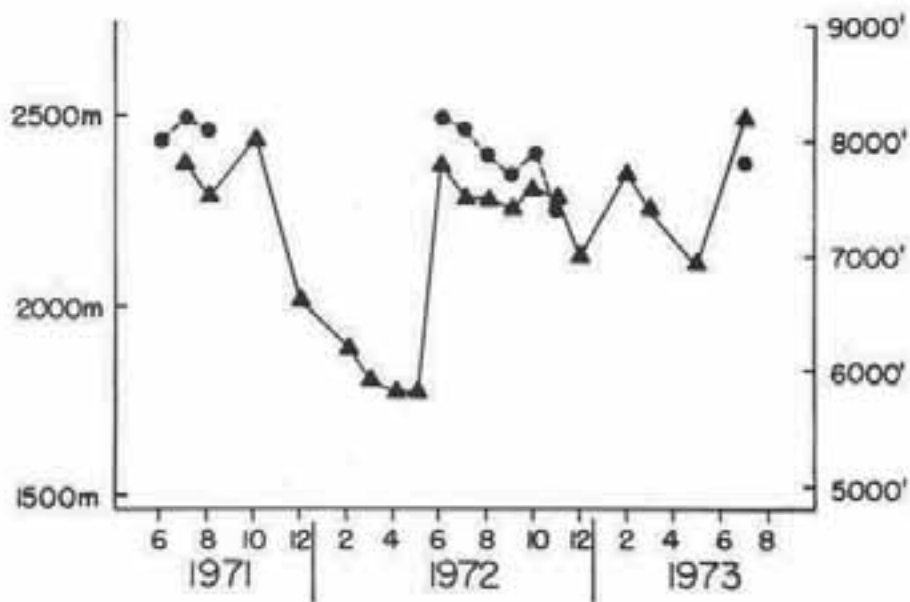


Figure 11. Altitude by month in the Sapphire Mountains. Triangles indicate mean altitudes determined by radio tracking; circles indicate mean altitudes determined by observation.

## Altitude

During summer months radio collared goats were found at altitudes greater than 2,250m. During the severe winter of 1971-72 goats sought lower altitudes than in the mild winter of 1972-73; this information is, however, based on a total of 21 winter locations obtained by air tracking. Summer-fall altitude estimates from observational data are slightly higher than radio-tracking estimates in 1971 and 1972; we established our camp on Dome Shaped Mountain and did our hiking along the top ridge of the Sapphires, so goats at higher altitudes were more easily seen (Fig. 11).

## Home Range Use and Seasonal Movements in the Sapphires and their Significance

Mountain goats migrate to low altitudes in the Sapphires during severe winters, but like mountain goat habitat in other areas, good summer range is extensive whereas good winter range (south-facing cliffs at low elevations) is rare (Smith 1976). As a result, during mild winters in the Sapphires goats stay at high elevations within or near their SFHR.

Female goats in the Sapphires were traditional in their use of their home range; goats 21, 22 and 23 used the same areas in successive summers. Males were never seen in the study area the year following their capture, and one male (yearling 35) was located in another goat range. Male mountain goats have been known to move to new mountain ranges, whereas females use the same summer and (in some areas) the same winter ranges year after year (Chadwick 1973, Smith 1976). Geist (1971) observed bighorn rams (*Ovis canadensis*) moving between widely separated female groups during the rut, and he suggested that the chance of breeding success in distant herds due to hybrid vigor would result in selection for this behavior. Preobrazhenskii (1961) has shown that reindeer cows (*Rangifer tarandus*) bred by closely related bulls have lower fertility and smaller calves than those bred by bulls of distant ancestry. The home range use exhibited by males and females of the Dome Shaped Mountain goat herd suggest a pattern of home range constancy by females and emigration by males; such behavioral differences between the sexes would help guard against inbreeding in small isolated mountain goat herds.

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