MIGRATION OF THE BEARTOOTH-ROCK CREEK BIGHORN SHEEP HERD

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ABSTRACT

Migration data was obtained from April of 1977 through December of 1979 using radio collared bighorn sheep as part of a study of movements and habitat use of the bighorns which winter in the Rock Creek area of the Beartooth Mountains, Montana. The summer range of this herd was found to lie in the Absaroka Mountains just east and north east of Yellowstone National Park and overlapped with the summer ranges of several other bighorn herds. Most of the Rock Creek herd migrated to the Pilot-Index Peaks area of Wyoming while some rams moved to the Wolverine Peak area of Montana. Although these areas are 23 and 28 miles, respectively, from the Rock Creek winter range, the migration routes were found to follow arcs at least 35 and 40 miles long. Both of these routes cross the headwaters of five major drainages of the Beartooth Mountains and require travel through four passes over 11,200 ft elevation. Timing of spring migration was primarily influenced by sex and reproductive status, rams and barren ewe-juvenile groups left before ewes with lambs. Fall migration coincided with the arrival of permanent snow on the summer range. Advantages and consequences of these migration patterns are discussed.

INTRODUCTION

Practically all mountain sheep move from one segment of their habitat to another sometime during the year. The seasonal movements vary from incomplete local elevational drifts (Spencer 1943, Blood 1963, Woolf et al 1970) to complete long range migrations between at least two widely separated seasonal ranges (Smith 1954, Morgan 1970, Geist 1971, Stewart 1975). Mountain sheep occupying seasonal ranges separated by several miles distance use traditional migration routes developed historically to move between these ranges (Geist 1971). These routes are an integral part of mountain sheep habitat.

Knowledge of the route and timing of migration is important in formulating sound management policies for individual sheep populations. It is also

important to identify migration routes in order to protect them from disturbances or obstacles which could constitute barriers to sheep migration and to study the effects of barriers already in place across these routes (Wishart 1975).

In 1977 a study was initiated dealing with distribution, movements, and habitat use of the Rocky Mountain bighorn sheep which winter in the Rock Creek area of the Beartooth Mountains of Montana. Intensive study was conducted during the summer of 1978 and the summer and fall of 1979. As part of this study migration data was collected using radio-collared or otherwise marked bighorn sheep. This paper presents the results of this portion of the study.

STUDY AREA

The study area is located in the Beartooth and Absaroka mountain ranges of southcentral Montana and northwestern Wyoming (Figure 1). The differing geological history of these ranges has resulted in distinctly contrasting landforms. The Beartooths, dominated by Precambian Era granites, are characterized by barren rocky peaks, deep glaciated canyons, and high alpine plateaus. Elevations vary from 12,799 ft (3901 m) on Granite Peak to about 6,600 ft (2012 m) in the Rock Creek canyon. The Absarokas, on the other hand, are dominated by tertiary volcanics of the Cenozoic Era and consist of steep rocky mountain tops and ridges above rolling mountains and broad glaciated valleys. Elevations here range from 11,708 ft (3569 m) on Pilot Peak to about 6,600 ft (2021 m) in the Clarks Fork River drainage.

The climate of the Absaroka and Beartooth ranges is characteristic of the Rocky Mountain region and is locally controlled by altitude. At the higher elevations it approaches that of the subarctic, while in the lower

