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Mountain goat ecology : logging relationships in the Bunker Creek drainage of western Montana

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MOUNTAIN GOAT ECOLOGY - LOGGING RELATIONSHIPS IN THE BUNKER CREEK DRAINAGE OF WESTERN MONTANA

by

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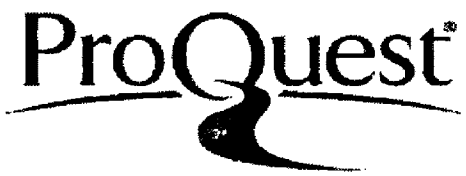

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CHAPTER I

INTRODUCTION

The Bunker Creek study area is in the Swan Mountains of Western Montana. The Swans extend from Glacier National Park southward to the Bob Marshall Wilderness, of which they form the western boundary. Bunker Creek has two major forks, the North Fork of Bunker Creek, often referred to in the thesis as simply the North Fork, and Middle Fork Creek. They begin in subalpine cirques near the crest of the Swan Mountains, join after 5 miles, then run eastward 6 miles to join the South Fork of the Flathead River. Gorge Creek, running northward from Sunburst Lake at the base of Swan Peak in the Bob Marshall Wilderness, is the other major tributary of Bunker Creek.

Extensive road-building and logging on the west slope of the Swans and the lower South Fork of the Flathead River was conducted in recent years. Over the same period, there was an apparent decline of Rocky Mountain Goat (Oreamnos americanus) populations in these areas. Richard Weckwerth, Region 1 Game Manager of the Montana Fish and Game Department, initiated this study of the ecology of the Bunker Creek mountain goat herd and its response to road-building and logging operations beginning in the de facto wilderness drainage.

Field work began in March of 1971 and terminated in October of 1972. During that time, my wife and I remained in nearly continuous contact with a herd of from 20 to 30 goats which used the North Fork

of Bunker Creek and Little Creek, a tributary of the adjacent Addition Creek drainage. Outposts were constructed across from goat cliffs to permit continuous observations in both areas. Periodic censuses were conducted in nearby drainages. Major research objectives were to describe the daily life of a mountain goat herd throughout the year and gather information neccessary to help assess immediate and long-term effects of resource extraction disturbances on goat populations. Research on mountain goats in the Swan Mountains has been continued and expanded since October of 1972, and pertinent observations from recent research have been included.

A description of terms used in following chapters is neccessary. First, the terms "mountain goat" and "goat" are freely interchanged. Rocky Mountain Goats are a rupicaprid bovid, and not closely related, except in some superficial aspects, to other goats. Where domestic goats (Capra hircus) are referred to, this is always qualified by inclusion of the word "domestic". A herd refers to a particular population of mountain goats sharing specific seasonal ranges which are separate from those of other concentrations of goats under most circumstances. The terms "group" and "band" both refer to small, family-size associations of goats within a herd, and are used reciprocally. Goats typically became sexually mature at 2 years of age, but did not reach full size until at least 4 years. Goats were therefore separated into age classes of kids (K) and yearlings (Y), both of which were separated into sex classes whenever possible,

2-year-olds (2♂ or 2♀), 3-year-olds (3♂ or 3♀), and adults (Ad♂ or Ad♀). Adult females are further separated in some tables into nannies with kids (NwK) and adult females without young (Ad♀). Though most authors use the term "nanny" to refer to all female mountain goats, I have restricted its use to indicate only adult females with kids. I assumed that the presence of kids demands important behavioral changes in females. Therefore, 3-year-old females with kids were classed as NwK with older nannies, and 3-year-old females without kids were considered separately as 3♀'s in most tables. No 2-year-old females were observed with kids of their own. Also, 3-year-old females without kids and 3-year-old males became difficult to distinguish with certainty from adults after replacing their coat by fall. The 3-year-old classes are therefore somewhat under-represented in some considerations. The terms "male" and "billy" are used interchangeably.

Most mountain goat range in the Swan Mountains occurs within subalpine habitat, from 5,000 to 9,000 feet elevation. Cliff exposures of argillaceous rock outcroppings with local Douglas fir (Pseudotsuga menziesii)communities are prominent on south- and west-facing slopes amidst spruce-fir (Picea engelmanni-Abies lasiocarpa) climax forest. This is an area of deep snows which remain on north-facing slopes through June. Open terrain occurs on ridgetops and avalanche tracks throughout the region.

CHAPTER II

ECOLOGY - THE AREA AND ITS USE

Habitat Types

The discontinuous nature of goat range made habitat typing difficult. Continual snowslides, rockfalls, and soil slippage made plant communities transitory on many portions of steep hillsides. In the Little Creek drainage, two methods were used to determine plant composition.-Daubenmire (1959) microplots (20 x 50 cm.) were used where height of vegetation permitted. In avalanche tracks and ravines with taller foliage, "hits" of plant species along 50-foot line transects were employed to estimate their relative frequency.

In range regularly used by mountain goats on the North Fork of Bunker and Little Creeks, five habitat types were recognized, with the following relative abundance: cliff type, 30%; dry meadow type, 15%; ravine-wet meadow type, 15%; timber type, 30%; and winter range ridgetop type, 3 to 10%, depending on snow depths. In Little Creek ledge and dry meadow types, a series of four stands, 25 microplots in each, was recorded. Ridgetop winter range was sampled in four stands of 25 microplots. Seven line transects were established in typical ravine-wet meadow habitats. Vegetation in timbered areas, most of which experienced very little use by mountain goats, was simply observed and described.

Ledge types on cliff outcroppings support an average vegetational

cover of 58%. Ledges are relatively level (25% average slope) amidst vertical rock faces, and generally dry soon after spring melt. Cliff outcroppings in the Little Creek drainage are composed of Belt rocks, largely slates and phyllites, in various stages of consolidation from massive to highly cleaved. Ledge soils are shallow, and slippage is a dominant feature of the gravelly surface layer. Abundant mosses and Selaginella sp., together comprising 36% of ledge cover, help stabilize the surface layer. Runoff is rapid on ledges, but water is held longer than in dry meadows and ridge-top winter range, and vegetational cover is greater. Grasses are the major feature of ledges, comprising 12% of total cover, with forbs making up 8%. Shrubs, usually associated with cracks and crevices in rocks which permit deep moisture concentration, are an insignificant coverage class. Blue-bunch wheatgrass (Agropyron spicatum) is the major flowering plant species. Bluegrasses (Poa spp.), the most often selected forage species, are also common on ledges. Major forbs present are Alberta penstemon (Penstemon albertinus) , yellow eriogonum (Eriogonum flavum), and gland cinquefoil (Potentilla glandulosa).

Dry meadow types are those sparsely-vegetated, dry, open hillsides unable to support stands of timber. Soils there dry deeply by mid-summer. Slopes of dry meadows average about 35%. Plant coverage averages 43%. Grasses and sedges, with an average cover of 13%, are the main vegetative feature. Ephemeral forbs compose 11% of cover, and shrubs 4%. Club mosses make up the remainder. As on ledges,

blue-bunch wheatgrass is the dominant species. Elk sedge (Carex geyeri), Idaho fescue (Festuca idahoensis), fern-leaved parsley (Lomatium dissectum), and yellow eriogonum all have coverage values of 3%. Shiny leaf spirea (Spirea betulifolia) is the only woody shrub found in significant quantities.

Winter range type, though not obviously distinct from cliff and dry meadow areas, was sampled beacuase of its importance to goats. The west-facing Little Creek ridgetop at 7,200 feet is swept by strong winds which keep the area free from snow in winter and partially account for its extreme dryness and alpine aspect. Very little soil covers the crumbling phyllite bedrock. This unstable surface layer slips perpetually downward and is easily displaced by walking atop it. Vegetation is sparse, only 19% of total cover. Forbs account for 8% and grasses for 7%. Blue-bunch wheatgrass and purple reedgrass (Calamagrostis purpurascens) are major grass species, and gland cinquefoil the most significant forb. Several species such as slender crazyweed (Oxytropis campestris), wooly groundsel (Senecio canus), silky phacelia (Phacelia sericea), and starry chickweed (Cerastium arvense) are confined exclusively to winter range.

Ravine-wet meadow types are primarily drainage channels which carry snowfield runoff at least part of the summer. Some have permanent water sources. Avalanches occur regularly in nearly all ravine areas, creating open, fan-shaped meadows near cliff bases. Due to differences in persistence of water sources, and avalanche

disturbance, ravine vegetation is somewhat variable. In ravines between cliffs where slopes exceed 40%, beargrass (Xerophyllum tenax), elk sedge, big huckleberry (Vaccinium membranaceum), and fireweed (Epilobium angustifolium) are abundant. Where slopes are less steep and drainage poorer, forb meadows form with aster (Aster spp.), fireweed, and thimbleberry (Rubus parviflorus) prevalent. Where permanent streams are present, almost impenetrable stands of wavy-leaved alder (Alnus sinuata) occur with an understory of wartberry fairy bells (Disporum trachycarpum), western meadow-rue (Thalictrum occidentale), and cow parsnip (Heracleum lanatum) near cliff bases. Less dense stands of Rocky Mountain maple (Acer glabrum), chokecherry (Prunus spp.), and common snowberry (Symphoricarpos albus) occur at the periphery of alder stands and in less moist ravine-wet meadow areas.

Timber types are variable. Cool, moist, north-facing slopes and the eastern, leeward side of the Little Creek ridge are characterized by subalpine fir-menziesia (Menziesia ferruginea) unions. This association is also found in damp, protected spots on south- and west-facing exposures with persistent snowfields, and forms ecotones on the northern aspect of ravines. Subalpine fir is joined by Engelmann spruce and grand fir (Abies grandis) toward creek bottoms where predominant understory species are western yew (Taxus brevifolia), Devil's club (Oplopanax horridum), and lady fern (Athyrium filix-femina) occurring under dense overstories where drainage is poor. Subalpine fir may extend to ridgetops on south- and west-facing

slopes where protected, but eventually grades into stands of whitebark pine (Pinus albicaulis) which dominate the very top of ridges except for winter range outcroppings. Typical ridgetop understory consists of beargrass, whortleberry (Vaccinium scoparium), sedge (Carex spp.), and Parry's rush (Juncus parryi).

In the North Fork of Bunker Creek drainage, four 50-foot line transects were used in each of several homogeneous habitats basically similar to those described for Little Creek, recording "hits" to determine species distribution. Differences between the two drainages are mainly due to the fact that cliff areas on the North Fork of Bunker Creek and Middle Fork Creek are basically south-facing instead of west-facing as on Little Creek. The Bunker Creek forks are more or less parallel to prevailing winds, and so the west side of ridgetop outcroppings are blown free of snow, but lower cliff areas become buried during a normal winter. There is less drying due to wind along Bunker Creek and more moisture from snowpack during spring and early summer. Bunker Creek outcrops are composed of more consolidated shale and are consequently somewhat more stable than those in Little Creek.

Ledge types in the Bunker Creek drainage support a plant cover of 40% excluding moss and selaginella, nearly double that of Little Creek. Ledges, moist until July from seepage and runoff, bear a wide variety of ephemeral forbs which provide the bulk of mountain goats' late spring and early summer diet. As at Little Creek, mosses and selaginella provide a stabilizing influence on soils. Stands of

grasses there are dominated by poas (Sandbergii complex). Blue-bunch wheatgrass is the dominant single species on ledge types, followed by michaux mugwort (Artemisia michauxiana), California brome-grass (Bromus carinatus), and gland cinquefoil. Where drainage is restricted, wet ledges support a wide variety of more mesic species such as shrubby cinquefoil (Potentilla fruticosa), smooth aster (Aster laevis), cut-leaved daisy (Erigeron compositus), and snowberry.

Ravine types in the Bunker Creek drainage are variable as on Little Creek. Where moisture and soil permit, shrubby stands dominated by mountain maple occur, although the snowpack bends these species to the ground nearly 5 months of the year. The understory is predominantly beargrass and a mixture of other forbs. Around 6,000 feet, shrubs disappear and beargrass-forb meadows occur at the head of ravines, grading into dry meadow types on open hillsides much like those near Little Creek. At cliff bases, avalanche fans support yellow fawn lily (Erythronium grandiflorum), sedges, meadow-rue, and asters, and these grade into brushy areas in less frequently disturbed peripheral areas.

Timber types occupy primarily north-facing slopes, creek bottoms, and ridgetops. Steep, north-facing aspects are dominated by subalpine fir with Engelmann spruce an abundant seral species. Understory is variable but reflects increased moisture and snowpack persistence with abundant alder, clasping-leaved twisted stalk (Streptopus amplexifolius), and Devil's club near valley bottoms, and menziesia understory on higher slopes. On south-facing slopes, belts of

Douglas fir are interspersed with cliff outcroppings. In open Douglas fir stands, mountain ash (Sorbus scopulina), thimbleberry, and snowberry are found with patches of serviceberry (Amelanchier alnifolia). Where Douglas fir stands are more dense, and light is a limiting factor, mountain arnica (Arnica latifolia)and beargrass are more common. At higher elevations, subalpine fir with beargrass and whortleberry understory becomes prominent before grading into whitebark pine on ridgetops. Winter range types resembling those on Little Creek occur around windblown ridgetop outcroppings.

Though the overall importance of non-vascular plants in the mountain goat's diet was not determined, I constructed a fine mesh grid to estimate moss and lichen cover on vertical rock faces which supported other plant species only in larger crevices. Only foliose lichens and those crustose forms with sufficient height to permit some foraging by scraping were considered along with mosses in total cover. I found that potentially accessible non-vascular plant cover on rock faces on the North Fork of Bunker Creek averaged close to 50% in 25 grid samples recorded in June. Though food total volume is small, vertical rock faces might be considered a distinct type supporting a potential food resource which goats are known to utilize to some extent.

A permanent collection of 223 species of grasses and sedges, forbs, and shrubs was made from the Bunker-Little Creek goat range and is now in the University of Montana herbarium. A complete list of these species and trees in the study area is given in Appendix I.

Food Habits

Of several methods considered, on-sight analysis of goat feeding areas seemed the most feasible and representative approach to a complete description of seasonal food preferences and habitat usage. I observed goats feeding throughout the day, noting time spent in each habitat and numbers of animals feeding. Whenever possible, one of us climbed to known feeding sites and recorded relative plot size, habitat type, number of bites taken of each species used, and manner of utilization (eating stems, leaves, buds, bark, roots, or seeds). Removal of a stem, blade, branch, or stalk was considered a single bite. No standard plot size was emphasized. An area considered to be an adequate sample of a feeding period was examined. A representative sample might be a 25-foot square plot in winter and a 200-foot long trail in summer. Since elk (Cervus canadensis), mule deer (Odocoileus hemionus), black bear (Ursus americanus), grizzly bear (Ursus arctos), and numerous Columbian ground squirrels (Spermophilus columbianus) used portions of goat range, feeding sites were examined only where goats had recently left and clipped vegetation ends were still fresh, or where goat tracks could be followed; 203 general feeding sites were sampled in this way. A total of some 152,000 bites was accumulated, and goats were recorded feeding on 163 species. No attempt was made to adjust numbers of bites on a volume intake basis. Percentage use, then, reflects only the number of plant parts taken from each species, whether grass blade or shrub leader. Food habits data are

given in Appendix II.

In autumn of 1971, leader lengths were measured on 75 individual plants of preferred browse species in Little and Bunker Creeks. The following spring, these tagged bushes were re-measured to record over-winter use, which proved insignificant since deep snows buried all but a few shrubby areas during winter.

Goats wintered on windblown ridgetops of the North Fork of Bunker Creek and Little Creek at elevations of about 7,200 feet. On Little Creek, goats regularly came down to partially windblown ledges on lower cliffs where it was possible to track them and determine winter food habits. In April, when weather permitted, the Little Creek winter range was visited and an attempt was made to describe winter food habits there by examining 15 randomly spaced 5-foot square plots. It was determined for each plot which species were present and the height to which each had been grazed. Since nearly every available species was used, and each was eaten to within 1 inch of the ground during winter of 1971-72, biomass production, as determined by clipping at ground level in fall before goats moved to winter range again, was considered to be nearly equivalent to forage consumption. Clipping was done in fall of 1972 within the confines of a 9.6 square foot area enclosed by a hoop which was thrown at random within the range. Samples from 10 clipped plots were then air-dried and weighed.

