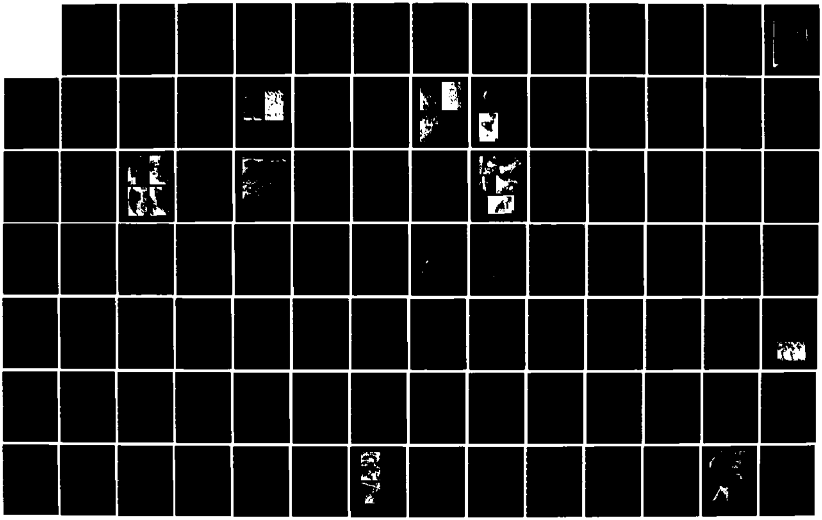
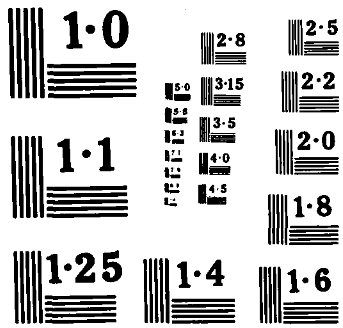
AD-A156 051 URAL-TWEED BIGHORN SHEEP INVESTIGATION(U) MONTANA DEPT OF FISH AND GAME HELENA G W BROWN 1979 DACW67-76-C-0083 1/2

UNCLASSIFIED F/G 6/3 NL





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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
Ural-Tweed bighorn sheep investigation

5. TYPE OF REPORT & PERIOD COVERED
Final Oct.1,1976-May 31,1979

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
Brown, Gerald W.

8. CONTRACT OR GRANT NUMBER(s)
DACW67-76-C-0083

9. PERFORMING ORGANIZATION NAME AND ADDRESS
MONTANA DEPARTMENT OF FISH AND GAME

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
US Army Corps of Engineers
Seattle District, P.O. Box C-3755
Seattle, WA 98124

12. REPORT DATE
[1979]

13. NUMBER OF PAGES
94

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)

AD-A156 051

15. SECURITY CLASS. (of this report)
Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

This document has been approved for public release and sale; its distribution is unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Bighorn sheep
habitat degeneration
habitat loss
Lungworms
Lake Koocanusa

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Investigation of declining status of the Ural-Tweed bighorn sheep herd. Sheep were captured and equipped with telemetry collars. The sheep population was found to be a contiguous herd which made recurrent use of specific key areas throughout the range. Natural as well as human decimating factors are discussed in relation to their overall influence on the shoop population. Recommemdations for management of the Ural-Tweed sheep herd and its habitat are specified.

ABSTRACT

Under contract with the U.S. Army Corps of Engineers, the Montana Department of Fish and Game initiated an investigation of the declining status of the Ural-Tweed bighorn sheep herd on 1 October 1976. The study was temporarily suspended from May through November 1977 and was completed on 31 May 1979. Seven bighorn sheep consisting of 3 ewes and 4 rams were captured and equipped with telemetry collars. Two hundred and six relocations of radio-collared sheep provided information on seasonal distribution and movements, key use areas, home range size, habitat selection and population dynamics. The sheep population, estimated at fewer than 25 animals, was found to be a contiguous herd which made recurrent use of specific key areas throughout the range. Ural-Tweed bighorns were consistent in their use of south, southwest, and west exposed oversteepened terrain along the east escarpment of Lake Koocanusa. Five habitat types, PSME/SYAL, PSME/CARU, PSME/PHMA, PSME/ARUV and PSME/LIBO received 100 percent of the sheep use annually, based on telemetry relocations. Grassy openings and open forest cover types consisting of sparsely stocked, but large diameter ponderosa pine and Douglas-fir characterized sites selected by sheep during most seasons of the year. Rough fescue was found to be an important dietary constituent throughout the year, while browse, as a forage class, was important during periods of heavy-crusted snow conditions and also during spring flowering. Endoparasite loads were low, but the possibility of a population crash due to the lungworm-pneumonia complex during the 1960's is discussed. Thirty-five hundred acres of bighorn sheep habitat lost to Libby Dam Project and degeneration of residual habitat due to ecological succession in the absence of natural fires continues to reduce the carrying capacity of the range. Natural as well as human-caused decimating factors are discussed in relation to their overall influence on the sheep population. Recommendations for management of the Ural-Tweed sheep herd and its habitat are forwarded.

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CHAPTER I

INTRODUCTION

Seton (1929) estimated between 1.5 and 2 million bighorn sheep, (*Ovis canadensis*), in North America during the 1800's. By the early 1940's, this species was extirpated in four of the fifteen western states they formerly inhabited. Within the remaining states, their distribution was reduced to approximately ten percent of their former range, and their numbers diminished to less than 20,000 (Buechner 1960). Probable causes for their decline are: 1) forage competition with domestic, as well as wild ungulates; 2) disease introduced by domestic livestock; 3) conversion of mountain grasslands into timberlands or sagebrush deserts (Morgan 1971); 4) indiscriminant hunting, and 5) human encroachment and development on key bighorn ranges.

In an attempt to rectify this situation, several states initiated reintroduction programs to restore bighorns onto historic range (Yoakum 1963). The Montana Department of Fish and Game began transplanting activities in 1942. Results of reintroductions varied from complete failures to establishment of a few huntable populations. A notable characteristic of bighorns introduced onto unfamiliar range was an inability to establish migration routes between seasonal ranges. For mountain sheep, knowledge of home range and migration routes is transmitted from generation to generation and appears to be a learned trait in native herds (Geist 1971). Once indigenous herds perish, home range knowledge is lost with the results that introduced sheep are frequently unable to exploit potential seasonal ranges.

The Ural-Tweed bighorn sheep herd, inhabiting the East Kootenai adjacent to Lake Koocanusa, is the last remnant native population of bighorn sheep in northwestern Montana. Historically, the Ural-Tweed sheep range was more extensive than it is today and supported a viable population of mountain sheep. Chronological population estimates for this herd by Ensign (1937), Brink (1941), Bergeson (1942), Couey (1946), Zajanc (1948), Blair (1955), and Quick (1965), were 97, 100, 98, 150, 168, 150-175, and 170, respectively. This information suggest an expanding population into the 1950's which appears to have stablilized at 150-200 animals by 1965. Since that time, a drastic decline in sheep numbers has occurred. Presently, there are no more than 25 bighorn sheep remaining on the Ural-Tweed range, and their future as a viable sheep herd is in doubt.

Several factors, including natural as well as human induced phenomena, have been responsible for the overall demise of the Ural-Tweed sheep population. Habitat loss to Libby Dam Project and successional trend on residual habitat have dramatically reduced the carrying capacity of the sheep range. In addition, a sheep population crash associated with the lungworm-pneumonia complex may have occurred concurrent with Canadian sheep herd declines in the 1960's. However, there is no documentation to confirm this speculation.

Libby Dam Project resulted in substantial reduction of bighorn sheep habitat along the Koocanusa Reservoir face. Inundation of the impoundment area directly removed approximately 3500 acres of critical bighorn winter-spring range. Additional key habitat was lost to construction of Montana State Highway 37 which bisects the sheep range from Fivemile Creek to Pinkham Creek. This highway traverses a documented lambing area (Brink 1941), rutting grounds, winter range, and spring range in the lower slope area between Volcour Gulch and Peters Gulch. High-speed vehicle traffic along this highway has applied additional stress on these animals through vehicle-sheep collisions as well as general harassment of sheep attempting to cross the roadway. Increased access onto the sheep range, brought about by the highway, has resulted in several animals being illegally shot. The loss of 13,800 acres of big game winter range to Libby Dam Project further compounds range problems encountered by these sheep. Documentation in the literature suggests that bighorns demonstrate a competitive inferiority when competing with sympatric ungulates for available forage. Interspecific, as well as intraspecific competition for forage and space would undoubtedly provide a selective advantage for other ungulates over sheep, with consequences being manifested in a downward adjustment in the sheep population through a general decrease in productivity and lamb survival.

Through time, ecological succession has been a subtle but, nonetheless, important factor responsible for vegetation changes on the sheep range. Rigorous fire suppression has allowed advanced stages of plant succession on an area previously maintained as a fire disclimax, with the end result being reduced support capabilities on habitats which were formerly more open and maintained greater numbers of sheep.

Considering the impacts of Libby Dam Project on the Ural-Tweed sheep herd, the Montana Department of Fish and Game requested funding from the U.S. Army, Corps of Engineers to initiate an investigation of this sheep population. Overall purpose of the project was to gather biological information applicable to formulation of management guidelines to perpetuate a viable sheep population on residual range. Specific study objectives included the following:

1) Delineate seasonal ranges, migration routes and key use areas;
2) Determine habitat parameters being selected for by sheep during various seasonal periods;
3) Determine herd health as it reflects range condition;
4) Monitor population dynamics (i.e. productivity, recruitment, mortality, age and sex composition to assess herd status and trend, and identify possible factors limiting herd growth; and
5) Identify critical areas of potential vehicle-sheep collisions along State Highway 37.

This investigation was initiated on 1 October 1976. Due to an extremely mild and dry winter, terms of the contract requiring six bighorn sheep be instrumented with telemetry collars could not be met. After discussion of this situation with the Corps of Engineers, it was determined advantageous to temporarily suspend work on the project after 30 April 1977, rather than proceed through a summer season with an insufficient number of radio-collared animals. The second phase of the project commenced on 1 December 1977 with intensive field work being completed on 31 December 1978.

CHAPTER II

DESCRIPTION OF THE STUDY AREA

Location

The study area is situated along the east side of Lake Koocanusa between Fivemile Creek in the south and Pinkham Creek in the north (Figure 1). The project area is accessed by State Highway 37 which enters the southern extreme of the sheep range approximately 30 miles northeast of Libby, Montana. Early reports (Ensign 1937, Brink 1941) suggest the northern limits of sheep distribution to be Beartrap Mountain. Sheep sightings north of this point recommended extension of sheep range delineation to include lower Pinkham Creek. Conversely, sheep were not observed in the upper Cripple Horse drainage near Warland Peak, an area known to be historic sheep range. Consequently, this area was deleted from the study area map.

Topography

With a North-South orientation of the sheep range, westerly exposures overlooking Lake Koocanusa predominate. Several drainages and small tributaries including Pinkham Creek, Sutton Creek, Peck Gulch, McGuire Creek, Tweed Creek, Rocky Gorge, Allen Gulch, Peters Gulch, Sheep Creek, Tenmile Creek, Packrat Gulch, Volcour Gulch, and Fivemile Creek dissect the area from east to west providing south and southwesterly aspects.

Generally, topographic features of the area are conveniently divided into two distinct components: 1) the initial escarpment sloping from high pool level of Lake Koocanusa, 2,459 feet, to a deflection point which approximates the 4,800 foot elevation along the reservoir face, and 2) the more gentle terrain ranging from upper elevation limits of the reservoir escarpment to subdued ridges and peaks ranging to 6,872 feet on Sutton Mountain. The escarpment consists of over-steepened terrain with high relief ratios where elevational changes of 2,500 feet occur in less than 1.0 mile and slopes average 50 percent. Rocky, broken terrain, talus slides, cliffs and discontiguous benches or bluffs are characteristic landforms along the escarpment (Figure 2). Geomorphic features on areas above the escarpment are less pronounced, with rock outcroppings and exposed parent material occurring infrequently throughout this component of the study area. Soil development and stability are greater than that found on the escarpment.

Soils, landform and geologic structure are discussed in some detail in the Inch Mountain Planning Unit, Final Environmental Statement (Anonymous 1974).

Climate

Climatological data for the general vicinity are collected by the U.S. Forest Service, Libby Ranger Station which is located in Libby, Montana approximately 20 air miles southwest of the study area. Table 1 lists monthly mean temperatures and precipitation for 1976-1978 and also shows departures from normal mean temperatures and average precipitation based on long-term weather data collected at the station.

Annual precipitation averages 19.4 inches with approximately 50 percent occurring as snow in the higher elevations. Maximum precipitation occurs during

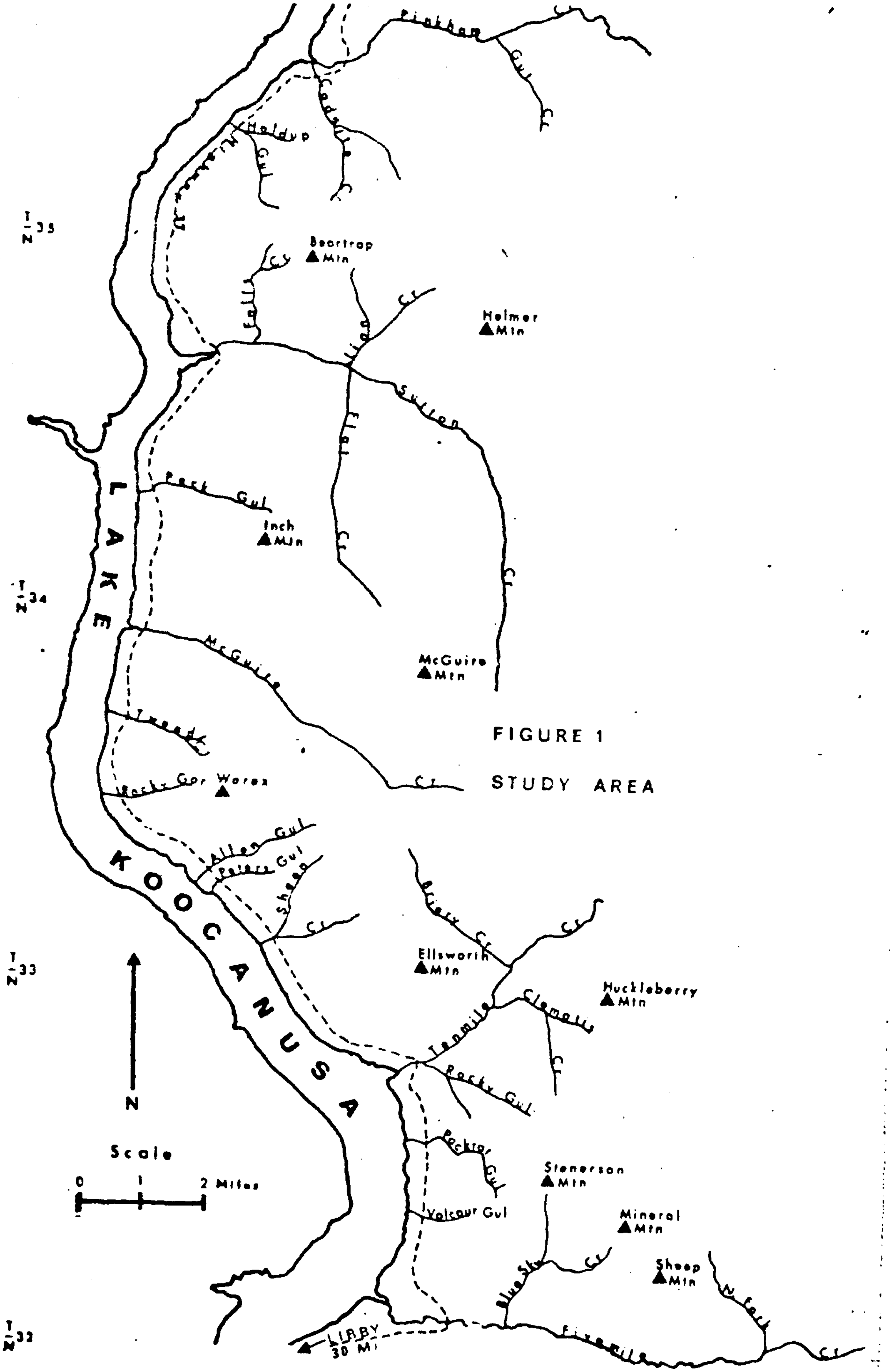

FIGURE 1

STUDY AREA

FIGURE 2

VIEW EAST INTO SHEEP CREEK SHOWING CHARACTERISTIC LANDFORM AND TOPOGRAPHY ON THE SHEEP RANGE

OBS. NO. TR RO BSO DATE TIME

NO. SHEEP GROUP TYPE: EWE-JUVENILE RAM-EWE-JUVENILE RAM-EWE RAM EWE JUVENILE

NO. ADULT EWES NO. YEARLING EWES NO. LAMBS

NO. YRLG RAMS NO. 2YR NO. 3YR NO. 4YR NO. 5YR NO. 6YR NO. 7YR NO. 8YR

NO. UNCLASSIFIED SHEEP NO. MARKED SHEEP ANIMAL NOS.

ACTIVITY: BEDDED FEEDING ALERT WALKING RUNNING ESCAPING OTHER

LOCATION: HWY. MILE ¼ ¼ SEC. T N R W UTM: LO LA

ELEVATION SLOPE: MICRO MAP ASPECT: 339-23 24-68 69-113 114-158 159-203 204-248 249-293 294-338

TOPOGRAPHY:: TALUS CLIFF BLUFFS RIDGE BROKEN SIDEHILL

TEMPERATURE: BELOW 0 0-20 21-40 41-60 61-80 81 plus

WIND SPEED: 0-3 4-10 11-20 20 plus WIND DIRECTION: N NE E SE S SW W NW

CLOUD COVER: 0-25% 26-50% 51-75% 76-100%

PRECIPITATION: DRY LIGHT RAIN STEADY RAIN SNOW FLURRIES STEADY SNOW FOG

GROUND: DRY DAMP MUDDY FROZEN HEAVY FROST PATCHY SNOW UNIFORM SNOW COVER

SNOW DEPTH: 1-3" 3-6" 6-9" 9-12" 12-15" 15-18" 18" plus

SNOW CONDITION: POWDER WET PACKED CRUSTED FROZEN

SUBSTRATE: BEDROCK TALUS ROCKY SOIL DEVELOPED SOIL

COVER TYPE: ROCKLAND SHRUB-GRASS PARKS OPEN FOREST CLOSED FOREST

HABITAT TYPE: CANOPY COVERAGE: 0-20% 21-40% 41-60% 61-80% 81-100%

NEAREST CLIFF: NEAREST STEEP TERRAIN: NEAREST CONIFER SPECIES DBH

TIMBER STAND CHARACTERISTICS

DBH CLASS

SPECIES

FIGURE 8

Habitat Selection

In addition to seasonal range use and movement patterns information provided by telemetry equipment, specific data on site selection were obtained each time an instrumented animal was located. Biotic and abiotic factors such as vegetation characteristics, topographic and geomorphic features and climatic conditions were recorded to establish the relationship between habitat situations being selected for during different seasons and under variable climatic conditions. A data collection form sheet was developed and used to record information at relocation sites (Figure 8).

Cover Type

A cover type classification scheme for the study area was developed utilizing canopy coverage of existing vegetation as the determining factor in differentiating cover types. Five broad cover types were recognized on the sheep range and are described below:

1) Rockland is characterized by a low total canopy coverage of bryophytic as well as non-bryophytic vegetation. Lichens, mosses, scattered shrubs, grasses and forbs growing on talus slides and rock outcrops typically distinguish this cover type.

2) Shrubland-grassland complex. Shrub-grass plant communities occur only minimally on the study area, and are generally restricted to previously disturbed sites (i.e. logged, burned) where early successional stages of shrub-grass associations persist. The bitterbrush-bunchgrass plant community near the mouth of Sutton Creek and the logged areas at Allen Gulch and Volcour Gulch are representative of this cover type. Conifer canopy coverage is less than 25 percent while coverage values for grasses and shrubs generally exceed 50 percent. Depending on topo-edaphic factors, common shrubs found on this type are bitterbrush, serviceberry, ninebark, mock-orange, and chokecherry, while bluebunch wheatgrass, rough fescue, Idaho fescue, Junegrass, and purple reedgrass are typical graminoids on this cover type.

3) Parks are characterized by canopy coverage values of less than 25 percent for both conifers and shrubs, but by comparatively high coverage values, 50-75 percent, for graminoids and herbaceous plants. Common perennial herbaceous flora included yarrow, arrowleaf balsamroot (*Balsamorhiza sagittata*), wild buckwheat, strawberry (*Fragaria vesca*), alumroot, lomatium (*Lomatium macrocarpum*), penstemon, and phlox (*Phlox hoodii*). The two dominant bunch grasses growing on this cover type were bluebunch wheatgrass and Idaho fescue. With respect to total area, parks are not a common cover type on the study area but typically occur at upper elevations along the interphase between the reservoir escarpment and upper slope forested areas.

4) Open Forest is the characteristic cover type on the warmer and drier aspects of the reservoir escarpment. Conifer canopy coverage ranges between 25-75 percent, while collective shrub coverage was 5-75 percent and grass coverage also ranged from 5-75 percent.

5) Closed Forest is the predominant cover type over much of the study area, especially at the higher elevations above the steep reservoir face. Intrusions of the closed forest cover type occur at lower elevations particularly on the

Telemetry equipment was purchased through AVM Instrument Company, Champaign, Illinois. Radio-collars, preassembled at the factory, were of the LM type with SB2 transmitters powered by one (1) lithium battery, and ranged in frequency from 150.860-151.132 MHz. The standard LA 12 receiver with sweep option was used on this project. Two strut-mounted 4-element yagi antennas in conjunction with a right-left switch box, were employed during aerial tracking of radio-collared sheep. A single hand-held 3-element yagi antenna was used while ground tracking radioed animals.

Telemetry relocations were made initially from aircraft, with subsequent ground confirmations that normally provided visual contact with the instrumented animal or at least signs of its activity in the immediate area of the radio "fix". Ground initiated tracking of radioed sheep and resultant plotting of the location was not determined through triangulation, but rather, was established through direct observation. All locations of marked sheep were plotted on U.S.G.S. 1:24,000 scale (7.5 minute) topographic maps with 40 feet contour intervals. Oblique aerial photographs of the study area aided in accurate determination of each relocation site. Each radio-collared bighorn was located approximately four times monthly throughout the functional period of the transmitter.

Distribution and Movements

In conjunction with telemetry relocations, reconnaisance trips were made over the study area to establish sheep distribution through direct observation of animals or their sign (i.e. tracks, beds, pellet groups). Due to the rugged, broken, well-forested nature of the Ural-Tweed sheep range, assessment of sheep distribution through random reconnaisance was very time consuming and unproductive. The telemetry system proved absolutely essential to the collection of sound data for all facets of the project. Telemetry apparatus permitted relocation of sheep in both open and timbered habitats, whereas random observations of bighorns were biased towards openings, mostly adjacent to State Highway 37. Radio-collared sheep provided reliable data on seasonal home ranges and key use areas, seasonal and short-term movements, migration routes, habitat selection, population numbers, group fidelity, and herd structure.

Continued use of areas between State Highway 37 and Libby Reservoir necessitates sheep crossing of the roadway. Specific crossing points have been adopted by these animals and these sites were identified and located with respect to the nearest highway milepost.

Data for movements, seasonal centers of activity, and minimum home range sizes for marked sheep were analyzed on an IBM Computer, utilizing a program developed by the Montana Department of Fish and Game, Research Bureau. The UTM Grid system was drawn directly on U.S.G.S. 1:24,000 scale topographic maps to facilitate precise plotting of a radioed animal's location down to the nearest 2.5 acres (1 hectare) area. Grid coordinates for individual relocations were keypunched on IBM Computer Cards and line printouts edited for errors prior to analyses by the computer. Computer printouts provided calculations on home range sizes, distances moved, geographic centers of activity, and standard diameters for an individual marked sheep during a given time period. The standard diameter represents the diameter of a circle with the center of activity as its center, and which contains 68.26 percent of all relocations of an animal during the period considered.

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TRAPPING/CASUALTY FORM

COLLECTION NO. SPECIES DATE TIME

SEX AGE

LOCATION OF CAPTURE OR DEATH

TRAPPED OR DRUGGED DRUG USED DOSAGE

TIME OF INJECTION TIME DOWN TIME RECOVERED

CIRCUMSTANCES OF DEATH

PHYSICAL MEASUREMENTS

WEIGHT: WHOLE FIELD DRESSED

TOTAL LENGTH SHOULDER HEIGHTH CHEST GIRTH

EAR LENGTH TAIL LENGTH HIND FOOT LENGTH

NECK CIRCUMFERENCE: AT SHOULDER AT SKULL MIDSECTION

HORN MEASUREMENTS

LENGTH:	BASE-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	TOTAL
RIGHT-											
LEFT-											