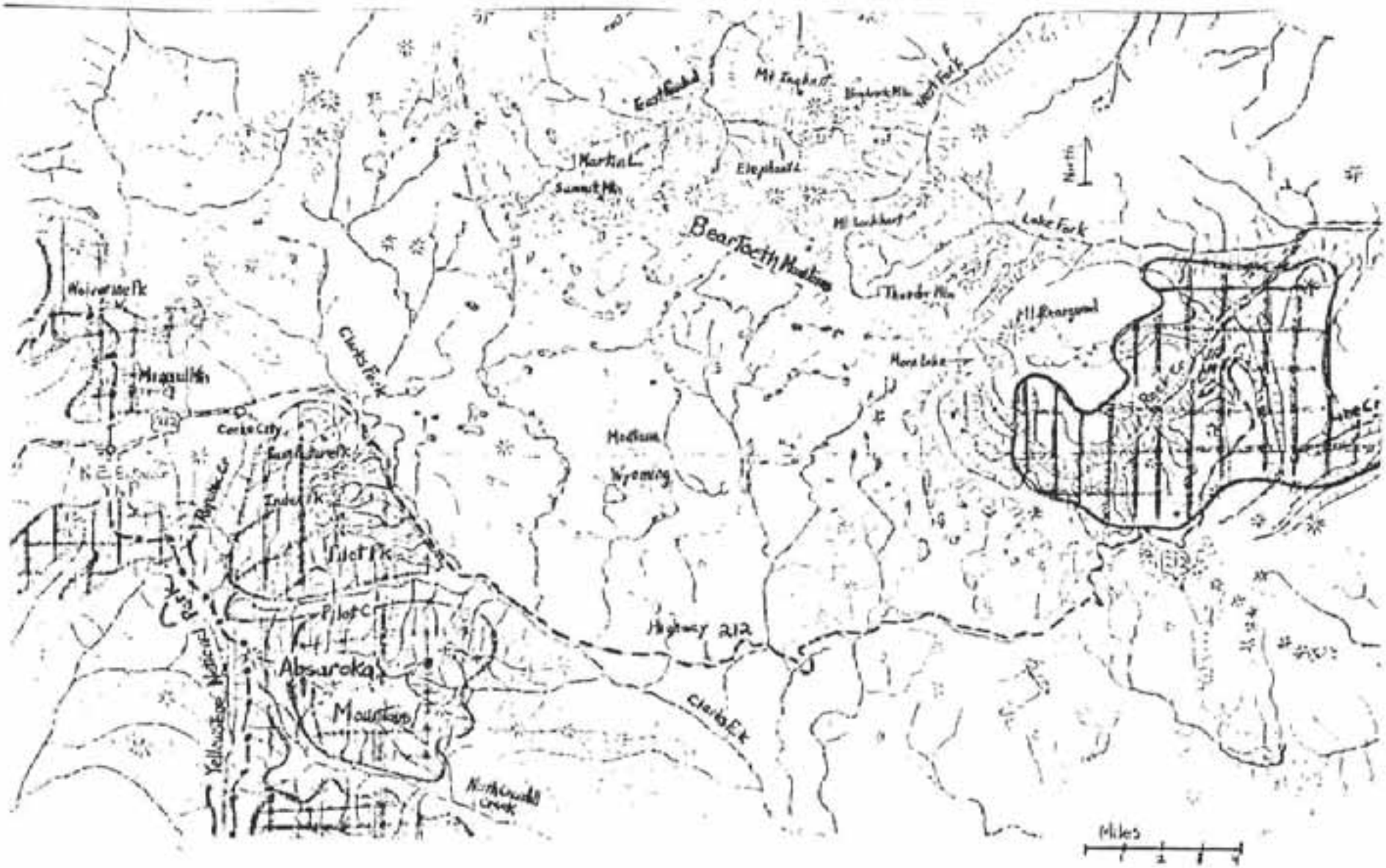


Figure 1: Map of study area showing summer and winter ranges of the Beartooth-Rock Creek bighorn sheep herd. Rock Creek Winter Range ▦ Summer Ranges: Ewe-juvenile range of Rock Cr herd ▤, Other ewe-juvenile ranges ▤, Ram ranges ▥

basins and valleys it is less harsh. Vegetation varies from alpine tundra and meadow types above 9,600 ft (2926 m) to montane forests below 7,200 ft (2195 m).

METHODS

During the three years of the study 14 bighorn sheep were captured and marked on the winter range. Capture was by chemically immobilizing free ranging bighorns with Rompun (xylazine) or succinylcholine chloride using a "cap-chur" gun. Radio transmitter collars were placed on 13 sheep. These collars consisted of a transmitter and antenna package of a frequency between 150.915 and 151.015 MHz inserted into molded, color coded, PVC plastic pipe. One sheep was fitted with a color coded neckband. Most sheep were tagged in both ears with numbered, yellow Ritchey eartags. A summarized history of bighorn captured and transmitter types used over the study period is given in Table 1.

Radioed sheep were monitored from the air and on the ground with portable AVM Model LA12 receivers. Ground relocations of instrumented animals were made using various handheld two, three, and four element Yagi antennas. Aerial relocations were obtained during flights in a Piper Supercub airplane equipped with a three element Yagi antenna or in a Cessna 182 aircraft equipped with dual whip antennas. Information was also obtained from aerial and ground surveys of unmarked bighorns. Standard diameters were calculated for all animals for which three or more locations were obtained on a seasonal range. Climatological data were obtained from U.S. Weather Bureau stations at Cooke City and Red Lodge, Montana.

TABLE 1. Dates and ages of bighorns captured on the Beartooth-Rock Creek Winter Range with history of the animal after capture.

SHEEP ID	CAPTURE DATE	AGE AT CAPTURE	SEX	TRANSMITTER BRAND	COMMENT
WR01	4/7/77	3.5	Female	AVM	Radio operating 12/17/79.
B/Y04	4/7/77	2.5	Male	AVM	Radio never functional, collar dropped spring 1979, hunter kill 11/10/79
BS12	4/26/77	3.5	Male	AVM	Hunter kill 9/3/77.
YS03	4/29/77	6to7	Female	AVM	Died shortly after capture.
RS11	5/2/78	2.5	Female	AVM	Radio quit late August 1979.
R/Y09	5/2/78	1.5	Male	AVM	Dropped collar mid-July 1978.
G/W15	5/10/78	3.5	Female	AVM	Died about a week after capture.
YS14	5/10/78	6to7	Female	AVM	Died 1 to 2 days after capture.
WB15	5/12/78	7.5	Female	Neckband	With collar 2/28/80.
G/W20	5/11/79	1.5	Female	AVM	Radio operating 12/17/79.
GS29	5/15/79	1.5	Female	AVM	Dropped collar mid-September 1979.
R/W28	5/16/79	1.5	Male	Telonics	Radio operating 12/17/79.
BSn	5/17/79	1.5	Male	Telonics	Died early July 1979.
YS22	5/21/79	8.5	Female	Telonics	Died 1 to 2 days after capture.