Percentages of forage classes taken by mountain goats during the winter period from December through March are shown in Table 1.

Table 1.

Percentage Use of Forage Classes by Mountain Goats During Winter

Lichens, Mosses, & Ferns	Grasses & Sedges	Forbs	Deciduous Browse	Conifer
13.8%	60.9%	5.0%	11.5%	8.8%

Monthly forage class percentages are presented in Figure 1.

Most investigators have shown grasses and sedges to be the most important winter staples of mountain goats (Anderson 1940, Casebeer 1948, Klein 1953, Saunders 1955, Hibbs 1967). Hjeljord (1971) found that goats on Kodiak and Kenai islands fed primarily on rhizomes and petioles of lady fern during winter months, foraging on lower mountain slopes with limited snow cover. When heavy snows limited access to this forage, goats retreated to high, windblown ridgetops where bunchgrasses and sedges were principal forage plants. Grasses and sedges constituted the bulk of the Bunker-Little Creek herd's winter diet. Sedges, bluegrasses, and purple reedgrass were most often selected. Few forbs were available, and most shrubs in the area were covered by deep snows. Exposed serviceberry and chokecherry received moderate to heavy use. The bark of Rocky Mountain maple was often eaten, but rarely were any leaders taken from this species in winter. Records of goats spending long periods removing mountain maple bark probably exaggerated actual percentage-importance of browse in the winter diet as presented in Table 1. Goats also nibbled bark from elderberry (Sambucus racemosa) shrubs on several occasions in winter, and

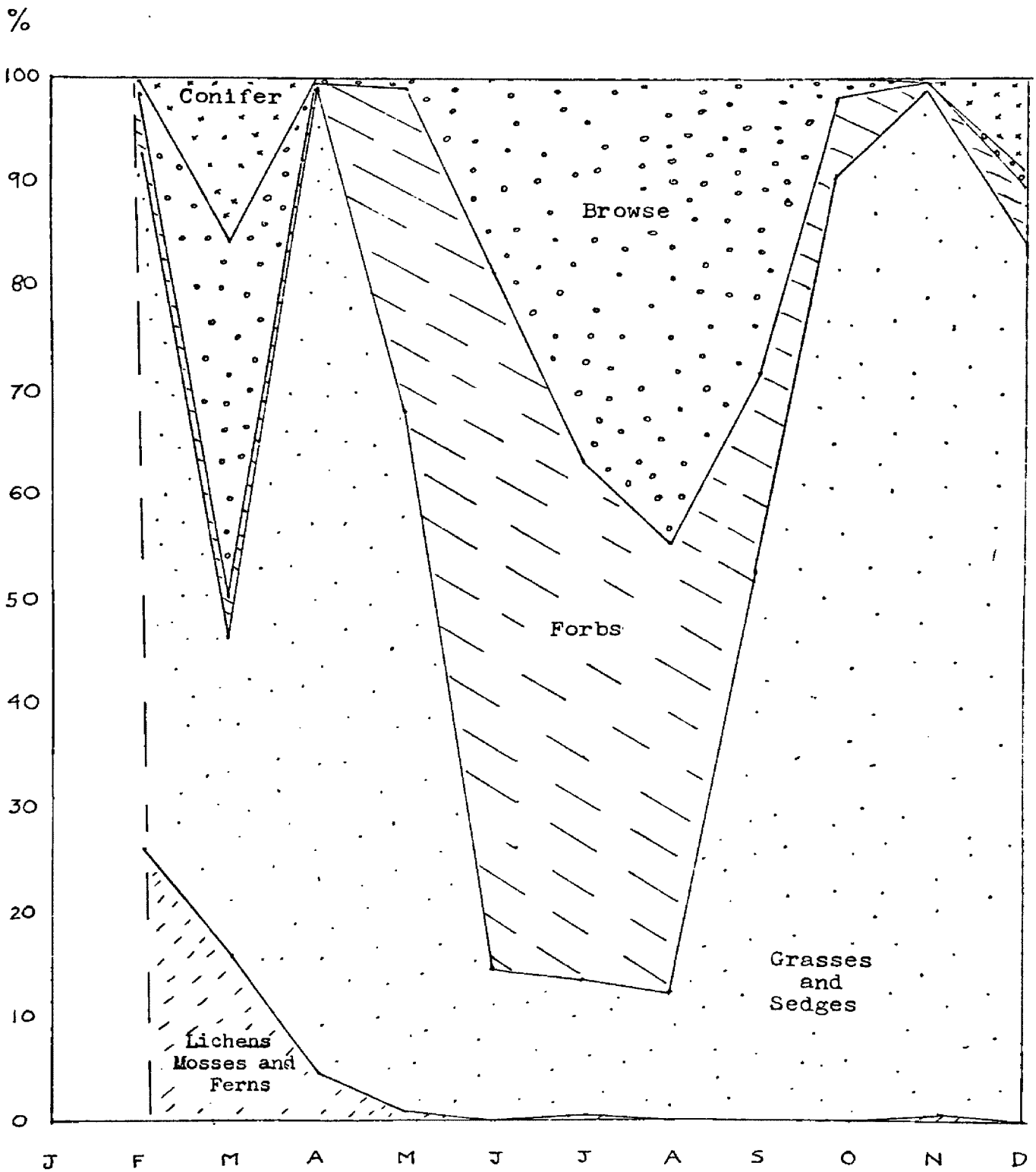


Fig. 1 Monthly Forage Class Percentages

in spring when other forage was abundant. Where shrubs were readily available, moderate to heavy winter use was recorded by other investigators. Casebeer (1948) and Brandborg (1955) found shrubs only slightly less important than grasses and sedges in winter diets. Brandborg noted severe hedging in 50% of mountain mahogany plants on winter range near the Salmon River. Kuck (1970) found that 90% of winter range use in the Lemhi Mountains of Idaho involved mountain mahogany, and 64% of this species showed severe hedging, though mule deer were abundant on the range. Peck (1972) reported that mountain goats in one winter range area in the Spanish Peaks of Montana removed 75% of leader growth from curl-leaf mahogany (Cercocarpus ledifolius).

Saunders (1955) and Brandborg (1955) observed increased use of conifers by goats in winter. Geist (1971) found between 20 and 30% of winter feeding points to involve conifer use and showed that goats fed primarily on conifers during early portions of feeding periods, suggesting that they sought primarily to fill their rumens before becoming more selective. Frequent observations of goats feeding on Douglas fir indicated that it was more extensively used than shown by on-site feeding data. Subalpine fir and western yew were also used during winter. Common juniper (Juniperus communis) and Rocky Mountain juniper (J. scopulorum) made up close to 5% of winter forage.

Selaginella and mosses were eaten and identified in many pellets. Actual percentage use was confused by the possibility that some of these non-flowering forage species were ingested

accidentally as goats selected other plants, foraging close to ground level. Bits of rock were seen in many winter pellets. Both mosses and selaginella were removed, or a part of them scraped off as though eaten, by pawing, and simply from climbing activities. Goats were observed licking and nibbling rock faces, and follow-up observations revealed lichen had been removed. Tree-lichen was occasionally taken. Hanson (1950) found tree-lichen to represent a major portion of the winter diet of goats in the Black Hills of South Dakota. Brandborg (1955) noted that mountain goats on Salmon River winter range spent 24% of timed feeding observations taking foliose lichen.

Results of forage production measurements on primary winter range taken in fall of 1972 are presented in Table 2. Production of grasses is considered an estimate of consumption since all grass species on the winter range were eaten down to within 1 inch of the ground in the winter of 1971-72. Most forb species were also eaten above basal portions. It appeared that, as on cliff ledges, goats often pawed and ingested selaginella accidentally while seeking other species. Goats did paw to remove dry outer parts and feed on inner portions of selaginella which remained green throughout winter, but this was not considered a major food source. Primary winter range in the Little Creek drainage was estimated at 8.7 acres from maps and photographs. This refers to portions of the ridgetop blown free of snow throughout most of the winter. It does not include peripheral areas where snows were partially removed by

Table 2. Primary Winter Range Forage Production

SPECIES	[Av.Wt.(gm.) in 9.6 sq. ft. plot] x 10 =	[Lbs./ Acre] x 8.7 =	[Lbs. on Winter Range] ÷ 17 =	[Lbs. Avail-able/ goat]
Achillea millefolium	.46	4.60	40.02	2.35
Agropyron spicatum	6.55	65.50	569.85	33.52
Arenaria capillaris	.17	1.70	14.79	.88
Calamagrostis purpurescens	3.43	34.30	298.41	17.51
Erigeron compositus	1.50	15.00	130.50	7.68
Eriogonum flavum	.63	6.30	54.81	3.22
Eriogonum ovalifolium	2.21	22.10	192.27	11.31
Festuca idahoensis	2.11	21.10	183.57	10.80
Geum triflorum	5.28	52.80	459.36	27.02
Heuchera cylindrica	1.48	14.80	128.76	7.57
Lupinus sp.	.87	8.70	75.69	5.25
Penstemon albertinus	3.29	32.90	286.23	16.84
Phacelia sericea	.34	3.40	29.58	1.74
Poa sp.	.71	7.10	61.77	3.63
Polemonium pulcherrimum	.07	.70	6.09	.36
Potentilla glandulosa	4.43	44.30	385.41	22.67
Selaginella sp.	4.18	41.80	363.66	21.39
TOTALS	37.71	377.10	3280.77	193.78

winds, or lower cliff ledges. The 8.7 acre figure is also somewhat arbitrary since it is not corrected for vertical components: slope of the range and vertical rock faces. Of 443 goat-hours (no. goats x no. hours observed) recorded during winter (December through March), 48% involved use of ridgetop winter range, and between 80 and 90% of this observed winter range use was in optimal, or primary, winter range; that is, within approximately 8.7 acres. Actual percentage use was probably less as goats were more easily located and observed on bare winter range than elsewhere, and despite variation in feeding locations, goats nearly always bedded on winter range outcroppings when present in the area.

The condition of winter range habitat in the Little Creek drainage is difficult to evaluate. The winter of 1971-72 was more severe than usual, and snowpack depth exceeded that of several previous years. Erosion is a prominent feature with vegetative cover on winter range less than 19%. Goats affect the range not only by concentrated grazing, but by continually walking on the loose shale soil. The effect of mountain goats on this range is hard to distinguish from that of steep slopes, crumbling phyllitic bedrock, and high winds which remove moisture and small soil particles. Goats were not confined to this range. They appeared able to leave and secure food from lower cliff ledges at any time. Ledge types accounted for just over 50% of winter habitat use in 1971-72. During the mild winter of 1972-73, the amount of exposed winter range in the Little Creek area was more than double that of 1971-72. Grasses on the ridgetop range were grazed to within an average of 2.5 to 3.0 inches of the

ground during the winter of 1972-73. Forage was more accessible on lower cliff ledges that winter, and it appeared from limited observations that approximately half of the herd wintered along the North Fork of Bunker Creek, or at least spent some portion of the winter there.

It may be that primary ridgetop winter range on Little Creek was simply the "living room" of the goats' winter residence in 1971-72. Travel and foraging there required a minimal expenditure of time and energy. Partially windblown ledges on lower cliffs which supported more robust vegetation showed moderate to heavy use in places, and most cliff ledges showed light to moderate use of available forage.

As goats proceeded along ledges, they typically pawed through snow on the ledge on which they stood, or pawed snow down from the outer edge of the ledge above them where vegetation was better exposed. Geist (1971) commented on the goat's flexibility in pawing by comparison with bighorn sheep (Ovis canadensis) and other ungulates. Goats paw at a variety of angles from directly toward them to sideways, often while standing on hind legs to reach the ledge above. Mountain goats also push, pull, and shove snow to the side with their snout. They usually pawed where some vegetation protruded through the snow cover. Some animals appeared to sniff snow before pawing it aside, possibly testing forage presence or palatability. After deep snows on ledges, or when feeding on snowbound hillsides with no protruding vegetation, goats appeared to paw randomly,

feeding in one of every two or three craters pawed.

Studies of mountain goat food habits usually reveal an ability to exploit a wide variety of forage, from lichen to conifer. I observed several goats pawing to expose and consume roots of round-leaf alumroot (Heuchera cylindrica) and to expose inner portions of mosses and selaginella during winter. Such flexibility is probably an adaptation for survival in a winter environment where severe storms could make even the best of ranges virtually inaccessible for days or possibly weeks at a time.

Except for winter range and cliff ledges, other habitat types remained largely snowbound until May or June. Habitat percentage use data, taken from 4,389 goat-hours of feeding observations, is presented on a monthly basis in Figure 2. Goats used ledge types almost exclusively in early spring, eating grasses and sedges which were the most abundant new forage. In April, grasses and sedges accounted for 97% of bites recorded. Thereafter, goats selected increasing numbers of forbs as they appeared. In April, only three species of forb were eaten, but in May, the number of forb species selected increased to 25, and percentage use approached that of grasses and sedges. New grasses and forb shoots were snipped off within 1 or 2 inches of the ground.

By June, forbs had replaced grasses as the major food class. Continuing a trend begun in late May, goats exploited all habitat types where flowering forbs were abundant. Travelling at an average rate of 8 to 15 feet per minute, goats passed along hillsides

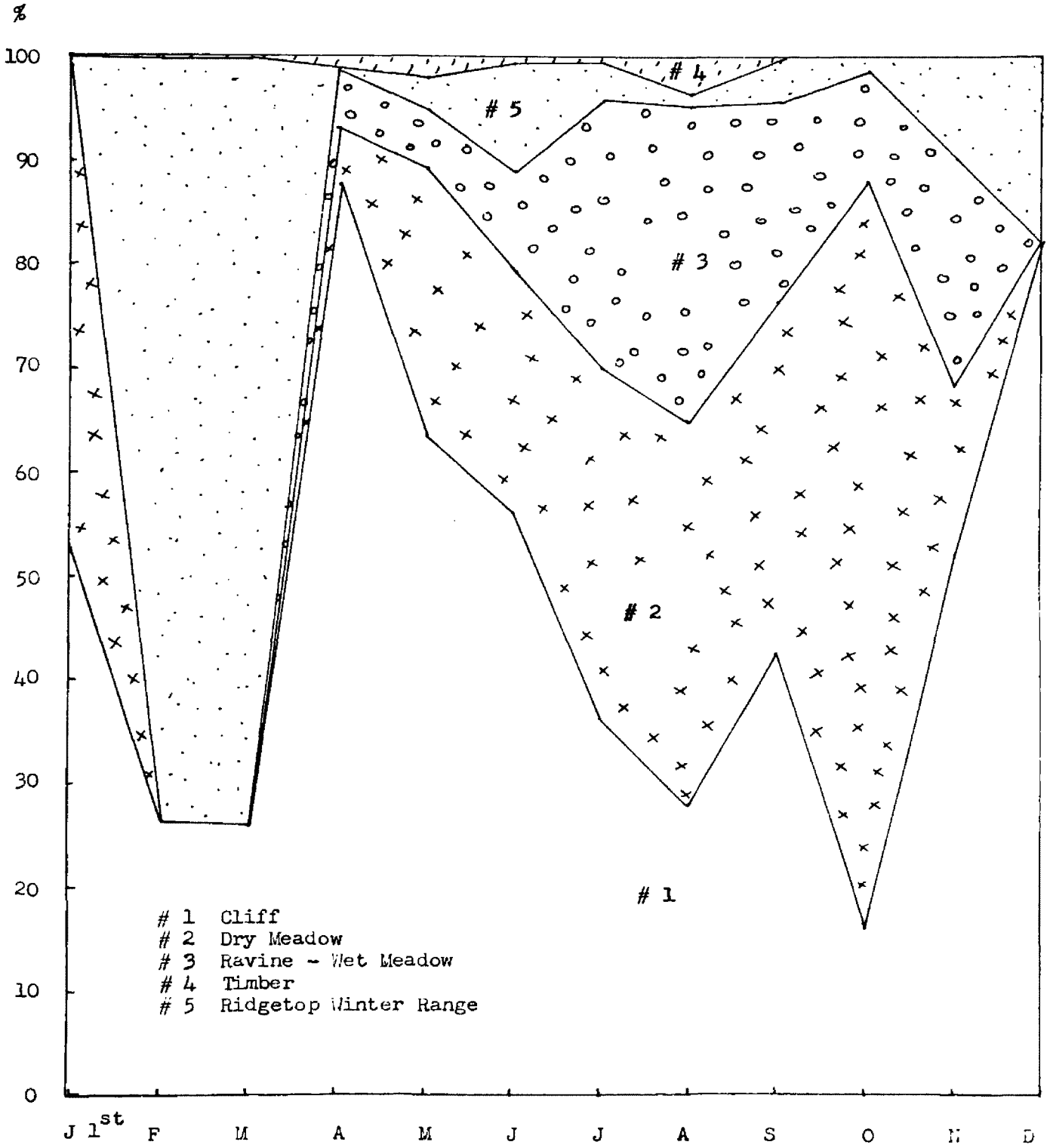


Fig. 2 Monthly Habitat Percent Use

crowded with early summer flowers, snipping off inflorescences from patches of newly-blossomed species. When feeding on grasses, goats tended to mow their way through them, snipping at a fairly constant rate of about 3 snips per second and occasionally as rapidly as 5 snips per second. The usual feeding pattern was one of 6 to 10 rapid snips, followed by a jerking of the head to break off vegetation gathered into the mouth. When feeding on forbs in summer, however, goats often selected one recently-blossomed species out of an array of flowers, snipping one blossom here, another several feet away, and so forth. Though other forage was readily accessible, goats often pawed to eat the roots and bulbs of various species, such as pointed mariposa lily (Calochortus apiculatus). Pawing was often observed in all months of the year, but I was not always able to determine which species had been removed and eaten. In wet soil, some species grasped by the stem were entirely removed from the soil and ingested. One goat nibbled at a pitchy area on Douglas fir for several minutes, and another very tidily snipped off several pink plastic flagging markers from bushes we had carefully measured.