CIRCUMFERENCE:	BASE	1	2	3	4	5	6	7	8	9	10
RIGHT-											
LEFT-											

TIP-TIP SPREAD

EAR TAGES: RIGHT LEFT

RADIO COLLAR: CHANNEL COLOR

FIGURE 7

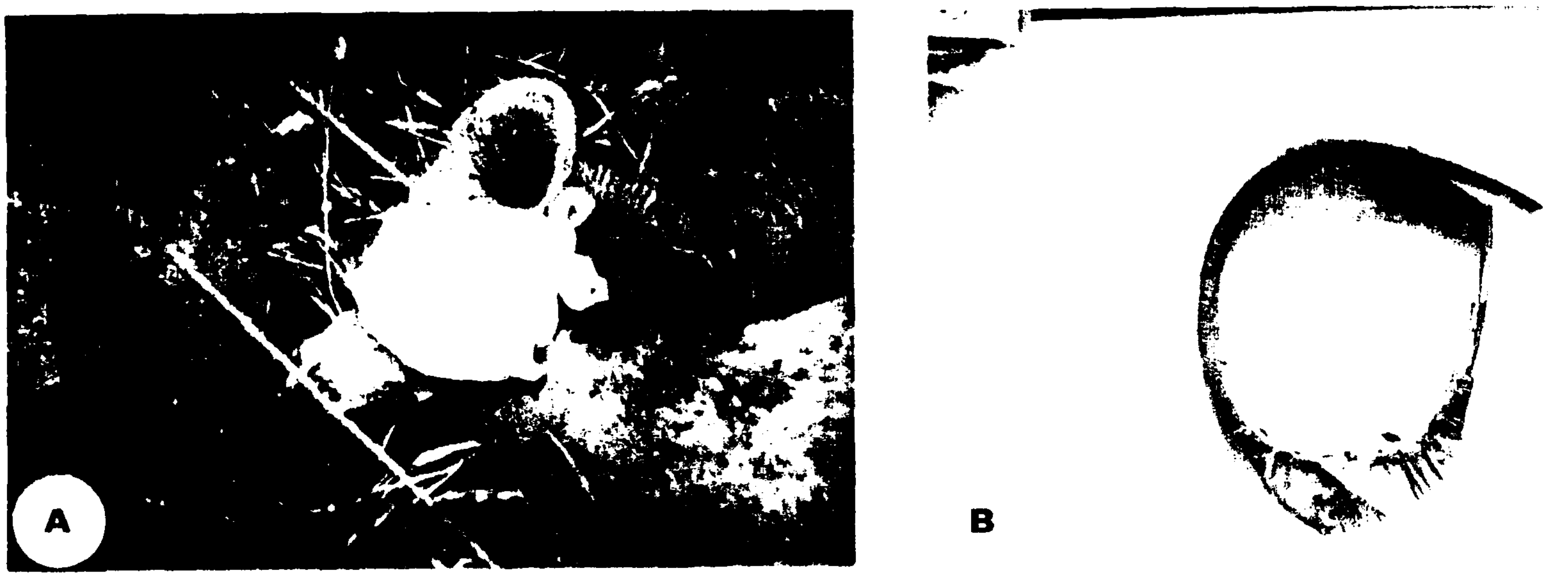


FIGURE 6

A-BLINDFOLDED YOUNG RAM

B-RADIO COLLAR

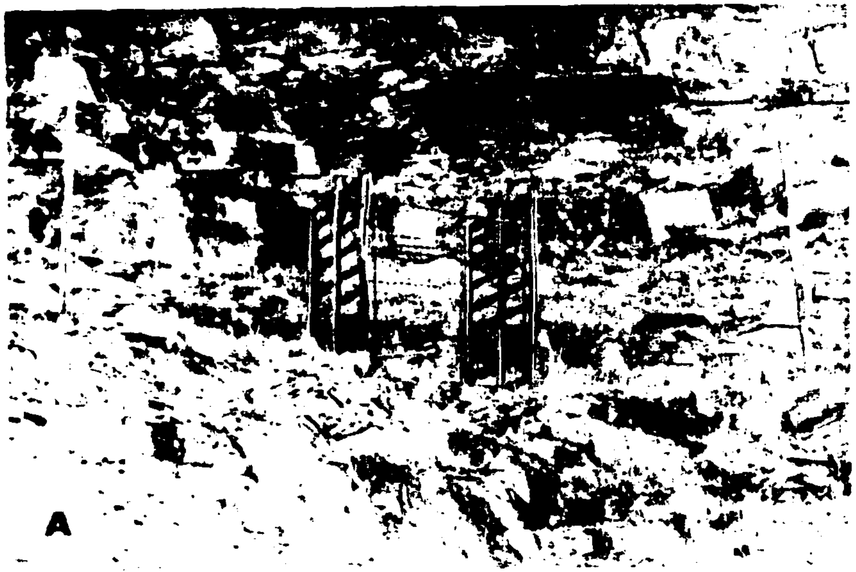


FIGURE 5

A-DOUBLE-GATED PANEL TRAP
B-WING TRAP
C-CLOVER TRAP

CHAPTER III

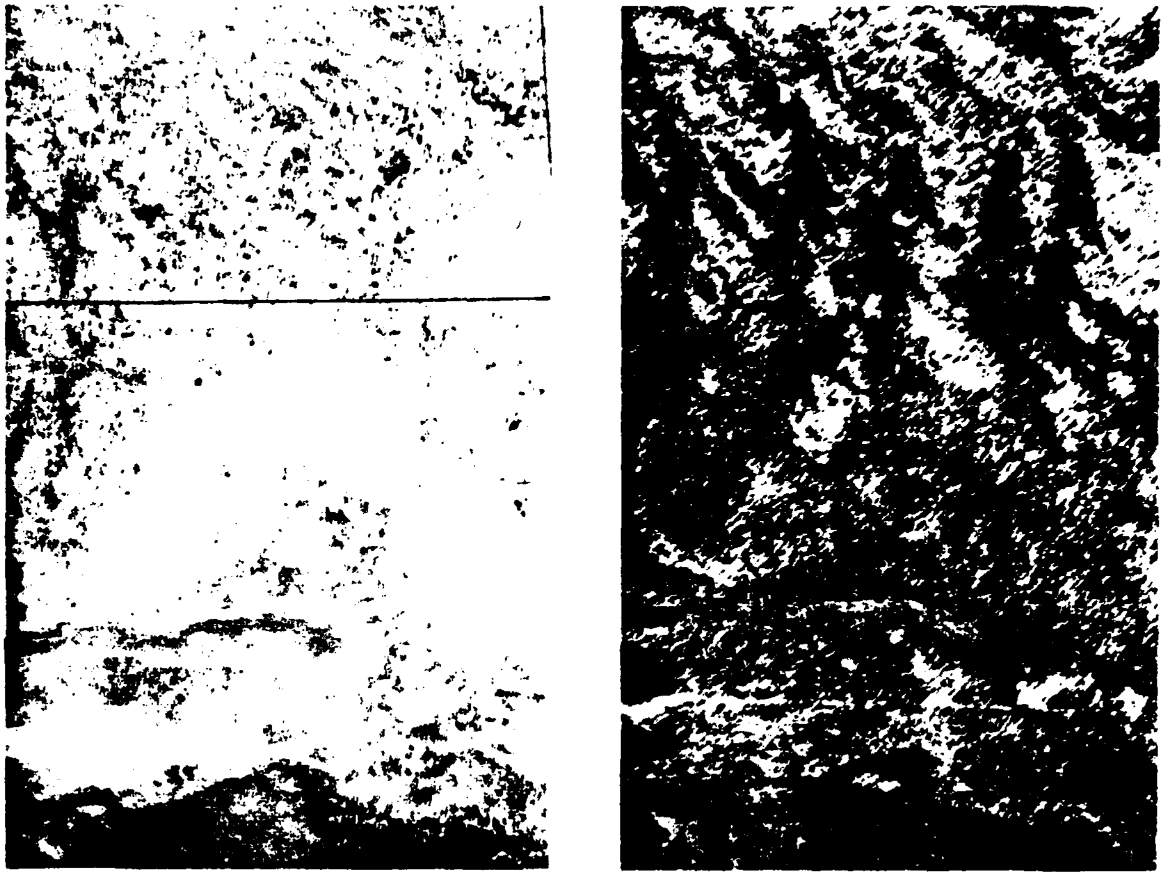
MATERIALS AND METHODS

Capture and Marking Techniques

In an attempt to satisfy contract stipulation that six bighorn sheep be captured and fitted with telemetry-collars, initial project emphasis during the 1976-77 field season centered on trapping activities. Five clover traps and two double-gated Oregon style panel traps (Figure 5) were established adjacent to State Highway 37 between Tenmile Creek and Peters Gulch, in an area normally occupied by sheep during winter. A small drive trap, consisting of nylon netting wings funneling into a nylon netting trap enclosure of approximately 20 x 30 feet, and with an animal-triggered drop gate mechanism, similar to that used on the Oregon panel traps, was constructed in the timber at a major sheep crossing along Highway 37 near Sheep Creek. Traps were baited with alfalfa-grass hay, and a commercial livestock sweet-feed mixture consisting of rolled oats, barley and molasses. Apple pulp used successfully on bighorns in Colorado (Schmidt 1971) was tried at two of the trapsites. In addition, 50-pound blocks of stock salt (NaCl 99 percent; inert matter 1 percent) were placed at three of the trapsites and rock salt was scattered around one of the panel traps in attempts to establish lick-sites for spring trapping. A natural mineral lick near Tweed Creek was discovered and supplemented with block salt. Two live-snares as described by Mossman et al. (1963), were set on trails leading to this lick site. During the 1977-78 winter, an additional wing trap (Figure 5) was established at another important sheep crossing along State Highway 37 near Sheep Creek. All traps were checked at least once each day and snares were inspected twice daily while in operation.

At appropriate opportunities, attempts were made to immobilize free-ranging sheep with Sernylan (phencyclidine hydrochloride) or Rompun (xylazine) in aqueous solution, contained in hypodermic syringe darts propelled from a Palmer powder charged Cap-Chur rifle. Sheep were darted directly from a stationary pickup truck along State Highway 37, as their avoidance response to a vehicle was much less pronounced than their reaction to a man on foot. Initial attempts to stalk bands of sheep for purposes of darting proved unproductive and were abandoned since this activity tended to increase the already wary nature of these animals. In conjunction with a helicopter survey of the sheep range, an attempt was made to dart a bighorn sheep from the air. Animals captured in traps were not subjected to tranquilizing agents, but were manhandled and their legs secured in a fashion similar to that of tying up a calf. A blindfold (Figure 6) was used on trapped animals to reduce stress induced through handling. Darted animals generally departed the area quickly and were allowed several minutes travel time prior to pursuit. They were then tracked to where they had succumbed to the drug. Handling of sedated bighorns was similar to that of handling trapped animals, in that they were blindfolded and tied to reduce stress and the possibility of injury. Captured individuals were assigned an age and sex class, and general body measurements were recorded on form sheets (Figure 7). Each animal was examined for ectoparasites and general body condition was noted. Montana Department of Fish and Game ear tags were attached to each of both ears on captured bighorns and a color-coded collar (Figure 6) housing a radio transmitter was attached to each sheep. Upon release, drugged sheep were observed for several hours and relocated the following day to insure full recovery. Each transmitter package was color-coded with a wear-resistant friction tape to facilitate identification of a marked animal in the field.

(Physocarpus malvaceus), snowberry (Symphorycarpos albus), oceanspray (Holodiscus discolor), white spirea (Spirea betulifolia), serviceberry (Amelanchier alnifolia), mock-orange (Philadelphus lewisii), Oregon grape (Berberis repens), bearberry (Arctostaphylos uva-ursi), chokecherry (Prunus virginiana), rose (Rosa spp.), bitterbrush (Purshia tridentata); grasses: bluebunch wheatgrass (Agropyron spicatum), rough fescue (Festuca scabrella), Idaho fescue (Festuca idahoensis), Junegrass (Koleria cristata), pinegrass (Calamogrostis rubescens), purple reedgrass (Calamogrostis pupurescens); perennial forbs: penstemon (Penstemon spp.), alumroot (Heuchera cylindrica), wild buckwheat (Eriogonum herocleoides), yarrow (Achillea millefolium). A variety of annuals and other herbaceous plants common along the reservoir face assume seasonal dominance during spring and summer according to their respective phenologies.



1932 1974

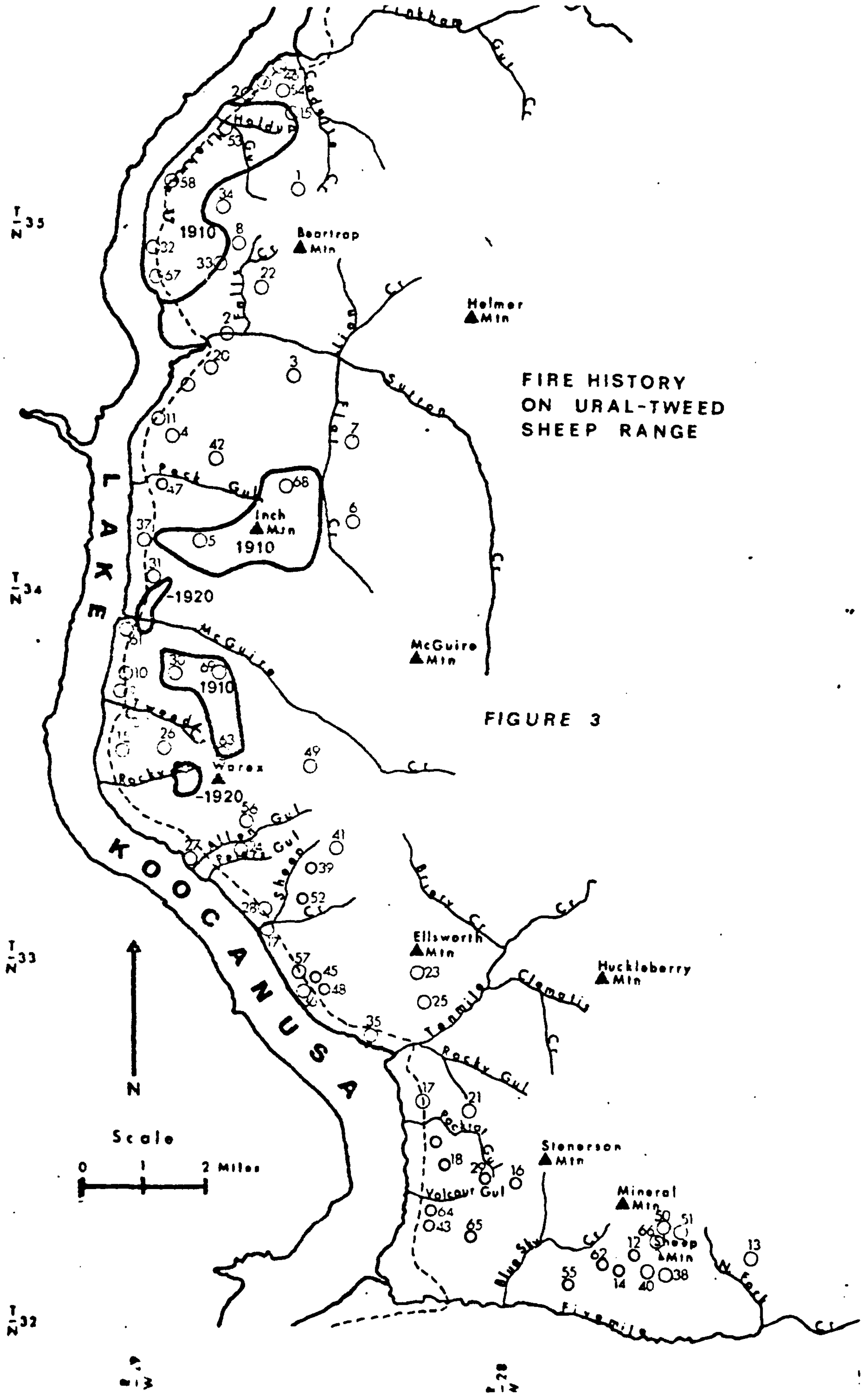
FIGURE 4

LOWER CRIPPLE HORSE CREEK AREA FORMERLY INHABITED BY URAL—TWEED SHEEP SHOWING SUCCESSIONAL TREND IN VEGETATION BETWEEN 1932 AND 1974

TABLE [illegible]*. FIRE INCIDENCE ON URAL-TWEED BIGHORN SHEEP RANGE FOR THE PERIOD 1940-1977.

NO.	YEAR	CAUSE	ACRES	LOCATION	NO.	YEAR	CAUSE	ACRES	LOCATION
1	1940	Lightning	Spot	Beartrap	36	1959	Railroad	Spot	Ural
2	1940	Lightning	Spot	Sutton Cr.	37	1960	Railroad	5.[illegible]	Inch Mtn.
3	1940	Lightning	Spot	Flat Cr.	38	1960	Lightning	.25	Sheep Mtn.
4	1940	Lightning	Spot	Peck Gulch	39	1960	Lightning	.2	Sheep Cr.
5	1940	Lightning	Spot	Inch Mtn.	40	1961	Lightning	[illegible]	Sheep Mtn.
6	1940	Lightning	Spot	Flat Cr.	41	1961	Lightning	Spot	Warex Mtn.
7	1944	Lightning	Spot	Flat Cr.	42	1961	Lightning	Spot	Inch Mtn.
8	1945	Lightning	Spot	Beartrap	43	1961	Lightning	Spot	Volcour
9	1945	Railroad	90.0	Tweed Cr.	44	1963	Lightning	.5	Cadette Cr.
10	1945	Smoking	15.0	Tweed Cr.	45	1963	Lightning	Spot	Ural
11	1946	Lightning	8.0	Stone Hill	46	1964	Railroad	1.0	Cadette Cr.
12	1947	Lightning	Spot	Sheep Mtn.	47	1965	Lightning	Spot	Peck Gulch
13	1947	Lightning	Spot	Fivemile Cr.	48	1966	Lightning	Spot	Ural
14	1947	Lightning	8.5	Fivemile Cr.	49	1967	Lightning	.3	Warex Ridge
15	1949	Lightning	0.3	Warex Ridge	50	1967	Lightning	.3	Sheep Mtn.
16	1949	Lightning	Spot	Stenerson	51	1967	Lightning	Spot	Sheep Mtn.
17	1952	Lightning	Spot	Stenerson	52	1967	Lightning	.14	Sheep Cr.
18	1952	Lightning	Spot	Stenerson	53	1968	Lightning	.5	Holdup Gulch
19	1955	Railroad	Spot	Sheep Cr.	54	1968	Lightning	Spot	Cadette Cr.
20	1956	Lightning	Spot	Stone Hill	55	1968	Lightning	Spot	Blue Sky Cr.
21	1956	Lightning	Spot	Volcour	56	1970	Lightning	Spot	Allen Gulch
22	1956	Lightning	Spot	Beartrap	57	1970	Lightning	.1	Ural
23	1957	Lightning	Spot	Ellsworth	58	1970	Railroad	12.0	Stone Hill
24	1957	Lightning	1.8	Allen Gulch	59	1970	Railroad	10.0	Holdup Gulch
25	1957	Lightning	.5	Tenmile Cr.	60	1970	Equipment	4[illegible].0	Tweed Cr.
26	1957	Lightning	.3	Warex Mtn.	61	1971	Slash	2.75	McGuire Cr.
27	1958	Railroad	1.0	Allen Gulch	62	1971	Lightning	.20	Blue Sky Cr.
28	1958	Railroad	Spot	Sheep Cr.	63	1973	Lightning	.5	Warex Mtn.
29	1958	Lightning	Spot	Stenerson	64	1973	[illegible]	[illegible]	Volcour
30	1958	Lightning	Spot	McGuire Cr.	65	1973	Lightning	.[illegible]	Blue Sky Cr.
31	1958	Lightning	Spot	Inch Mtn.	66	1973	Lightning	.[illegible]	Sheep Mtn.
32	1958	Railroad	1275	Stone Hill	67	1975	Slash	[illegible]	[illegible]
33	1958	Lightning	Spot	Beartrap	68	1975	Lightning	Spot	Inch Mtn.
34	1958	Lightning	Spot	Beartrap	69	1977	Lightning	.75	McGuire Cr.
35	1959	Unknown	Spot	Tenmile Cr.					

* Table corresponds with Figure 3.



FIRE HISTORY ON URAL-TWEED SHEEP RANGE

FIGURE 3

November, December, and January with secondary peaks in May and June. Summers are short and relatively dry, with average precipitation for July and August being .68 and 1.05 inches, respectively.

The average annual temperature is 45.1°F. January is the coldest month averaging 22.4°F. Warmest temperatures are recorded during July and August with monthly means of 67.0°F and 65.3°F, respectively.

The winter of 1976-1977 was the mildest on record for the Libby area. Mean monthly temperatures were 3.4°F, .9°F, and 4.2°F above the long-term averages for December, January, and February, respectively. Conversely, winter precipitation was well below normal with records for December, January and February registering, respectively, 1.72, 2.10, 1.11 inches less precipitation than the long-term average. The project study area reflected these extremely mild winter conditions in that the reservoir escarpment was mostly bare of snow throughout the winter.

The 1977-78 winter period was more nearly normal, with respect to climate, than the previous year. Mean monthly temperatures were cooler in December, and slightly warmer in January and February than long-term averages, while total precipitation for the three month period was .83 inches below average. There was, however, persistent snowpack on the study area throughout the 1977-78 winter season.

Fire History

Historically, fire assumed an important role in maintenance of natural ecosystems on the study area. Fire disclimax plant communities are well represented throughout the sheep range as evidenced by burn scarred ponderosa pine (*Pinus ponderosa*) and dense stands of lodgepole pine (*Pinus contorta*). Records kept by the U.S. Forest Service, Kootenai National Forest, reveal a higher than average incidence of fire within the Ural-Tweed Sheep Range (Figure 3, Table 2). Of 69 fires recorded between 1940-1977, 53 or 77 percent were induced by lightning, a natural causative agent. With adoption of an aggressive fire suppression policy by the U.S. Forest Service since about 1930, the natural role of fire has been circumvented. Consequently, plant succession favoring more densely forested Douglas-fir (*Pseudotsuga menziesii*) dominated communities is gradually replacing open grown ponderosa pine-bunch grass associations which are fire dependent for perpetuation. The successional trend on the sheep range, although subtle, shows conifer encroachment on previously more open sites (Figure 4). With the absence of fire this trend will, no doubt, continue.

Vegetation

Flora in the Libby region reflects Pacific Coast Climatic influences and falls broadly into the Douglas Fir Coniferous Forest Zone. Many species common to the west coast such as western red cedar (*Thuja plicata*), western hemlock (*Tsuga heterophylla*), mountain hemlock (*T. mertensiana*), grand fir (*Abies grandis*), and western white pine (*Pinus monticola*) occur on the study area.

Ponderosa pine and Douglas-fir dominate the conifer overstory along the reservoir escarpment, but give way to more dense stands of Douglas-fir, lodgepole pine and subalpine-fir (*Abies lasiocarpa*) on the more gentle terrain sloping up towards the Kootenai-Pinkham divide. Common understory associates on the xeric south, southwest and west aspects of the sheep range include: shrubs: ninebark

TABLE . CLIMATOLOGICAL SUMMARY FOR THE TIME PERIOD DURING WHICH THE URAL-TWEEL SHEEP PROJECT OCCURRED.

	[illegible]		[illegible]		[illegible]	
MONTH	TEMP.[a]	PRECIP.	TEMP.	PRECIP.	TEMP.	PRECIP.
Jan.	23.2	1.75	27.3	.30	25.5	1.9
Feb.	31.3	3.17	34.3	.44	32.4	.36
Mar	32.7	.74	37.4	1.43	40.3	.51
Apr.	45.7	.85	47.8	.29	46.4	1.25
May	55.3	.77	51.9	1.85	50.9	2.64
June	57.2	.93	64.3	.75	61.7	.49
July	66.7	.90	66.3	1.50	65.6	2.42
Aug.	64.8	1.94	66.8	1.29	63.7	1.43
Sept.	--	.40	55.0	2.05	56.9	1.31
Oct.	--	.66	45.5	.49	47.0	.32
Nov.	35.2	1.19	32.0	2.32	29.4	1.97
Dec.	29.1	.63	24.7	3.11	21.2	1.81
Annual	--	13.95	45.5	15.87	45.0	16.71
Long-term Averages	45.1	19.4				

[a] Mean monthly temperatures in degrees F.

cooler more moist northerly and easterly aspects. Canopy coverage of conifers on this type exceeds 75 percent, shrub coverage ranges from 1-75 percent and grass coverage, especially pinegrass, ranges to 100 percent.

Photographic examples of the various cover types are shown in Figure 9.

Habitat Type

Habitat type classification follows that described by Pfister et al. (1977). Briefly, a habitat type reflects the potential vegetation association on a given area if allowed to proceed to successional climax. By definition, "all land areas potentially capable of producing similar plant community at climax may be classified as the same habitat type" (Daubenmire 1968). Habitat type designation follows a two element system consisting of 1) the climax tree species and 2) the characteristic or dominant understory associate. For example, Pseudotsuga menziesii/ Physocarpus malvaceus, abbreviated PSME/PHMA refers to the Douglas-fir/ninebark habitat type.

A habitat type map overlay, on a scale of 1:24,000, was constructed for the study area and used in conjunction with the U.S.G.S. 7.5 minute topographic maps to determine bighorn sheep use of various habitat type (Figure 10).

Landform Types

To characterize geomorphic features being selected by bighorns, six different landform types were categorized on the study area. These types consisted of:

1) Talus-masses of large diameter angular boulders produced by backweathering and mass wasting of scarps or rock outcrops. Talus slides or cones are generally unstable due to continual downslope movement, and incapable of supporting vegetation to climax.

2) Cliffs-near verticle rock faces with a minimum verticle drop of 25 feet and ranging to over 100 feet. Faults along cliff faces often provided avenues of travel for sheep.

3) Bluffs- a series of discontinuous benches or terraces ranging in width from a few feet to over 100 feet and separated by steep to near verticle rock faces.

4) Ridgetop-the raised line of land separating two sloping surfaces and generally separating two drainages.

5) Broken-terrain of an obviously rocky nature but not qualifying as talus, bluffs, or cliffs.

6) Sidehill-steep areas generally less rocky than any of the other landform types due to a higher degree of soil development.

Each relocation site for radio-collared sheep was placed into one of the landform type categories. The various terrain types are shown in Figure 11.

Microsite refers to a small area immediately surrounding a sheep relocation site. Biotic and abiotic environmental parameters were measured at each of these

FIGURE 9

COVER TYPES

A. Rockland

B. Shrub-grass

C. Park

D. Open Forest

E. Closed Forest

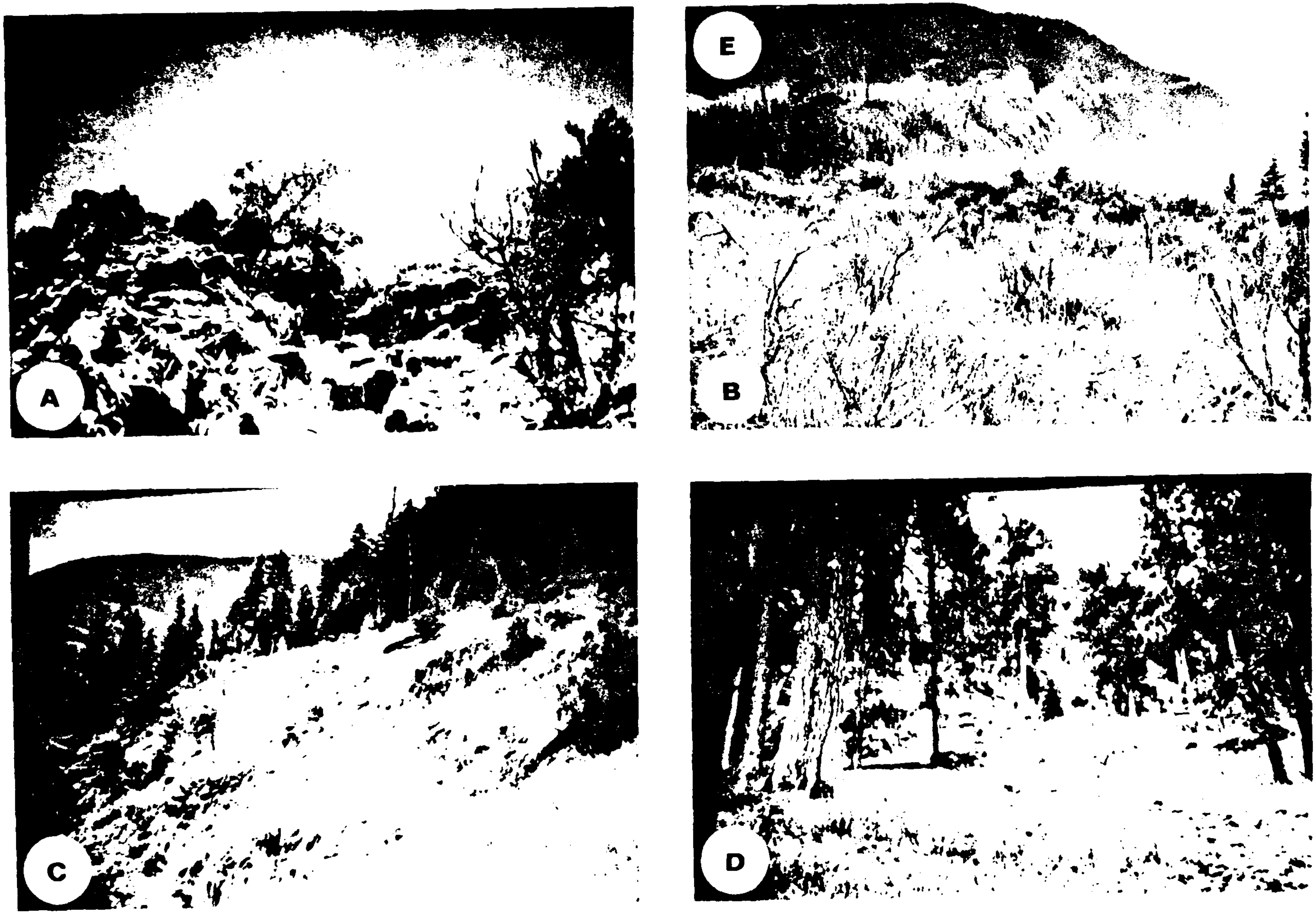
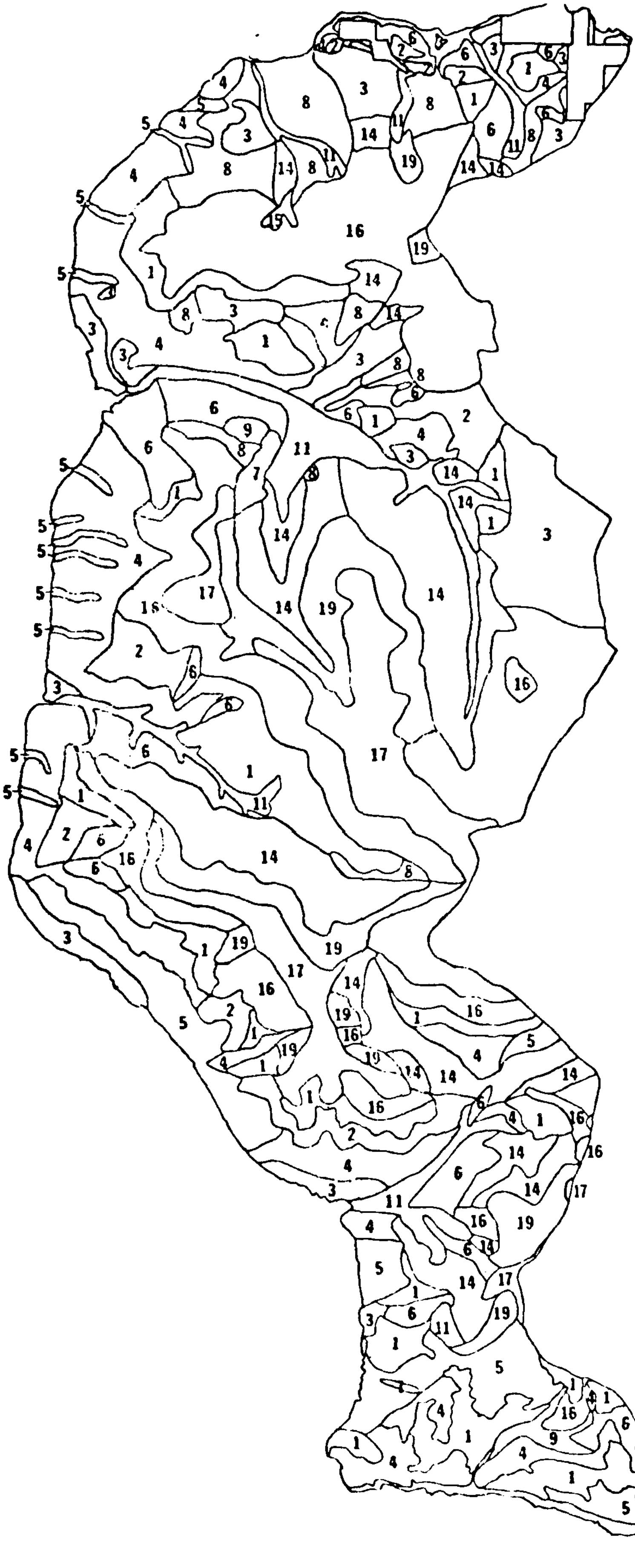


FIGURE 9



KEY

1 PSME/CARU
2 PSME/ARUV
3 PSME/VACA
4 PSME/SYAL
5 PSME/PHMA
6 PSME/LIBO
7 PSME/XETE
8 PIEN/LIBO
9 ABGR/CLUN
10 ABGR/XETE
11 THPL/CLUN
12 TSHE/CLUN
13 TSHE/OPHO
14 ABLA/CLUN
15 ABLA/OPHO
16 ABLA/VAGL
17 ABLA/XETE
18 TSME/XETE
19 ABLA/MEFE

FIGURE 10

HABITAT TYPES

FIGURE II LANDFORM TYPES

1 TALUS
2 CLIFF
3 BLUFF
4 RIDGE
5 BROKEN
6 SIDEHILL

sites to determine characteristic features of areas being selected by bighorn sheep. Abiotic features of a site were determined as follows: Elevation was measured to the nearest 10 feet with a Thommens pocket altimeter; aspect was determined with a Silva compass corrected for declination; slope steepness was measured with a Suunto inclinometer; landform type was classed as discussed above; temperature was measured in degrees F with a Taylor thermometer and placed in one of six temperature classes; windspeed was measured with a Dwyer handheld anemometer and recorded in one of the four windspeed classes; cloud cover was estimated to fall within one of four cloud cover classes ranging from clear to overcast; precipitation was subjectively measured as to type and rate; ground condition was also subjectively measured and recorded in one of 7 classes ranging from dry to uniformly covered with snow; snow depth was measured and also placed in one of seven classes; snow condition was classed as wet, powder, packed, crusted or frozen; substrate was classed as bedrock, talus, rocky soil, or developed soil. Biotic environmental factors were determined as follows: Cover types and habitat types were determined using criteria discussed above; conifer coverage was measured with a Lemmon Model-C Forest Densiometer and recorded in one of five coverage classes; conifer stem densities and basal areas were determined through measurements with a Cruz-All Angle Gauge (Basal Area Factor-10) in conjunction with a Biltmore Stick for measuring conifer dBH classes.