RESULTS

Winter Range: The winter range of the Beartooth-Rock Creek bighorn sheep herd is located in the upper Rock Creek and Line Creek drainages of the Beartooth Mountains. It consists of the alpine plateaus and subalpine canyon sides which surround these drainages. Bighorns occupied elevations from 10,600 ft (3231 m) to 7,400 ft (2256 m) on the winter range. This area is used by about 95 bighorns for approximately eight to nine months of the year.

Use of habitats on the area shifted with the seasons. After their return in the fall bighorns ranged from the lower canyon sides up to the plateau edges and movement from one side of the canyon to the other was frequent. It appeared that as the rut ended and winter conditions became more severe most of the sheep moved onto the alpine plateaus south of Rock Creek, probably seeking areas blown free of snow as was reported for the sheep which winter on the West Rosebud plateaus of the Beartooths (Stewart 1975). When spring arrived the sheep dropped back off the plateaus onto the canyon walls where green-up of the vegetation occurred earlier. Ewes lambed in the steeper more rocky areas of these slopes in early June.

Standard diameters of 10 individual sheep calculated over their entire period of use of the winter range gave a pooled value of 2.55 miles (4.10 km). This figure is similar to the 2.30 miles (3.70 km) reported by Brown (1974) in northwestern Montana for sheep on the winter range. Ram and ewe standard diameters were similar at 2.75 miles (4.43 km) and 2.41 miles (3.88 km), respectively.

None of the bighorn sheep marked on the winter range were unaccounted for during any of the winters of the study. All successfully marked bighorns

are known to have returned to Rock Creek each winter after marking with the exception of two animals which died. Of five ewes, one returned three consecutive winters, two returned two consecutive winters, and two returned the winter after capture. Of three rams, one returned for three consecutive winters, one for two consecutive winters and one returned the winter after capture.

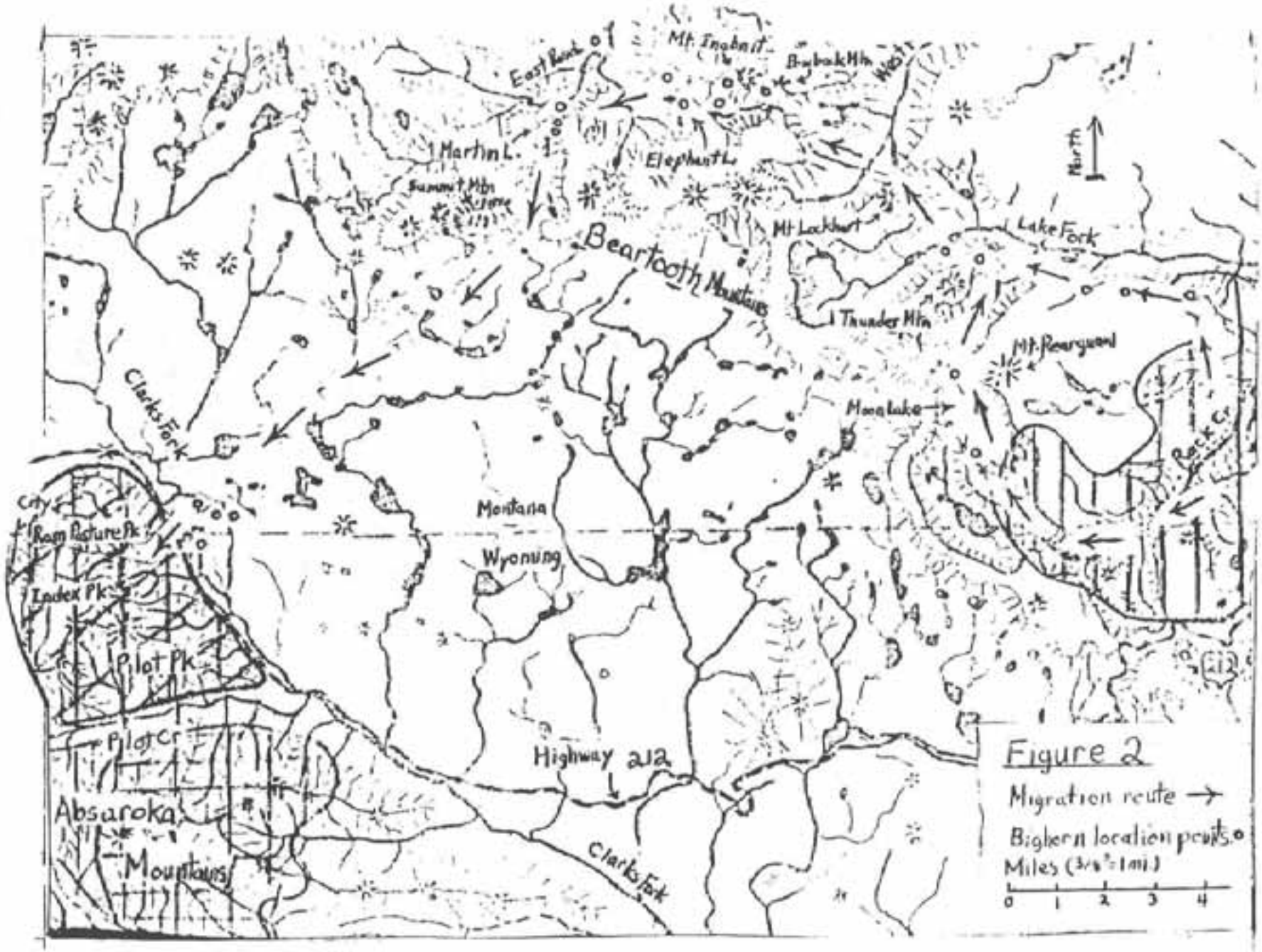
Spring Migration: From the interpretation of declines in bighorn sightings and departure dates of radio-collared animals, movement off the winter range begins during the last half of May, peaks in early June and is for the most part complete by early July. The entire herd eventually is absent from the winter range during most of the summer. Weather conditions did not appear to affect spring departure dates during the study.