Goats showed different uses of the same species. As an example, leaves of beargrass were occasionally eaten in winter, and Craighead et al. (1969) list beargrass as an important winter forage species of goats in some areas. In June and July, goats often selected the large, white inflorescences, and many observed with the telescope concentrated almost entirely on this species for a considerable portion of their feeding period. In late July and August, the green

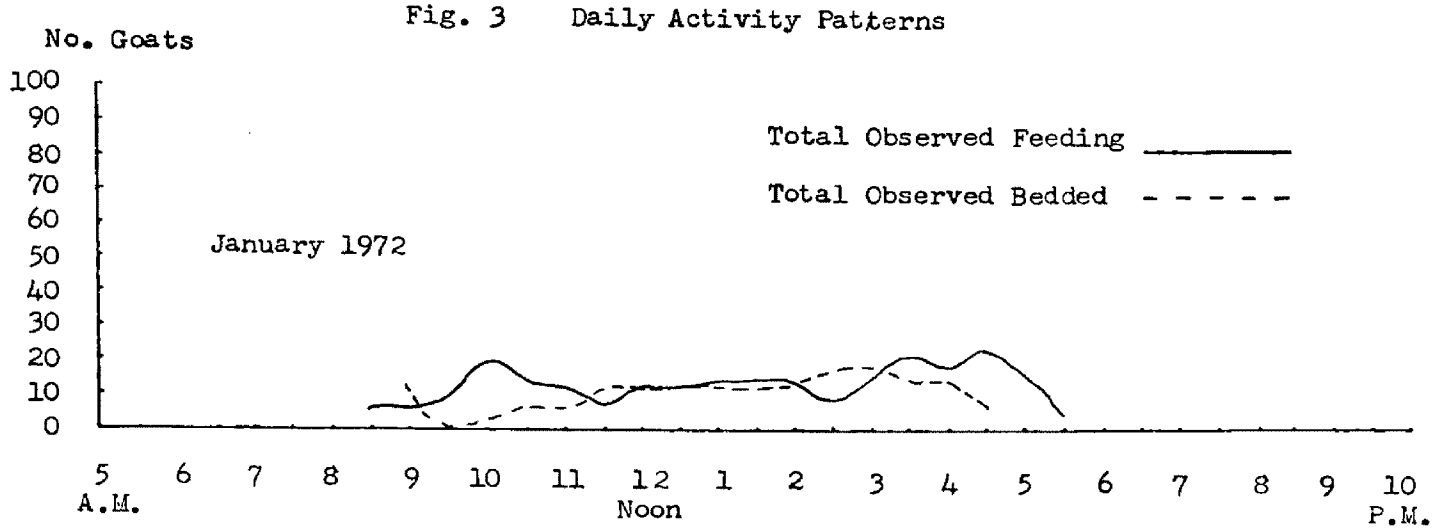
seeds were carefully stripped from the stalk by feeding goats, and in September, goats used both dried pods and terminal portions of the stalk as food.

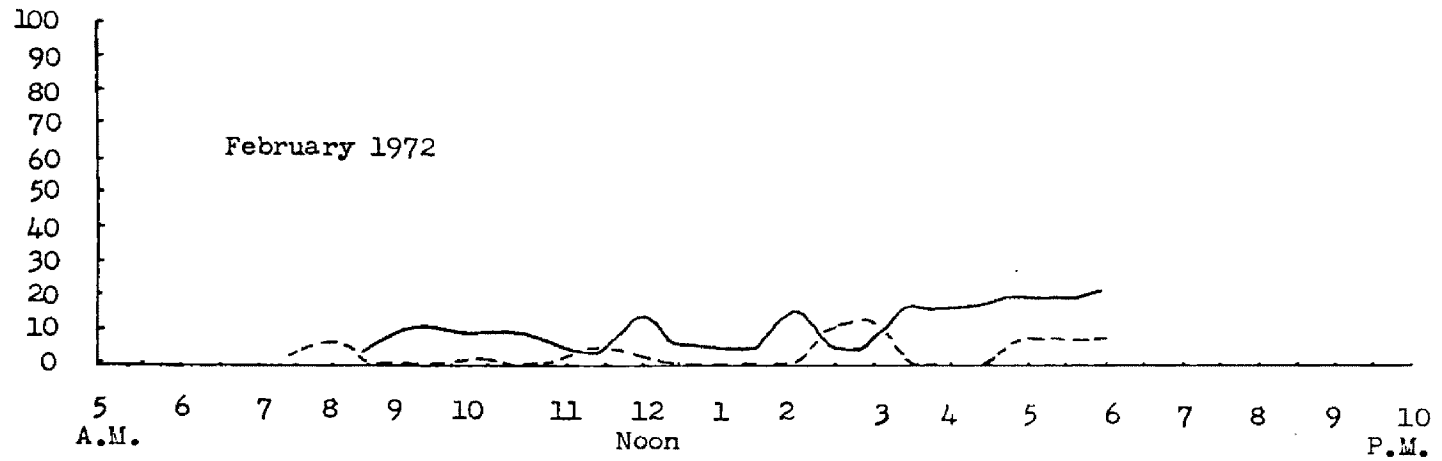
As forbs on ledge and dry meadow types dried in July, goats shifted to ravine-wet meadow habitats to select still-succulent forbs and browse available there. Ledge types were rarely used for feeding in late summer, though goats regularly travelled and bedded there. The trend toward ravine-wet meadow feeding continued through August until maturation, increased dessication, and, finally, frosts in September made ravine vegetation less palatable. After that time, grasses and sedges once again formed the bulk of the diet. Use of ledge types increased, and both dry meadows and ravine-wet meadow areas were used where grasses were abundant. Mature grasses were usually eaten to within 5 or 6 inches of the ground. Deciduous browse continued to be an important forage class in early fall. Goats made use of meadows and brushy areas through October until snows restricted movements and access to forage in these habitats. By late fall, goats had assumed winter food habits. Their diet consisted mainly of grasses and sedges taken from ledges and ridgetop winter range, and food items were grazed to within 1 to 3 inches of the ground.

Daily and Seasonal Activity Patterns

Daily activity patterns are presented for each month in Figures 3-7. Continuous observations of feeding and bedded goats are divided

Fig. 3 Daily Activity Patterns





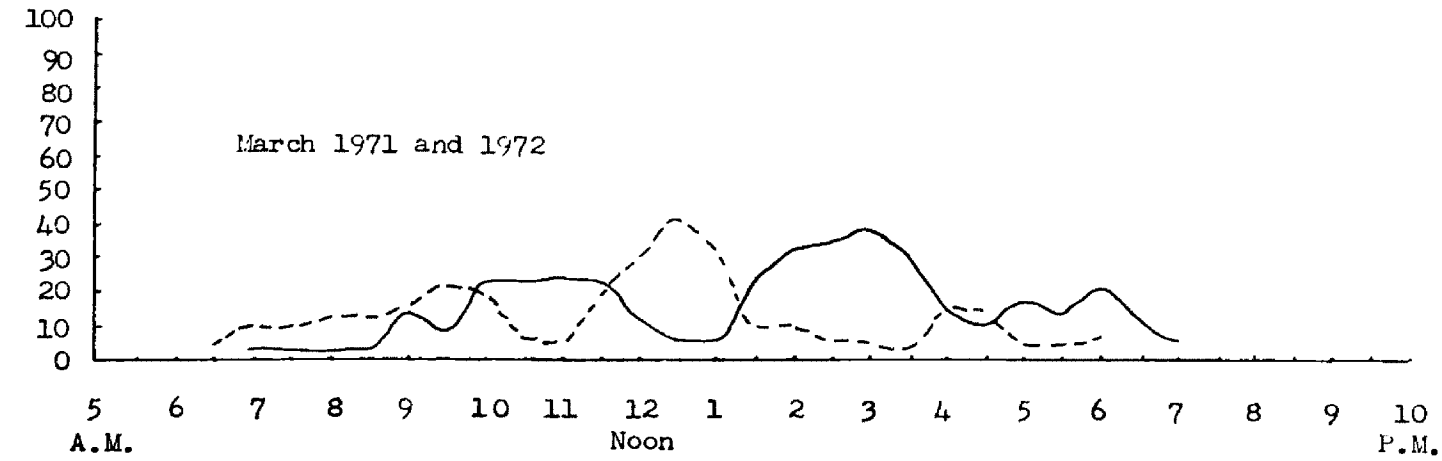
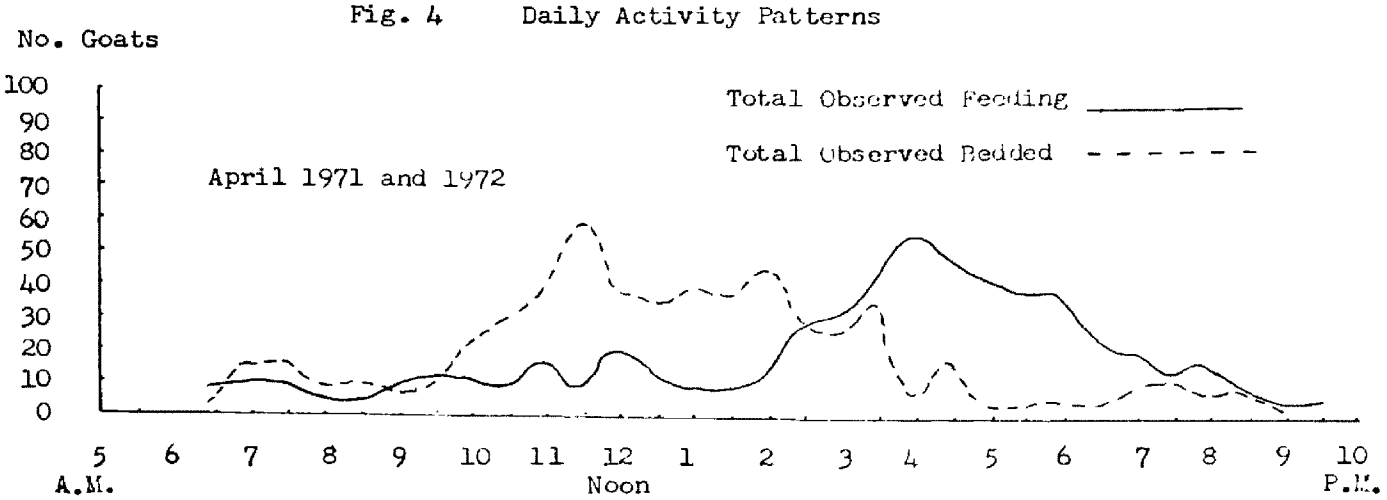
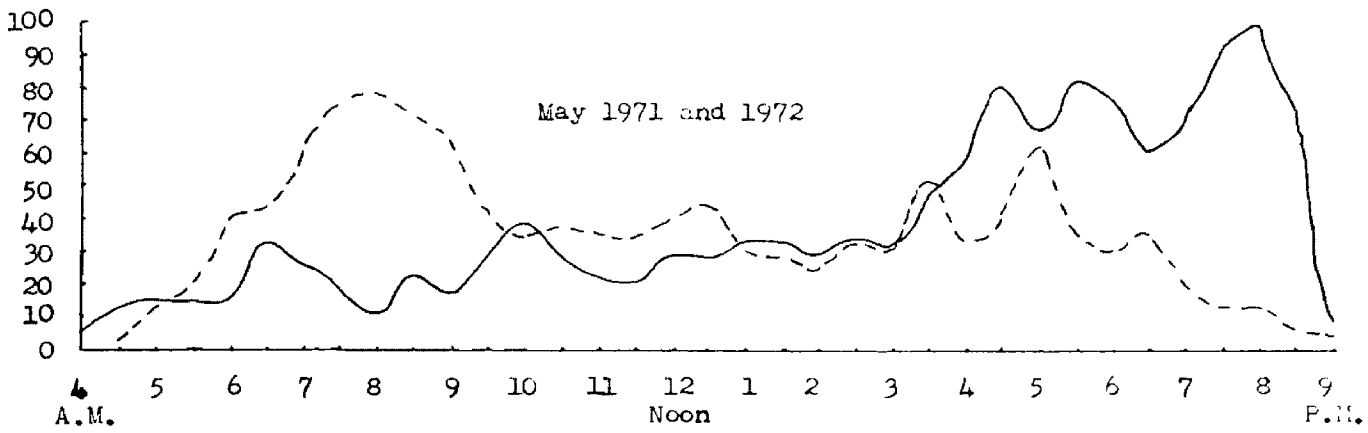