With slight modifications, a computer program developed by the Montana State Department of Natural Resources and Conservation was used to analyze and summarize much of the habitat selection data.

Herd Health

To provide a general indication of animal condition, bighorn sheep fecal pellet groups were collected and analyzed for incidence and intensity of lungworm (Protostrongylus spp) infection. During the 1976-77 field season, a total of 50 fecal pellet groups was collected. From 1 January 1977 through 31 December 1978, 240 bighorn fecal pellet groups, consisting of 20 samples monthly for the 12 month period were collected. All samples were sent to the Veterinary Research Laboratory, Montana State University, Bozeman and analyzed for lungworm larvae using the Baermann technique. Two yearling bighorns, illegally shot at Sheep Creek on 24 October 1976, were retrieved and necropsy information collected. On 4 and 16 January 1978 one adult ewe and one adult ram were found dead near Highway 37 at Allen Gulch and Rocky Gorge, respectively. Vicera from the two yearlings and whole carcasses for the adult ewe and adult ram were sent to Dr. D. Worley at the Veterinary Research Laboratory for parasitological and pathological examination.

Food Habit

In conjunction with collection of fecal pellet groups for parasite analysis, fecal pellets also provided determination of bighorn sheep food habits on a monthly basis for the calendar year 1978. Two pellets were randomly selected from each of the 20 different pellet groups collected for a given month. A monthly composite sample of 40 pellets was prepared for each of the twelve months. Composited samples were sent to the Composition Analysis Laboratory, Fort Collins, Colorado for determination and quantification of plant fragments through identification of plant epidermal tissue (Sparks and Malechek 1968). For each composited sample, 10 microscope slides were prepared and 20 fields per slide, for a total of 200 fields, were examined at 100x under a binocular microscope to determine relative densities of plant fragments. Research by Dearden et al. (1975) has shown the microhistological technique to be quite accurate in determining relative importance of food items in the diets of ungulates.

Rumen samples from two yearling bighorns were also examined for food habit information.

Population Dynamics

Bighorn sheep were classified as to age and sex whenever possible. An effort was made to classify ewes as adults or yearlings. Young-of-the-year were classified as lambs, with no distinction between the sexes. Whenever possible, rams were aged in the field through horn annuli counts (Geist 1966). These data provide information on present herd composition and give an indication of the population trend from reproductive success and recruitment.

Deceased bighorns found in the field, were aged by horn annuli counts, sequence of incisor erruption, or by tooth sectioning and cementum layer counts. If possible, cause of mortality was determined.

Direct observations of sheep in the field were aided by the use of 6x30 mm binoculars and a 15-60x variable spotting scope.

CHAPTER IV

RESULTS

Capture and Marking Techniques

Necessary field equipment (i.e telemetry apparatus) did not arrive until late November 1976 which deferred trapping activities until 1 December 1976. From that date through 30 April 1977, 90 full or partial days were spent on the sheep range attempting to capture bighorn sheep. With an almost complete lack of snow on the study area, bighorns remained dispersed over their entire range and did not concentrate on wintering areas. Total availability of natural forage precluded sheep use of artificial baits at trapsites which rendered trapping efforts completely unsuccessful. Although sheep were observed feeding and traveling in the vicinity of traps, they demonstrated no interest in either bait stations or salt blocks. In addition to trapping efforts, 13 attempts were made to capture free-ranging sheep with immobilizing drugs. These attempts resulted in eight strikes, five misses, but only one successful capture. Four rams and three ewes were struck with darts containing Sernylan at 100 mg/ml concentration and 1 adult ewe was struck with a dart containing Rompun at 100 mg/ml concentration. Sheep reaction to Sernylan varied from no noticeable response, mild ataxia, to partial immobilization. Dart failure and a consequent incomplete injection of drug was recorded for the single dart containing Rompun. On 10 December 1976, one ram, 5 1/2 years of age, was successfully immobilized with Sernylan and fitted with a radio-collar.

During the 1977-78 field season, trapping operations were reinstated on 1 December 1977. As in the 1976-77 trapping season, baited traps proved unsuccessful. However, one adult ram and one adult ewe were captured at the winged drive trap established along Highway 37 at mile 36.6. Both animals were eartagged, instrumented with radio-collars and released. During winter 1978, three more sheep consisting of one ram and two ewes from diverse portions of the sheep range were immobilized with Rompun and equipped with radio transmitters. One additional ram was drugged on 1 September 1978 and fitted with a radio-collar.

During the course of the study, a total of seven bighorn sheep were captured and radio-collared. Each marked study animal was assigned an alphabetical prefix which corresponded with the chronological order of their capture (Figure 12, Table 3).

None of the study animals were noticeably injured during the handling process and there were no capture mortalities.

Distribution and Movements

During the course of the project, 206 relocations of marked study animals provided the basis for delineation of seasonal distribution and movement patterns. Figures 13-19 demonstrate overall movements and corresponding dates of relocations for each of the seven study animals A through G. Site specific relocations are shown in Figure 20 a-h. Tables 4-10 list statistics for home range size, geographic centers of activity, standard diameters, distances moved between consecutive relocations, and elevational ranges for each radioed bighorn sheep during various seasonal periods. Seasonal key use areas for rams and ewes are shown in Figure 21 a-f.

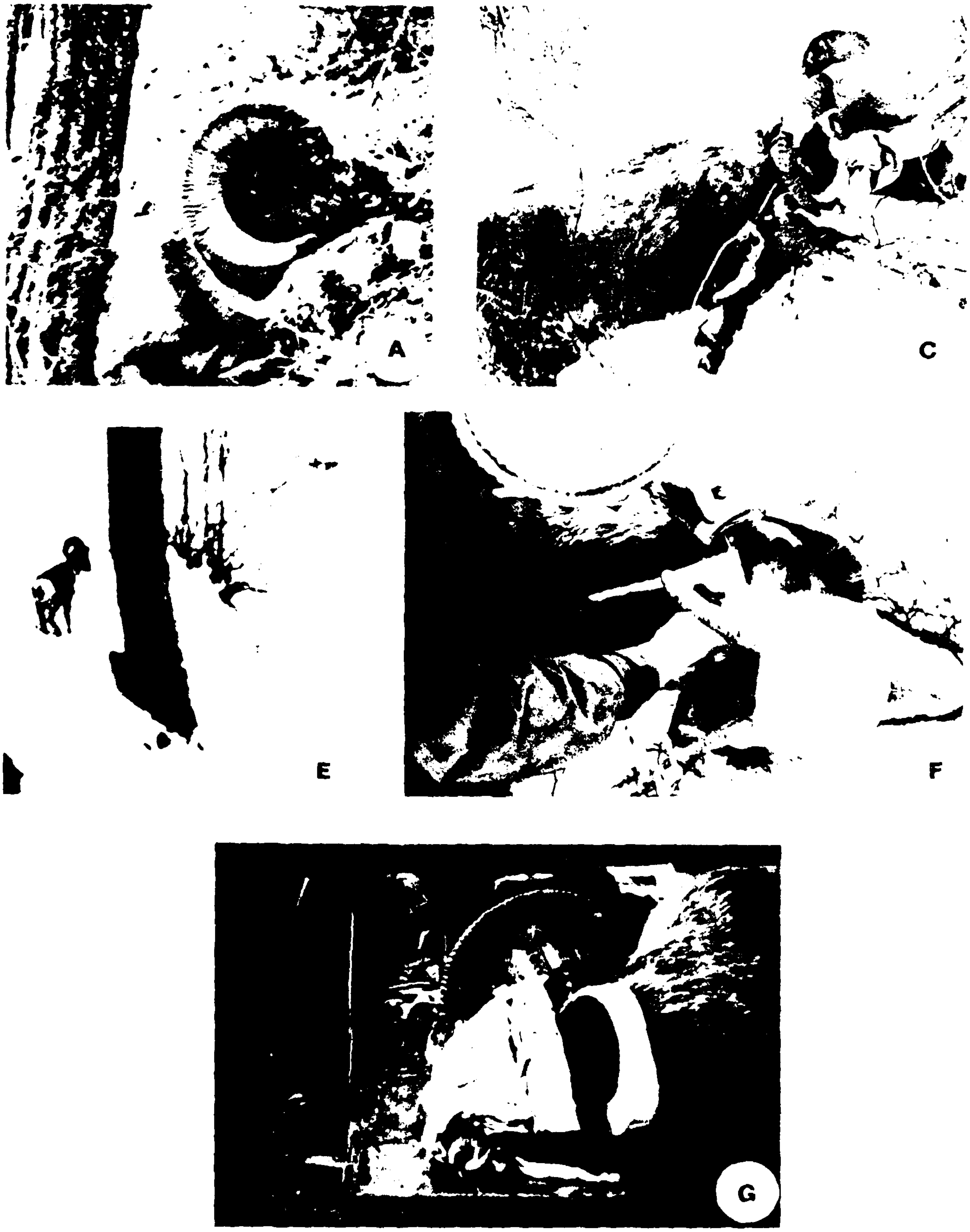


FIGURE 12

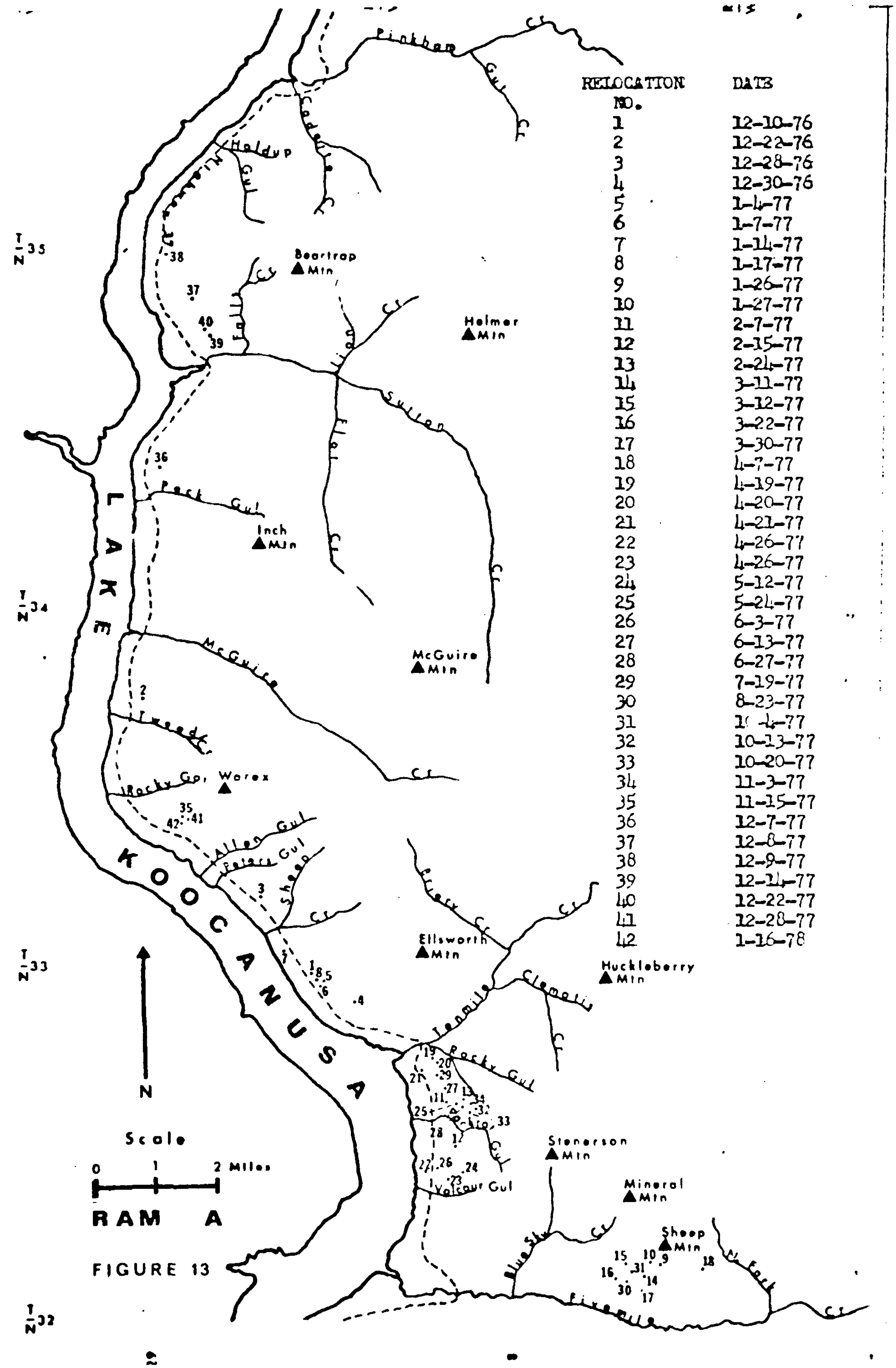
TABLE [illegible]. AGE, SEX AND CAPTURE [illegible] BIGHORN SHEEP [illegible] COLLARED BETWEEN [illegible] DECEMBER [illegible] AND SEPTEMBER [illegible].

ANIMAL	TRANSMITTER COLLAR				EAR TAGS		CLASS		CAPTURE		
NUMBER	BAND	CHANNEL	FREQUENCY	COLOR	L	R	SEX	AGE	DATE	AREA	METHOD
A	[illegible]	[illegible]	150.[illegible]	Red	N[a]	N	[illegible]	[illegible]	[illegible]	Ural	Sernylan[b]
[illegible]		[illegible]	151.[illegible]	[illegible]	AOT	AOT	[illegible]	[illegible]	[illegible]	Pack [illegible].	[illegible]
[illegible]		[illegible]	151.[illegible]	[illegible]	[illegible]	A[illegible]	[illegible]	[illegible]	[illegible]	S[illegible]	[illegible]
[illegible]		[illegible]	[illegible]	[illegible]	A[illegible]	A[illegible]	[illegible]	[illegible]	[illegible]	S[illegible]	[illegible]
E	[illegible]	[illegible]	150.[illegible]	Yellow	AOT	AOT	[illegible]	[illegible]	[illegible]	[illegible]	Trapped
F			[illegible]	[illegible]	A[illegible]	A[illegible]		[illegible]	[illegible]	[illegible]	Trapped
[illegible]		[illegible]	15[illegible]	[illegible]	A[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]

[a] [illegible]

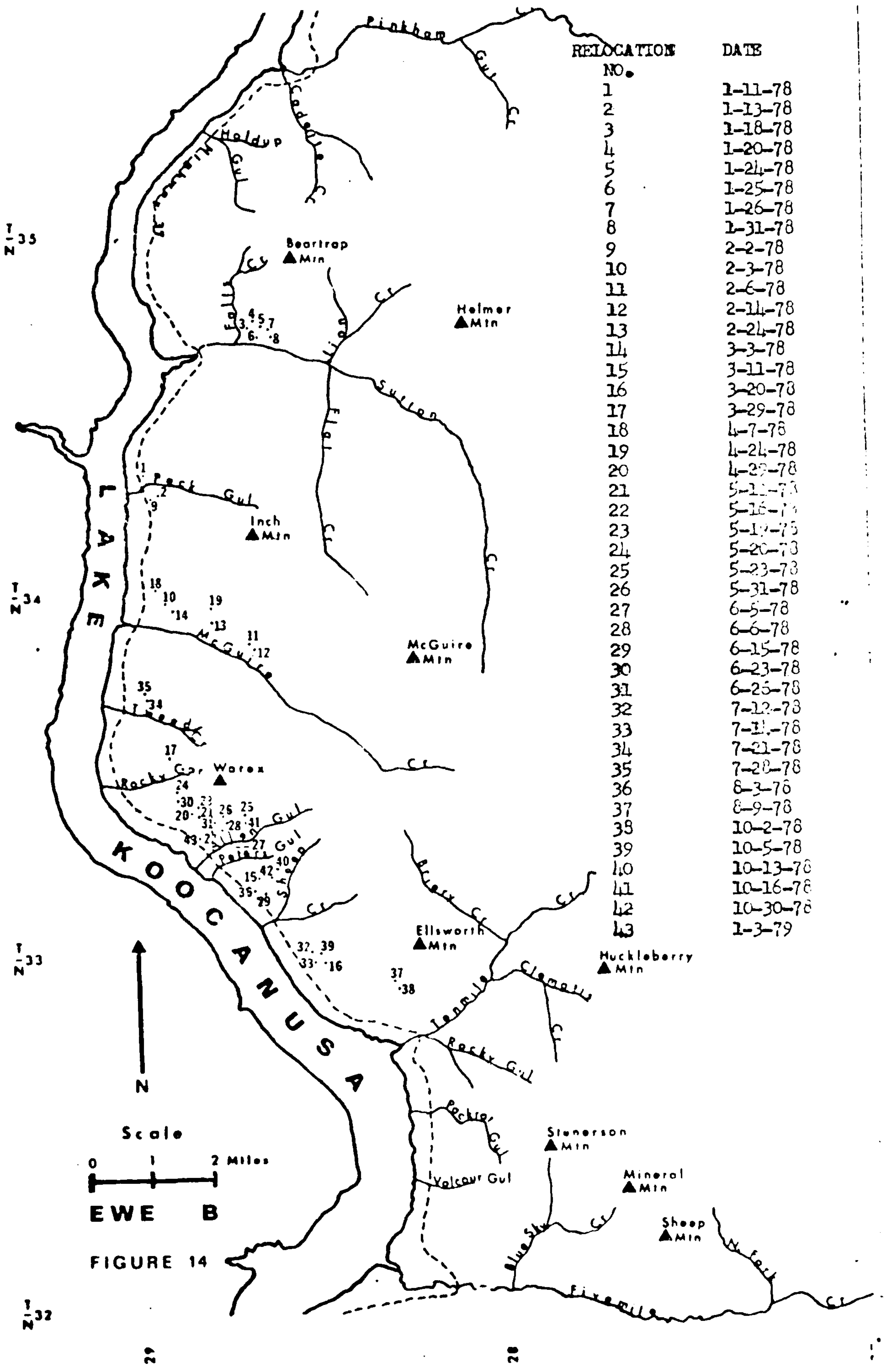
[b] [illegible]

[c] [illegible]



RELOCATION NO.	DATE
1	12-10-76
2	12-22-76
3	12-28-76
4	12-30-76
5	1-4-77
6	1-7-77
7	1-14-77
8	1-17-77
9	1-26-77
10	1-27-77
11	2-7-77
12	2-15-77
13	2-24-77
14	3-11-77
15	3-12-77
16	3-22-77
17	3-30-77
18	4-7-77
19	4-19-77
20	4-20-77
21	4-21-77
22	4-26-77
23	4-26-77
24	5-12-77
25	5-24-77
26	6-3-77
27	6-13-77
28	6-27-77
29	7-19-77
30	8-23-77
31	1[illegible]-4-77
32	10-13-77
33	10-20-77
34	11-3-77
35	11-15-77
36	12-7-77
37	12-8-77
38	12-9-77
39	12-14-77
40	12-22-77
41	12-28-77
42	1-16-78

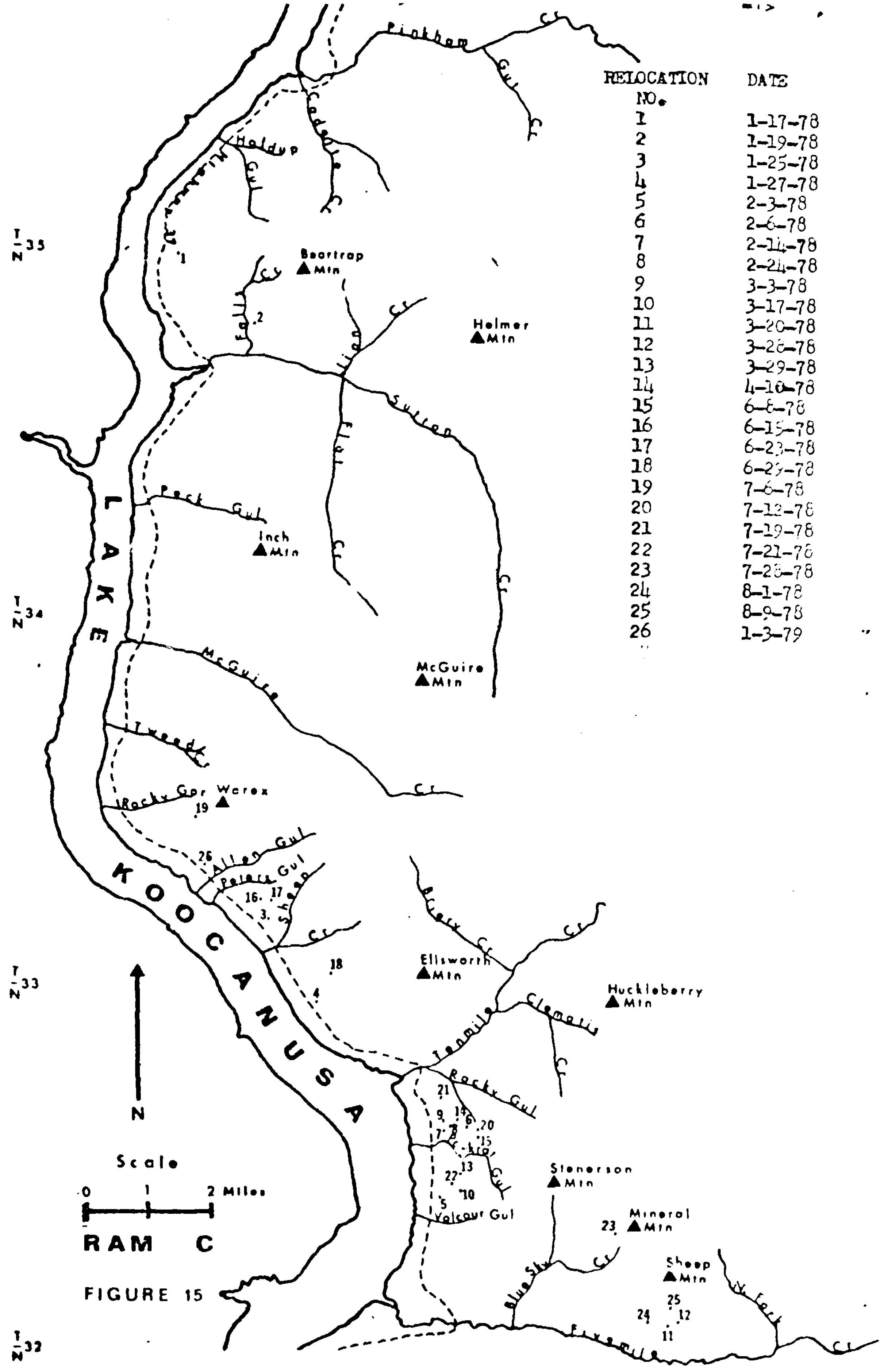
FIGURE 13



EWE B

FIGURE 14

RELOCATION NO.	DATE
1	1-11-78
2	1-13-78
3	1-18-78
4	1-20-78
5	1-24-78
6	1-25-78
7	1-26-78
8	1-31-78
9	2-2-78
10	2-3-78
11	2-6-78
12	2-14-78
13	2-24-78
14	3-3-78
15	3-11-78
16	3-20-78
17	3-29-78
18	4-7-78
19	4-24-78
20	4-29-78
21	5-11-78
22	5-16-78
23	5-17-78
24	5-20-78
25	5-23-78
26	5-31-78
27	6-5-78
28	6-6-78
29	6-15-78
30	6-23-78
31	6-25-78
32	7-12-78
33	7-14-78
34	7-21-78
35	7-28-78
36	8-3-78
37	8-9-78
38	10-2-78
39	10-5-78
40	10-13-78
41	10-16-78
42	10-30-78
43	1-3-79



RELOCATION NO.	DATE
1	1-17-78
2	1-19-78
3	1-25-78
4	1-27-78
5	2-3-78
6	2-6-78
7	2-14-78
8	2-24-78
9	3-3-78
10	3-17-78
11	3-20-78
12	3-28-78
13	3-29-78
14	4-10-78
15	6-8-78
16	6-15-78
17	6-23-78
18	6-29-78
19	7-6-78
20	7-12-78
21	7-19-78
22	7-21-78
23	7-28-78
24	8-1-78
25	8-9-78
26	1-3-79

FIGURE 15

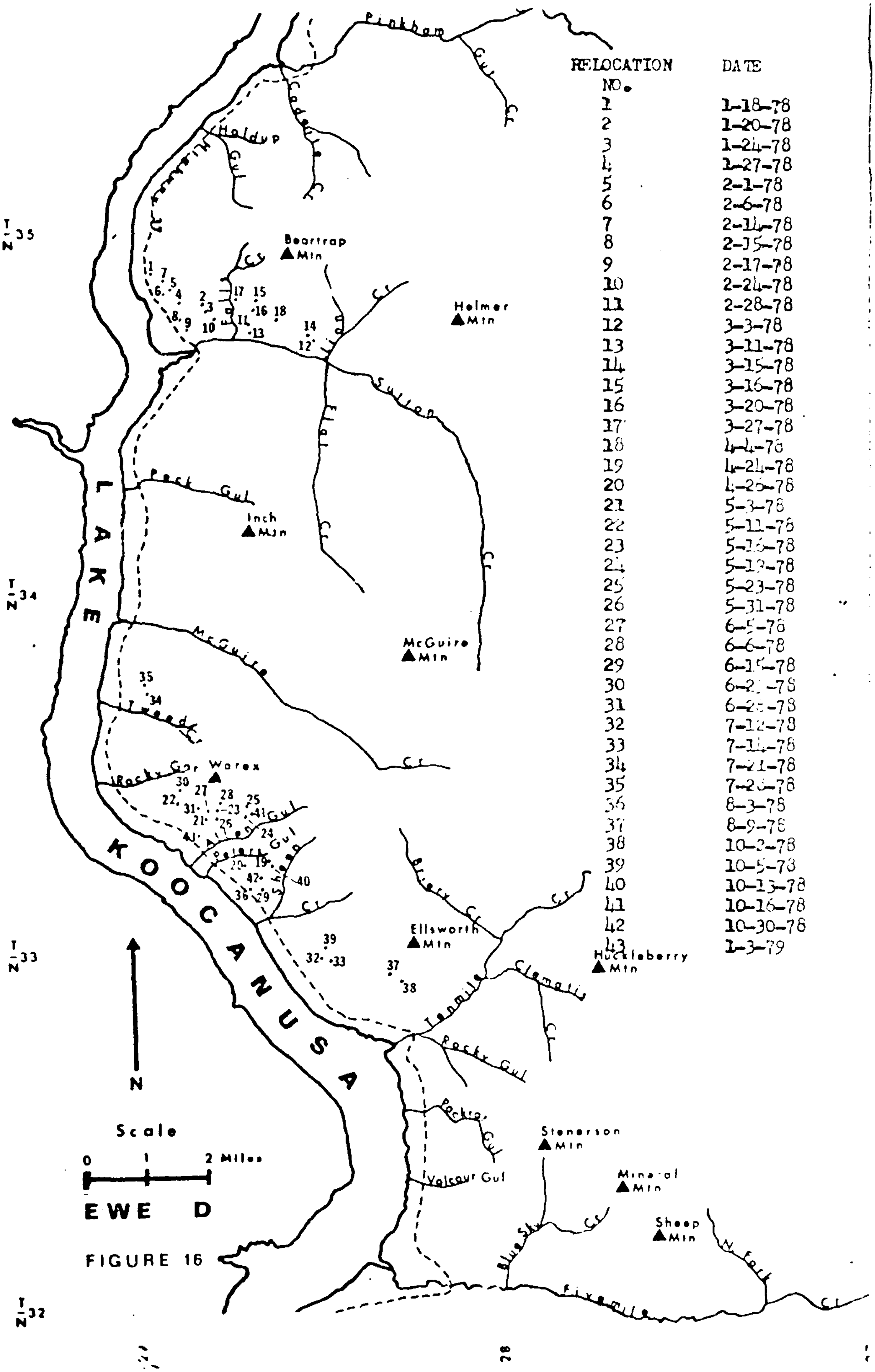


FIGURE 16

RELOCATION NO.	DATE
1	1-18-78
2	1-20-78
3	1-24-78
4	1-27-78
5	2-1-78
6	2-6-78
7	2-14-78
8	2-15-78
9	2-17-78
10	2-24-78
11	2-28-78
12	3-3-78
13	3-11-78
14	3-15-78
15	3-16-78
16	3-20-78
17	3-27-78
18	4-4-78
19	4-24-78
20	4-25-78
21	5-3-78
22	5-11-78
23	5-16-78
24	5-19-78
25	5-23-78
26	5-31-78
27	6-5-78
28	6-6-78
29	6-15-78
30	6-21-78
31	6-25-78
32	7-12-78
33	7-14-78
34	7-21-78
35	7-26-78
36	8-3-78
37	8-9-78
38	10-2-78
39	10-5-78
40	10-13-78
41	10-16-78
42	10-30-78
43	1-3-79

TABLE [illegible]. SEASONAL ACTIVITY CENTERS, HOME RANGE SIZE AND MOVEMENT STATISTICS FOR BIGHORN SHEEP [illegible].