Departure dates of individual sheep varied with sex and reproductive status. Rams and barren ewe-juvenile groups for the msot part left the area by late June. However, ewes which lambed from late May to mid-June on the winter range spent two weeks to over a month in nursery bands grazing on the canyon sides before migrating. This trend is illustrated by marked ewes. Ewe WR01 lambed in 1977 and that year did not migrate until late July or early August. In 1978 she didn't lamb and left the winter range on June 20. In 1979 she lambed again and did not migrate until July 3. Ewe RS11 lambed in 1978and waited until July 11 to migrate, while in 1979 she did not lamb and left the area in mid-June. Ewe WB15 lambed on or about June 11, 1978, but had lost her lamb by June 20. She remained on the winter range in a nursery band until she miRrated with them in early July. Late departure dates of ewes lambing on the winter range was also reported by Blood (1963) for California

bighorns in southern British Columbia. There is a possibility that some pregnant ewes may leave the winter range the last half of May or early June and lamb along the migration route as has been reported by Smith (1954). We were unable to confirm this, however.

Figure 2 plots all locations of migrating bighorns obtained during the study and charts the most probable path of migration taking into account topographic features. The route travels through the heart of the Beartooth Mountains and traverses extremely rough terrain. The headwaters of five major and several minor drainages of the Beartooth Mountains are crossed, as well as four passes over 11,200 ft (3414 m) in elevation.

Sheep leaving Rock Creek appear to do so in two areas. Many move from their spring ranges on the south side of the Rock Creek canyon down to about 8,800 ft (2682 m) to cross to the north canyon wall. They then move upstream, eventually entering the Lake Fork drainage, probably through the 11,200 ft (3414m) pass just west of Mount Rearguard. Other sheep appear to move along the south wall of the Lake Fork to leave the winter range. Once into the Lake Fork drainage the two routes join on Thunder Mountain. From here the sheep drop down to 9,100 ft (2774m) to cross the upper Lake Fork canyon only to climb back to 11,000 or 11,600 ft (3353 to 3536m) in order to move into the West Fork drainage through the passes east or west of Mount Lockhart. They then drop to approximately 9,600 ft (2926m) and cross the head of the West Fork, but must then make their way back up at least to the 11,680 ft (3560m) pass southwest of Bowback Mountain. From here they drop into the East Rosebud drainage, moving down to Elephant Lake at 9,500 ft (2896m). Most sheep continue along the south wall of the East Rosebud until they reach Martin Lake at 9,200 ft (2804m). From here they appear to ascend Falls Creek out of the East Rosebud and into the Clarks Fork drainage over the 11,520 ft (3511m) pass east of Summit Mountain. From this pass they travel in a southwesterly direction