Fig. 4 Daily Activity Patterns





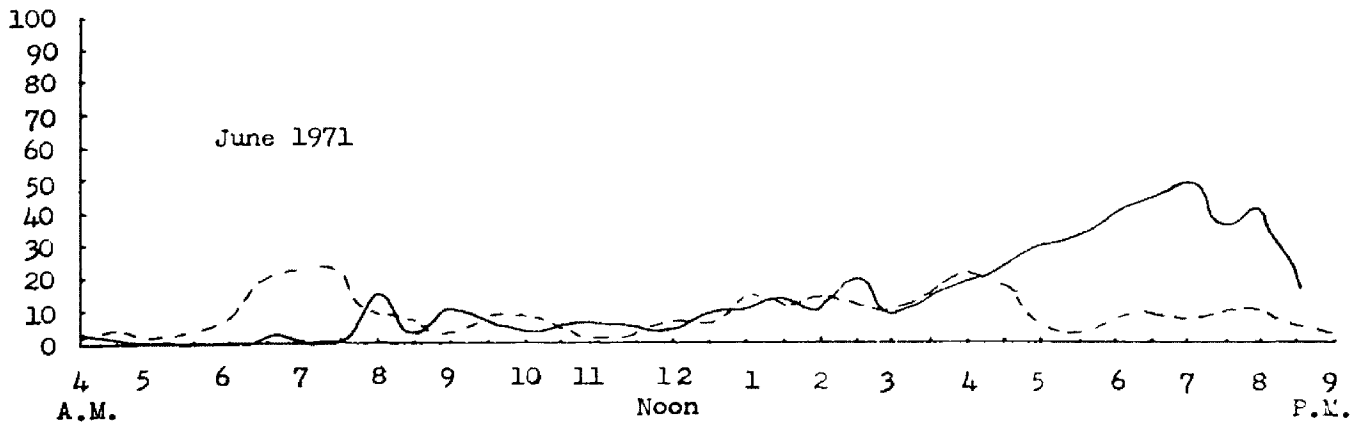


Fig. 5 Daily Activity Patterns

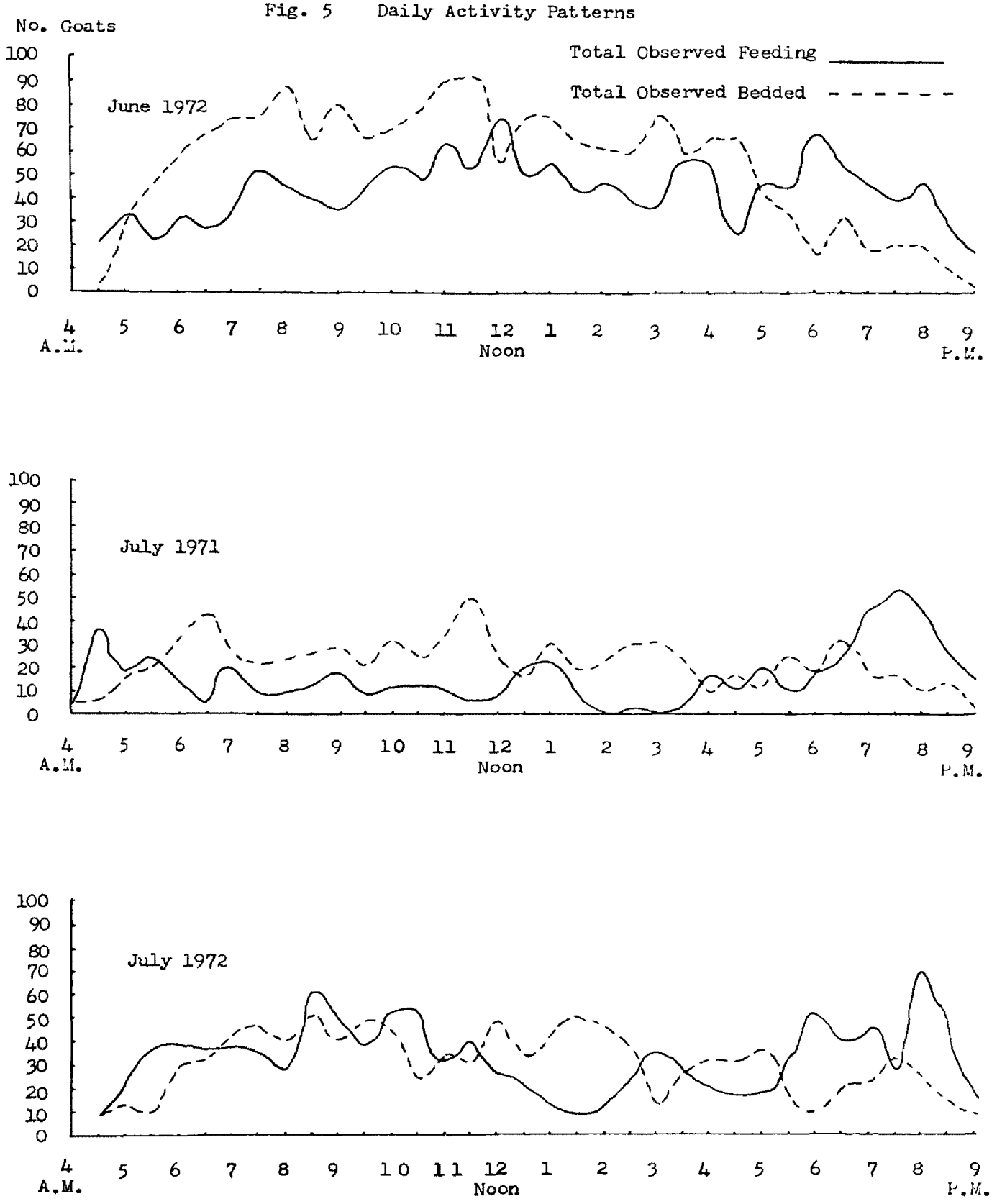


Fig. 6 Daily Activity Patterns

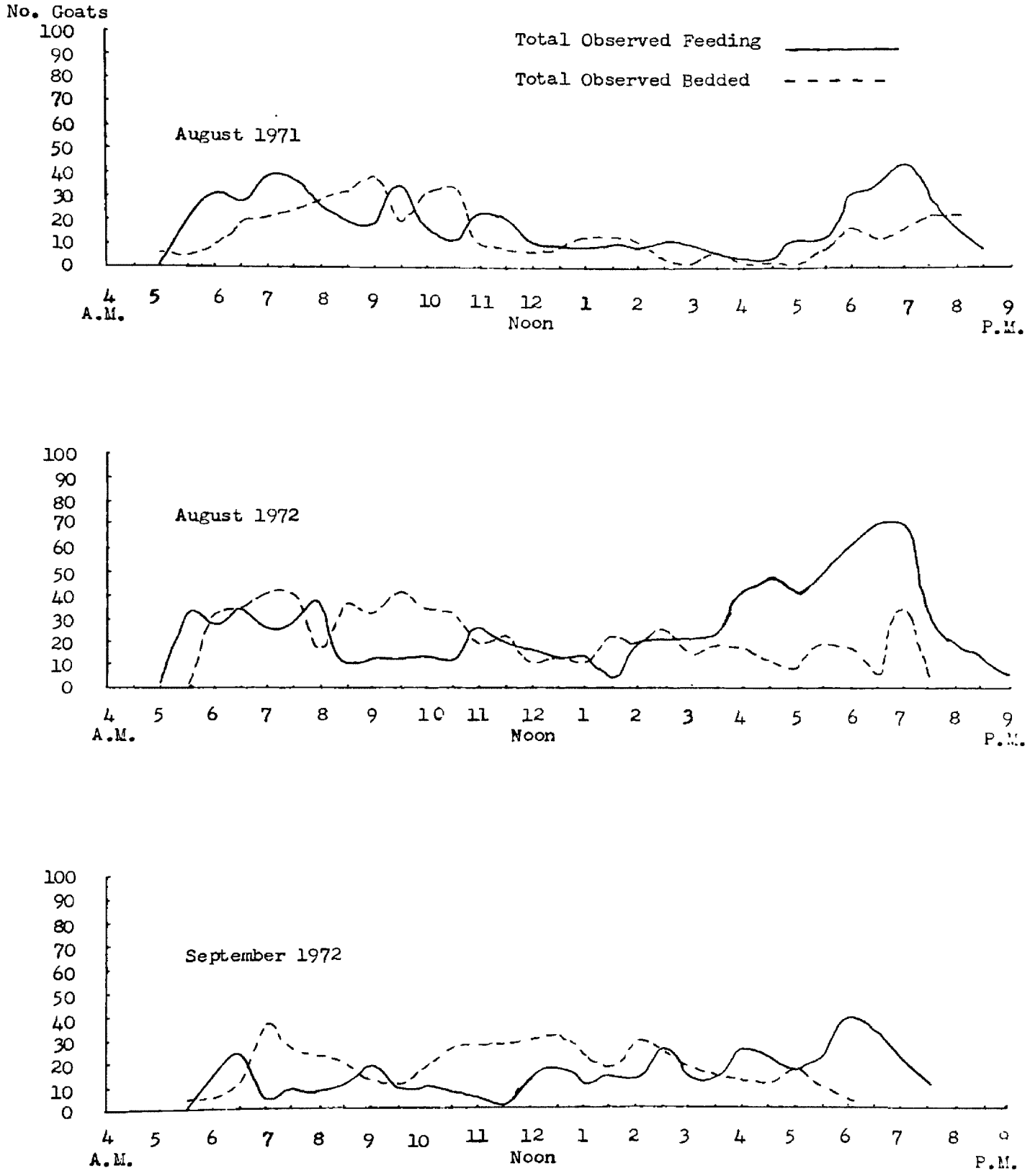
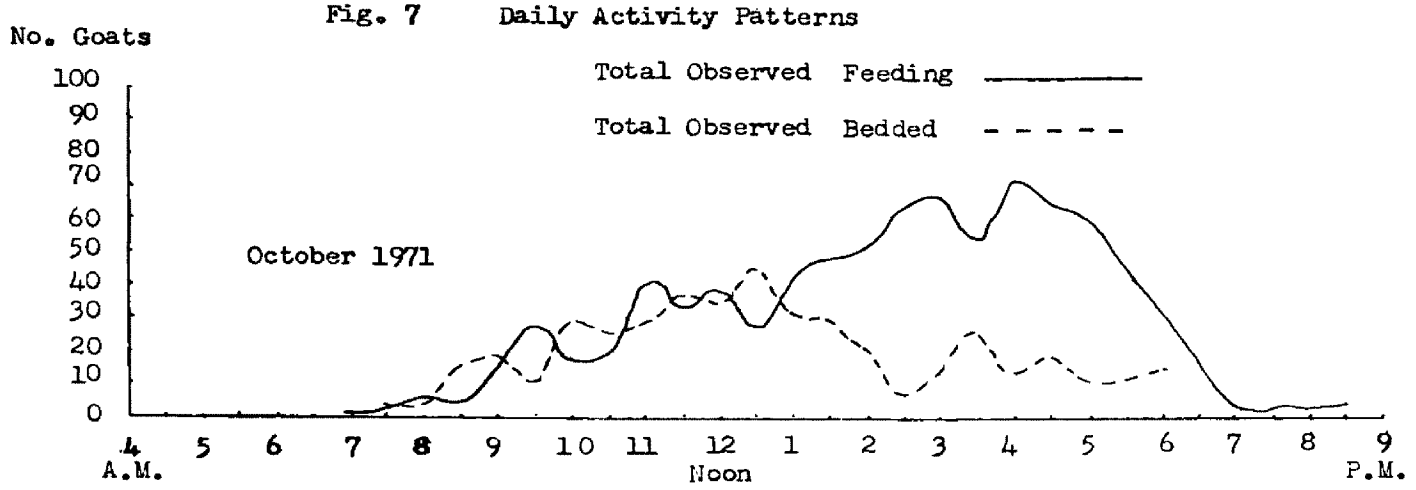
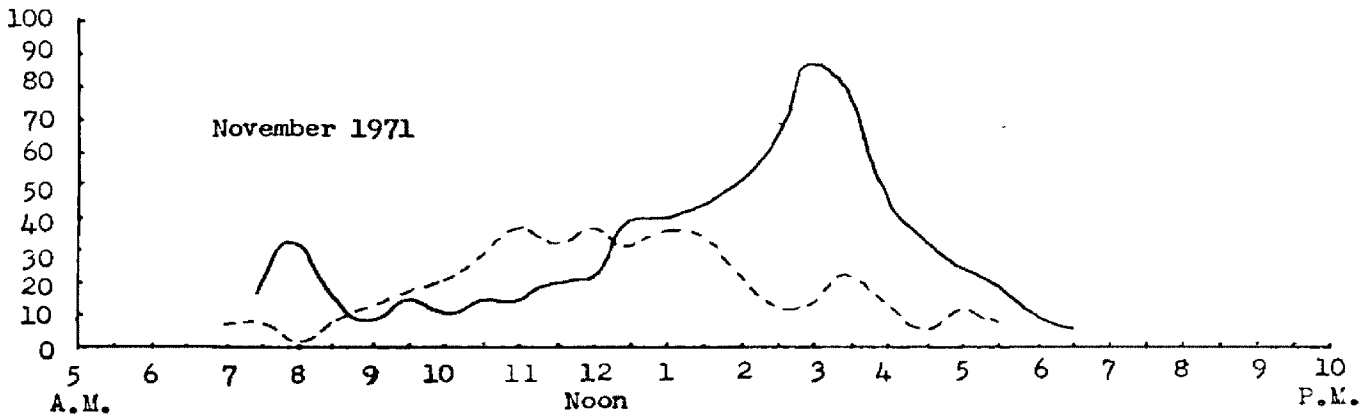
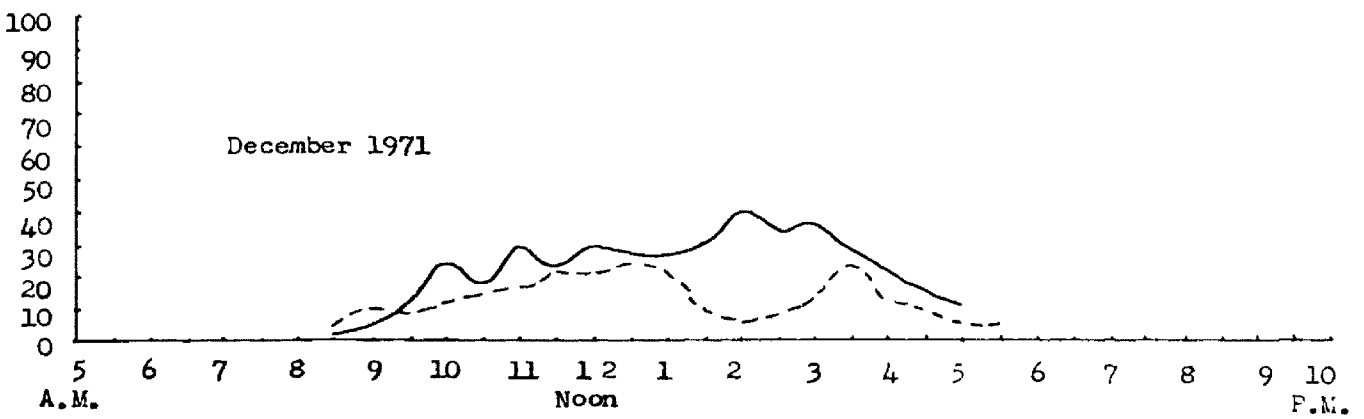


Fig. 7 Daily Activity Patterns







into half hour periods and tallied for each month. Records of summer months are provided for both 1971 and 1972 for comparative purposes. Numbers of animals engaged in feeding or bedding are not adjusted to a common percentage. The graphs, therefore, reflect absolute numbers of animals participating in these activities and also the likelihood of observing goats in the study area at different hours of the day. Very low numbers were recorded in early morning and twilight hours as goats were gradually located or lost to view, respectively. Similarly, although I worked with basically the same herd from day to day, midday numbers are sometimes low for both feeding and bedded animals in warmer months, indicating the difficulty of observing goats at that time, and implying increased use of timber types beyond that actually observed for those months. Because of short day lengths and adverse observation conditions, goats were observed for fewer total hours during winter. As a result, winter activity charts may not be so representative as those recorded in other months.

In spring and summer, goats usually started feeding with the earliest pre-dawn light and continued for 2 or 3 hours until mid-morning when they bedded. Mountain goats in the study area showed consistent midday feeding periods from 25 minutes to 2 hours long. Midday feeding, however, occurred amidst shaded areas in summer and was performed at different times, depending on when sunlight struck morning beds (if early, goats usually rebedded in shaded sites), durations of morning feeding periods, and group size and stability.

It should be emphasized that a herd of goats consists of separate bands, or subgroups, acting more or less independently, rather than as a single unit. In addition, nocturnal activity appeared to influence morning activity patterns. Groups tended to remain bedded throughout a greater portion of the morning following bright nights. Because midday feeding periods were irregular and often somewhat inconspicuous in lightly timbered or other shaded areas, they did not usually create activity peaks in the graphs, but they were an important part of the daily cycle.