TIME PERIOD	ACTIVITY CENTER	MAXIMUM[a] AREA	STANDARD DIAMETER	DISTANCE[b]				ELEVATION[c]				N. RELOCATIONS
				MAX.	MIN.	$\overline{X}$	$\overline{S}$	MAX.	MIN.	$\overline{X}$	$\overline{S}$	
1/11/78 -1/31/78	Falls Creek	.69	2.93	3.28	.06	.57	1.20	3500	2800	3250	250	[illegible]
[illegible]	McGuire Creek	[illegible]	2.[illegible]	1.[illegible]	.[illegible]	1.0[illegible]	.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	5.[illegible]	3.[illegible]	1.07	[illegible].75	[illegible]	5000	[illegible]	4300	[illegible]	5
[illegible]	Allen Gulch	.[illegible]	1.15	2.[illegible]	.06	.[illegible]	.[illegible]1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	3.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Annual	Tweed Creek	24.[illegible]9	7.17	5.0[illegible]	.06	1.3[illegible]	1.44	5000	[illegible]	[illegible]	[illegible]	[illegible]

[a] Home range size measured in miles squared

[b] Maximum and minimum distances traveled between any [illegible] during the given time period

[c] Elevation measured in feet above mean sea level

TABLE 4. SEASONAL ACTIVITY CENTERS, HOME RANGE SIZE AND MOVEMENT STATISTICS FOR BIGHORN SHEEP A.

TIME PERIOD	ACTIVITY CENTER	MAXIMUM[a] AREA	STANDARD DIAMETER	DISTANCE[b] MAX.	DISTANCE[b] MIN.	DISTANCE[b] $\bar{X}$	DISTANCE[b] $\bar{S}$	ELEVATION[c] MAX.	ELEVATION[c] MIN.	ELEVATION[c] $\bar{X}$	ELEVATION[c] $\bar{S}$	NO. RELOCATIONS
12/10/76 -1/17/77	Sheep Creek	[illegible]	[illegible]	5.47	.06	[illegible].04	2.[illegible]	4100	2800	3087	418	8
2/24/77 -4/[illegible]/77	Sheep Mountain	1.74	[illegible]	4.20	.14	1.20	1.[illegible]	5100	4400	4616	256	6
4/19/77 -[illegible]/19/77	Packrat Gulch	.80	1.5[illegible]	1.5[illegible]	.06	[illegible]	.45	4400	2600	3200	526	11
8/23/77 -10/4/77	Sheep Mountain	--	--	.06	.06	.06	.00	5100	5100	5100	[illegible]	2
10/13/77 -11/3/77	Packrat Gulch	--	[illegible]	.09	.06	[illegible]	[illegible]	4600	4300	4433	152	3
[illegible]	Stone Hill	[illegible]	8.57	[illegible].52	.00	3.11	3.1[illegible]	[illegible]	2800	[illegible]	[illegible]	[illegible]
Annual	Tenmile Creek	[illegible]	11.[illegible]	8.52	[illegible]	[illegible]	[illegible]	5100	2600	3775	771	3[illegible]

[a] Home range size measured in miles squared.

[b] Maximum and minimum distances traveled between any two consecutive relocations during the given time period.

[c] Elevation measured in feet above mean sea level.

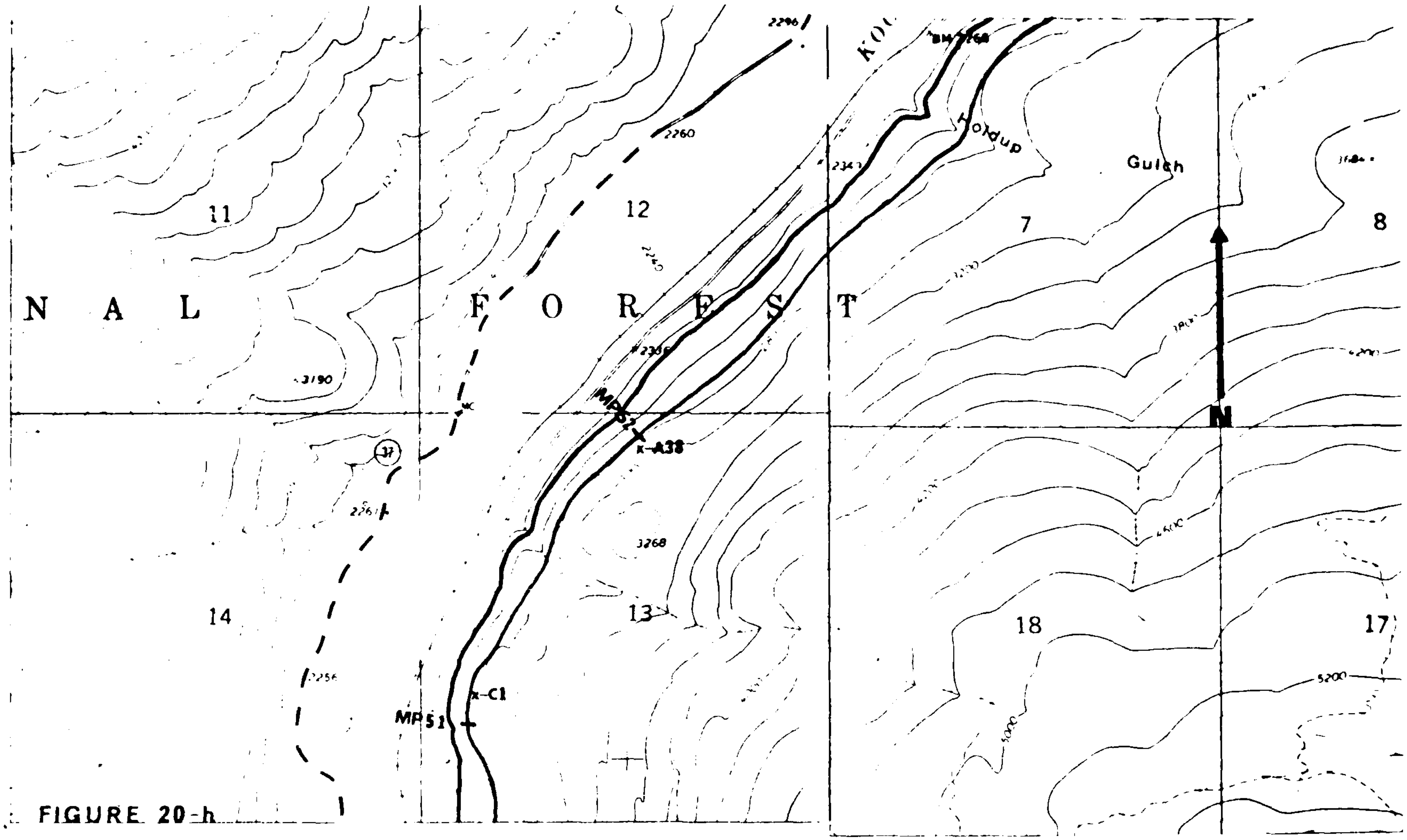
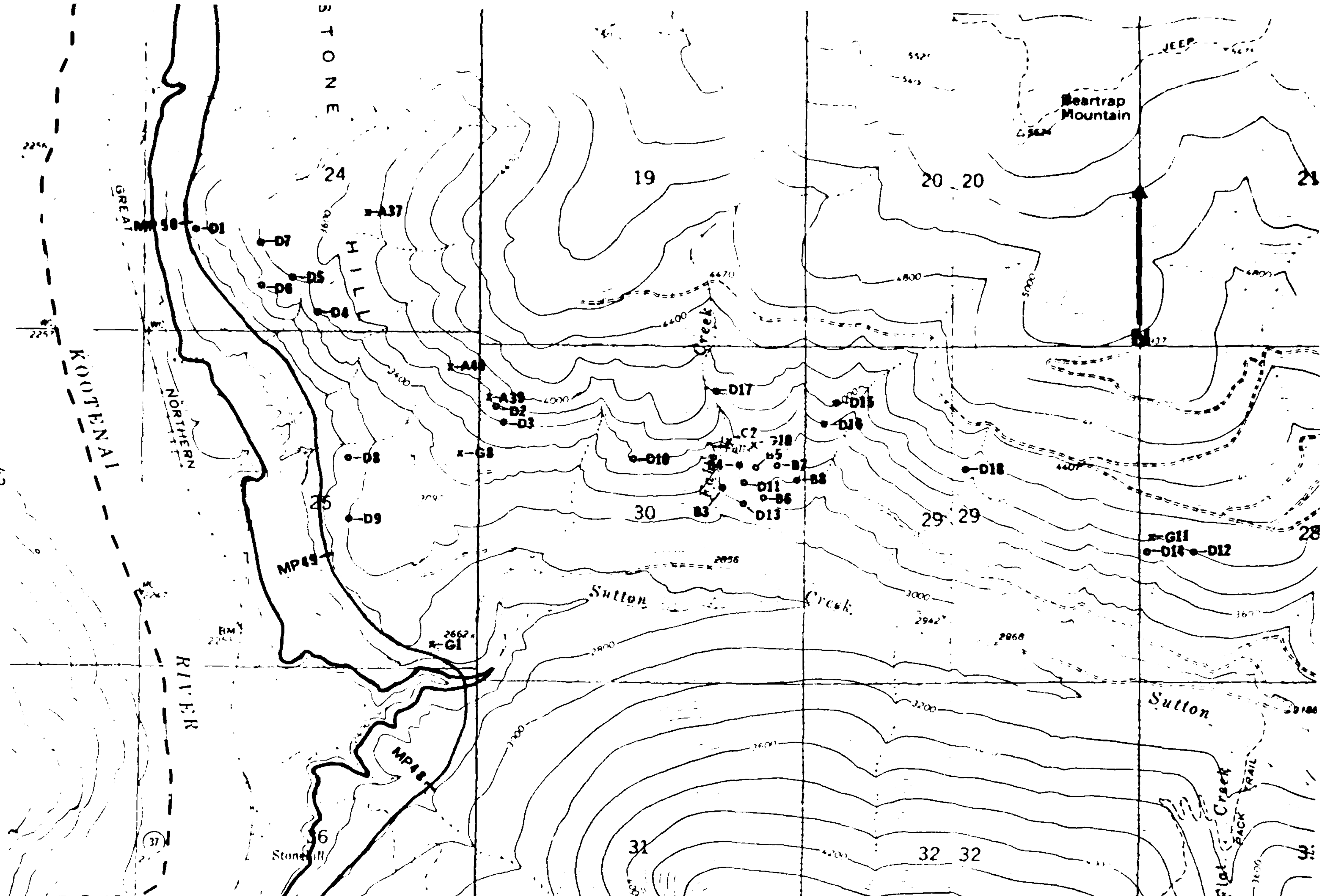
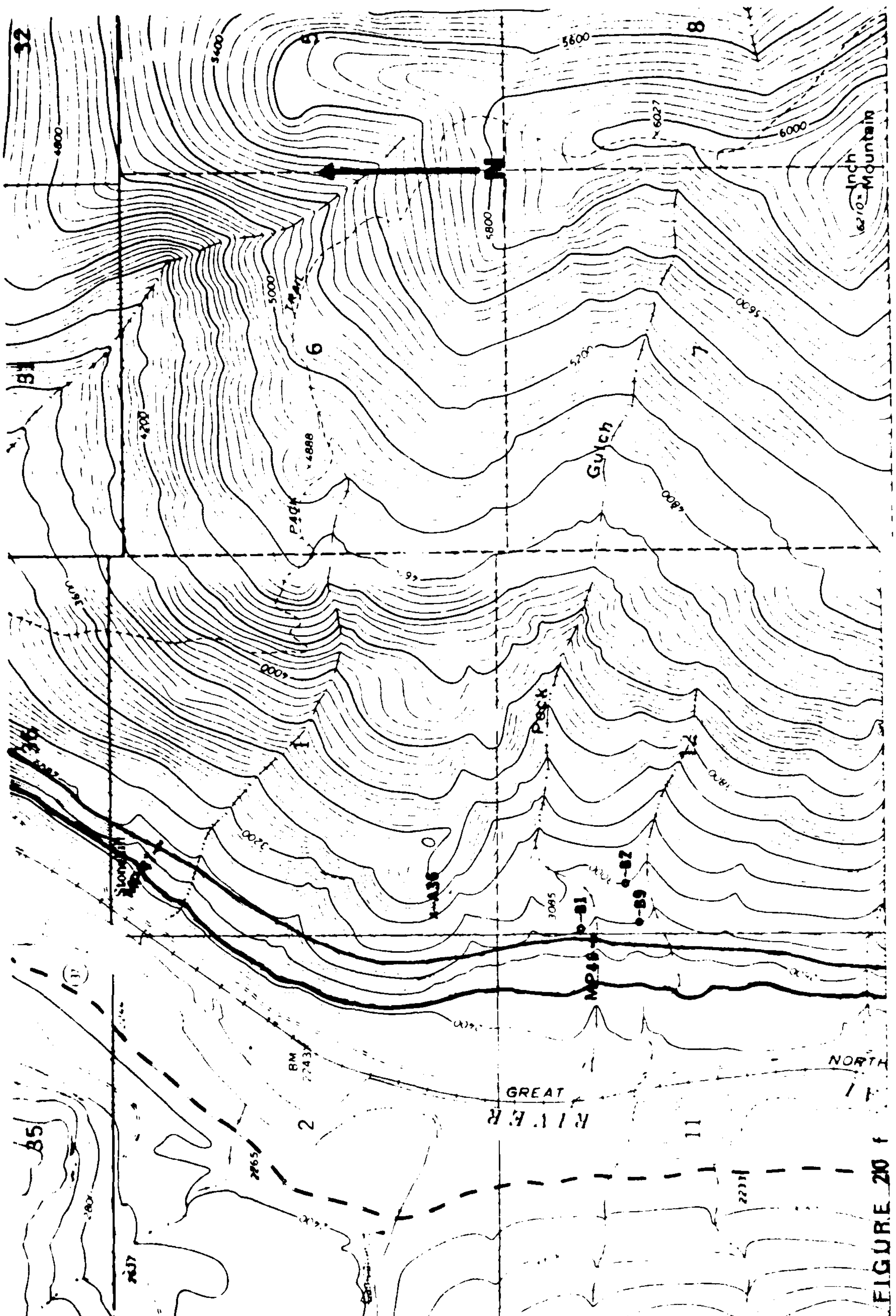

N A L F O R E S T
11
12
7
8
14
13
18
17
Holdup
Gulch
N
MP52
x-A38
MP51
x-C1
2296
2260
3190
2336
2343
3268
2261
2256
5200
37

FIGURE 20-h


Beartrap Mountain
STONE HILL
KOOTENAI RIVER
GREAT NORTHERN
Sutton Creek
Flat Creek
PACK TRAIL
JEEP
Stonehill
19
20
21
24
25
28
29
30
31
32
36
MP 50
MP49
MP48
D1
D2
D3
D4
D5
D6
D7
D8
D9
D10
D11
D12
D13
D14
D15
D16
D17
D18
A37
A39
A40
G1
G8
G11
C2
B2
B3
B6
B8
FIGURE 20-9



32
31
36
35
5
6
7
8
1
2
11
12
N
Inch Mountain
6210
6027
6000
5600
5800
5200
5000
4800
4898
4200
3600
3200
PACK
TRAIL
Gulch
Peck
A36
B1
B2
B9
MP46
3085
GREAT
NORTH
RIVER
BM

FIGURE 20

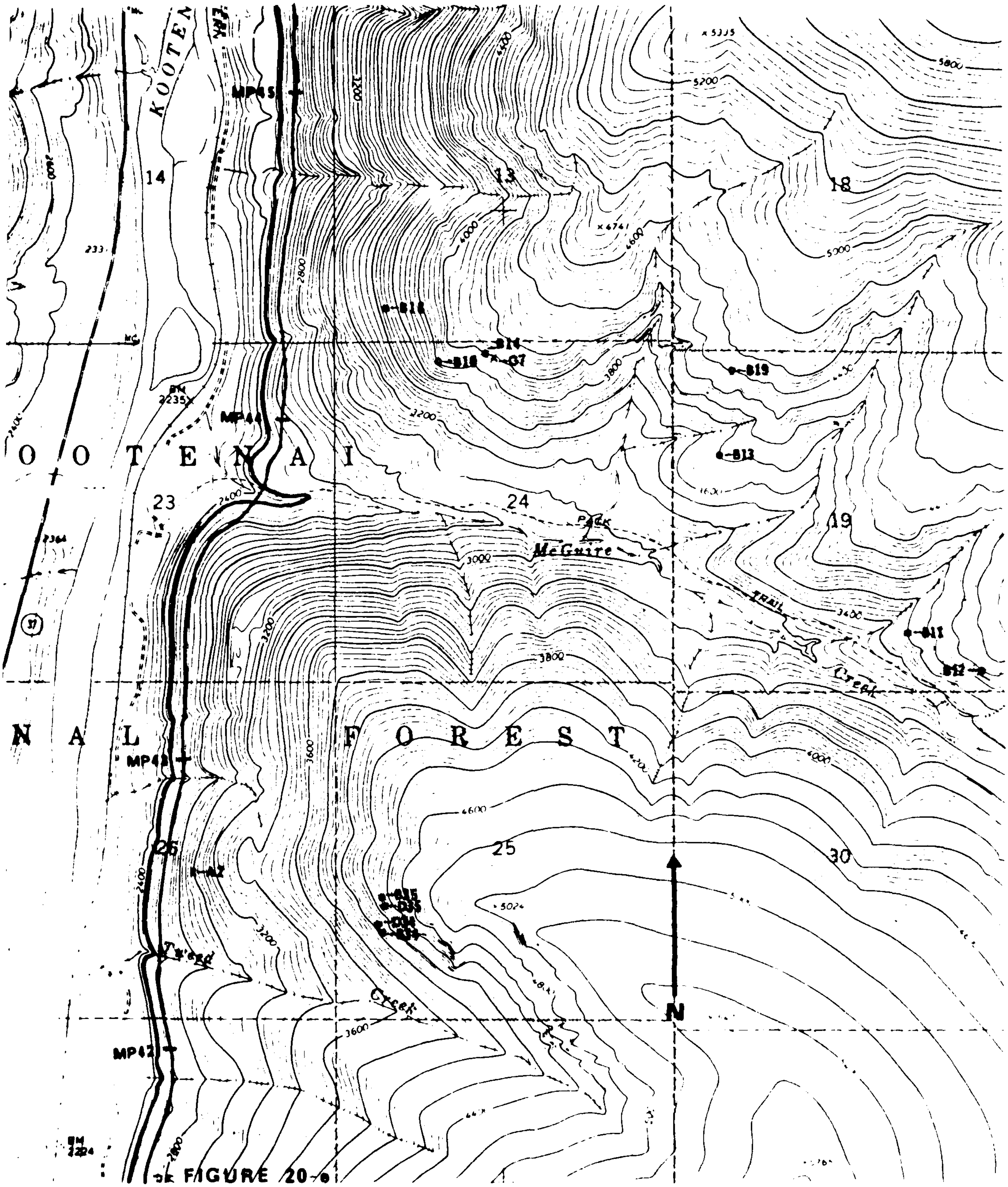

KOOTENAI
NAL FOREST
MP45
MP44
MP43
MP42
14
13
18
23
24
19
26
25
30
McGuire
Creek
Pack
TRAIL
Tweed
Creek
B18
B16
B14
G7
B19
B13
B11
B12
A2
N
5200
5800
5000
4000
2800
3200
3800
3000
3600
4600
3400
4000
2400
3200
3600
x 5335
x 6741
BM 2235
BM 2224
37

FIGURE 20

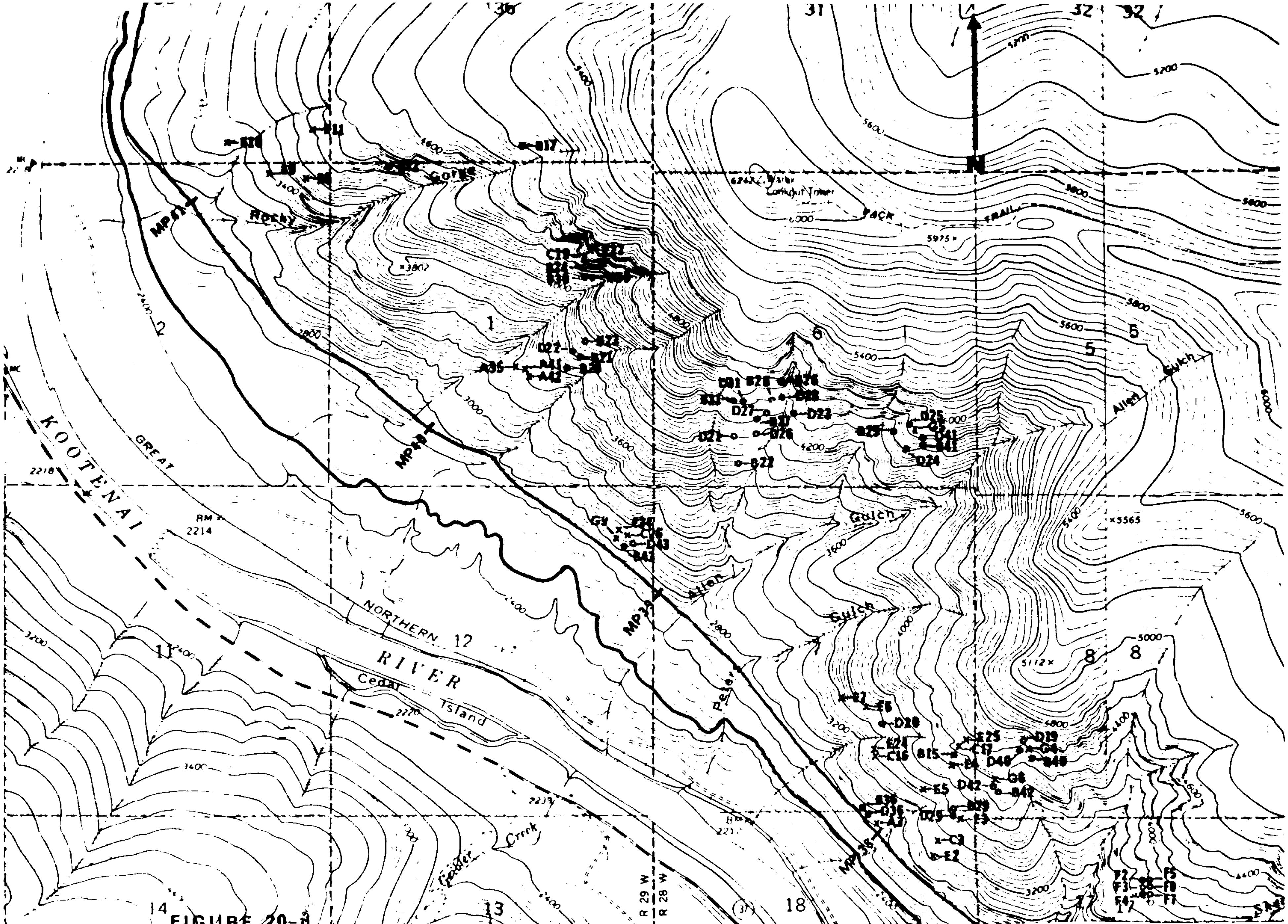

KOOTENAI
RIVER
GREAT
NORTHERN
Cedar
Island
Rocky
Gorge
Allen
Gulch
Peter
PACK
TRAIL
Lookout Tower
MP38
MP39
MP40
MP41
R 29 W
R 28 W
2214
2218
5975
5565
5112
3802