Mt. Engbart
East Rent
Bybak Mtn
Martin L.
Elephant L.
Summit Mtn
North
Mt Lockhart
Lake Fork
Beartooth Mountains
Thunder Mtn
Mt. Rearguard
Clarks Fork
Mona lake
City
Ram Pasture Pk
Montana
Wyoming
Ladex Pk
Pilot Pk
Pilot Cr
Highway 212
Absaroka
Mountains
Clarks Fork
Figure 2
Migration route →
Bighorn location points
Miles (3/8" = 1 mi.)
0 1 2 3 4

to the Pilot-Index Peaks area of the Absaroka Mountains, first crossing the Clarks Fork at about 7,500 ft (2286m), then moving into the mountains at points east of Ram Pasture and Index Peaks. Some rams apparently do not turn toward the Pilot-Index Peaks area, but instead travel in a westerly direction from the East Rosebud ending up in the Wolverine Peak-Mineral Mountain area. Bighorns which migrate along the route to the Pilot-Index Peaks must travel at least 35 miles (56km) between winter and summer ranges while those rams which move to the Wolverine Peak-Mineral Mountain area travel over 40 miles (64km).

Movement of bighorn groups off the winter range is abrupt. Radio-collared sheep monitored as they began their migration generally left their spring home ranges during the morning hours and by late afternoon had traveled five to seven airline miles from their morning locations. This rapid rate of travel, which continues during the entire migration to the summer range, is in contrast to the slow drifts observed during spring migration for other bighorn herds. (Smith 1954, Blood 1963, Geist 1971).

The rate of migration is best illustrated by the movements of two radio collared two year old ewes which were monitored over the entire route to the Pilot-Index area at an average of 16 hour intervals (Table 2). These sheep traveled the approximately 35 mile route in less than 104 hours for a rate of 8.1 miles (13.0km) per day. Four radioed bighorns, all ewes leaving the winter range in late June to early July, are know to have migrated in about 4.5 days or less (84 to 104 hours). Two of these ewes were accompanied by lambs. Sheep leaving the winter range earlier appear to spend more time migrating. A young ram left the winter range in late May or early June and spent a minimum of seven days on the route to the Pilot-Index area. At least four of those days were spent in the East Rosebud drainage.

TABLE 2. Movement of C/W20 and CS29 during spring migration 1979.

DATE	TIME	LOCATION Drainage*	AREA	DISTANCE FROM LAST RELOCATION (mi./km.)	TIME ** ELAPSED (hr.)	RATE OF TRAVEL*** (mi/hr km/hr)
6/26	0600	RC	South wall	---	---	---
6/26	1800	RC	Moon Lake	5.1/8.3	12(12)	0.43/0.69(0.43/0.69)
6/27	0600	LF	Thunder Mtn	2.3/3.8	12(4)	0.19/0.32(0.58/0.95)
6/28	0600	ER	Elephant Lake	6.2/9.9	24(16)	0.26/0.41(0.39/0.62)
6/28	2000	ER	Martin Lake	2.5/4.1	14(14)	0.18/0.29(0.18/0.29)
6/29	0600	ER	Martin Lake	0.2/0.4	10(2)	0.02/0.04(0.10/0.20)
6/29	2000	CF	MT-WYO Line	10.9/17.5	14(14)	0.79/1.25(0.79/1.25)
6/30	1400	CF	Index Peak	0.7/1.1	18(10)	0.04/0.06(0.07/0.11)
				28.0/45.1	104(72)	0.27/0.43(0.39/0.63)
				Minimum Rate of Migration	=	or 6.5 mi/day 10.3km/day
				Probable Rate of Migration (assuming 35 mi. route)		0.34/0.54 or 8.1 mi/day 13.0 km/day

* RC=Rock Cr
LF=Lake Fork
ER=East Rosebud
CF=Clarks Fork

**Time elapsed between relocations and (Travel time assuming movement only during daylight hours (0600 to 2200))

***Rate using elapsed time and (Rate using travel time)

Taking into consideration the observation times and grouping of relocations of sheep on the migration route it appears that certain areas are used as stopover points where sheep spend variable periods of time delaying their migration. Late migrants use these areas only to spend the night, while early migrants may delay for longer periods. Four such areas were found: the Thunder Mountain area, the Elephant Lake-Mount Inabnit area, the Martin Lake area, and the Clarks Fork River-highway 212 area.

Much of the route traveled in migration is over 10,000 ft (3048 m) and the terrain is rocky and barren. Open timberline subalpine fir-whitebark pine stands reach up into some of the valleys to about 9600 ft (2926 m), but generally the vegetative cover is alpine tundra or nonexistent. However, seven miles (11.3 km) of the route to the Pilot-Index Peaks area lies across the forested Clarks Fork-Beartooth Lakes country. This area consists of a vast plateau of broken rocky hills and ridges covered by a dense forest dominated by subalpine fir and/or lodgepole pine. Numerous lakes and wet meadows dot the area. All monitored radio-collared sheep moved through this area rapidly until reaching the Clarks Fork River or highway 212. This hurried movement through a large timbered expanse is in line with the observations of McCann (1956) and Geist (1971) that bighorns possess an inborn fear of extensive heavily timbered areas but will cross such an area during migration.