Midday feeding was usually followed by a long afternoon bedding period, longer on warmer days, and then by an evening feeding bout of from 2 to 4 hours. Use of natural salt licks was also an important spring and summer activity during evenings and at night. Goats often remained at salt licks on the North Fork of Bunker Creek for several hours at a time on successive evenings. Although morning activities were often variable, nearly all goats in an area could be observed feeding in the hours before dusk. This was particularly true following hot, clear days which caused goats to remain bedded throughout the afternoon despite variations in earlier sequences, thereby synchronizing activities to some extent. Many animals were seen to rise as soon as the mountain's shadow fell across afternoon beds. Similarly, as Brandborg (1955) noted, goats were observed feeding following summer storms which forced them to seek shelter and remain inactive.

Saunders (1955) in the Crazy Mountains, and Peck (1972) in the

Spanish Peaks, both in Montana, provided activity tables for goats during summer months. Saunders also included spring and fall observations. Both noted early morning and late afternoon to evening peaks of feeding. Peck noted that during any hour of the day at least 22% of the goats observed were feeding, and Saunders found at least 34% feeding at any time of day. Peck found the highest percentage of goats moving, between 1000 and 1100 hours, to coincide with the time when most feeding sites became fully illuminated by sunlight. He also noted that during July and August, goats preferred shaded areas for all activities.

In June 1971, the pattern of activity reflected goats using the lower cliff levels of Bunker Creek, primarily to lick salt. The activity graph of June 1972 showed a different pattern. Most 1972 observations were from Little Creek and included irregular activity patterns resulting from birth and early maintenance of kids. Nannies with kids sometimes remained bedded for over 8 hours at a time. As seen in Table 5, June had the highest precipitation of any non-winter month during both years. Goats were much more active on cooler, overcast days, and this also caused a good deal of variation in activity patterns. On cool spring and summer days, goats exhibited more regular and frequent cycles of activity, alternating feeding and bedding in approximately 2-hour intervals.

In fall, with cooler daily temperatures and shorter days, goats often fed for long periods throughout the afternoon. Winter activities had the same basic pattern of feeding throughout afternoon hours.

Geist (1971) found mountain goats in the Canadian Rockies feeding primarily in afternoons from 1300 to 1600 during December and January. Goats fed for a greater percentage of daylight hours during colder months as shown by Table 3, based on 19,252 datum points. However, if activity percentages are multiplied by number

Table 3. Seasonal Percentages of Feeding and Bedding Activities

	Spring	Summer	Fall	Winter
% Time Observed Feeding	53.5	52.3	58.4	67.0
% Time Observed Bedding	46.5	47.7	41.6	33.0

9 Hrs. Daylight (Ave.) x 67.0% Feeding Activity = 6.03 Hrs. Winter
16 Hrs. Daylight (Ave.) x 52.3% Feeding Activity = 8.37 Hrs. Summer

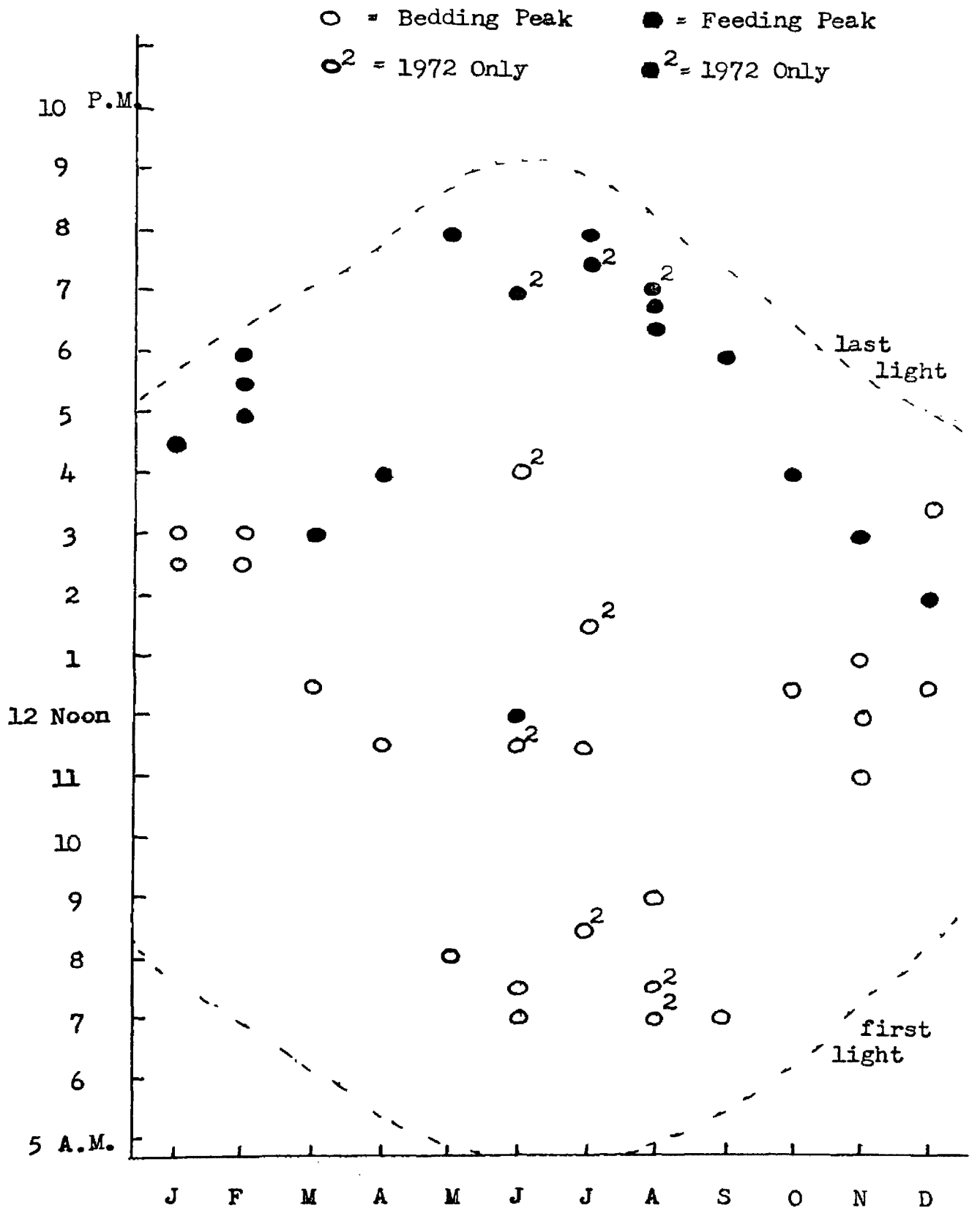
of daylight hours for each month, it becomes evident that although summer feeding percentages were smaller than winter, more time was actually spent feeding during summer months. Summer feeding periods also included more travelling and playing, however, so foraging time was probably fairly constant during the year.

Figure 8 illustrates monthly feeding and bedding peaks. Feeding peaks tended to fall in afternoon hours each month, usually toward late afternoon or evening. Bedding peaks shifted from morning hours in warmer months toward early afternoon in winter, but were, in nearly every case, earlier than feeding peaks.

The nature of goat range in the Swan Mountains, where portions of most cliff habitats are lightly timbered and separated by forested and brushy terrain, makes censusing by aircraft difficult. Responses of mountain goats to helicopters and fixed-wing aircraft

Fig. 8 Monthly Activity Peaks - Taken From Figs. 3 - 7

(Secondary peaks, if within 1 of the highest figure, have been included.)



are discussed under the heading: Response to Specific Natural and Artificial Disturbances. On the ground, I was most successful in censusing mountain goats in spring and early summer months on a drainage by drainage basis. Prior to kidding season, airplane censusing would probably be most rewarding in late March and April when feeding goats utilized exposed cliff habitats almost exclusively. In these months, feeding peaks occurred during late afternoon from about 1500 to 1700, somewhat later on hot days. In May and warm summer months, best results were obtained in the hour or 2 before sunset after hot, clear days. Many goats were visible in early morning hours as well, but because of nocturnal activities during bright nights and differences in feeding durations, morning feeding periods of various groups were usually less synchronous than during evenings. The tendency of females to seek isolation and restrict movements prior to giving birth in late May and early June made censusing difficult, but very good results were obtained in later June, as post-kidding groups were larger and more localized than at other times of year.

After June, goats spread out over more diffuse summer range, including higher elevations, and increased their use of brushy and lightly timbered areas, making them more difficult to locate. Mature males, usually solitary and travelling widely between drainages, would be most readily censused on female ranges during October and November in the study area, but identification from fixed-wing aircraft would be quite difficult. Though goats tended

to concentrate in restricted areas during winter months, I found that the Bunker-Little Creek herd was rarely together on windblown ridgetop range. Some individuals were usually on lower cliff habitats. Even during rare intervals of good winter weather with clear skies, high winds quickly removed tracks, making goats in snowbound terrain very difficult to locate without prolonged searching. Winter censuses would be helpful in describing the extent of range areas used by different herds, but would probably yield unrepresentative population estimates.

Nocturnal Activity

I observed 66 goats in the hours between dusk and dawn. All recorded nocturnal activity occurred when some lunar illumination was present, and most observations were made on bright moonlit nights. On summer nights, a telescope or binoculars were sufficient to distinguish goats from their dark surroundings at considerable distances. During fall and early winter, I observed them with the aid of a Starlight Scope (U.S. Army, Night Vision Sight, Individual Weapons Mounted An/PVS-2).

Of 71.9 nocturnal goat-hours recorded, 33.7 were at salt licks. The remainder, 38.2 hours, were of feeding animals. During warmer months, particularly, many goats were first seen feeding in early morning. Others were lost to view as they fed in gathering twilight. It did not appear, however, that movement was extensive on dark nights or dark portions of the night, though Rideout (pers. comm.)

monitored some movements on dark nights. I observed goats bed at twilight, then rise to feed or lick salt as soon as moonlight illuminated their bedsite. Most goats entered our trap at a salt lick soon after nightfall, and on four different occasions, animals were trapped between midnight and dawn, having entered the trap shortly after the moon rose. A yearling, feeding actively across the cliffs, bedded as clouds obscured the moon. After moonless nights, I usually observed goats in or near beds of the previous evening. In winter, I regularly noted tracks indicating nocturnal activity, and following bright nights, individuals were first located some distance from evening bedsites. Observations after dark nights suggested limited movements.

Nocturnal activity seemed essentially comparable to diurnal sequences. I was only able to observe a few goats throughout the entire night, but those animals carried out characteristic intervals of feeding and bedding during moonlit hours, then bedded as the moon passed below the horizon. Aggressive interactions, long chases, play activities, and nursing were seen at night. One group of nine travelled nearly 2.5 miles feeding across the extent of the cliffs and back before dawn. Radio detection of local movements was difficult due to signal reflection in narrow valleys. The only extensive nocturnal movements noted took place on bright nights. During summer, goats frequently bedded at or near salt licks and would rise periodically throughout the night to lick.

Moonlight nights in high mountain regions are quite bright,

particularly when a reflecting snow cover is present. Climbing to observe goats, we were able to negotiate steep cliff terrain at night with little difficulty.

Bedding

Goats tended to choose beds on the upper portions and very tops of outcroppings. Night beds were selected just before dark on moonless nights. Goats used steeper areas, often with impassable walls at their back, for night beds than for day beds. Figures 11-17 show that despite use of different habitats for feeding, cliff habitat was nearly always used for bedding. A few beds were noted in meadows above cliffs, but over 95% of all beds observed were on cliff areas.

As part of the goat's traditional use of cliff areas and trail systems, the same bedsites were used by most members of the herd. A scan of habitual bedding areas would usually locate many animals on the hillside during bedding periods. The location of summer beds was most variable due to use of areas with loose, dry soil for dustbathing in midday beds without the usual requirements of vantage and relative inaccessibility. A few individuals were seen bedded in precisely the same spot each day for over a week, but most goats travelled widely during non-snow months and used different bedsites from day to day. In winter months, deep snows and the need for shelter from severe storms led goats to reuse the same bedsite in succession, sometimes for several days. Due to the limited number of well-sheltered ledges beneath overhangs, these winter beds were

predictable and received heavy use.

Upon reaching a bedding area, goats typically surveyed their surroundings from 2 to 5 minutes, then began sniffing the bedsite and nearby objects. At that point, individuals often rejected a particular site and moved to an adjacent bed, or sometimes, to another bedding area. Haven chosen to remain in a spot, goats continued sniffing the bed, usually while circling counter-clockwise, then, still sniffing, they knelt. Some goats rejected beds at this stage, but most remained. On some occasions, younger goats and a few older animals bedded by squatting on their haunches first, or by simply flopping on their side; but the majority knelt, forelegs first, while sniffing.

After resting their weight on the substrate, goats usually remained in an alert position for several minutes or longer with both forelegs tucked beneath the body (Figure 9a). This position allowed them to rise quickly if neccessary. Relaxed goats quickly drew extended forelegs beneath them to this position if alerted or preparing to move. As a rule, goats appeared less vigilant after several minutes and assumed a more relaxed position. The head was tilted back a bit, a foreleg extended (usually the uphill foreleg when on slightly inclined hillsides, to level the body), and a yawn with several half-chewing movements performed. After this, goats sometimes rose and rebedded if not comfortable, or else began to ruminate. Figure 9c shows a kid in a typical relaxed position.

After ruminating from 30 minutes to an hour, goats remained in a mildly alert position for a short time, then began to show signs

of drowsiness if not disturbed. The head would begin to sink toward the ground or rest briefly on the forelegs before being jerked back to the upright position. Eventually, goats assumed one of three sleep positions. Sometimes the head was rested on the ground or forelegs while in an upright bedded position. The two other sleep positions were quite distinctive. In the swan position, illustrated by the nanny in Figure 9c, the head is tucked against the side. The horse position, shown in Figure 9b, was seen only during warm months when exposure of so much surface area would not create a detrimental heat loss. Goats usually dozed with the eyes closed for 1 to 12 minutes, the average being about 2.5 minutes. The longest sleep interval recorded during the study was 25 minutes. Very few intervals exceeding 15 minutes were witnessed. As noted in the section on Alertness, young goats were the first to begin sleeping in a group and slept more total time than older animals. Intervals of periodic sleep usually lasted about 0.5 to 1 hour and were followed by rumination if the goat did not rise to feed. In successive rumination periods, goats appeared less alert and sometimes chewed with their eyes closed for several seconds. Some individuals then went immediately to sleep after the last chewing bout.