FIGURE 20-d

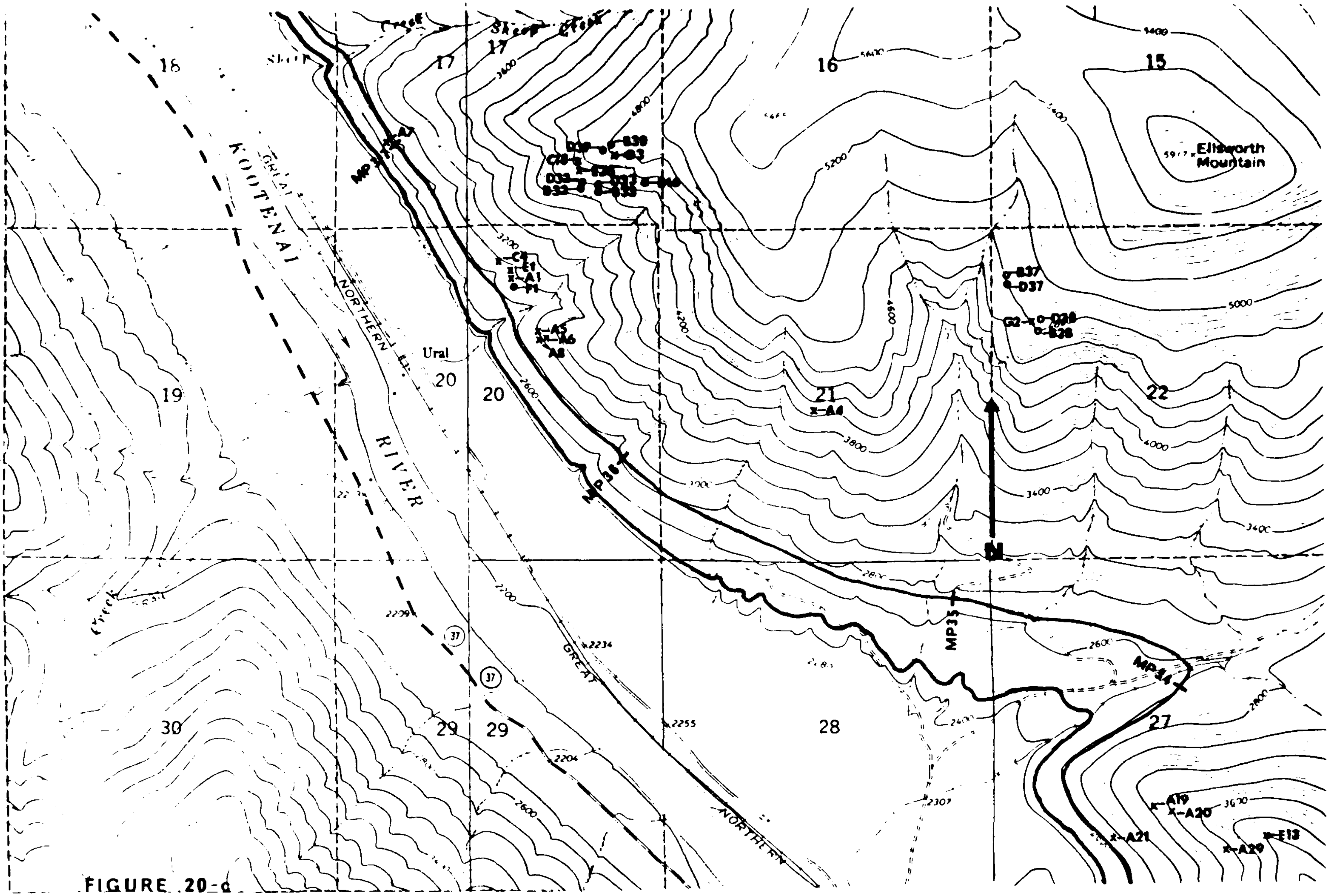
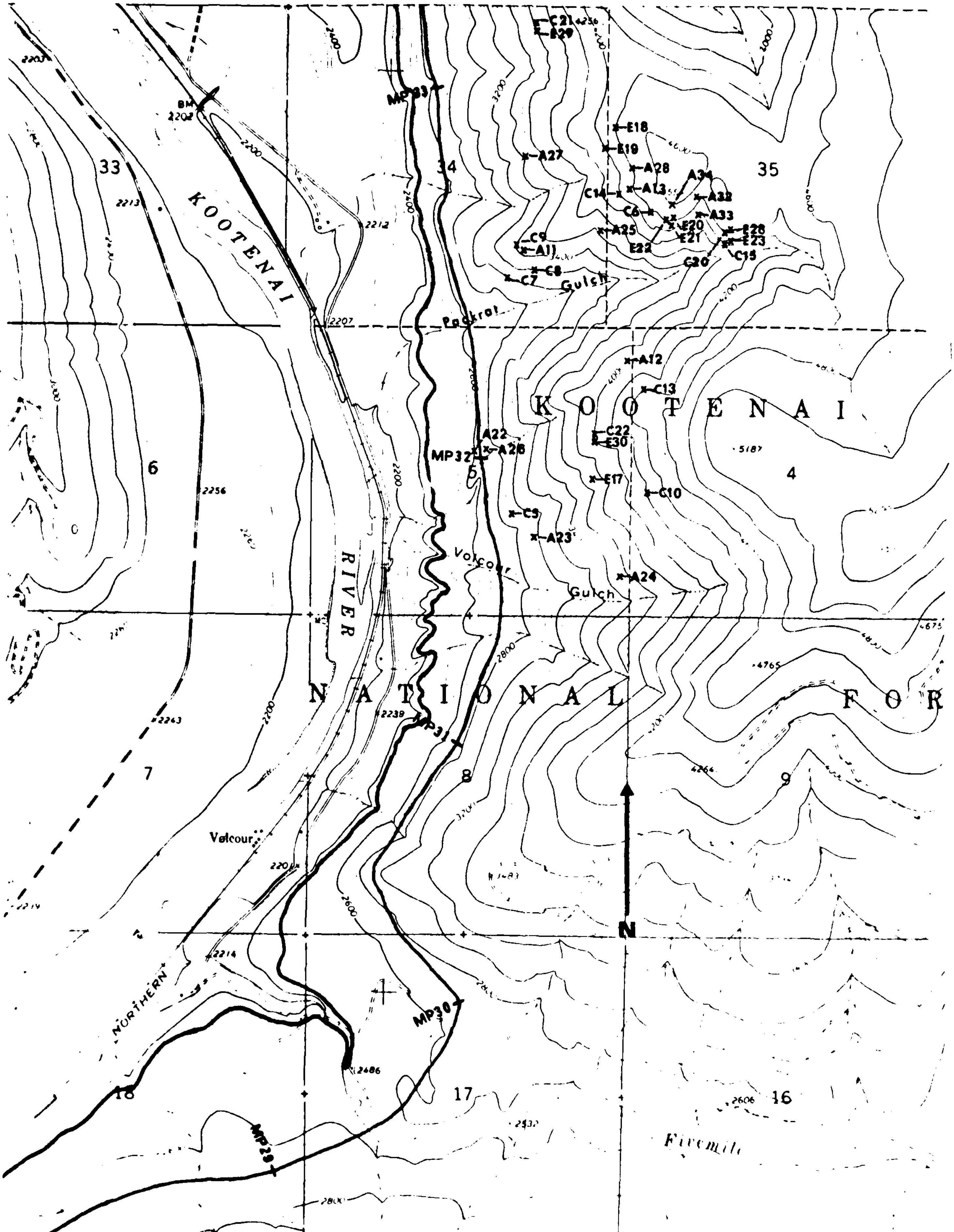
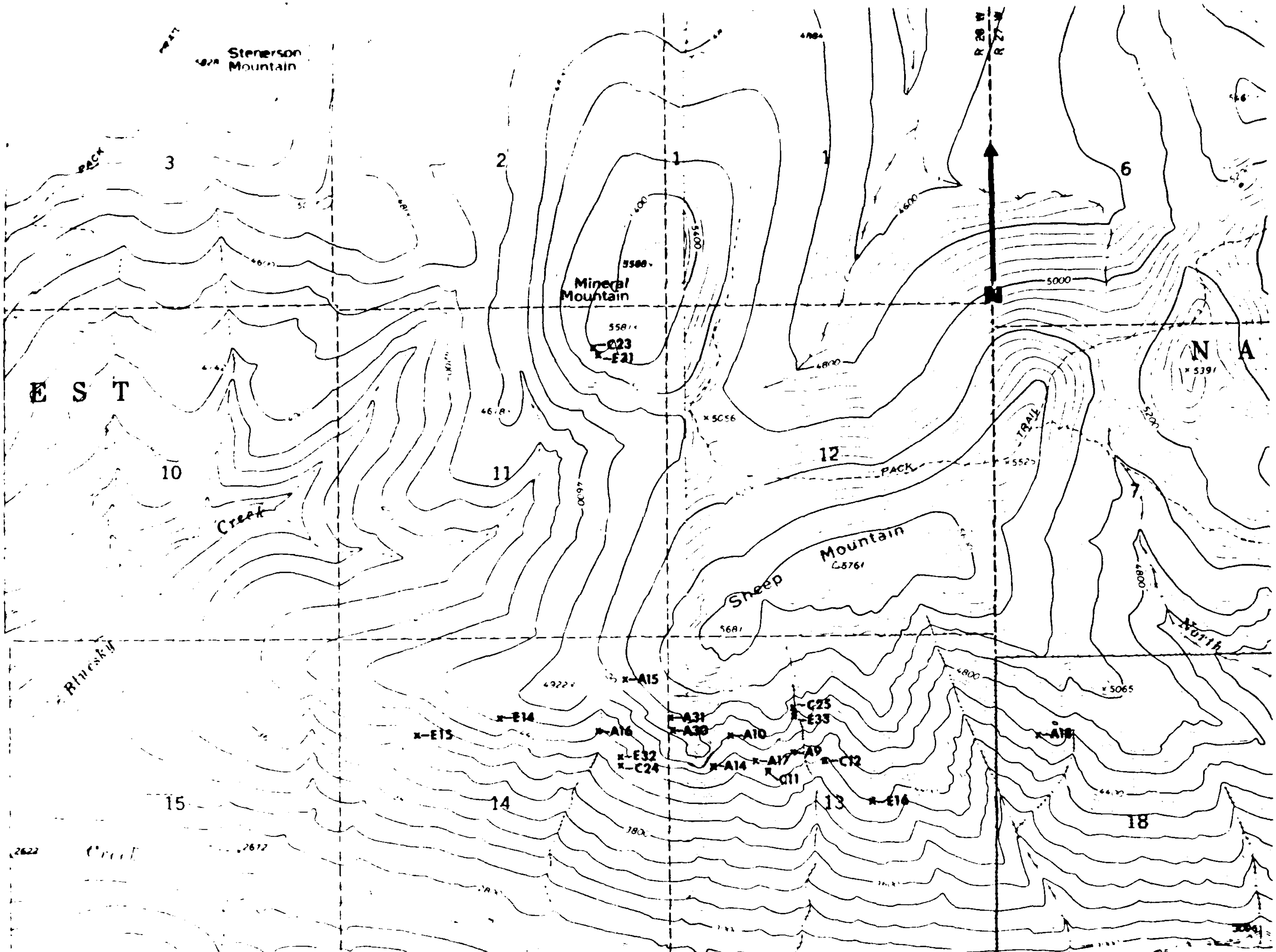

Ellsworth Mountain
KOOTENAI
RIVER
GREAT
NORTHERN
Ural
Sheep Creek
MP35
MP34
MP36
15
16
17
18
19
20
21
22
27
28
29
30
5000
4000
3400
2600
2255
2234
2204
2307
A19
A20
A21
A29
E13
A4
B37
D37

FIGURE 20-d


KOOTENAI RIVER
KOOTENAI NATIONAL FOR
NORTHERN
Packrat Gulch
Volcour Gulch
Volcour
Firemile
MP33
MP32
MP31
MP30
MP29
BM 2202
33
34
35
6
5
4
7
8
9
18
17
16
N
C21
E29
E18
E19
A27
A28
A34
A13
A32
C14
C6
A33
A25
E20
E28
E21
E23
E22
C20
C15
C9
A11
C8
C7
A12
C13
A22
A26
C22
E30
E17
C10
C5
A23
A24
5187
4765
4675
4266
2606
2486
2214
2201
2239
2243
2256
2213
2212
2207
2203
2200
2600
2800
3200
FIGURE 20-b



Stenerson Mountain
PACK
3
2
1
6
Mineral Mountain
5600
5000
4800
4600
E S T
N A
x 5391
5200
10
11
12
Creek
PACK
TRAIL
x 5056
x 5523
7
Sheep Mountain
5681
4800
North
Bluesky
x-A15
x-E14
x-E15
x-A16
x-A31
x-A30
x-A10
x-C25
x-E33
x-E32
x-C24
x-A14
x-A17
x-A9
x-C12
C11
x-E16
x-A18
x 5065
C23
E21
15
14
13
18
2622
2612
2621

FIGURE 20-a

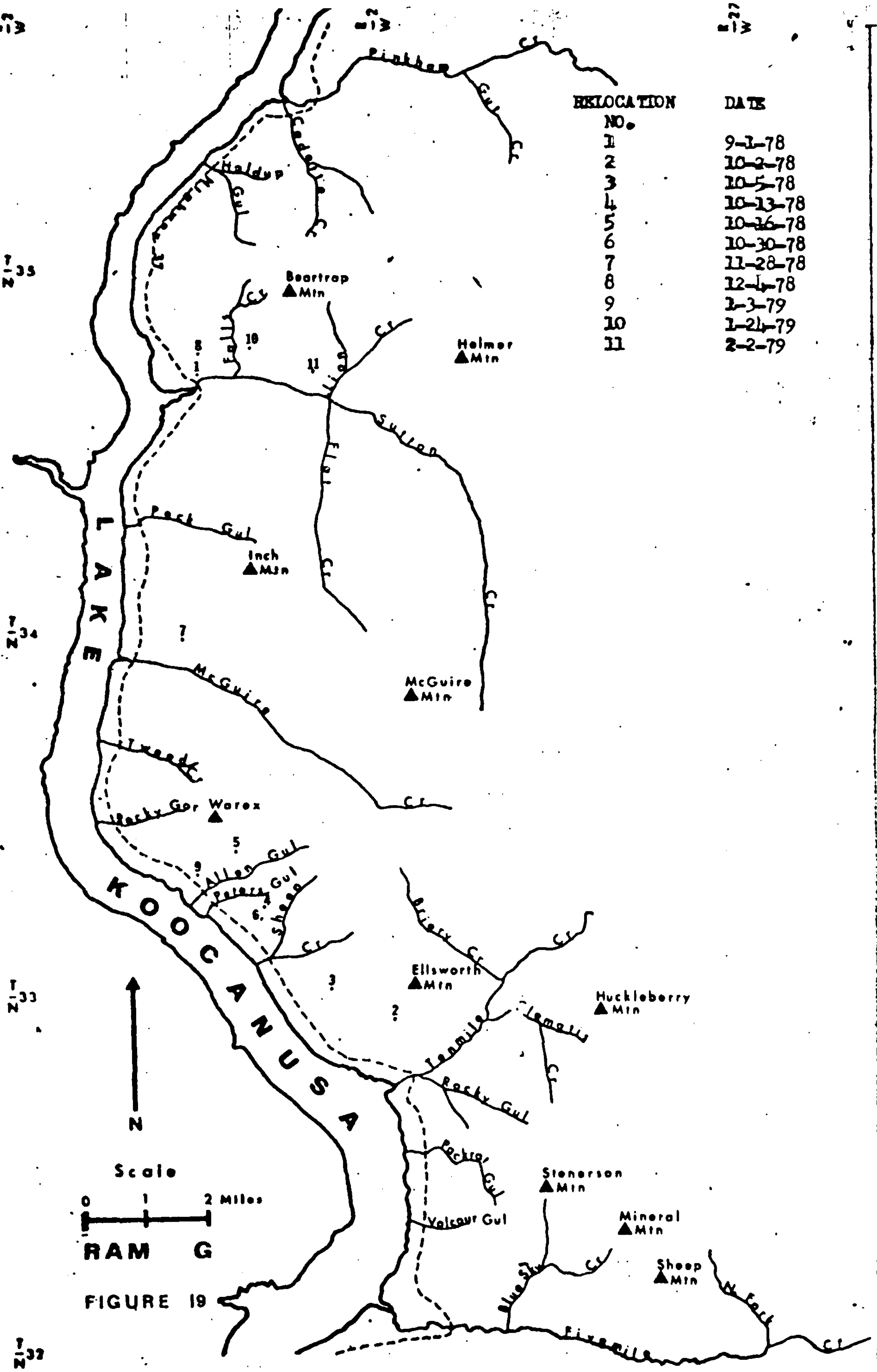
FIGURE 20 a-h

SITE SPECIFIC SHEEP RELOCATIONS

x - Ram locations

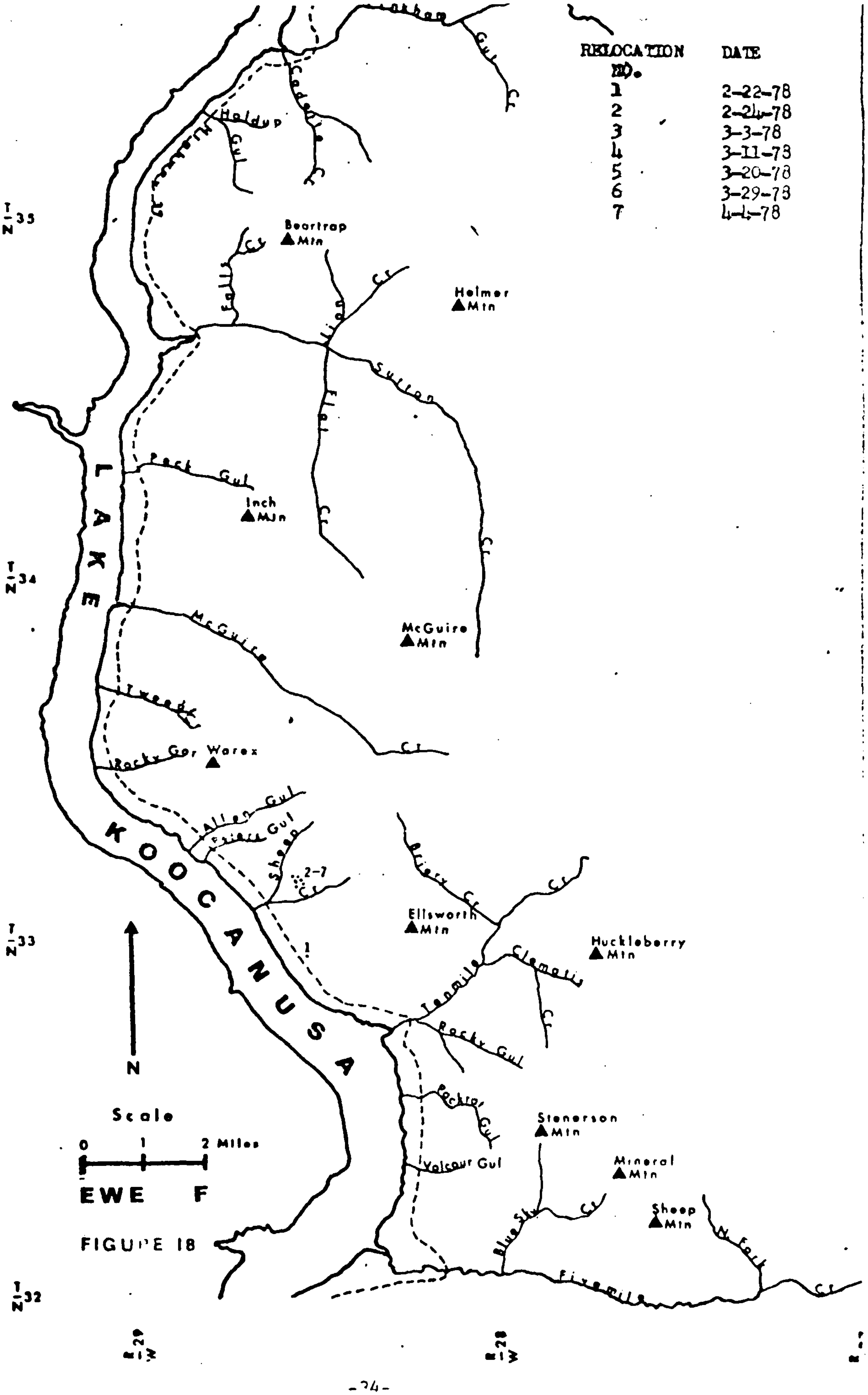
o - Ewe locations

Alphabetical prefix corresponds with study animal designation. See Table 3.



RELOCATION NO.	DATE
1	9-1-78
2	10-2-78
3	10-5-78
4	10-13-78
5	10-16-78
6	10-30-78
7	11-28-78
8	12-4-78
9	1-3-79
10	1-24-79
11	2-2-79

FIGURE 19



EWE F

FIGUPE 18

RELOCATION NO.	DATE
1	1-29-78
2	2-2-78
3	2-3-78
4	2-6-78
5	2-11-78
6	2-14-78
7	2-17-78
8	2-24-78
9	3-3-78
10	3-11-78
11	3-16-78
12	3-20-78
13	3-29-78
14	4-6-78
15	4-18-78
16	4-24-78
17	4-26-78
18	5-19-78
19	5-26-78
20	5-31-78
21	6-2-78
22	6-5-78
23	6-8-78
24	6-15-78
25	6-23-78
26	6-29-78
27	7-6-78
28	7-12-78
29	7-19-78
30	7-21-78
31	7-28-78
32	8-1-78
33	8-9-78
34	1-3-79

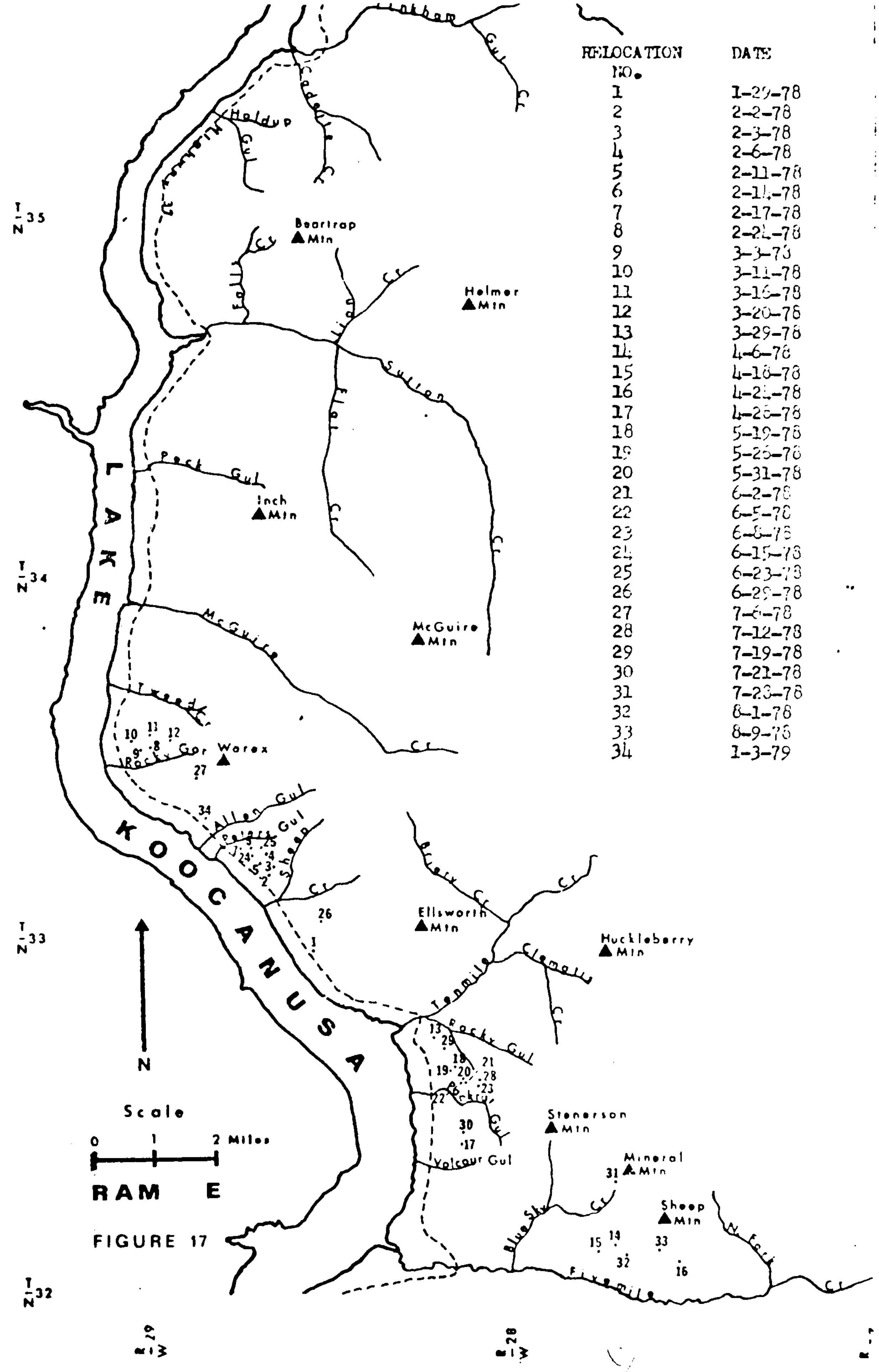


FIGURE 17

TABLE 6. SEASONAL ACTIVITY CENTERS, HOME RANGE SIZE AND MOVEMENT STATISTICS FOR BIGHORN SHEEP [illegible].

TIME PERIOD	ACTIVITY CENTER	MAXIMUM AREA[a]	STANDARD DIAMETER	DISTANCE[b]				ELEVATION[c]				NO. RELOCATIONS
				MAX.	MIN.	$\bar{X}$	$\bar{S}$	MAX.	MIN.	$\bar{X}$	$\bar{S}$	
1/17/78 -1/19/78	Stone Hill	--	--	2.29	--	--	--	3600	2800	3200	565	2
1/25/78 -3/28/78	Packrat Gulch	6.69	5.49	4.17	.09	1.32	1.54	4600	2900	3620	654	10
3/29/78 -6/ 8/78	Packrat Gulch	.09	.58	.56	.32	.44	.17	4400	4200	4333	115	3
6/15/78 -7/ 6/78	Rock Gut	.34	2.33	3.27	.25	1.63	1.53	4600	3400	4175	531	4
7/12/78 -[illegible]/ 9/78	Sheep Mountain	3.95	3.91	2.98	.51	1.37	.96	5400	[illegible]	[illegible]	[illegible]	[illegible]
Annual	Tenmile Creek	51.68	9.92	9.83	.09	2.21	2.47	5400	2800	[illegible]	[illegible]	[illegible]

[a] Home range size measured in miles squared

[b] Maximum and minimum distances traveled between any two consecutive relocations during the given time period

[c] Elevation measured in feet above mean sea level

TABLE 7. SEASONAL ACTIVITY CENTERS, HOME RANGE SIZE AND MOVEMENT STATISTICS FOR BIGHORN SHEEP D.

TIME PERIOD	ACTIVITY CENTER	MAXIMUM[a] AREA	STANDARD DIAMETER	DISTANCE[b]				ELEVATION[c]				NO. RELOCATIONS
				MAX.	MIN.	$\overline{X}$	$\overline{S}$	MAX.	MIN.	$\overline{X}$	$\overline{S}$	
1/18/78 -4/4/78	Falls Creek	1.19	1.90	1.38	.06	.60	.48	4100	2800	3533	411	18
4/24/78 -6/26/78	Allen Gulch	.94	1.25	2.00	.06	.63	.58	4800	3500	4184	384	13
7/12/78 -10/30/78	Rock Gut	3.58	4.[illegible]	4.97	.06	1.63	1.64	4800	2800	4300	581	11
Annual	McGuire Creek	33.90	9.43	[illegible].45	.06	1.13	[illegible].68	4800	2800	3935	56[illegible]	42

[a] Home range size measured in miles squared

[b] Maximum and minimum distances traveled between any two consecutive relocations during the given time period

[c] Elevation measured in feet above mean sea level

TABLE 9. SEASONAL ACTIVITY CENTERS, HOME RANGE SIZE AND MOVEMENT STATISTICS FOR BIGHORN SHEEP E.

TIME PERIOD	ACTIVITY CENTER	MAXIMUM[a] AREA	STANDARD DIAMETER	DISTANCE[b] MAX.	DISTANCE[b] MIN.	DISTANCE[b] $\bar{X}$	DISTANCE[b] $\bar{S}$	ELEVATION[c] MAX.	ELEVATION[c] MIN.	ELEVATION[c] $\bar{X}$	ELEVATION[c] $\bar{S}$	NO. RELOCATIONS
1/29/78 -3/20/78	Allen Gulch	1.25	3.00	2.29	.09	.47	.68	4200	2900	3566	370	12
3/29/78 -6/ [illegible]/78	Packrat Gulch	3.[illegible]	3.55	4.27	.00	1.18	1.68	4600	3700	4272	279	11
6/15/78 -7/ 6/78	Rock Gut	.34	2.33	3.27	.25	1.63	1.53	4600	3400	4175	531	4
7/12/78 -8/ 9/78	Sheep Mountain	3.25	3.91	2.98	.51	1.37	.96	5400	3600	4466	656	6
Annual	Tenmile Creek	13.17	7.86	7.05	.00	1.50	2.01	5400	2900	4039	551	33

[a] Home range size measured in miles squared

[b] Maximum and minimum distances traveled between any two consecutive relocations during the given time period

[c] Elevation measured in feet above mean sea level

TABLE 9. SEASONAL ACTIVITY CENTERS, HOME RANGE SIZE AND MOVEMENT STATISTICS FOR BIGHORN SHEEP F.

TIME PERIOD	ACTIVITY CENTER	MAXIMUM[a] AREA	STANDARD DIAMETER	DISTANCE[b] MAX.	DISTANCE[b] MIN.	DISTANCE[b] $\bar{X}$	DISTANCE[b] $\bar{S}$	ELEVATION[c] MAX.	ELEVATION[c] MIN.	ELEVATION[c] $\bar{X}$	ELEVATION[c] $\bar{S}$	NO. RELOCATIONS
2/22/78 -4/4/78	Sheep Creek	.03	.64	.94	.00	.20	.36	3600	2900	3500	264	7

[a] Home range size measured in miles squared

[b] Maximum and minimum distances traveled between any two consecutive relocations during the given time period

[c] Elevation measured in feet above mean sea level

TABLE 10. SEASONAL ACTIVITY CENTERS, HOME RANGE SIZE AND MOVEMENT STATISTICS FOR BIGHORN SHEEP G.