Approximately 90 percent of the migration route to the Pilot-Index area occurs in the Absaroka-Beartooth Wilderness Area. Here the potential for human disturbance of migration is very low. However, in two places the route crosses roads where considerable human activity takes place. Highway 212, which travels over Beartooth Pass and serves as access to the northeast entrance of Yellowstone National Park, cuts straight though the center of the

winter range and passes along the eastern edge of the summer range of the Rock Creek bighorns. This highway is generally open for travel between late May and mid-October. In addition, a Forest Service road in the Rock Creek canyon serves several campgrounds and provides access to backcountry trails in the area. All bighorns migrating to the Pilot-Index area must cross both of these roads.

By the time peak migration is occurring in mid-June, recreational travel on the roads has started in earnest. There is some evidence indicating that the roads at this time can be disturbing to bighorns. A ewe-lamb group was observed attempting to cross the Rock Creek Forest Service road on two consecutive afternoons, a period of the day when recreational activity in the canyon is high. The sheep in both instances dropped about 500 ft (152 m) to the canyon bottom and made their way rapidly to the creek, which runs near the road. In the first instance, the sheep just began to ford the creek when a vehicle approaching on the road disturbed them and the sheep hurridly reversed their course back to their original position on the canyon wall. In the second instance, the sheep reversed their course even though no disturbing factor could be discerned. Radio-collared animals provided more evidence for the disturbing influence of roads on migration. Monitored sheep spent up to 24 hours in the Clarks Fork forest just east of highway 212 before crossing into the summer range. Most bighorns appeared to cross the highway under cover of darkness during hours when traffic was light.

Summer Range: The summer distribution of Rock Creek bighorn sheep varied between ram and ewe-juvenile groups. Ewes and juveniles moved exclusively to the Pilot-Index Peaks area of the Absaroka Mountains of Wyoming. Their summer range consisted of an approximately 13 square mile (33.7 km^2) area bounded by highway 212 on the east and north, Republic Creek on the west, and Pilot Creek on the south. Movement beyond this area by Rock Creek ewes and juveniles appeared to be very rare.

Rock Creek rams, on the other hand, traveled to one of two separate areas for the summer. Some would follow the route of the ewe-juvenile groups to the Pilot-Index area, then would range over the Wyoming Absarokas from the Montana line south to the Hurricane Mesa area of the Crandall Creek drainage. Other Rock Creek rams moved to the Wolverine Peak-Mineral Mountain area of Montana. Both the Wyoming and Montana summer ranges of Rock Creek rams overlapped the summer ranges of other bighorn herds. Rock Creek rams on the Wyoming summer range shared the area with rams from herds which winter in Wyoming, and mixture of older rams from the separate herds probably occurred here. This ram summer range overlapped the separate summer ranges of ewe-juvenile bands from Rock Creek and Wyoming. The Montana portion of the Rock Creek ram summer range overlapped the summer ranges of both ram and ewe-juvenile groups from the Beartooth-West Rosebud bighorn herd (Stewart 1975). Mixture of rams from these two herds during the summer was known to occur here. Aerial surveys indicated that at least 250 bighorn sheep occupied the Montana and Wyoming summer ranges during this study. The mean distance between summer and winter centers of activity for Rock Creek rams was 28.0 miles (45.0 km) compared to 23.1 miles (37.1 km) for ewes.

During this study it appeared that rams less than three years old followed ewes to the Pilot-Index ewe-juvenile summer range while those three years and older generally followed older rams to either the Montana or the Wyoming ram summer ranges. Summer movement of bighorns between the Montana and Wyoming summer ranges was not observed, however one young ram switched from using the Pilot-Index Peaks area as a two year old, to using the Wolverine Peak-Mineral Mountain area as a three year old.

Movements of ewes and rams differed on the summer range. Ewes generally showed very restricted movements. Average distance marked ewes were seen away from their center of activity was only 0.53 miles (0.85 km), while their pooled standard diameter was 1.21 miles (1.95 km). Brown (1974) and Klaver (1978) obtained much higher figures of 6.28 and 5.8 miles, respectively, for ewes on the summer range. A four-year-old ram had a summer standard diameter of 3.64 miles (5.86 km) compared to 5.03 and 6.0 miles found by Brown and Klaver, respectively, for rams on the summer range. This low standard diameter was probably an underestimation due to the low number of relocations obtained during the summer, however. Farthest distance between points of relocation on the summer range was 8.8 miles (14.2 km) for this ram.

From about mid-June to early August bighorns primarily occupied the high alpine ridges above 10,000 ft. (3048 m) elevation. During this period snowbank runoff is plentiful and the alpine vegetation is still in early stages of growth. By mid-August, however, snowbanks on the upper ridges have become scarce and the alpine vegetation has matured or dried out. At this time bighorns move off the alpine areas into subalpine screen basins at about 9600 ft. (2926 m) or onto east slopes where water can still be found and vegetation is still green. A similar pattern of summer range utilization was reported by Blood (1963). Bighorns generally occupied the summer range for about three to four months of the year.