Rebedding occurred with natural discontinuities of activity such as immediately before or after rumination or sleeping intervals. Goats rose, sometimes stretched, turned 180 degrees, usually while sniffing, and rebedded facing the opposite direction from their former bed. This varied the field of visual awareness and enhanced alertness in drowsy animals, though rebedding may simply

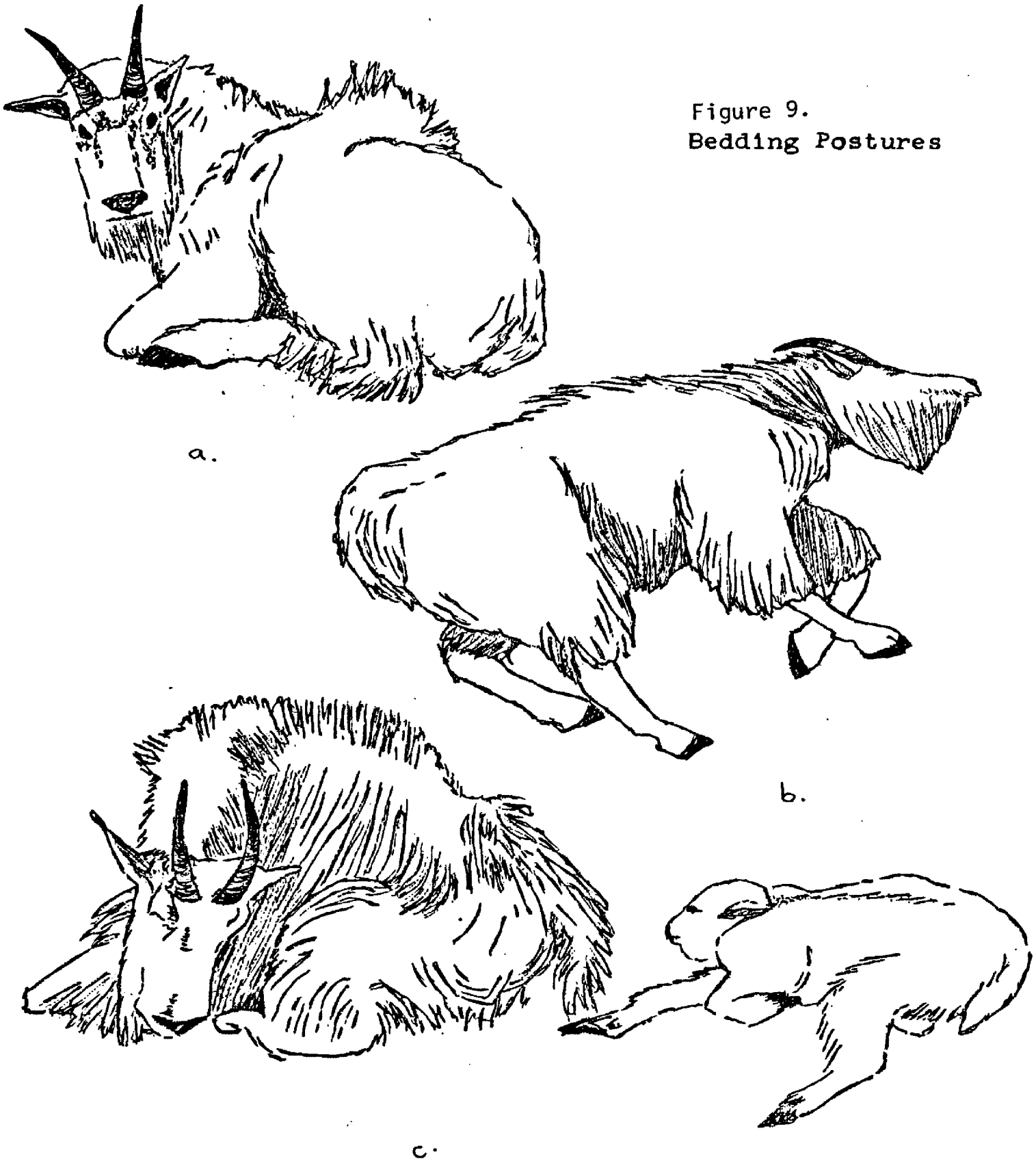


Figure 9.
Bedding Postures

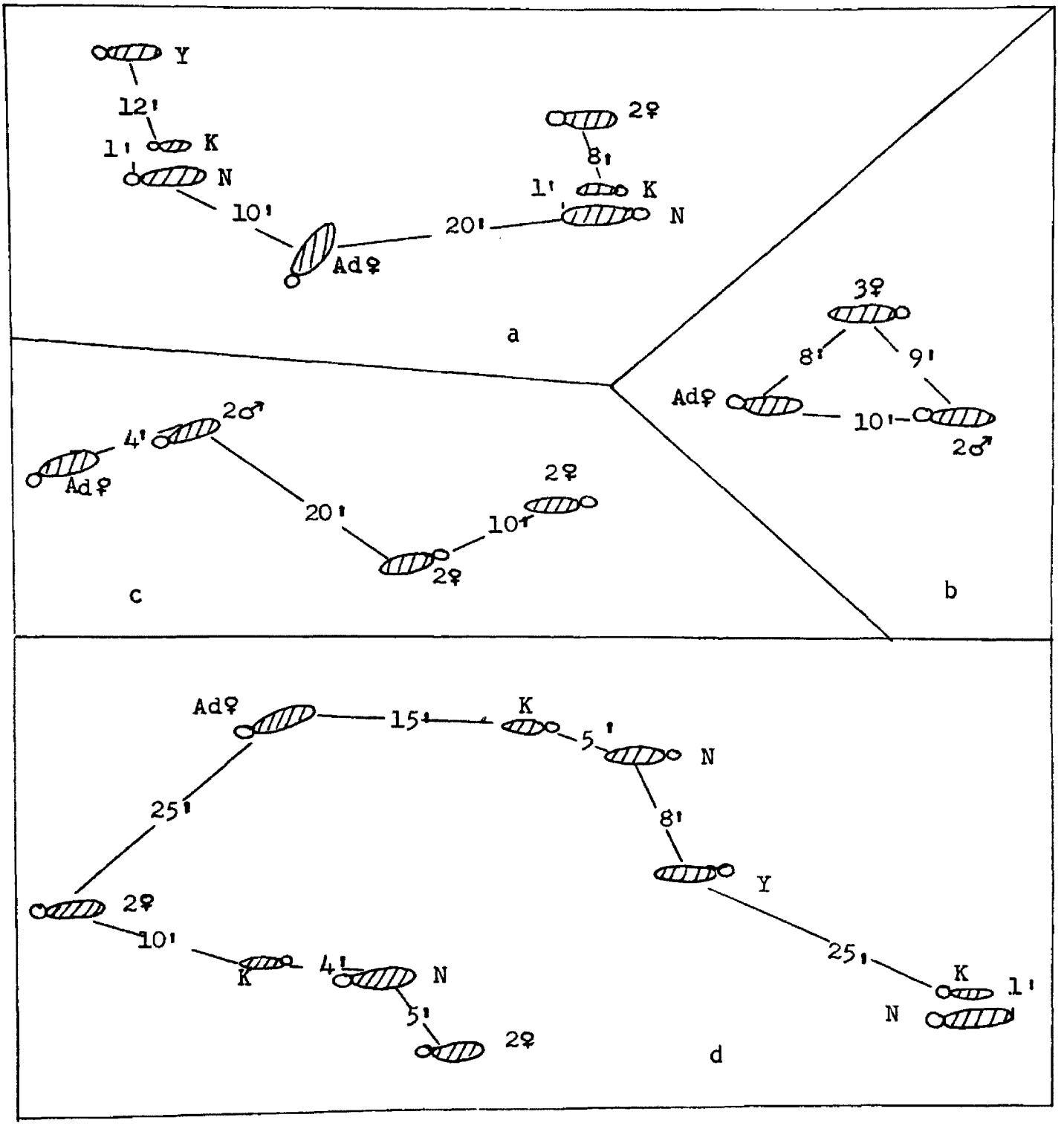
have occurred to alleviate soreness in muscles and joints. Rebedding was frequent during summer, particularly in association with dustbathing and high rates of other comfort activities. Rebedding, and other less marked shifts of body position in a bedsite, was uncommon during colder months.

In bedsites, goats continued to alternate rumination and sleeping intervals until they began feeding. Younger goats seemed more restless after initial rumination and rest sequences. Kids, yearlings, and 2-year-olds often fed around bedsites during long bedding periods while other goats rested. Kids commonly played and fed together through bedded groups.

Configurations of bedded groups reflected social regulations. The leader, generally the most alert animal, usually selected bedding areas, was the first to bed, and occupied the best vantage point, though there were many exceptions. After the leader bedded, subordinates bedded nearby. When the leader was a nanny with a kid, subordinates occasionally appeared to be competing for beds closest to the nanny. Beds were chosen so that head-to-head interpersonal spaces of at least 5 feet were maintained, but I could see no other patterns in bedded groups. Four typical bedded groups are illustrated in Figure 10. It sometimes appeared that individuals faced outward at different points, thereby making the group more alert to threats from any side, but this was highly variable, and "outpost" animals often rebedded facing the group.

Bedding was seen in goats which were uncertain of continuing

Figure 10. Bedding Patterns in Typical Groups



because of a suspicious disturbance, because their path was blocked by a dominant animal, or as they waited for a group leader to make a decision. The latter activity was most common in younger goats. Irregularities in the routines of bedding and sleeping which have been described were also noticed in stressful situations. Very young kids, which foraged only a small percentage of the time, often bedded as their nanny fed. Bedding as a displacement activity and in association with dustbathing has been described elsewhere under Comfort Activities.

Daily and Seasonal Movements

Figures 12-17 present daily movement for marked animals. These individuals were followed alone or as they associated with other animals, and their movements were visually monitored as nearly continuously as possible for several days. These sequences were selected from regular daily movement charts to depict extent and location of movements typical of different times of year with different forage composition and snow depths. All examples were taken from females and subadults for comparison. Figures 12-17 should be compared to Figure 11 which depicts general habitats on corresponding portions of the Little Creek range. Winter range ridgetop areas are not shown. Percentage habitat use was noted for each group of goats observed during the study. The bulk of information, then, comes from Little Creek, but includes Bunker Creek and other drainages throughout the study region.

Fig. 11 View of Major Little Creek Cliff Area

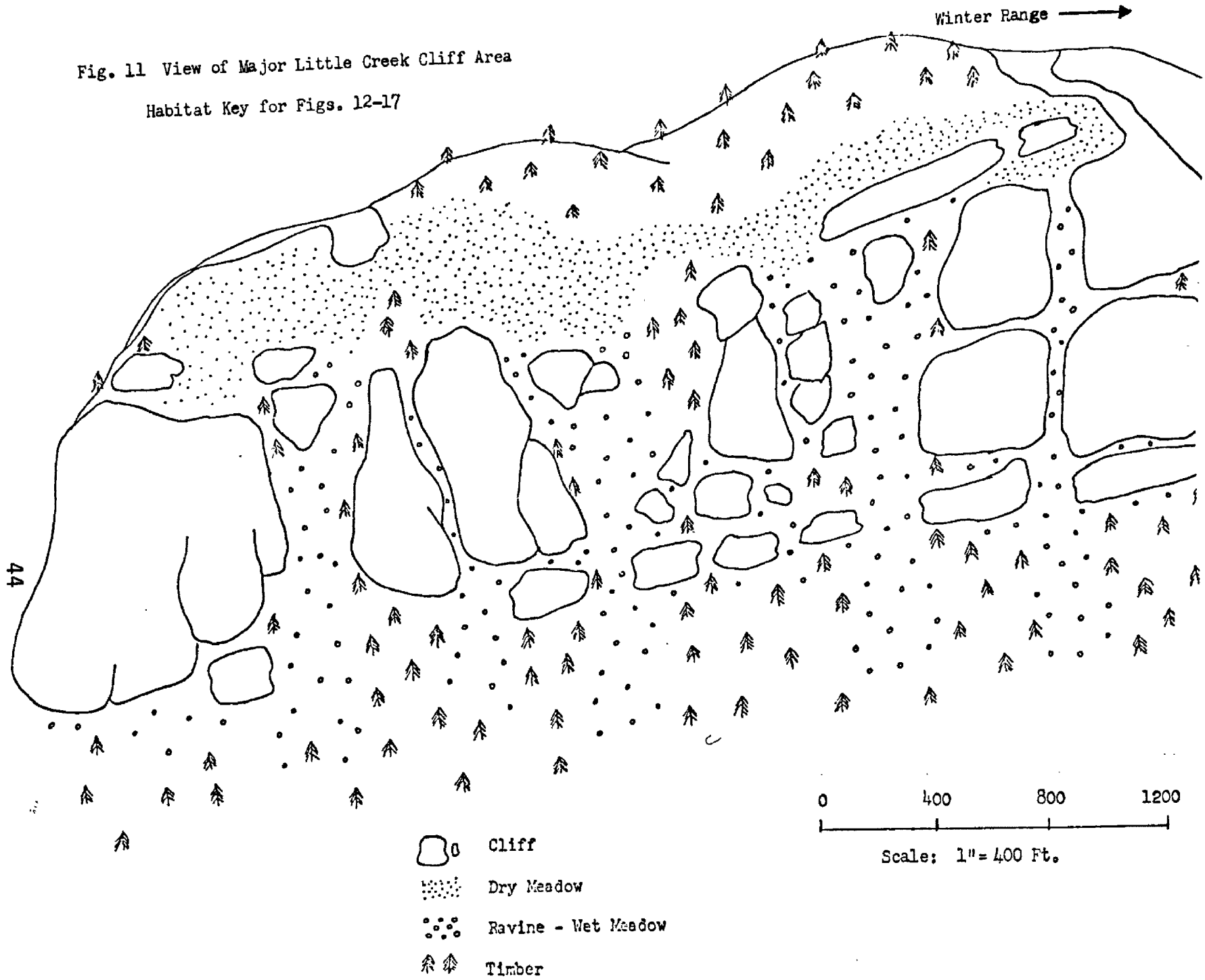


Fig. 12

Nanny and K
1/20 - 1/24

0 400 800 1200

Scale: 1" = 400 Ft.