TIME PERIOD	ACTIVITY CENTER	MAXIMUM[a] AREA	STANDARD DIAMETER	DISTANCE[b] MAX.	DISTANCE[b] MIN.	DISTANCE[b] $\bar{X}$	DISTANCE[b] $\bar{S}$	ELEVATION[c] MAX.	ELEVATION[c] MIN.	ELEVATION[c] $\bar{X}$	ELEVATION[c] $\bar{S}$	NO. RELOCATIONS
9/ 1/78 -10/30/78	Allen Gulch	9.50	7.37	10.98	1.09	3.17	4.37	4800	2700	4283	815	6
11/28/78 -1/ 3/79	McGuire Creek	1.81	7.23	8.83	4.74	6.79	2.90	4000	2900	3400	556	3
1/24/79 -2/ 2/79	Falls Creek	--	--	1.27	--	--	--	4000	3600	3800	282	2
Annual	McGuire Creek	28.13	9.22	10.98	1.09	4.47	3.86	4800	2700	3954	751	11

[a] Home range size measured in miles squared

[b] Maximum and minimum distances traveled between any two consecutive relocations during the given time period

[c] Elevation measured in feet above mean sea level

FIGURE 21 a-f

Seasonal key use areas for sheep on the
Ural-Tweed sheep range

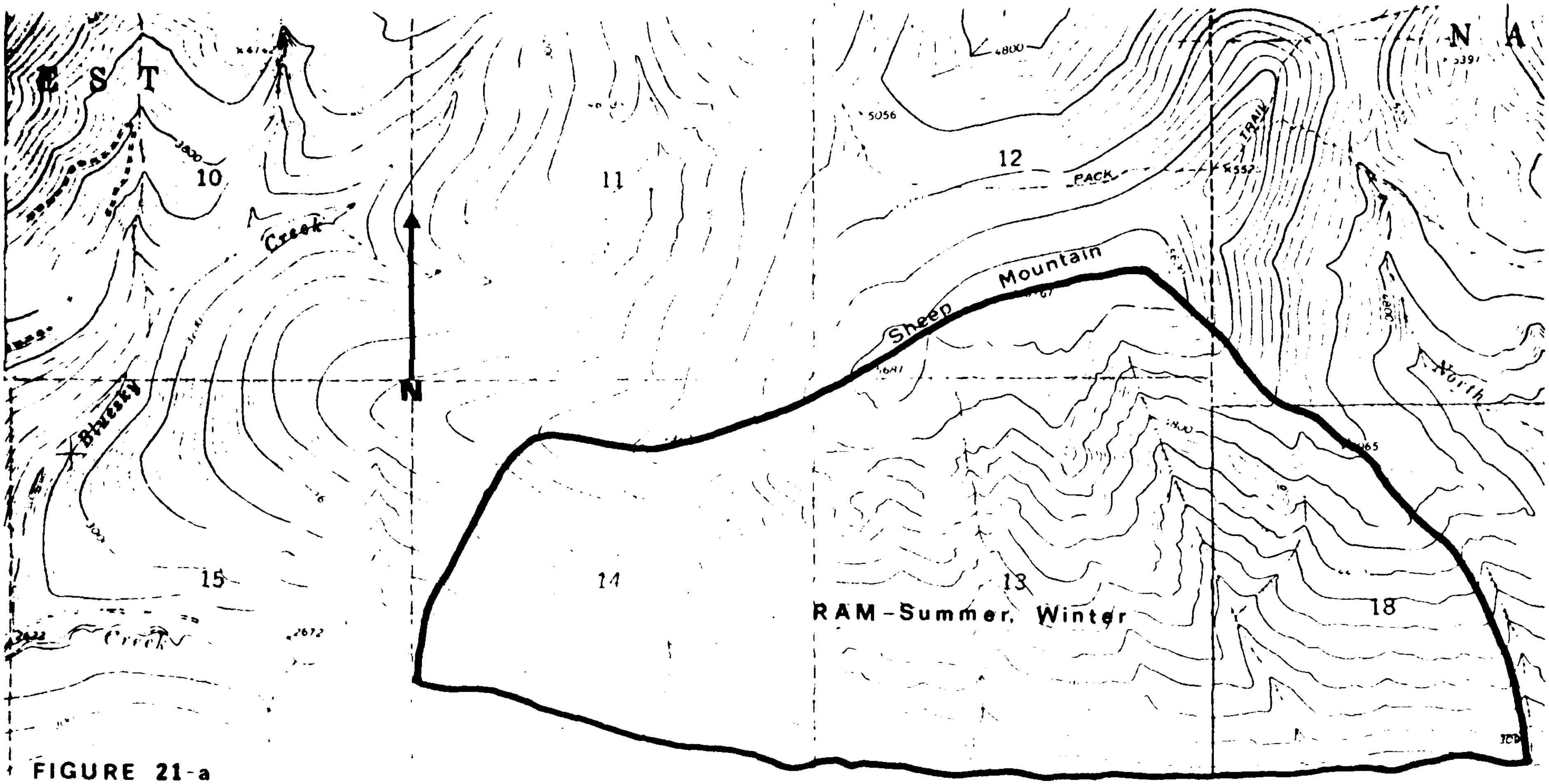
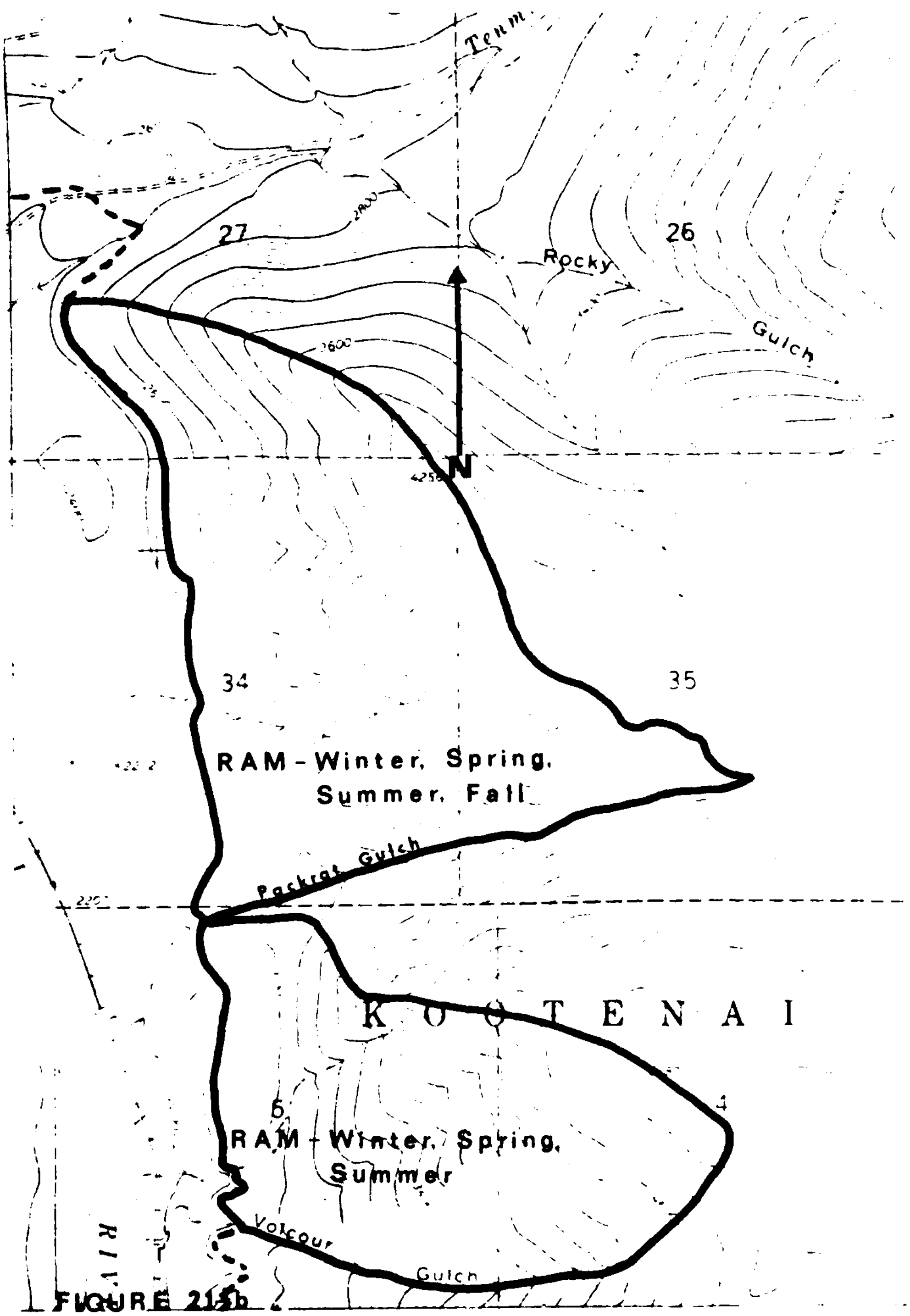

E S T
N A
10
11
12
13
14
15
18
Creek
PACK
TRAIL
Sheep Mountain
North
RAM-Summer, Winter
N
4800
5056
3800

FIGURE 21-a



Tenm
27
26
Rocky
Gulch
N
34
35
RAM - Winter, Spring, Summer, Fall
Packrat Gulch
KOOTENAI
6
4
RAM - Winter, Spring, Summer
Volcour
Gulch

FIGURE 21b

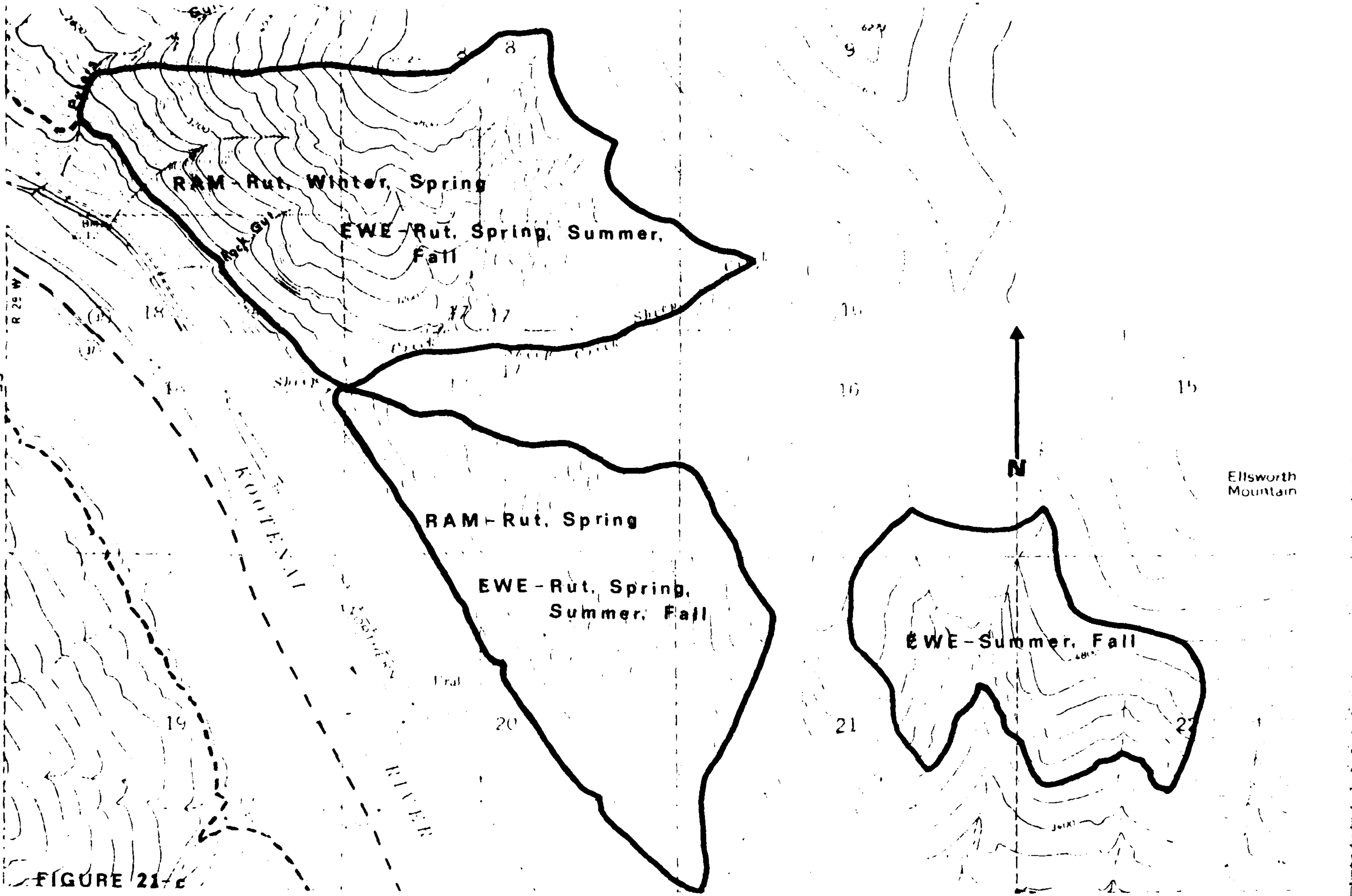

RAM-Rut, Winter, Spring
EWE-Rut, Spring, Summer, Fall
RAM-Rut, Spring
EWE-Rut, Spring, Summer, Fall
EWE-Summer, Fall
N
Ellsworth Mountain
KOOTENAI
RIVER
R 29 W
8
9
16
15
17
18
19
20
21
22

FIGURE 21-c

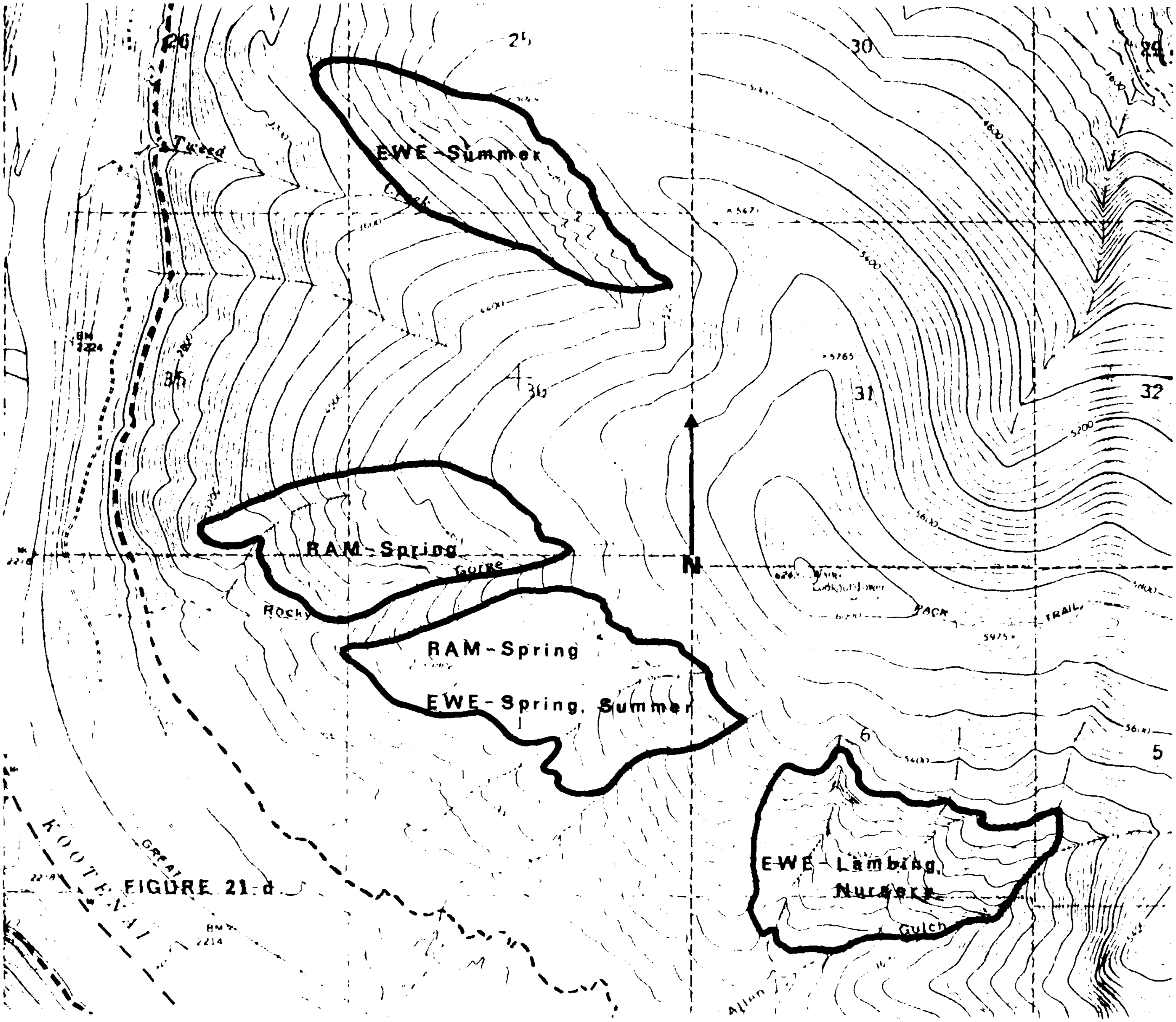

EWE-Summer
Creek
RAM-Spring
Gorge
Rocky
RAM-Spring
EWE-Spring, Summer
EWE-Lambing
Nursery
Gulch
Tweed
PACK TRAIL
KOOTENAI
GREAT
N
30
31
32
36
35
26
25
29
6
5

FIGURE 21-d

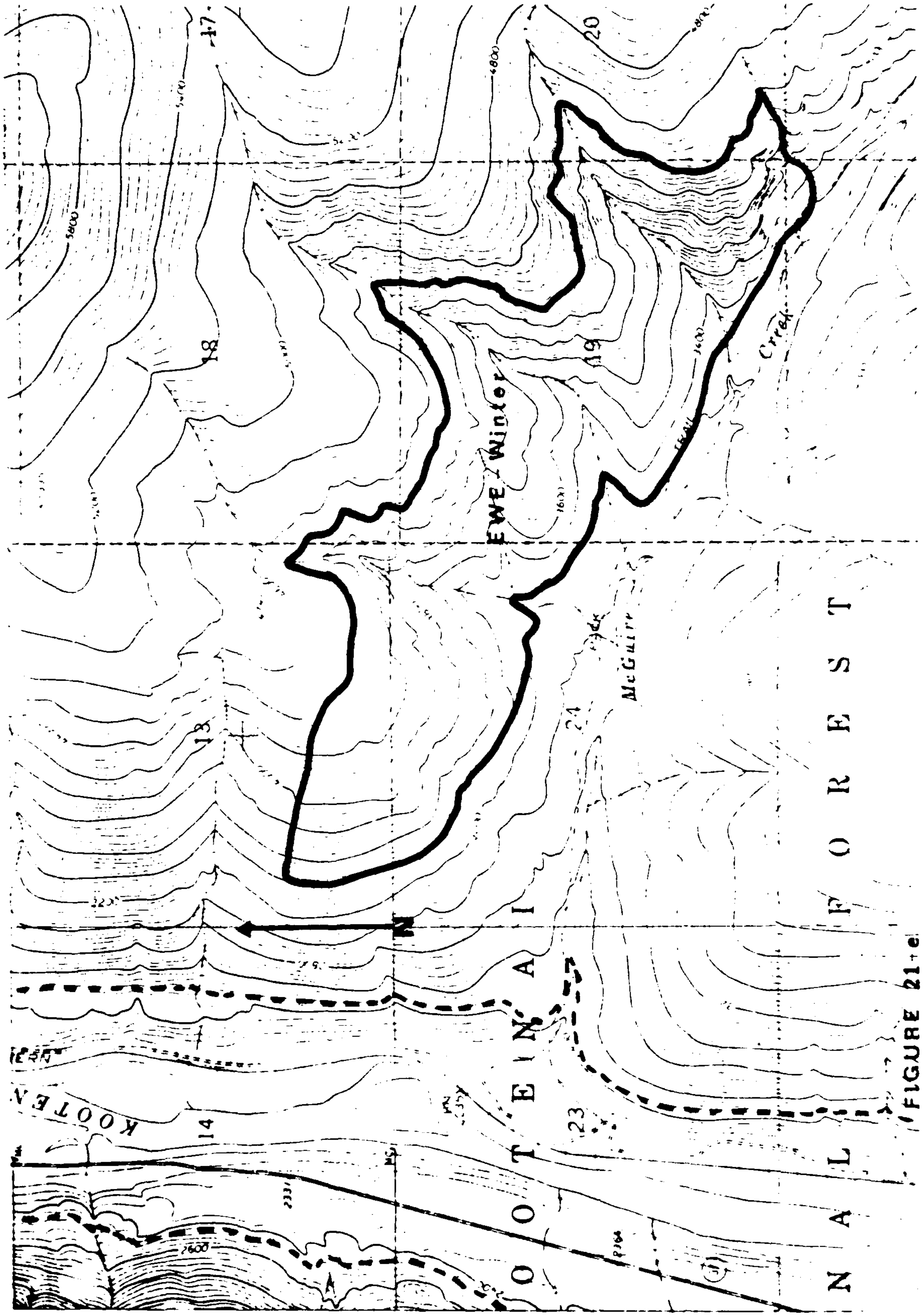

KOOTENAI NATIONAL FOREST
EWE Winter
McGuire
Creek
17
18
19
20
13
14
23
24

FIGURE 21-e

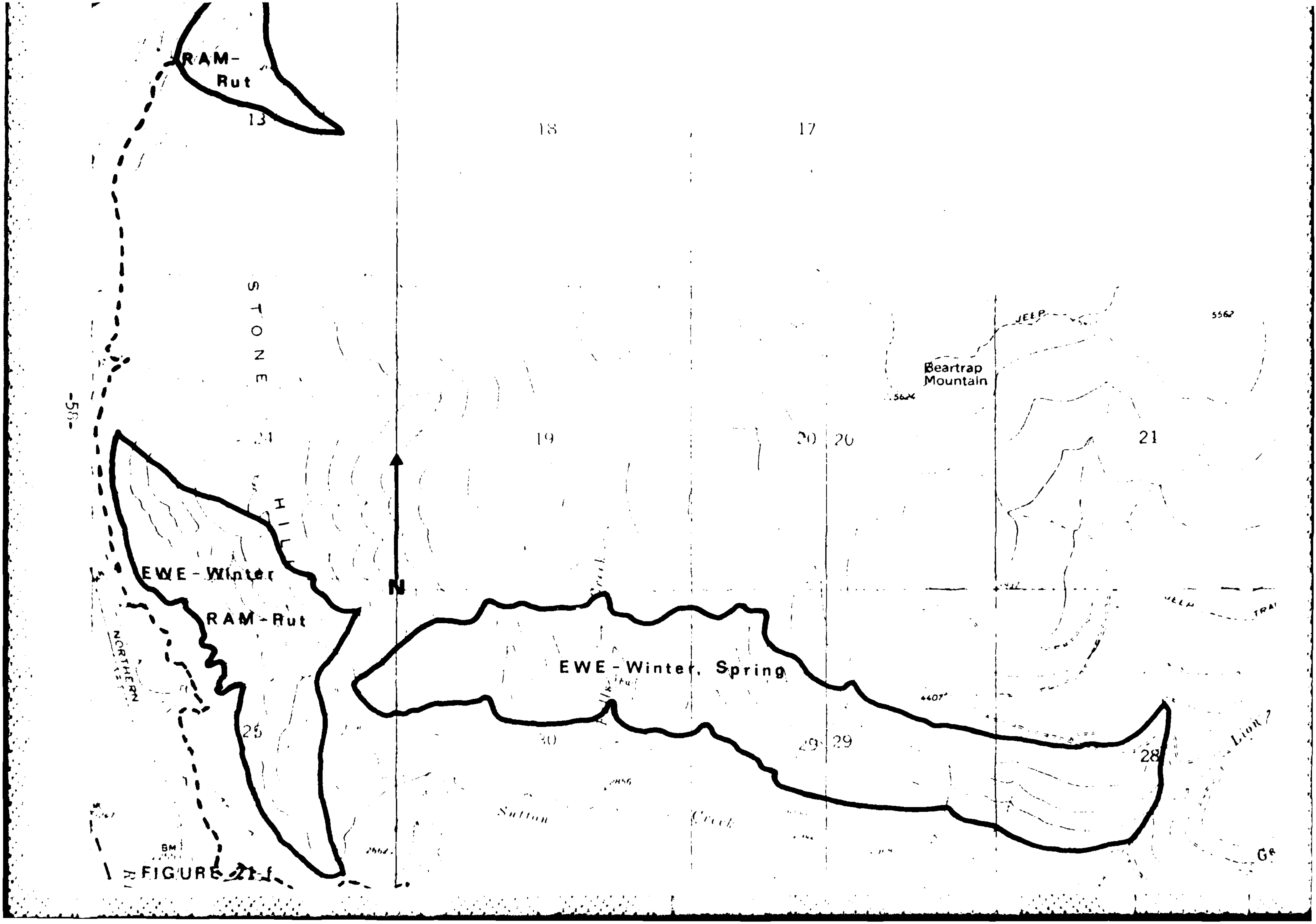

RAM-
Rut
13
18
17
STONE
HILL
Beartrap
Mountain
JEEP
5562
19
20
21
N
EWE-Winter
RAM-Rut
EWE-Winter, Spring
NORTHERN
25
30
29
28
Sutton
Creek
BM

FIGURE 21 f

Aside from the rutting season, rams and ewes maintained relatively discrete home range tendencies during other seasons, Throughout most of the year, rams confined their range use to the Packrat Gulch-Sheep Mountain area south of Tenmile Creek during the course of the project.

Rutting activity occurred from mid-November through mid-January, but appeared to reach peak intensity during early December. The rut for 1976 centered along State Highway 37, between Tenmile Creek and Peters Gulch. For unknown reasons, this area received little rutting activity during the 1977 and 1978 seasons, while the Stone Hill-Sutton Creek vicinity served as rutting grounds during both of these years. Ewe distribution during late fall-early winter appeared to differ between years and, as a consequence, dictated ram distribution during that period. For example, rams that rutted near Sheep Creek in 1976, spent the pre-rut period at Packrat Gulch in 1977, began moving north after 15 November 1977, by-passed rutting grounds of the previous year, and traveled north to Stone Hill where they remained throughout the rut. Rutting areas for 1976 and 1977 were, therefore, separated by approximately 12 air miles.

Winter Range

Winter key use areas for rams were located in the following areas: 1) Packrat Gulch, 2) Volcour Gulch, 3) Sheep Mountain, 4)Rock Gut. Rams occupying the Packrat Gulch-Volcour Gulch area were generally sedentary during winter months, but did occasionally travel east over the reservoir divide to Sheep Mountain where they spent short periods of time. Use of Sheep Mountain during winter 1976-77 may have been atypical due to the extremely mild winter conditions which allowed unrestricted mobility over the area. The 1977-78 winter period more nearly approached normal winter conditions on the sheep range and rams spent considerably less time on Sheep Mountain.

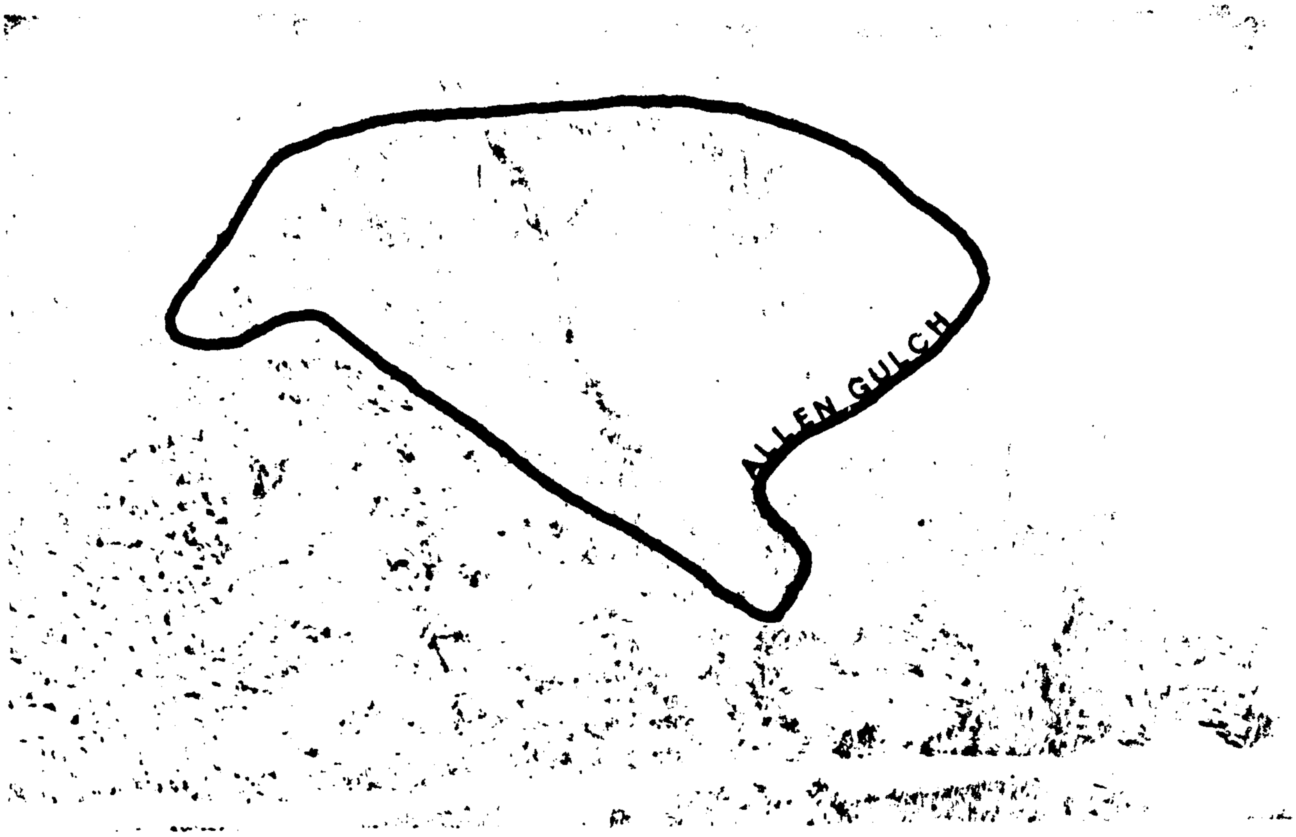
Important wintering areas for ewes were 1) McGuire Creek, 2) Stone Hill along the bluffs between Sutton Creek Bridge and the big burn and 3) Falls Creek vicinity. At the end of the 1978 field season, ewes were again moving onto the Stone Hill-Falls Creek area indicating traditional use of the area during winter.

Spring Range

During spring 1977 and 1978, rams used the Volcour Gulch-Packrat Gulch area consistently. In addition, Ram E spent early spring months at Rocky Gorge before traveling south to Packrat Gulch. Both Ram E and Ram C spent portions of late spring along the reservoir face between Sheep Creek and Tenmile Creek.

Lambing

After maintaining distinct winter-early spring ranges at McGuire Creek and Falls Creek, respectively, Ewe B and Ewe D traveled south in late April 1978 to converge at Allen Gulch where they remained through lambing and spring (Figure 22). Ewe D and Ewe B gave birth to single lambs at Allen Gulch on 16 and 23 May 1978, respectively. At least five additional ewes lambed and spent the postpartum period with their offspring at Allen Gulch, indicating the importance of this location as a lambing-nursery area. No other lambing areas were documented during this project.