A two-year-old radio-collared ram, RW28, showed erratic movements late in the summer of 1979. On August 15 and 16 he was on the ewe-juvenile summer range associated with another two-year-old male and a small group of ewes, lambs, and yearlings. When next relocated on August 30 he was 11.5 miles (18.6 km) away, traveling with a two-year-old ram in the upper East Rosebud drainage. This was

about three miles north west of the nearest point on the migration route. On September 29 he was in the Mount Inabnit area of the East Rosebud portion of the migration route where he remained until he moved into the winter range on October 14. Erratic movements by young rams has also been reported by Geist (1971).

Fall Migration: Dates of departure from the summer range varied with weather conditions, specifically with the severity and length of fall snowstorms as reflected in the date when permanent snow began to accumulate on the area. In 1977, light snowstorms occurred in the mountains from mid-September on and permanent snow began to accumulate by early October. Although 1977 observations are limited, it appears that most bighorns left the summer range in early to mid October. In contrast, 1978 was a year when permanent snow did not occur in the mountains until the last week in October and it appears that most sheep remained on the summer range until early November. The fall of 1979 was intermediate in snowstorm occurrance, snow did not accumulate until mid October. That year sheep began migrating in mid to late October, when snow depths were 6 to 8 in (15 to 20 cm) on the summer range.

The effect of fall snowstorms on sheep movement is illustrated by the reaction of bighorns to two early storms in 1978. In mid-August of that year a snowstorm dropped about 2 in (5 cm) on the summer range and the snow stayed for about a day. Sheep on the east side of Pilot and Index Peaks dropped into subalpine forests during this period. In mid-September a week of intermittent snowstorms deposited over 7 in (18 cm) of snow on the summer range. Hunters reported seeing several ewes and juveniles moving off the summer range into the Clarks Fork portion of the migration route during this period. Shortly after this the storm subsided and unseasonably warm dry weather returned to the area. An aerial survey conducted on October 6 showed a relatively high fall count of bighorns on the summer range

while no bighorns were reported at this time on the winter range. This suggests that the sheep which moved onto the migration route reversed their migration and returned to the summer range once weather conditions moderated. Similar responses to fall storms were described by Smith (1954).

There is some evidence to suggest that younger rams left the summer range and arrived on the winter range earlier than ewes. In 1977, three year old ram B/Y04 was located on the winter range on September 14, about one month before significant numbers of ewes and juveniles began showing up. In 1978 this ram and two other younger rams arrived on the winter range by October 22, two weeks before ewes and juveniles were seen. In 1979, two year old ram R/W28 reached the winter range on October 14, again about two weeks before ewes and juveniles arrived.

In leaving the Pilot-Index summer range bighorn sheep used traditional routes of departure. Local residents, hunters and Forest Service employees have reported seeing sheep leave the summer range by crossing highway 212 at points just north of the Montana-Wyoming border and east of Ram Pasture Peak. In 1977 large numbers of trails in the snow crossed the highway in this area. Individual groups of bighorns were observed to gather in the forested areas just west of and above the highway as they began their migration. Sheep waited above the highway at least a few hours before crossing. Traffic is much lighter at this time of the year and there is ample opportunity to cross during quiet periods. After crossing the highway the sheep moved into the Clarks Fork forest. Trails made in the snow by migrating sheep indicate that travel through the forest is single file and rapid but that sheep may spread out and graze on raised hilltops with less of a forest canopy. Bighorns took advantage of rocky ridges and hilltops as much as possible while traveling through the forest. Radio-collared animals indicate that bighorns may spend up to 24 hours in the forested Clarks Fork drainage

before moving rapidly northeast toward the East Rosebud drainage.

We were unable to follow any radioed bighorns through an entire fall migration but locations obtained from several sheep indicate that the route of migration back to the winter range is the same as that traveled in the spring. The rate of travel was similar to that seen with early spring migrants. Two radioed bighorn are known to have required about nine to ten days to reach the winter range.

DISCUSSION

The placement of roads across bighorn sheep migration routes has been a subject of concern to wildlife managers since interruption of seasonal movement patterns could very likely lead to the elimination of the sheep population dependent upon them (Wishart 1975). The Rock Creek bighorns have clearly adapted to the placement of roads across their migration route. Although migratory behavior may be modified, the roads cannot be considered barriers to migration. The major problem caused by the roads at this time is in their allowing snowmobiles access into key winter range areas during the winter months.