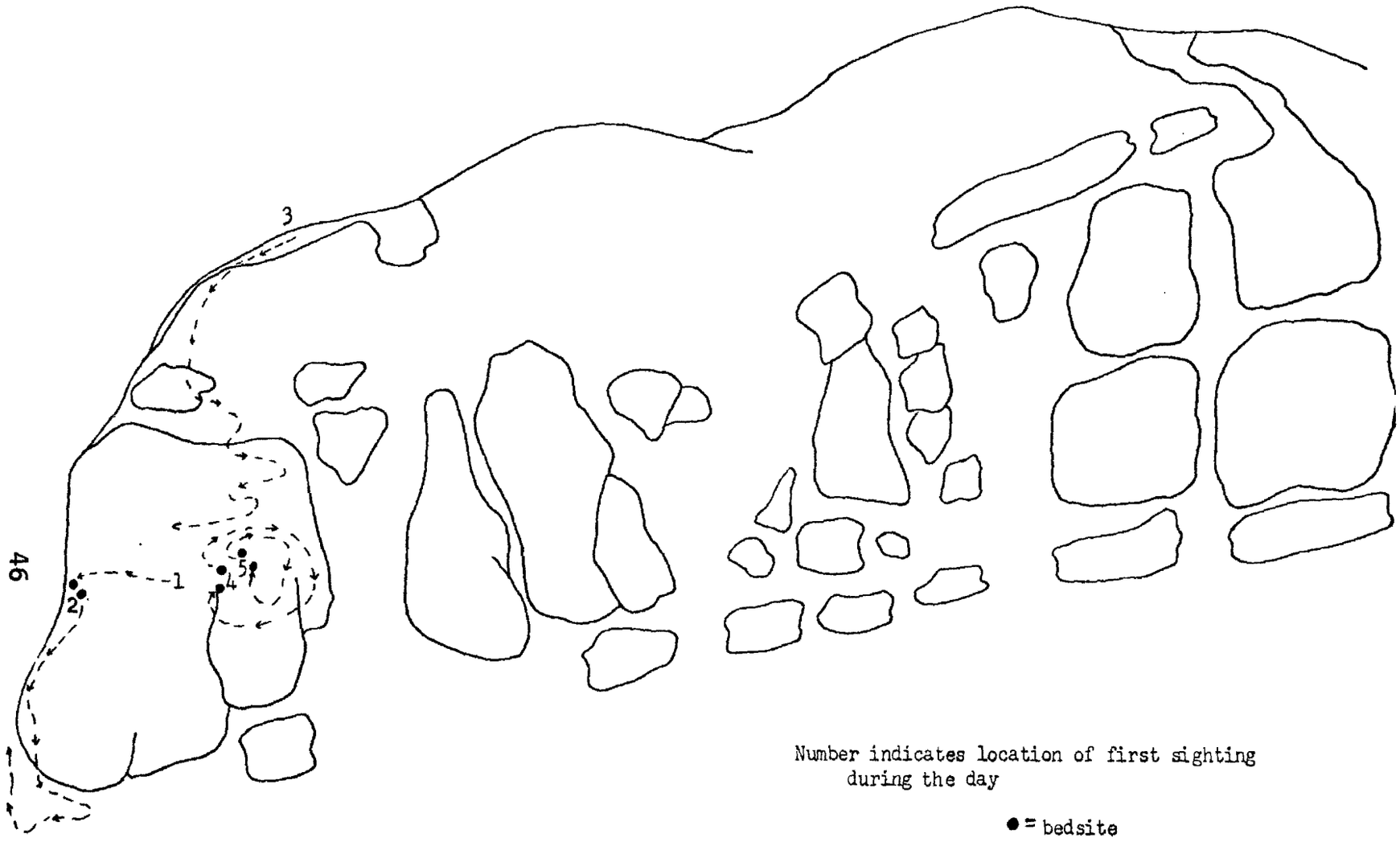


Fig. 13
Nanny and K
3/6 - 3/11

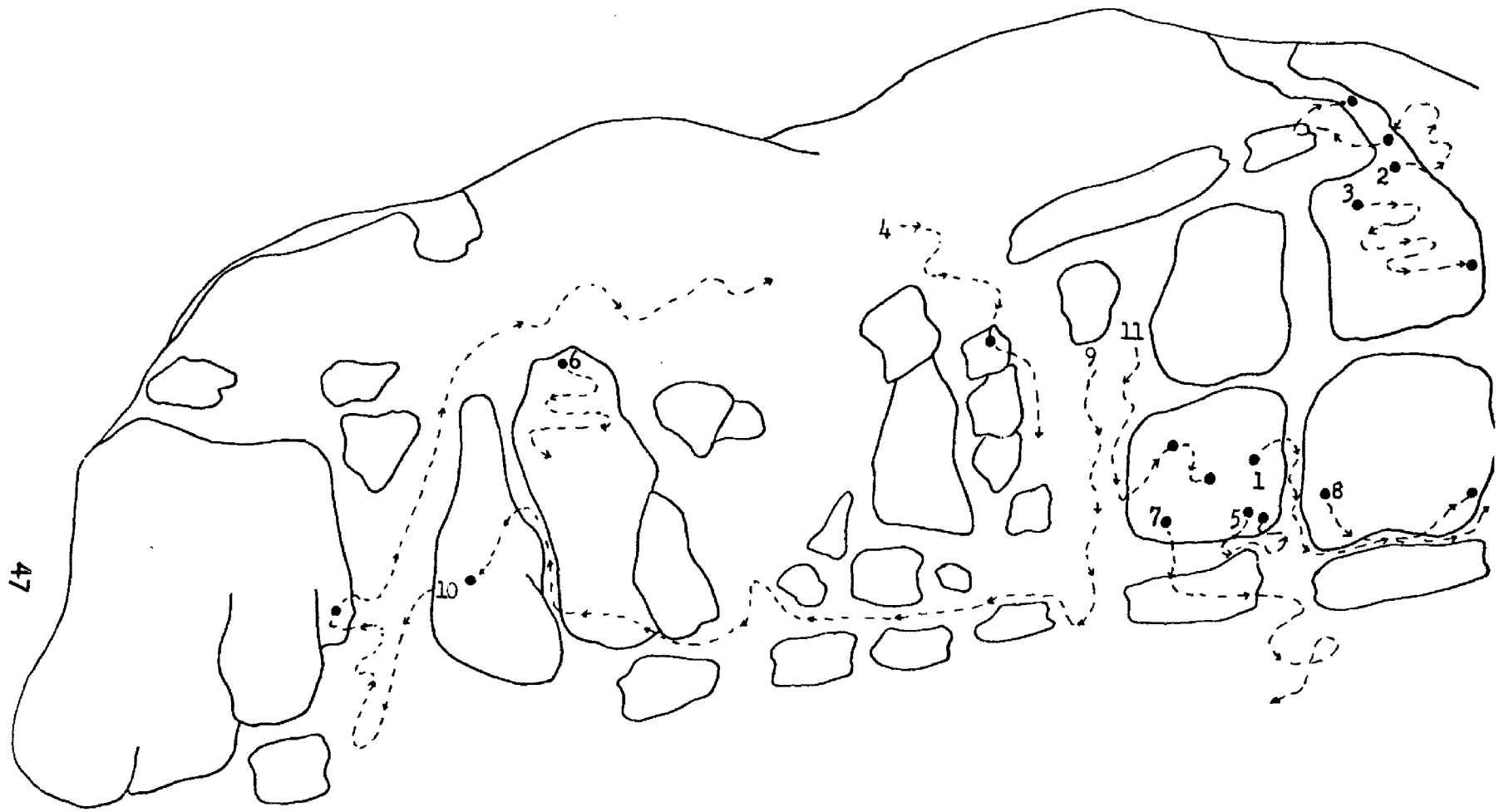


Fig. 14
N #1 and K
6/26 - 7/16

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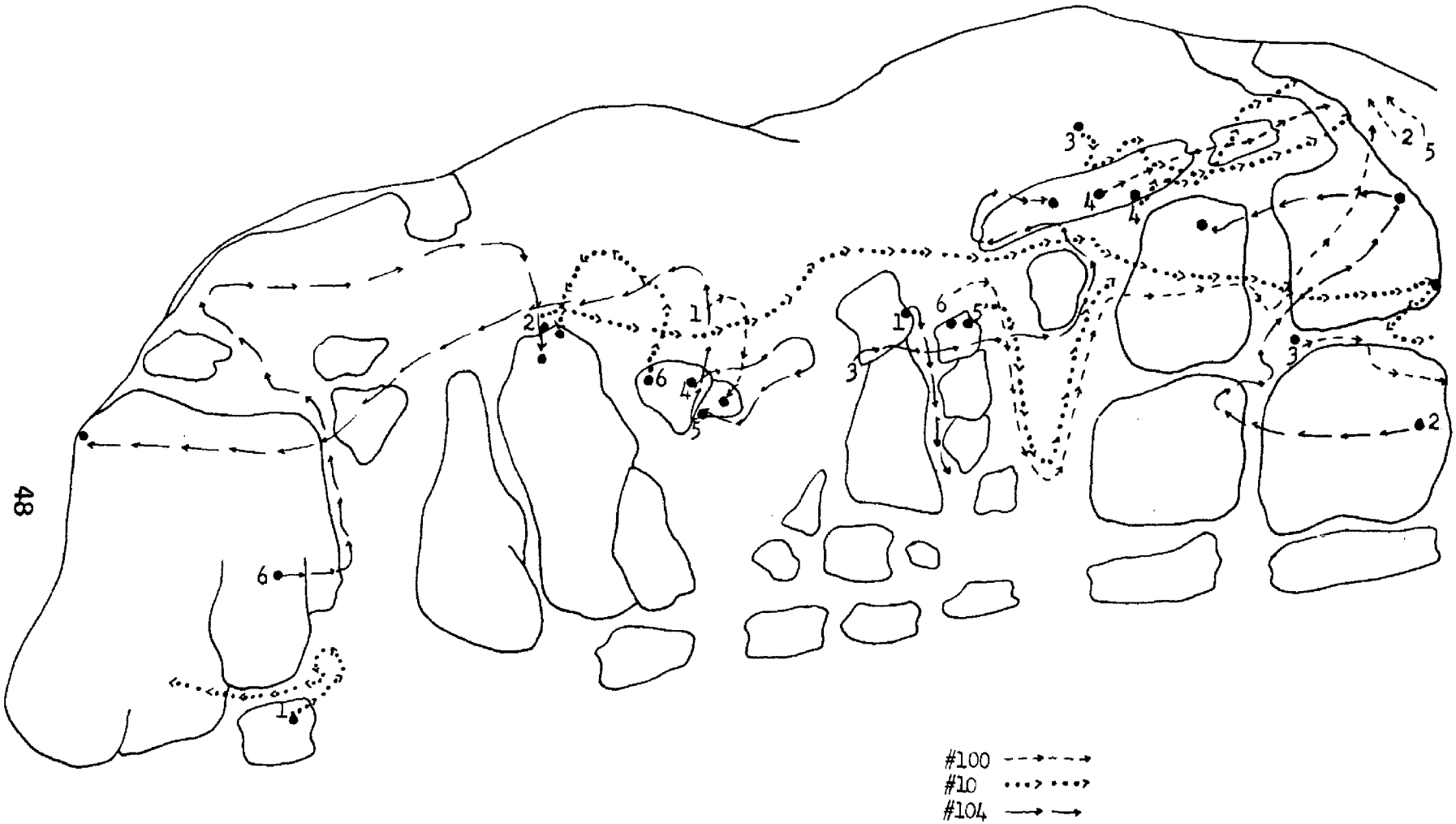

Fig. 15
#100, #10, and #104
8/21 - 8/27

Fig. 16
N Patch and K
9/29 - 10/15

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Scale: 1" = 400 Ft.

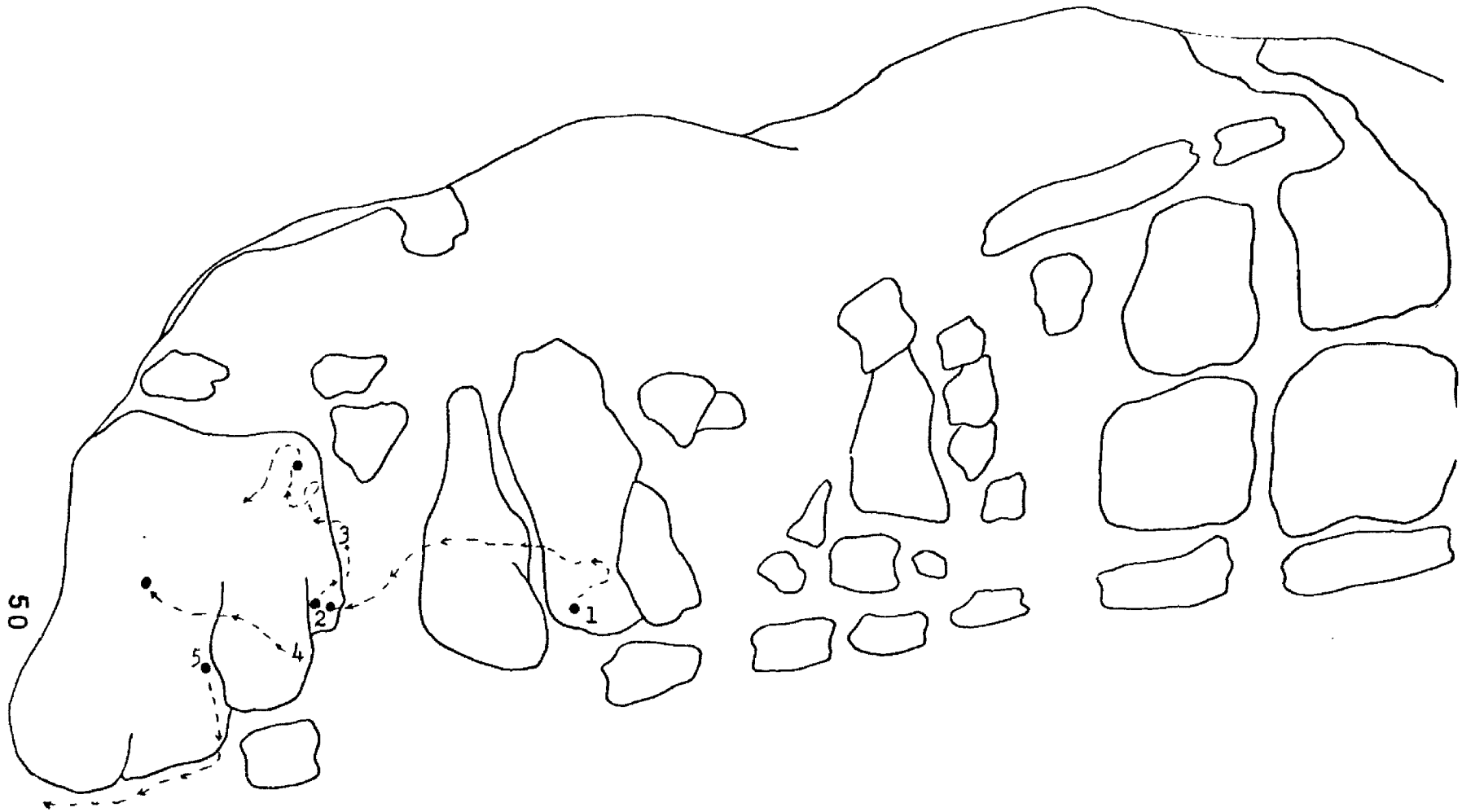


Fig. 17
Nanny and K
12/7 - 12/11

0 400 800 1200
Scale: 1" = 400 Ft.

Table 4 summarizes movement data relevant to Figures 11-17.

Table 4. Rates and Extent of Movements

	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Av.No. Ft./Min. Feeding	3-6	2-5	1-3	1-3	3-6	8-15	8-15	8-12	6-10	3-5	2-5	1-2
Av.Dist. (Ft.)Trav. In Feeding Period	108	226	462	374	385	535	473	406	528	454	192	100
Av.Dist. (Ft.)From A Previous Day's Sighting	101	356	639	865	986	1241	1564	2026	2086	2778	1130	403

Average rate of movement while feeding and overall distance travelled during the feeding period were recorded for all observed groups. Feeding rate figures apply only to goats involved in active foraging and do not include animals travelling alertly between feeding areas. Since many goats were lost to view while still feeding, overall distances travelled during feeding bouts are probably underestimated, but representative of monthly differences. Distance between a day's first sighting of an individually recognizable goat and the location of its last sighting on a previous day, usually the day before, was also recorded to help describe overall daily movements by including movements between as well as within feeding areas, and general travel throughout the range.

Each movement category reflects seasonal changes of considerable magnitude. Feeding movement rates were greatest during summer as goats shifted from a spring pattern of concentrated foraging on cliffs supporting grasses and sedges to selective snipping of newly-blossomed forbs while moving from patch to patch in cliffs, meadows, and ravines. Goats again concentrated on grasses and sedges during fall, primarily in dry meadow areas. During late fall and winter, snows curtailed movement, and the need to paw snow away from forage further reduced rates of travel while feeding. Slightly higher rates in January and February partially reflect increased use of ridgetop winter range where both footing and forage were usually blown free of snow.

Distances travelled while feeding were highest in June as goats selected forbs throughout the area. Figures decreased slightly in July, and again in August, as goats selected succulent forage within more specific moist meadow and ravine areas, then rose again in September as goats moved through large dry meadow habitats feeding primarily on dried grasses. Travelling distances in feeding periods dropped to less than 25% of summer values by mid-winter. During storms and after deep snows, goats often remained on the same outcrop for several days in succession.

Average distances from a previous day's sighting yielded similar patterns of winter restriction (101 feet average in January) and summer mobility (2,026 feet average in August). Daily movements increased as soon as crusts formed on snows in spring, permitting

more rapid travel to new foraging sites. Distances between sightings, however, did not directly coincide with feeding movements. Instead, increases were greatest in late summer and early fall, reaching a peak in October and declining sharply thereafter. This corresponds to patterns of use in meadow habitats where goats concentrated on available forage but travelled long distances across meadows between feeding periods. Undetermined factors, perhaps related to the fall breeding season, may also have influenced movements of this category.

Range

Outside of the rutting season, the Bunker-Little Creek herd was composed primarily of females and subadult males. Males wandered apart from the herd more fequently than females as yearlings and upon reaching 2 years of age began spending much of their time alone. By 3 years of age, males had become independent of the female-subadult herds and had begun a largely solitary existence.

Adult males were uncommon in the portion of the Swan Mountains studied, and observations of them were irregular. Sightings made throughout the area, including locales rarely used by female-subadult bands, indicated males range widely by comparison and communicate long distances between herds. One large billy utilized the Bunker Creek cliff area across from Gorge Creek for 2 weeks during spring of 1971. This billy, recognizable because of an eye injury eliminating vision on one side, was shot in early fall on the other side of the Swan Range on the North Fork of Lost Creek, 11 miles distant. (Jack Whitney, the archer who killed Billy One-Eye, informed me that

the eye injury was due to a previous bullet wound).