LAMBING—NURSERY AREA AT ALLEN GULCH

FIGURE 22

TABLE 21. RUMEN ANALYSES OF TWO ILLEGALLY KILLED BIGHORN YEARLINGS COLLECTED AT SHEEP CREEK ON 24 OCTOBER 197[illegible].

FOOD ITEM	YEARLING RAM	YEARLING EWE
TREES AND SHRUBS		
Amelanchier alnifolia	.5[illegible][a]	1.[illegible]
Arctostaphylos uva-ursi	.2[illegible]	
Holodiscus discolor	1.2[illegible]	6.[illegible]
Philadelphus lewisii	1.1[illegible]	
Physocarpus malvaceus	.[illegible]	
Pinus ponderosa	1.9[illegible]	.[illegible]
Pseudotsuga menziesii	.5[illegible]	.1[illegible]
Rosa spp.		.[illegible]
Spiraea betulifolia	.[illegible]	1.[illegible]
Symphoricarpos albus		.[illegible]
Unidentified browse	35.5[illegible]	3[illegible].4[illegible]
Total	42.63	4[illegible].[illegible]
GRASSES AND GRASSLIKE PLANTS		
Unidentified grasses	4[illegible].3[illegible]	4[illegible].3[illegible]
FORBS		
Achillea millefolium	.14	
Heuchera cylindrica		1.[illegible]
Penstemon spp.	1.71	[illegible].1[illegible]
Unidentified forbs	[illegible].27	[illegible]
Total	[illegible].12	[illegible]
[illegible]PHYTES		
Selaginella spp.	.[illegible]	.[illegible]
Lichens	3.	
Total	3.[illegible]	.[illegible]

[a] Values expressed as percent by volume

BLE 20. PROTOSTRONGYLID LARVAL DISCHARGE FOR URAL-TWEED BIGHORN SHEEP AS DETERMINED FROM 240 FECAL SAMPLES COLLECTED ON A MONTHLY SCHEDULE BETWEEN JANUARY AND DECEMBER 1978.

NTH	SAMPLE SIZE	NUMBER NEGATIVE	NUMBER POSITIVE	PERCENT POSITIVE	MEAN LARVAL DISCHARGE[a]
n.	20	0	20	100	[illegible]
b.	20	1	19	95	2?.5
r.	20	4	16	80	11.3
r.	20	0	20	100	1?.7
y	20	2	18	90	[illegible]
ne	20	0	20	100	10.?
ly	20	2	18	90	13.?
g.	20	11	9	45	.5
pt.	20	4	16	80	1.3
t.	20	5	15	75	2.5
v.	20	3	17	85	2.?
.	20	3	17	85	2.4
nual	240	35	205	85	9.5

[a] Per gram dry fecal material

TABLE 19. PROTOSTRONGYLID LARVAL DISCHARGE FOR URAL-TWEED BIGHORN SHEEP AS DETERMINED FROM 50 FECAL SAMPLES COLLECTED BETWEEN OCTOBER 1976 AND MARCH 1977.

MEAN LARVAL[a] DISCHARGE	SAMPLE SIZE	NUMBER NEGATIVE	NUMBER POSITIVE	PERCENT POSITIVE
5.3	50	10	40	80

[a] Per gram dry fecal material

Protostrongylus spp. However, neither had any extensive scarring or plaques on the pleura. and No. 2 (yearling female) yielded only the bronchiolar lungworm, P. rushi. Gastrointestinal worm burdens were very minimal compared with those we see occasionally from the Bison Range or Wildhorse Island sheep."

Results from fecal analyses for presence of lungworm larvae are summarized in Tables 19 and 20. For the 50 samples collected during 1976-1977, 20 percent were negative, 22 percent showed less than 1 larvae per gram feces, 32 percent showed 1-5 larvae per gram feces, and 26 percent had more than 5 larvae per gram feces. Mean larval output for all 50 samples was 5.3 larvae per gram. Mean larval discharge for the 240 samples collected during 1978 was 9.5 larvae per gram, and the frequency distribution was as follows: less than 1 larvae per gram (LPG)-33 percent; 1-5 LPG-36 percent; 5-50 LPG-27 percent; 50-100 LPG-3 percent; greater than 100 LPG-1 percent.

For both sample collection periods, winter 1976-77 and calendar year 1978, lungworm infection rates for the herd were 80, and 85 percent, respectively. However, for all samples, intensity of infection was low to moderate. A seasonal trend in larval discharge associated with stress periods for sheep is apparent from the data, with higher outputs of lungworm larvae occurring during winter and spring than during summer and fall.

In addition to necropsy information, live-captured bighorns were thoroughly examined for ectoparasites. Ear mites, and lice were not noted on any of the animals handled. However, winter ticks (Dermacentor albipictus) were common on some of the animals examined, and were especially numerous in the neck and genital regions of the body. On several occasions, fully engorged ticks were found lying on the snow in and adjacent to sheep bed sites.

Food Habits

Rumen contents from two bighorn sheep collected as illegal-kills during October 1976 are listed in Table 21. Grasses and grasslike plants, shrubs, forbs, and bryophytes averaged 43, 43, 11 and 3 percent, respectively, for these two samples.

Microhistological analysis of fecal material showed rough fescue (Festuca scabrella) to be an important dietary component for bighorns during all seasons of the year (Table 22). Sheep were not as consistent in their use of other bunch habit graminoids as they were of rough fescue; however, Idaho fescue, bluebunch wheatgrass, Junegrass, and needle-and-thread grass (Stipa comata) were common dietary constituents. There was a trend towards greater use of shrubs and forbs in spring and early summer months, with a shift back to grasses in fall. Common winter browse included, serviceberry, Douglas-fir, ceanothus, (Ceanothus spp.), oceanspray, snowberry, and bitterbrush. On an annual basis, grasses and grasslike plants, browse, and forbs constituted 64.20, 29.96 and 5.74 percent of the diet, respectively.

Population Dynamics

Interpretation of population status and trend through analyses of temporal changes in primary age ratios (ewe:lamb ratios) has little meaning when working with a very small total population number, such as is the case with the Ural-Tweed herd. To provide better assessment of the actual population dynamics of

TABLE 18. RESULTS OF ENDOPARASITE ANALYSIS OF FIVE BIGHORN SHEEP CARCASSES FOUND ON THE URAL-TWEED STUDY AREA.

SEX	AGE	CAUSE OF DEATH	DATE OF COLLECTION	ENDOPARASITES SPECIES	NO.	LOCATION
♀	4 1/2	Vehicle	11/24/74	*Marshallagia marshalli*	290	Abomasum
				Protostrongylus stilesi	[illegible]	Lungs
				P. rushi	2	Lungs
				Skrjabinema spp.	4[illegible]	Cecum
♂	[illegible] 1/2	Illegal Kill	10/24/76	*P.* spp.	[illegible]	Lungs
				Trichuris spp.	19	Intestines
				M. marshalli	41	Abomasum
♀	1 1/2	Illegal Kill	10/24/76	*P. rushi*	2[illegible]	Lungs
				T. spp.	[illegible]	Intestines
				M. marshalli	75	Abomasum
[illegible]	12 1/2	Natural	1/ 4/78	*P. rushi*	44	Lungs
				M. marshalli	3[illegible]	Abomasum
♂	[illegible] 1/2	Vehicle	1/16/78	*P. rushi*	1	Lungs
				M. marshalli	[illegible]	Abomasum
				Wyominia tetoni	[illegible]	Liver

TABLE 17. ANALYSES OF TIMBER STAND CHARACTERISTICS ON SITES SELECTED BY BIGHORN SHEEP ON THE URAL-TWEED SHEEP RANGE.

	TIMBER STAND PARAMETERS				
MONTH	CANOPY[a] $\bar{X}$	BASAL AREA[b] $\bar{X}$	DBH[c] $\bar{X}$	TREES PER ACRE $\bar{X}$	SAMPLE SIZE
Jan.	16.2	46.4	19.[illegible]	[illegible]	15
Feb.	14.2	22.2	21.0	23.3	12
Mar.	15.4	26.9	18.1	24.7	17
Apr.	29.4	51.1	18.0	46.5	14
May	45.8	92.5	18.5	94.7	12
June	22.7	40.0	20.6	29.[illegible]	11
July	30.0	48.2	24.8	27.1	11
Aug.	52.0	68.0	21.0	52.8	5
Sept.	35.0	70.0	14.7	10[illegible]	2
Oct.	37.5	80.0	19.6	111.1	[illegible]
Nov.	30.0	70.0	22.6	40.4	[illegible]
Dec.	15.0	37.5	20.9	2[illegible].33	4
Annual	28.6	54.4	20.0	51.4	[illegible]

[a] Canopy - percent conifer crown closure

[b] Square feet of conifer basal area per acre

[c] Conifer diameter at breast heighth (dBH) measured in inches

TABLE 16. MONTHLY BIGHORN SHEEP USE OF ELEVATION AND SLOPE ON THE URAL-TWEED SHEEP RANGE.

		JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
ELEVATION[a]	$\bar{X}$	3256	3499	4059	3757	4120	4078	4277	4315	3350	4602	[illegible]	[illegible]
	$\bar{S}$	490	416	492	645	401	475	531	907	919	[illegible]	[illegible]	[illegible]
	MIN.	2780	2800	3200	2560	3500	2700	3440	2800	2700	4200	[illegible]	2780
	MAX.	4800	4350	5080	4600	4700	4400	5400	5080	4300	[illegible]	[illegible]	4100
	SAMP. SIZE	31	29	28	18	17	23	18	9	2	18	3	11
SLOPE[b]	$\bar{X}$	34.0	30.6	34.7	[illegible]	35.1	39.1	37.3	32.0	30.0	[illegible]	[illegible]	32.4
	$\bar{S}$	7.1	6.7	6.8	4.7	5.6	7.9	8.5	5.7	7.1	6.4	[illegible]	2.8
	MIN.	25	5	23	23	27	30	23	25	25	28	[illegible]	27
	MAX.	58	38	59	40	52	55	55	40	35	55	[illegible]	35
	SAMP. SIZE	30	29	28	18	17	23	18	9	2	18	3	[illegible]

[a] Elevation measured in feet

[b] Slope measured in degrees

TABLE 14. MONTHLY BIGHORN SHEEP USE OF VARIOUS LANDFORM TYPES DESCRIBED FOR THE STUDY AREA

MONTH	LANDFORM TYPE					
	BROKEN	BLUFF	HILL	CLIFF	TALUS	RIDGE
Jan.	[a]17/57[b]	4/13	5/17	2/7	2/7	
Feb.	9/31	14/48	5/17	1/3		
Mar.	12/43	5/18	5/18	3/11	[illegible]	[illegible]
Apr.	7/39	1/6	7/39		3/17	
May	8/47		7/41	1/6	[illegible]	
June	15/65	2/9	1/4	4/17	1/4	
July	8/44	2/11	1/6	4/22	3/17	
Aug.	4/44		3/33		2/22	
Sept.		2/100				
Oct.	9/50	3/17	4/22	2/11		
Nov.	3/100					
Dec.	6/55	3/27	2/18			
Annual	98/48[c]	36/17	40/[illegible]	17/8	[illegible]	[illegible]

[a] Number of relocations

[b] Percentage of total during the month

[c] Percentage of annual total

below cliff complexes served as convenient foraging areas. Table 14 lists bighorn sheep use of the various landform types described for the study area.

Microsite

With respect to aspect, slope and elevation, Tables 15 and 16 show bighorn sheep selection of these various parameters on a monthly basis. Collectively, south, southwest, and west exposures received 89 percent of all bighorn sheep use annually, and appeared to be the predominant aspects of sheep occupation during all seasonal periods. Very few radioed-sheep observations were made on northerly aspects (3 percent) and probably reflect transient individuals traveling from one key use area to another. Radioed sheep were consistent in their selection of oversteepened terrain during all seasons. Average slope steepness for sites used by sheep throughout the year was 34.4 degrees, and mean values for each month ranged between 30.0 and 39.1. As might be expected, there appeared to be a trend in sheep utilization of different elevational zones during various seasons, with greatest use occurring at lower elevations during winter months and higher elevations during late summer-fall months. Sheep tended to be at higher elevations (above 4200 feet) near the top of the reservoir escarpment during October and November just prior to the rut. During the rut and early winter months of December, January and February, most sheep activity occurred below 3500 feet, but some use of higher elevation habitats was not uncommon.

Timber stand characteristics for 98 sheep occupation sites are displayed in Table 17. Two species of conifers, ponderosa pine and Douglas-fir dominated all sites examined, while Western larch (Larix occidentalis), aspen (Populus tremuloides), and lodgepole pine (Pinus contorta), were present on 3, 2, and 1 plots, respectively. Conifer canopy coverage values ranged from 0 (opening) to 100 percent (closed canopy), but averaged only 28.6 percent for all sites examined, reflecting higher sheep use of open forested areas. Conifer stem densities (trees/acre) ranged from 0 (openings) to 260, but averaged annually, 51.4 trees per acre, again demonstrating bighorn preference for more open cover types on the Ural-Tweed range. Mean DBH values reflected a preponderance of larger diameter class trees on all sites, for each month (range 14.7-24.8 inches) and annually ($\bar{x}$ = 20.0). However, nearly all diameter classes ranging from 4" Douglas-fir saplings to 46" ponderosa pine and 54" Douglas-fir were found on some of the plots. Sheep occupation of sites showing increased stem densities during September and October may indicate a preference for these sites for their thermal cover attributes or may be a factor of the small sample sizes for these two months.

Observations of sheep bedding-resting situations showed an obvious tendency for bighorns to select sites immediately adjacent to large diameter ponderosa pine and/or Douglas-fir trees located along the rims of bluffs, cliffs or rock outcrops.

Herd Health

Results of parasite analysis for five bighorn sheep carcasses collected on the Ural-Tweed sheep range are summarized in Table 18. Of the five carcasses necropsied, all were positive for Protostrongylus spp. (lungworm), either the bronchiolar lungworm P. rushi or the parenchymal lungworm P. stilesi or both, but showed little signs of excessive buildup of either of these lungworms. All carcasses were found to be only lightly burdened with gastrointestinal worms. In his examination of the two illegally shot yearlings, Dr. D. Worley of the Veterinary Research Laboratory at Bozeman commented that "neither animal showed evidence of a buildup of internal parasites, although both were infected with

TABLE 13. MONTHLY BIGHORN SHEEP USE OF VARIOUS HABITAT TYPES ON THE URAL-TWEED SHEEP RANGE

MONTH	HABITAT TYPE				
	PSME/CARU	PSME/ARUV	PSME/SYAL	PSME/PHMA	PSME/LIBO
Jan.	[a]2/7[b]		14/47	14/47	
Feb.	9/31		9/31	10/34	1/3
Mar.	12/43	1/4	10/36	3/11	2/7
Apr.	9/50	2/11	6/33	1/6	
May	3/18		12/71	2/12	
June	6/26	2/7	8/35	7/30	
July	10/56	4/22	3/17	2/11	
Aug.	7/78			2/22	
Sept.			2/100		
Oct.	9/50	6/33		3/17	
Nov.	1/33		1/33	1/33	
Dec.		1/9	7/64	3/27	
Annual	67/33[c]	16/8	72/35	48/23	3/1

[a] Number of relocations

[b] Percentage of relocations during the month

[c] Percentage of relocations during the year

TABLE 12. MONTHLY BIGHORN SHEEP USE OF VARIOUS VEGETATION COVER TYPES DESCRIBED ON THE STUDY AREA

	COVER TYPE				
MONTH	ROCKLAND	SHRUB-GRASS	PARK	OPEN FOREST	CLOSED FOREST
Jan.	[a]6/2[illegible][b]			23/[illegible]	[illegible]
Feb.	4/14		2/7	[illegible]	[illegible]
Mar.	7/25		2/[illegible]	[illegible]	
Apr.	3/[illegible]		[illegible]	[illegible]	[illegible]
May	[illegible]		[illegible]	[illegible]	
June	6/2[illegible]		[illegible]	[illegible]	
July	7/[illegible]		[illegible]	[illegible]	
Aug.	2/2[illegible]			[illegible]	[illegible]
Sept.				[illegible]	
Oct.	3/17			13/72	[illegible]
Nov.				3/[illegible]	
Dec.				[illegible]	[illegible]
Annual	39/19[c]		12/6	[illegible]	[illegible]

[a] Number of relocations

[b] Percentage of total during the month

[c] Percentage of annual total

Habitat Selection

To insure unbiased data on habitat selection, only telemetry relocations were used to assess characteristics of sites being selected by Ural-Tweed bighorns. Radio-collared sheep permitted relocation of these animals in both open and timbered cover types, whereas random observations of sheep were biased toward openings, mostly adjacent to Highway 37. Habitat site selection data were pooled for each month during different years. However, most data came from the 1978 calendar year.

Cover Types

Of the five major cover types designated on the study area, only four were of importance to bighorns (Table 12). None of the radio "fixes" occurred on the true shrub-grass cover type (i.e. bitterbrush-rough fescue area near mouth of Sutton Creek). However, this cover type has a very limited distribution and coverage on the sheep range. Conversely, the closed forest cover type has extensive coverage on the area but received relatively light use. Most radio "fixes" on the closed forest cover type were thought to be animals in transit as these sites showed little sign of continual sheep use. Although parks accounted for only six percent annual use by sheep, this cover type was of particular importance to rams during spring and summer months, especially near Packrat Gulch and on Sheep Mountain. Rockland types were of importance to sheep during all periods of the year in that bighorns tended to bed along rims or at the base of cliff faces, and also on talus slides.

Habitat Types

Of 19 habitat types delineated on the sheep range, only 5 of the driest types appeared to receive 100 percent of the sheep use (Table 13). In order of apparent decreasing importance, these habitat types were: 1) PSME/SYAL, 2) PSME/CARU, 3) PSME/PHMA, 4) PSME/ARUV and 5) PSME/LIBO. The Douglas-fir/snowberry (PSME/SYAL) and Douglas-fir/ninebark (PSME/PHMA) types received greatest sheep use during winter months, while PSME/CARU (Douglas-fir/pinegrass) became increasingly important during spring, summer and fall.

Many of the relocation sites were individually habitat typed to phase and generally were of the drier phases within a type. For example, most of the PSME/PHMA and PSME/SYAL types were of the CARU phase, while the true PSME/CARU type usually fell into the AGSP (*Agropyron spicatum*) phase. In addition to the xeric and rocky nature of these sites, another common denominator was the presence of bunch grasses, i.e. bluebunch wheatgrass, Idaho fescue, rough fescue, Junegrass and purple reedgrass.

Landform Types

Sheep use of the broken landform type was consistent throughout all months of the year, but may only reflect the fact that this type predominated along the reservoir escarpment where bighorns spent nearly all of their time. Forty-eight percent of all radio locations were on this type. Bluffs were of some importance to sheep during winter months, as evidenced by Ewe D's use of the terraced terrain along Highway 37 between Sutton Creek and Highway MP 50.0 during January, February and March 1978. Again cliff faces and talus slides were of primary significance as resting and bedding areas during most seasons, while broken and sidehill terrain

TABLE 11. MONTHLY SPATIAL AND TEMPORAL DISTRIBUTION OF MARKED BIGHORN RELOCATIONS FOR ONE YEAR SHOWING NUMBER OF RELOCATIONS PERCENTAGE OF RELOCATIONS

AREA	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	ANNUAL
Sheep Mtn.	2/10		6/29	4/19			2/10	5/24	1/5	1/5			21/10
Volcour Gulch		1/13	1/13	3/37	1/13		2/25						8/4
Packrat Gulch		6/21	2/7	4/14	4/14	7/24	3/10			2/7	1/3		[illegible]/14
Tenmile Creek			1/33				1/33					1/33	3/1
Ellsworth Mtn.								2/40		3/60			5/2
Ural	6/33	1/6	1/6			2/11	4/22			3/17		1/6	18/9
Sheep Creek		1/8	4/34	1/8						6/50			12/6
Rock Gut	1/6	4/22	1/6	2/12		6/33		2/12				1/6	17/8
Peters Gulch	2/100												2/1
Allen Gulch	5/23				8/36	6/27				3/14			22/11
Rocky Gorge	1/6	1/6	5/28	1/6	4/22	2/11	2/11				1/6	1/6	18/9
Tweed Creek							4/80					1/20	5/2
McGuire Creek		4/50	1/12	2/25							1/12		[illegible]
Peck Gulch	2/50	1/25										1/25	4/2
Sutton Creek	2/40											3/60	5/2
F[illegible] Creek	[illegible]/57	2/14	4/29										14/7
[illegible] Creek		1/25	2/50	1/25									4/2
Stone Hill	3/27	5/45							1/9			2/18	11/5

Summer Range

Except for the rutting season, bighorns traveled more frequently during summer months than during other time periods. Exploitation of certain key use areas separated by intermittent travel between these areas characterized sheep movement patterns during summer.

Rams utilized areas south of Tenmile Creek exclusively during the late summer period. Sheep Mountain was the most important summering area, with Packrat Gulch being of secondary importance to rams during this season.

Ewes concentrated their activities on certain key sites between Tenmile Creek and Rocky Gorge, with the south slope overlooking Tweed Creek assuming secondary importance during late summer months. The late summer period was also the only time ewes used the area below and west of Ellsworth Mountain. Similar to rams, ewes made intermittent excursions between key use areas.

Fall Range

Approximately one month preceding the rut, rams moved from the Sheep Mountain summer range to occupy Packrat Gulch before moving north for the breeding season. Ewes appeared to remain in the same general vicinity they used during the summer, then began a gradual movement north towards McGuire Creek and Stone Hill. Observations of mature rams with ewe-juvenile groups at Allan Gulch, Tweed Creek, Peck Gulch and eventually Stone Hill marked the northward progression of all age and sex classes of sheep during the late fall-early winter rutting period.

Range use patterns of Ural-Tweed bighorn sheep do not facilitate designation of discrete and exclusive classical seasonal ranges since these sheep demonstrate recurrent use of certain key area during all seasons of the year. Figure 21 reflects only the predominant and most important seasons of use on a given area and does not necessarily preclude use of the area by either rams or ewes during a season not listed. Table 11 lists the monthly spatial and temporal distribution of the 206 radio relocations plotted during the study and provides some insight into the recurrent use and relative importance of key use sites on an annual basis.

Bighorns were observed using areas in close proximity to Highway 37 when traveling from one end of the sheep range to the other end. This was especially evident during the fall and early winter period when sheep were traveling long distances during the rut. Certain sections of Highway 37 served as common crossing areas for sheep. Bighorns were observed above, below and on the highway along these sections and made frequent crossings at the following highway mileage points; 35.9, 36.5, 36.6, 37.0, 37.4, 38.0 (Tenmile Creek-Rock Gut section); 42.0 (Tweed Creek section); 48.5 (Sutton Creek section); 49.9, 50.5, 51.0, and 52.0 (Stone Hill section). Rams moving to and from the rutting areas north of Tenmile Creek cross Highway 37 at mile post 34.0 at the south end of the Tenmile Creek Bridge. This is the same site at which an adult ewe was killed by a vehicle shortly after the highway officially opened in November 1974, and appears to be an important sheep crossing. Sheep crossing Sutton Creek usually do so at or near the Sutton Creek Bridge, and frequently cross the highway to travel under the bridge when moving onto Stone Hill. Rams using the Packrat Gulch-Volcour Gulch area during spring occasionally crossed the pavement to forage below the highway, but their crossing points were inconsistent due to ease of access along this section of Highway 37.

TABLE 22. PERCENT RELATIVE DENSITY OF PLANT FRAGMENTS [illegible] FECAL SAMPLES COLLECTED [illegible] A MONTHLY BASIS FOR CALENDAR YEAR [illegible].

PLANT SPECIES	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
GRASSES AND GRASSLIKE PLANTS												
Agropyron spicatum	[illegible]	[illegible]	[illegible]	5.44	3.50			5.93	6.03	[illegible]	9.56	9.72
Bouteloua gracilis										.30	.17	
Bromus tectorum	[illegible]	[illegible]	.30	[illegible]	.56	[illegible]	.27	1.41	2.17	1.55	.17	
Calamagrostis spp.	.30											
Carex spp.		.34	[illegible]	2.10	[illegible]	[illegible]		.04	1.15	.58	.17	.37
Danthonia spp.		.51	.60			[illegible]			.65	[illegible]		
Elymus spp.					.19							
Festuca idahoensis	[illegible]	10.72	17.61	12.73	3.40	[illegible]	10.04	9.93	[illegible]	13.51	13.71	12.65
Festuca scabrella	69.14	25.03	41.10	50.92	[illegible]	[illegible]	23.43	[illegible]	[illegible]	54.05	54.82	[illegible]
Koeleria cristata	1.06	.68			.19	[illegible]	.82	3.12	2.52	1.16	.53	[illegible]
Oryzopsis spp.	.45		.15			.64	.27		.16			
Poa spp.				.32		.64	[illegible]	2.62	3.41	4.87	1.41	2.25
Sitanion hystrix								.23				
Stipa comata	.45		.15		.19			.23		.77	.17	
TOTAL	86.83	39.71	62.21	71.67	40.76	54.82	35.10	47.58	84.70	86.45	80.71	[illegible]
BROWSE												
Amelanchier alnifolia	[illegible]	[illegible]	3.65	8.56	36.41	[illegible]	3.04					
Artemisia frigida				.16								
Atriplex spp.			1.06									
Ceanothus spp.									[illegible]	.06	[illegible]	[illegible]
Chrysothamnus viscidiflorus								[illegible]	[illegible]			
Cornus stolonifera											[illegible]	
Holodiscus discolor	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]				

TABLE 22. CONTINUED

PLANT SPECIES	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
BROWSE CONTINUED												
Mahonia repens	1.36	.34	3.99				1.10		.16	2.36	3.28	3.42
Pachistima myrsinites		.17	.76				.27			.19		
Physocarpus malvaceus			.15	.47	.94	12.10	23.40	1.41		.39	.37	
Picea engelmannii			1.06	2.77	6.48	1.28	.82	1.17	.65	1.36		
Pinus ponderosa	.45	1.20	1.37					2.62	3.77	4.23	.70	.73
Potentilla gracilis								6.99	1.37			.37
Prunus virginiana	.30											
Pseudotsuga menziesii	3.46	37.73	13.56	3.81	3.50	3.05				.77	3.67	1.86
Purshia tridentata	.30	4.64	.15			2.93	2.21					
Rosa spp.								2.13				
Salix spp.								5.67	.33	.39	.70	1.11
Shepherdia canadensis	.15			1.11	8.52	1.11	4.24	.70				
Symphoricarpos albus	.15	4.48	1.69			4.20	4.82	.70				
Vaccinium spp.			.45							.19		
TOTAL	11.81	60.12	33.27	16.88	56.79	40.68	59.02	22.09	7.37	10.84	18.77	21.85
FORBS AND BRYOPHYTES												
Astragalus spp.								.23				
Composite					.5	.64	4.24					
Dryas spp.			1.37	.32								
Erigeron spp.								2.13	.40	.39		.37
Fern	.15					.64	.27					
Geum triflorum					.94	.64		15.24	[illegible]	1.36		.37
Gilia spp.					.38							
Lichen	.15											
Lupinus [illegible]				11.13		[illegible]	1.10	[illegible]	5.64	.19		
[illegible]hera spp.					.20							

TABLE 22. CONTINUED

PLANT SPECIES	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
FORBS AND BRYOPHYTES CONTINUED												
Phlox hoodii						.64				.58		.37
Rubus parviflorus									.82	.19	.35	.18
Viola spp.					.19							
Unidentified Forb		.17	.15				.27		.16			
TOTAL	.30	.17	1.52	11 45	2.45	4.50	5.88	30.33	7.93	2.71	.35	1.29

this herd, the "cohort completion" total count method described and used by Smith (1976) for Rocky Mountain Goats was utilized on this study. Briefly, all sheep which could be accurately classified were placed in the appropriate age/sex class (cohort) as follows: Rams were classified into one of 8 age classes ranging from 1 year to 8 years of age; ewes were classified as yearlings or adults, because of the difficulty of aging ewes in the field; young-of-the-year were classed as lambs, with no sex distinction being made. For a given time period, a population estimate was calculated by totaling the maximum number of individuals from the various cohorts. Adequate sample sizes were not always obtainable for each month of the study, so three month periods were combined to correspond with seasonal periods of the year (Table 23).