Marked Rock Creek bighorns showed a high fidelity to their winter and summer ranges, which is in agreement with the highly traditional nature of bighorn sheep movement patterns (Geist 1971). Only two seasonal ranges could be defined for this herd. This does not preclude the possibility that some of the sheep may use more than two, however. Some rams may gather in a late summer or early fall prerut range in the Mount Inabnit area of the migration route and many sheep may have midwinter ranges that are distinct from their fall-spring ranges, but the lack of observations of marked animals at these times prevents further separation of seasonal ranges.

The young ram which switched from summering in the Pilot-Index area to summering in the Wolverine Peak-Mineral Mountain area was the only exception to the high

fidelity to seasonal ranges shown by marked bighorns. This change is not surprising however, as rams in this herd begin to follow other rams usually sometime during their third year. When last sighted on the winter range in 1979 this three year old ram was associated with a five year old marked ram. When next located they were together on the older ram's traditional summer range. This incident supports the hypothesis that young rams develop their movement patterns by following the movements of older rams (Geist 1971).

The mixing of rams from the Rock Creek herd with those from other herds on the summer range could potentially lead to genetic interchange between widely separate wintering populations. Rams from the Rock Creek herd are known to associate with those from the West Rosebud herd on the Montana Absaroka summer range and most likely also associate with rams from Wyoming herds on the Wyoming Absaroka summer range. In this situation rams probably will travel for a time with rams from other herds. A young ram in such an association when fall migration begins may very well follow these rams to a winter range other than the one in which he was born. Such a young ram might then incorporate this winter range into his traditional movement pattern and thereafter continue to return, eventually participating in the rut and producing offspring in that herd. In this manner the Rock Creek herd may likely have genetic interchange with bighorn sheep herds as widely scattered as West Rosebud Creek in Montana to Sunlight Basin in Wyoming. This could have important consequences in offsetting excessive inbreeding in small wintering populations of bighorn sheep. Although a switch in winter ranges by young rams was not observed during this study, such an occurrence is probably not uncommon.

What selective advantage does the Rock Creek bighorn sheep herd gain in migrating 35 to 40 miles to the Absaroka summer ranges in the spring and the reversing the movement and returning to the Beartooths in the fall? One of

the advantages of using the Absaroka Mountains as summer range is the longer period green vegetation can be found there versus in the Beartooths. During late summer, bighorns utilize the subalpine scree areas of the Absarokas where green forage is still available. Such areas are not present in the Beartooths, where from late summer on, green vegetation is confined to small scattered areas watered by perpetual snowbanks. The relatively large continuous subalpine scree areas of the Absarokas where succulent vegetation can still be found have enough escape terrain and an open enough forest canopy to make them acceptable to bighorn sheep. The Beartooths, on the other hand, offer the advantage once snow begins to fall because of their better snowshedding qualities. Snow is swept free from large continuous areas of the plateaus around Rock Creek by high winds. The exposed vegetation on these areas is used by the sheep during the winter. Such snowfree areas in the Absarokas are confined to narrow areas along the ridgetops.

The yearly patterns of movement of this bighorn herd can to a large extent then be explained by the location of the most available, highest quality vegetation. In the winter the windswept plateau tops of the Beartooths offer the only areas in the mountains with available vegetation. As the snow melts off the canyon walls in the spring the bighorns take advantage of the early green up there. In the early summer instead of moving up onto the alpine plateaus to take ad-advantage of the new green growth developing there, the sheep migrate to the Absarokas to use the new alpine vegetation growing in these mountains. This behavior preserves the vegetation on the Beartooth plateaus for use in winter. As the season progresses and alpine vegetation desiccates, the sheep begin to use the green growth which is still available in the subalpine areas of the Absarokas.

Here they remain until snow begins to accumulate, at which time it becomes advantageous to migrate back to the Beartooth winter range before the route becomes blocked by snow. Once back in the fall they use relatively snowfree areas on the canyon sides and edges until increasing winter snows force them to the exposed plateaus once again.

The migration routes used by the Rock Creek bighorns do not follow straight lines between the Beartooth and Absaroka ranges. The arc shaped routes require migration of at least 35 to 40 miles compared to 23 to 28 miles if direct routes were used. At the present time these routes offer several advantages. One of these is that they avoid the Clarks-Fork-Beartooth Lakes country as much as possible The route to the Pilot-Index Peaks area involves travel through seven miles of this broken forested habitat while a straight line route would involve travel through at least 12 miles of this country. Also, much of the route follows open rocky terrain offering excellent security and good visibility. Such terrain is probably advantageous and preferred by migrating bighorns. This terrain also has superior snowshedding characteristics to that of the lake plateau country. Navigation and orientation along a route which crosses distinct drainages may be easier than on a route through the broken high lakes plateau. Although these characteristics of the migration route make it advantageous at the present time, the route in all likelihood evolved under conditions of snow and vegetation cover dissimilar to those found in the area today. What sequence of events led to the establishment of this route and the use of these two widely separated ranges under the conditions which existed in the past? Although this is an interesting question, it is unfortunately probably unanswerable.

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