During December 1976, a total of 7 known age rams were observed on the rutting grounds near Sheep Creek. Of these seven, two were yearlings and one was a two-year old. They were not active in the rut. The other four breeding class rams consisted of one each 3 1/2-year old, 4 1/2-year old, 5 1/2-year old, and 6 1/2-year old. Early in December, the 3 1/2-year old ram and the 5 1/2-year old ram were observed with a band of ewes near Rock Gut. The following day, evidence of an illegal sheep kill was discovered in the exact spot where these sheep were observed the previous day. The 3 1/2-year old ram was never seen again and presumably was the victim of the poaching incident. During the next several months, the two yearling rams and the four rams older than two years were accounted for. On 10 December 1976, the 5 1/2-year old ram was captured and instrumented with a transmitter collar. On all visual contacts with this ram, from 24 February 1977 through 26 April 1977, and again from June 1977 through October 1977, he was accompanied by three additional rams which by their age and general appearance seemed to be the same individuals observed during the rut. During the early rutting period December 1977, these same rams were observed on Stone Hill, participating in breeding activities. In January 1978, two of the breeding class rams were removed from the population. The radio-collared ram (the 6 1/2-year old ram) was killed by a vehicle near Rocky Gorge, and the 5 1/2-year old ram was killed by a lion at Rock Gut on 8 January. There remained only two older age class rams in the population. On 17 January 1978, the 3 1/2-year old ram was radioed on Stone Hill, and the 7 1/2-year old was collared on 29 January near Sheep Creek. Subsequently, these two rams joined each other and began using the same areas they frequented the preceding year when the two other, now deceased, rams were traveling with them. No other older rams were observed during 1978. Suspicions that these were the only two breeding class rams remaining in the herd was confirmed, when both of these individuals were observed together with both radio-collared ewes, and the recently collared 2 1/2-year old ram near Allen Gulch on 3 January 1979.

Demographic data collected on the ewe-juvenile portion of the herd implies a very small but widely dispersed reproductive population segment. For example, of the three adult ewes radioed at diverse locations on the sheep range during January and February 1978, only two survived the winter. The two surviving ewes wintered in different locations, but merged at Allen Gulch to lamb and rear their offspring. They then continued their association throughout summer and fall 1978.

During June 1978, a total of seven ewes including the two marked ewes, and seven lambs were observed at Allen Gulch, and were thought to represent the gross primary production for the herd, as no other lambing areas were discovered. Again, in August seven ewes including Ewe B and Ewe D and seven lambs were observed at Rock Gut. By early fall, and also during the 1978-1979 rutting period, only five lambs could be accounted for, indicating late summer-fall lamb mortalities.

TABLE 23. POPULATION ESTIMATES FOR URAL-TWEED HERD, USING A COHORT COMPLETION-TOTAL COUNT METHOD

TIME PERIOD	♂♂ 1 yr.	2	3	4	5	6	7	8	♀♀ 1 yr.	Adult	LAMBS 1/2 yr.	POPULATION ESTIMATE Total
12/ 1/76 -2/28/77	2	1	[a]	1	1	1			2	[illegible]	[illegible]	2[illegible]
3/ 1/77 -5/15/77	2	1		1	1	1			[illegible]	[illegible]	[illegible]	[illegible]
12/ 1/77 -2/28/78	3		1		[b]	[c]	1		2	11	[illegible]	[illegible]
3/ 1/78 -5/15/78	2		1				1		2	10	4	2[illegible]
5/16/78 -8/31/78	2	2		1				1		9	[illegible]	[illegible]
9/ 1/78 -11/30/78	2	2		1				1		9	5	20
12/ 1/78 -1/31/79	2	2		1				1		7	5	1[illegible]

[a] Evidence of this ram being illegally killed early in December

[b] [illegible] 1/2 year old ram killed by mountain lion on 8 January 1978

[c] [illegible] 1/2 year old radio-collared ram killed by vehicle in mid-January

The 3 January 1979 observation of a single group of 18 sheep, consisting of two yearling rams, two 2-year old rams, one 4 1/2-year old ram, one 8 1/2-year old ram, seven adult ewes and five lambs, included all five marked sheep then present in the population, and would suggest that number to be the total population based on a simple Lincoln Index calculation. The possibility of a few sheep being detached from this main band is not, however, discounted. Nonetheless, a very small herd size of probably no more than 25 animals is the inescapable conclusion.

Sheep mortalities on the Ural-Tweed range were divided into two categories 1) natural and 2) man-caused. During the course of the project, eight bighorn sheep were known to have died on the study area. Three of these deaths were attributed to natural causes, while humans were responsible for direct removal of the other five sheep. Subsequent to the opening of State High 37, in November 1974, and prior to initiation of the sheep study, four additional sheep were known to have been removed from the herd through human causes. Other mortalities were, no doubt, occurring, but were not discovered during the study.

Human Caused Mortalities

Shortly after State Highway 37 officially opened, in November 1974, one adult ewe was struck by a vehicle and killed at Tenmile Creek (MP 34.0). The carcass was retrieved for necropsy information. During the same month, the remains of two illegally killed ewes were found on Stone Hill. On 2 March 1976, one adult ewe was killed by a vehicle while crossing Highway 37 at highway mile 50.6, Stone Hill. Coyotes had consumed nearly the entire carcass before it could be located.

On 24 October 1976, one yearling ram and one yearling ewe were illegally shot and left along Highway 37 at Sheep Creek. Both carcasses were recovered and examined. On 2 December 1976, evidence of an illegal sheep kill was found along Highway 37 at highway mile 38.3, near Rock Gut. A band of nine sheep, including two rams, was observed there the previous day. A local truck driver reported colliding with an adult ram on the highway between MP 38.0 and 39.0, near Peters Gulch, on 5 October 1977. Although the animal was badly injured and bleeding, the trucker could not capture it. Two days spent in the area attempting to find the ram were fruitless, and this animal presumably died of its injuries. Radio-collared Ram A was found deceased, just above the highway at MP 40.0 near Rocky Gorge on 16 January 1978. His left foreleg and shoulder region was badly fractured as a result of a vehicle collision. The carcass, although emaciated, had not been fed upon by scavengers and was otherwise intact (Figure 23).

Natural Mortalities

Only three carcasses discovered on the sheep range were attributed to natural causes. One old ewe (12 years plus) was found lying along the highway guardrail at MP 39.0 on 4 January 1978. The State Highway Department snow removal crew had observed this animal there the previous evening and reported that she was having considerable difficulty in her attempts at crossing over the guardrail. There was no evidence that she had been struck by a vehicle but her generally poor and emaciated condition suggested death through debilitation and subsequent starvation. The radioed ewe, F, was found dead up Sheep Creek in April. She was thought to have died a natural death over winter.

FIGURE 23

A-HIGHWAY FATALITY

B-LION KILL

The only evidence of a predator-killed sheep was the 5 1/2-year old bighorn ram taken by a large male mountain lion (*Felis concolor*) on 8 January 1978 at Rock Gut Bridge (Figure 23). The kill was made approximately 50 yards east of the Rock Gut Bridge on Highway 37. The predator covered the carcass between feeding sessions for the next three days, before it was killed by the client of a local outfitter.

CHAPTER V

DISCUSSION AND CONCLUSIONS

Capture and Marking Techniques

Capture and marking of free-ranging bighorn sheep was of critical consideration on this project. Contract stipulation required six bighorns from diverse portions of their range be instrumented with telemetry collars and to this end a total of seven sheep were eventually radio-collared. This aspect of the project was not only important to satisfying contract requirements, but was also imperative to overall success of the study. An extensive literature review was made to determine appropriate alternative methods for capturing bighorns. However, circumstances on the Ural-Tweed sheep range dictated eventual capture methods. Clover traps were successfully used to capture bighorn sheep in Colorado (Moser 1962) and Montana (Brown 1974), but proved to be an unproductive method in Idaho (Morgan 1970) and on this study. A variety of trapping techniques, ranging from foot snares (Aldous 1958), live neck-snares (Mossman et al. 1963), manually operated drop-nets (Erickson 1970) to portable corral traps (Tilton 1977) were explored for possible application on this project. Many of these options were discarded because either suitable areas for trap construction were not available or the techniques may have caused unnecessary injury to the animal. Immobilizing drugs were used as a last resort. Sernylan (phencyclidine hydrochloride) used effectively on Canadian bighorns (Stelfox 1976) proved unsatisfactory on this study. A change to Rompun (xylazine), a sedative and analgesic drug, during the 1978 field season provided consistently favorable results for capturing Ural-Tweed bighorns. Other investigators, (Stewart and Stoneberg pers. comm.) also found Rompun to be a suitable drug for use on bighorns in other areas of Montana. Although the number of animals drugged with Rompun was small, a dosage application of 300 mg. would appear to be suitable for adult sheep of both sexes.

In some respects, performance of telemetry equipment was disappointing. Although designed for two years operation, some of the radio transmitters failed after only several months of use. Were it not for the fact that study animals carrying inoperative collars were in continual association with other collared animals wearing functional transmitters, relocation of the former animals would have been on a random basis, at best.

Distribution and Movements

Various investigators, Blood (1963), Geist (1971), Erickson (1972), and Brown (1974) documented herd segmentation within populations of mountain sheep; herd units or subpopulations occupied discrete home ranges which were in close proximity, but interchange between segments did not occur or was minimal despite absence of major restrictive physical barriers. Geist (1971 80-81) explains this phenomenon as a function of the high degree of home range fidelity demonstrated by mountain sheep. He also suggested that distinct home-range groups are more typical of female sheep than for rams. Rams were more mobile and mingled with different ewe home-range groups, particularly during the rut.

During this investigation on the Ural-Tweed herd, these phenomena were found to be only partially true. Original speculation that the entire herd was contiguous, was confirmed. For instance, ewe-juvenile groups utilizing Stone Hill and McGuire Creek during winter mingled with each other and were the same animals observed using the Sheep Creek-Tenmile Creek vicinity during other seasons of the year. There were, therefore, no discrete ewe subunits in the population. Findings on this study showed herd segmentation to be a seasonal phenomenon and then only with respect to the sexes. While all ewes confined their range use to areas north of Tenmile Creek, rams tended to remain south of Tenmile Creek during most of the year. During the rut, however, the entire herd became a single unit.

Rutting Areas

The rutting ground above Ural was historically documented (Ensign 1937, Brink 1941). Reasons for bighorns changing rutting areas on the Ural-Tweed range between consecutive years of the present study are not clearly understood. However, speculation as to the reasons is forwarded in an attempt to provide some insight into the current situation. Ram distribution during the breeding season is obviously a function of ewe distribution. Ewe-juvenile groups, which normally spent the summer-fall period near Ural, appeared on the Stone Hill-Sutton Creek area earlier during the 1977 season than they did during 1976. A controlled burn for wildlife was conducted near the mouth of Sutton Creek by the U.S. Forest Service during spring 1977, and may have caused sheep to: 1) remain in that area summer and fall or 2) accelerate their return to the area after summering near Ural. As no ewes were radio-collared during that time period, neither of these assumptions could be verified. However, very little sheep sign was found near Ural during December 1977, and the one radioed ram by-passed this area on his way to Stone Hill where he and other rams rutted. Weather patterns were entirely different between the two rutting seasons. In 1976 there was literally no snow on the sheep range, whereas the 1977 season was characterized by early snow cover over the area. This may have caused ewes to move onto winter range earlier than the previous year. High-speed vehicle traffic on Highway 37 in conjunction with trapping and darting activities on the rutting area may have caused sheep to avoid this area during the succeeding rut. Desertion of suitable habitat through human disturbance has been documented by Geist (1971) for mountain sheep.

Winter Range

Ural-Tweed sheep remained comparatively mobile on the winter range, with rams having larger home ranges and standard diameters than ewes. Similar findings were reported by Morgan in Idaho (1970) and Brown (1974) in Montana. However, during a severe winter Erickson (1972) working with bighorns in the Sun River area of Montana found rams had moved less than ewes and both sexes showed small standard diameters compared to those found on this study. Winter standard diameters and home range size may only reflect weather conditions or may be related to factors intrinsic in different populations. More frequent travel and larger home ranges for wintering Ural-Tweed bighorns probably functions as a resource strategy which promotes dispersed use of small areas of primary sheep habitat separated by areas of marginal or non-sheep habitat.

Spring Range

In contrast to other bighorn sheep herds in Northwestern Montana, Ural-Tweed sheep demonstrated no distinct low elevation spring concentration areas.

Sheep in the Thompson Falls and Kootenai Falls herds characteristically capitalize on the spring "green-up" by moving down onto the river terraces during March and April. In contrast, Ural-Tweed sheep actually showed increased use of higher elevations immediately following the winter period. Old reports and interviews with longtime residents provided historical perspective on this aspect of Ural-Tweed sheep range use. Historical use of the Kootenai River flood plain by bighorns is well documented. Old residents formerly occupying homesteads along the Kootenai River between Fivemile Creek and Sutton Creek recall having mountain sheep in their fields prior to clearing of the reservoir impoundment area. Bighorn sheep remains were found along the old Great Northern Railroad track traversing the Kootenai River terrace between Rexford and Warland siding. With clearing of the Libby Reservoir impoundment and subsequent flooding of the area, the critical late winter-spring range at the base of the reservoir escarpment was inundated and irretrievably lost as spring habitat for mountain sheep as well as other ungulates.

The importance of spring range to the long-term well being of a sheep population is documented in the literature. Speaking of mountain sheep in Canadian Parks, Stelfox (1976;29) concluded that:

> "Valley-bottoms and low-elevation south-facing slopes are evidently important to sheep in late pregnancy, and they influence lamb production and survival because they are the first areas to green-up and provide the high protein forage necessary during late-pregnancy and early lactation."

If spring green-up is retarded or spring range has been lost, as is the situation on the Ural-Tweed range, ewes must sustain themselves on dormant winter forage which is lower in total nutrient content, especially protein, and less palatable than succulent new green forage. Geist (1971) suggests that early postnatal survival of lambs is a function of ewe nutrition during late gestation and the lactation period. Lack of a high protein diet during late pregnancy is generally reflected by low reproductive rates and subsequent increased lamb mortality (Hebert 1973). Ewes on the present study, after wintering on a maintenance diet, must forego optimum spring range conditions and enter late gestation in a nutritional deficit. This deficit is maintained through the lactation period and into summer months, and is apparently carried over to the fall period as evidenced by the less than thrifty appearance of these animals during autumn, at a time when body condition should be optimum. The ramifications of these conditions for animals going into winter are obvious.

Lambing

The lambing area at Allen Gulch was used intensively by ewes several weeks before and after parturition which peaked around 20 May 1978. The lambing period appears fairly synchronous for Northwestern Montana sheep herds. However, newborn lambs have been observed as early as late April (Matthews 1973) and early May (Brown 1974, Joslin 1978) on some of the ranges. In other Montana regions, lambing does not occur until late June (Stewart pers. comm.).

The Allen Gulch area was the only lambing ground located during this investigation. During spring 1941 Brink (1941) documented lambing areas at Ural and

Sheep Creek. Original concern that these areas would be abandoned as lambing grounds due to their proximity to Highway 37 appears to have been warranted. There was no evidence of lambing on these areas during this study. However, these sites were used by nursery bands during summer and fall, indicating that they have not been deserted during other seasons.

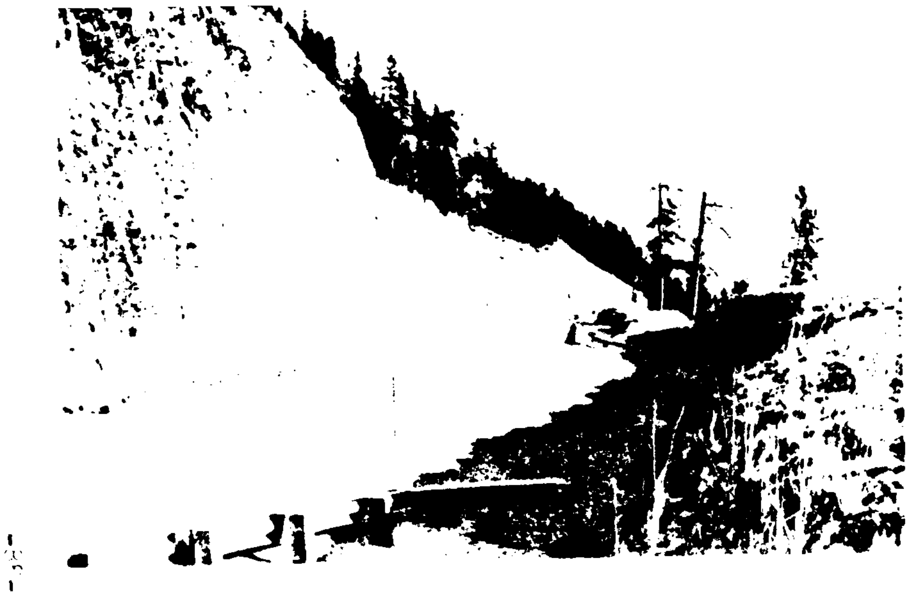
Summer Range

During summer months, ram and ewe bands remained separated on respective summer ranges. Similar findings were reported by Wolf et al. (1970) for Yellowstone Park sheep. Smith (1954), Sugden (1961), and Wolf et al. (1970) found both migratory and non-migratory sheep within their different study areas, and some sheep reportedly moved up to 40 miles between distinct winter and summer ranges (Smith 1954). These authors indicated that once on summer range, bighorns move very little. These observations were generally not true of Ural-Tweed sheep. True migrations were not noted for these sheep in that movements between seasonal key use areas usually involved only changes in elevation and/or lateral shifts along the reservoir face. Study animals on the Ural-Tweed range also moved frequently during summer. Similar findings were reported by Brown (1974) for sheep in the Thompson Falls region of Northwestern Montana.

Fall Range

Early fall distribution of Ural-Tweed sheep was indistinct from their summer distribution. Sheep were generally at their highest elevation zone during early autumn, but dropped to lower areas near the highway during late fall or the rutting period. Inclement weather on summer range was thought to be the influencing factor for sheep to move from summer to winter range in some studies, (Smith 1954, Blood 1963, Erickson 1972), but was not the case in the present investigation. Even during the 1976-77 winter, when there was literally no snow on the sheep range, bighorns still descended during the fall rut to utilize areas at lower elevations. A cooling trend in the weather along with fall moisture may have made lower slopes more habitable than they were during hot summer months. The descent and gradual drift onto wintering areas seems to be the characteristic pattern of movements for these sheep.

Sheep were in closer proximity to and made more frequent crossings of Highway 37 during fall rutting activities than during any other time period. Along certain sections of the highway, sheep had considerable difficulty in achieving a successful crossing of the roadway. Physical features of the highway require that sheep cross at very specific points, as areas between these sites are sheer vertical walls which were blasted out during highway construction (Figure 24). Bighorns are unable to negotiate these vertical cuts which range in height from 20 to over 100 feet. This situation causes problems as sheep moving from foraging areas below the highway must travel along the roadway for several hundred yards to reach access points to upslope security areas. The highway section immediately south of Sheep Creek, an area of heavy sheep use, exemplified these circumstances. Between highway mile 36.6 and 37.4 there is only one point, MP 37.0, at which sheep are capable of climbing the highway rock cut, and then it is done only with some difficulty. As a consequence, sheep normally traveled along the highway guard rail or on the pavement to cross the highway at either Mile 36.6 or 37.4. Outsloping of these bedrock cuts would greatly facilitate sheep access to foraging and security areas below and above the highway. The amount of time spent on the roadway by these animals would be lessened, thereby reducing the potential for a sheep-vehicle collision.



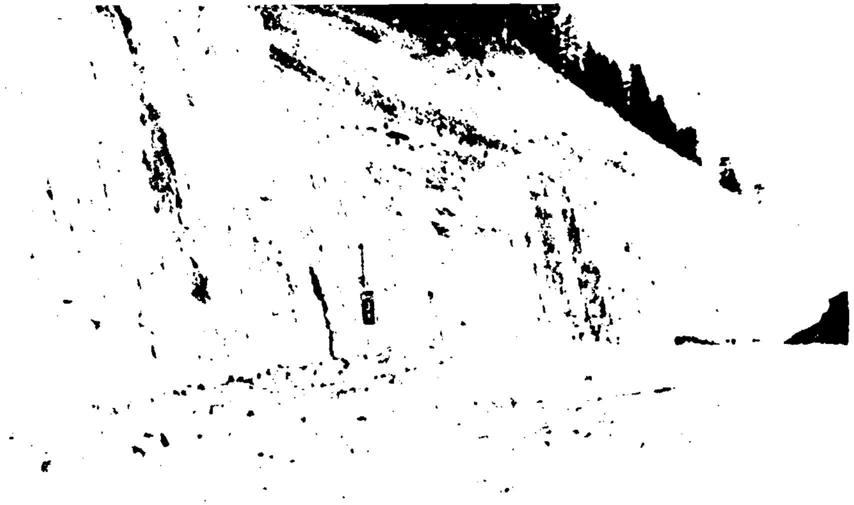


FIGURE 24

ROCK CUTS ALONG HIGHWAY 37, BARRIER TO SHEEP MOVEMENT

›itat Selection

Ural-Tweed bighorns were consistent in their use of steeper more broken ·tions of their range. There was little indication of sheep use above the reser- .r escarpment. Since there are no true grasslands available to sheep on the ıl-Tweed range, these bighorns have been relegated to the escarpments which ıcurs with the statement that "sheep remain almost exclusively on grasslands l rocky escarpments throughout the year" (Stelfox 1976).

Grassy openings, coniferous canopy coverage (circa 30%), large diameter ıss ponderosa pine and Douglas-fir (circa 20" dBH), and relatively low stem ısities (<50 trees/acre) characterized the cover types most frequently used bighorns. South, southwest, and west exposed broken and bluff terrain in :ess of 30° slope steepness received the greatest amount of sheep use. Rock .crops, cliffs and talus slides were important to bighorns as bedding and :urity areas. In addition to scree, the Douglas-fir/snowberry habitat type ı most frequently used during winter months and agrees with Tilton's (1977) ıdings for sheep in the Thompson Falls herd. The pinegrass phase was most ›quently used within the PSME/SYAL habitat type.

'd Health

With respect to endoparasit‹ ›oads, Ural-Tweed bighorn sheep were relatively ;htly burdened. Protostongylid larval discharge from bighorn populations in .erton, Banff, and Jasper Parks, Canada, averaged 594, 626, and 2,375 per gram :es, respectively (Stelfox 1976). Uhazy et al. (1973) concluded that heavy 'estation was reflected in larval counts over 1,400 per gram feces, while ınts averaging 157 larvae per gram feces were considered light. The highest ·val output for samples collected on the Ural-Tweed range was 262 larvae per ım feces, and annual average discharg‹ ›as 9.5 larvae per gram dry feces, in- :ating an extremely low lungworm infection intensity for these sheep. Forrester l Senger (1964) reported a 100 percent infection rate, and a mean larval dis- ırge of 970 larvae per gram feces for nine fecal samples collected from the Ural- ›ed herd in the early 1960's. This information suggests a much heavier lungworm ·den on these sheep previously, and probably reflects a higher sheep population ısity than at present. Stelfox (1976) found lungworm loads increased with sheep ›ulation densities on Canadian sheep ranges, and this was especialy true during ·ere winters. Demarchi and Demarchi (1967), reported massive die-offs of East ›tenai sheep herds during the mid-1960's and attributed the decline to the ıgworm-pneumonia complex. Judging from the widespread nature of the die-off l realizing the nearness of these sheep herds to the Ural-Tweed population, it reasonable to suspect that this herd too may have experienced a sudden and ›id decline. Presently, the Canadian herds have increased to near pre-crash ·els; however, all seasonal components of their ranges have remained intact, l the Canadian Fish and Wildlife Branch has been continually involved in range ›rovements through controlled burning. In contrast, since the mid-1960's, the ıl-Tweed herd has been subjected to range reduction via Libby Dam Project, and ıge degeneration through lack of fire. In conjunction, these factors have, no ıbt, precluded post-die-off increases in sheep numbers, if indeed, a population ısh occurred.

›d Habit

With the exception of February, May, July and August, grasses and grasslike ınts constituted greater than 50 percent of all forages consumed by sheep.

AD-A156 051 URAL-TWEED BIGHORN SHEEP INVESTIGATION(U) MONTANA DEPT OF FISH AND GAME HELENA G W BROWN 1979 DACW67-76-C-0083 2/2

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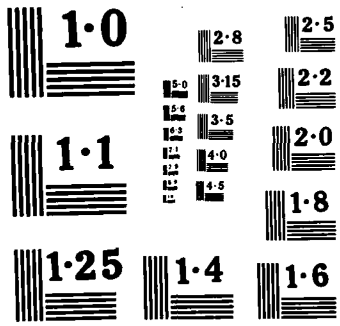

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Specifically, rough fescue was the most common single forage species consumed during every month of the year with the exception of February and May when Douglas-fir and serviceberry, respectively, assume temporarily greater densities in the diet. Bluebunch wheatgrass was consumed in lesser amounts than expected considering its prevalence on the sheep range and rough fescue occurred in the diet more often than expected from its availability. Similar findings were reported for mountain sheep in South-Central British Columbia (Wikeem and Pitt 1978). These authors formulated a diet preference index based on availability of the various forage species and found rough fescue was preferred over bluebunch wheatgrass, and in fact, showed a high preference value when compared to its availability on the range during the four month period, May-August. Forbs became increasingly important for Ural-Tweed sheep during spring and summer months when availability of this forage class was greatest. Shrubs assume dominance in the diet of sheep during mid-winter and again in late spring. Increased use of browse, Douglas-fir, serviceberry, oceanspray, bitterbrush, and snowberry occurred during February, at a time when snow depths were 12-15 inches and snow conditions were crusted and frozen during the latter part of the month. These conditions made bunch grasses very difficult for sheep to obtain. Renewed use of browse, particularly serviceberry, during May and June, corresponds with the blooming period for those shrubs, a time when terminal leaders and blooms have a high nutrient content. Percentage of forbs in the diet during spring and summer is consistent with the availability and nutrient status of this forage class and concurs with findings of Wikeem and Pitt (1978) who found a very high sheep selection for forbs during spring and summer months.

Population Dynamics

Historically, the Ural-Tweed sheep range was more extensive than it is today, and appears to have supported a high population level approaching 200 bighorn sheep in the early 1960's (Quick 1965). The population level at that time may have exceeded range carrying capacity and a population crash concurrent with nearby Canadian sheep herd declines (Demarchi and Demarchi 1967) is suspected to have occurred, but could not be verified. Presently, the Ural-Tweed population of bighorn sheep consists of no more than 25 animals, and appears to be still declining.

Interpretation of primary age ratios (lamb:ewe ratios) to determine population status and trend may be misleading if not considered in conjunction with other population parameters (Caughley 1974). Dynamics of the Ural-Tweed sheep population exemplify these pitfalls. The reproductive rate for Ural-Tweed sheep during this project was as high or higher than that reported by either Ensign (1937) or Brink (1941) for this same population; however, both authors were dealing with a stable or increasing population of approximately 100 animals, while the present population consists of fewer than 25 sheep and is declining. Lamb production was high, but so was lamb mortality during summer and winter. Consequently, juvenile recruitment into the population was low. Similar findings were reported for Jasper Park sheep by Stelfox (1976) and was thought to be an expression of the Inversity Principle (Errington 1956), whereby the population attempts to compensate low overall juvenile recruitment through high lamb production. Rates of natural attrition for older age classes, juvenile mortality and emigration, plus unnatural losses are greater than the rate of juvenile incorporation into the herd with consequent inadequate recruitment to maintain the current population level.

Recommendations

The Ural-Tweed sheep range was identified as a priority big game management unit in the U.S. Forest Service Final Environmental Statement for the Inch Mountain Planning Unit. Management guidance recommends maintenance or enhancement of winter range to favor bighorn sheep. The present investigation has identified key areas of seasonal importance to Ural-Tweed sheep and has quantified parameters of sheep habitat requirements which should be beneficial in project level planning designed to improve residual sheep range. The following general recommendations are forwarded in the hope that they may be applied to the management of the Ural-Tweed sheep herd and its habitat.

1. Identified key use areas should receive first priority for habitat improvement projects, while potential or marginal sheep habitat should receive secondary consideration.

2. Large-scale or long-term projects should be timed to correspond with seasons of non-use or light use by bighorn sheep on specific key sites. For example, helicopter logging operations should not be conducted on the Allen Gulch lambing and nursery area during the period 15 April -30 June.

3. Habitat improvement on key use areas should be coordinated and designed in concert with specific sheep habitat requirements for the season during which the site receives greatest sheep use.

4. Close coordination between the U.S. Forest Service and the Montana Department of Fish and Game should be maintained in the conceptual layout of habitat manipulation projects as field review of specific project sites.

5. Management guidance for areas below Highway 37 as outlined in the Land Use Plan, should be reevaluated considering the importance of this area to big game ungulates, especially bighorn sheep. The potential for improvement of spring range exists in this area and should not be overlooked.

6. Vegetative manipulation should favor increased production and improved quality of bunch grasses, specifically rough fescue, Idaho fescue, and bluebunch wheatgrass. The importance of browse during mid-winter and late spring and of forbs during spring and summer should be recognized and treated accordingly.

7. Considering the historic importance of natural fire on the Ural-Tweed sheep range, a long-range fire management plan should be developed and used on the area to retard conifer invasion and generally rejuvenate degenerating range conditions.

8. Sections of Highway 37 identified as problem areas for sheep crossing should be considered for alterations to facilitate sheep access to lower slope foraging areas and upslope security areas.

9. The future of native sheep on the Ural-Tweed range is in doubt. The current population may have declined to a level below which further decline may preclude response to habitat improvement. The U.S. Forest Service and the Department of Fish and Game are formulating a contingency transplant agreement in the event that indigeneous bighorns disappear from the range. The remnant band of sheep on the range should be closely monitored to determine if and when a supplemental introduction would be recommended.

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