Like Billy One-Eye, adult males could typically be sighted in a limited area from several days to 3 weeks, then disappeared for long periods, consistent with a pattern of temporary residency followed by extended movements. During the rut, this sort of pattern would ensure genetic communication between small and sometimes widely separated female-subadult groups. Billies travelled constantly during the rut over the length and breadth of individual female ranges. Since the number of adult males present on Little Creek in the rut varied from two to four, it is likely that they were also travelling between ranges. Geist (1964) noted that whereas females remained on their respective ranges, males were actively crossing from range to range in the Cassiars of British Columbia.

The range of the Bunker-Little Creek herd, as given in figures 18 and 19, refers to areas used by various female-subadult bands comprising the herd, based mainly on radio locations and sightings of collared and distinctively marked animals. In the course of the study, the longest period during which the herd was not monitored on a daily basis was 4 weeks.

Regular summer range, like winter range, was discontinuous, the majority of activities (greater than 95%) being concentrated in optimum cliff areas of Little Creek and the North Fork of Bunker Creek. Excursions from activity centers to other areas were irregular and infrequent. Many sightings used to delineate occasional summer range represent isolated instances. Movements between optimum

Figure 18. Summer Range

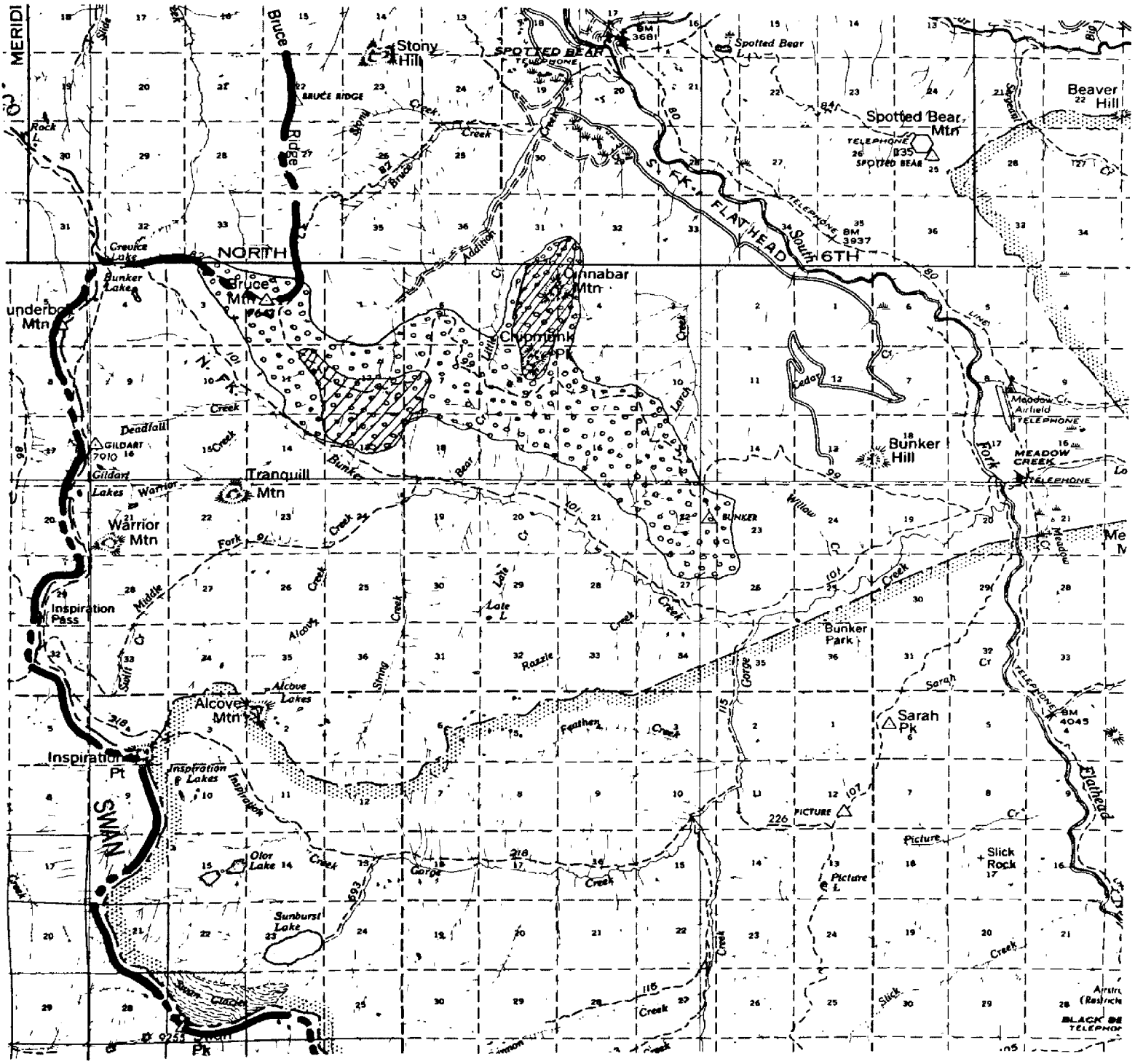
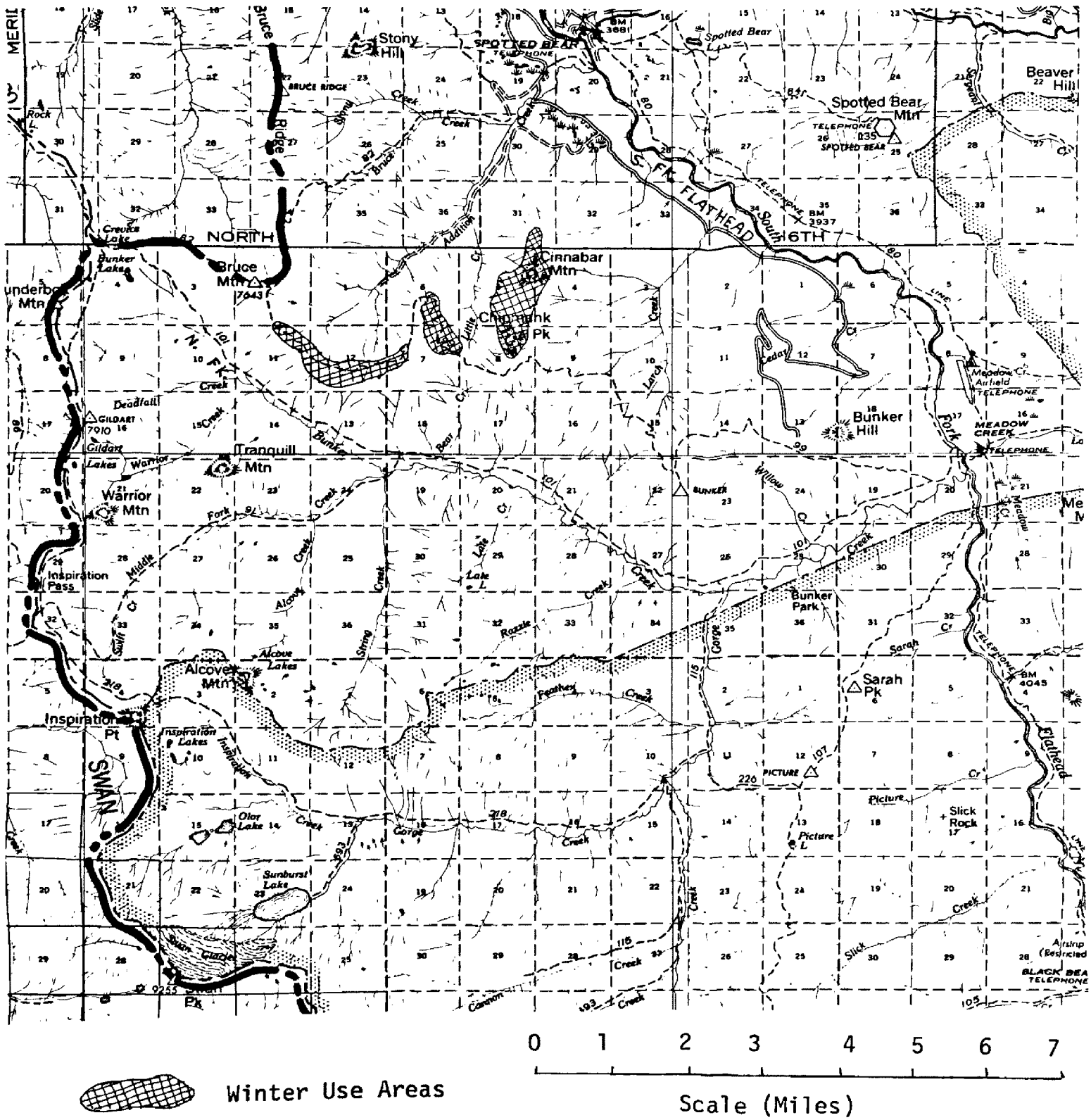


Figure 19. Winter Range



areas appeared to be fairly direct. Summer travel between the two drainages was common until late fall as accumulated snow restricted movements. In the deep snow winter of 1971-72, movement was almost entirely confined to exposed cliffs and ridgetops in each area, permitting no communication between Bunker and Little Creeks wintering areas until late April. By contrast, 1972-73 was a remarkably light snow winter, and observations during January suggested that goats could commute between the two winter areas to some extent. Individuals which wintered on Little Creek the previous winter were observed on Bunker Creek during a second trip to the study area in mid-March which revealed goats crossing between drainages on early crusts.

Logging disturbances, discussed elsewhere, contributed to a decline in use of traditional Bunker Creek range and increased use of Little Creek. Another factor modifying movements between activity centers may have been individual allegiance to specific portions of the range. As an example, a 3-year-old female, #103, observed throughout spring and summer of 1971 in the North Fork of Bunker Creek area and radio-collared in August, remained in that area through the succeeding year after late fall of 1971 except for brief, infrequent excursions to Little Creek. Within the North Fork cliffy area, she was observed in only a small portion of available range. The extent to which different individuals preferred different parts of the range cannot be evaluated because of ongoing disturbances on Bunker Creek. However, like #103, an old nanny on Goat Creek, on the other side of the mountains, exhibited a similar preference for,

or attachment to, a specific portion of potential range. I observed her seven times over a 3-month period in spring, recognizing her distinctively long horns and her kid which was afflicted by parasites or infection in the shoulder region. The greatest distance between sightings was 1,500 feet as she crossed from her usual haunts, within a few hundred feet of each other on south-facing cliffs, to north-facing cliffs as the weather warmed. The kid's affliction did not seem sufficient to hinder movement of any kind. Local residents and hunters stated that she had produced kids and been seen in this same limited area for at least 2 years prior to our acquaintance with her, though it cannot be proven that this was the same individual.

In general, goats appeared to be traditional in their use of areas. Both winter and summer ranges remained essentially constant both years for all known females and subadults. The Bunker-Little Creek herd showed intensive rather than extensive use of the area. Maximum extent of occasional summer range was approximately 7 miles in one direction, and over 95% of all sightings were in smaller areas,less than 2 square miles in each drainage.

A 2-year study is rather short-term. It is possible that goats naturally conduct large-scale migrations to new areas at times, though as a rule goats are reported in the same ranges year after year. I found evidence that different portions of a range may be used under different conditions. Goats were not seen on Middle Fork Creek in winter 1971-72 when deep snows buried most outcroppings. In mid-

March 1973, however, extensive cliff areas were accessible to foraging animals, and a group of at least six goats was present there. During non-winter months each year, bands of unfamiliar goats appeared sporadically near Middle Fork Creek. This fork of Bunker Creek apparently represents a portion of another herd's range which includes the Alcove Mountain area, but its relative position and importance could not be defined because of ongoing disturbances.

At least four factors which may have contributed to use of a traditional and limited area by the Bunker-Little Creek herd over 2 years and under extremes of winter conditions are evident:

1. The presence of road-building and logging operations may have directly discouraged egress from Bunker Creek in the direction of disturbances. More subtle effects creating confusion or stress may have promoted conservative use of familiar terrain and discouraged use of marginal habitats and exploratory movements.

2. In the Swan Mountains, many outcroppings used by goats occur in subalpine areas . Cliff habitats are patchy, and movement between them usually entails travel over timbered areas and open ridgetops in the absence of precipitous escape cover. Though he remarks that movements were in general confined to small distances, Brandborg (1955) observed goats moving several miles in a few hours on different occasions. Where steep rock exposures are more continuous, one might expect herds to travel greater distances on both a daily and seasonal basis.

3. Summer and winter ranges coincide in the study area. Brandborg

(1955) noted a well-defined tendency of animals to return to the same winter range, as was the case for an adult female observed 3 consecutive years on the same Salmon River range. He estimated, however, that migrations between summer and winter ranges might involve movements of up to 15 miles. On the other hand, Hjeljord (1971) observed goats on the Kenai Peninsula to simply drop in elevation on the same mountainside from fall to winter. Vertical shifts from summer ridgetops to lower valley cliffs in winter require transverse movements of about 3 miles in the Lemhi Mountains of Idaho (Lon Kuck pers. comm.). The extent of seasonal ranges is influenced by topographical factors affecting snow depths and prevailing winds, and availability of water in summer months. Persistent snowfields, streams, and seeps were available within close proximity of major cliff areas throughout the Bunker-Little Creek range during summer months. This, too, may have promoted use of a limited range and certainly helped minimize daily summer movements. The extent of seasonal range is also influenced by the acceptability of transitional range between summer and winter grounds.

4. Goat numbers were probably lower than in previous years (see Populations in Related Areas) throughout the study area on both sides of the Swan Mountains. Therefore, pressures to utilize marginal habitats and dispersion movements were probably minimal, and this would affect the extent of a herd's range.

It was not determined whether the limited nature of goat range described for the Bunker-Little Creek herd is representative of

largely subalpine goat populations or the result of unique natural or artificially induced circumstances.

Weather

Mountain goat habitat atop the Swan Range is in what is known as the snow belt of Montana. Like the west slope of the Rockies in Glacier Park just to the north, the Swans receive large amounts of precipitation, mostly in the form of snow, from moist air moving along a storm track. Hungry Horse Dam, 70 miles downstream along the South Fork of the Flathead River, is the nearest station providing complete year-round data (Swan Lake weather records, though slightly more appropriate, were incomplete). Hungry Horse Dam is about 4,000 feet lower in elevation than goat range in the area. I recorded many sub-zero temperatures during winter observations which were well below the lowest recorded at Hungry Horse. We experienced spells of -20 and -30 F weather during January. Daily winter temperatures were at least several degrees lower at our altitude, and strong winds swept across the top of the Swans from west to east, creating effectively colder temperatures.

Precipitation, too, was quite different in the immediate study area. Clouds passing over the Swans dropped moisture on goat range when none was falling in the valley 2,000 feet below. I sometimes found my observations of goats blocked by falling snows, yet could see vast stretches of blue sky above with only thin wisps of clouds. Clouds and snows hung continuously over the mountains during winter.

Table 5. Daily Temperature and Precipitation - 1971 and 1972

From U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Environmental Services Data.

Hungry Horse Dam Weather Station

1971	TEMP. (°F)			PRICIP. (In.)			1972	TEMP. (°F)			PRECIP. (In.)		
	AV. MAX.	AV. MIN.	AV.	TOTAL SNOW & SLEET	MAX. DEPTH ON GROUND	TOTAL		AV. MAX.	AV. MIN.	AV.	TOTAL SNOW & SLEET	MAX. DEPTH ON GROUND	TOTAL
Jan.	29.1	16.1	22.6	22.0	34	5.49		25.8	9.1	17.5	43.0	30	5.39
Feb.	35.5	20.3	27.9	12.0	18	1.95		35.1	18.8	27.0	17.5	31	4.03
Mar.	38.2	21.0	29.6	17.0	18	2.38		45.4	29.3	37.4	5.0	21	2.51
Apr.	50.4	31.5	41.0	0	11	1.27		49.1	30.7	39.9	1.0	1	2.71
May	63.5	39.9	51.7	0	0	3.24		61.2	40.2	50.7	0	0	2.23
June	64.4	43.6	54.0	0	0	5.26		71.1	46.1	58.6	0	0	3.69
July	77.1	47.1	62.1	0	0	2.33		74.3	48.4	61.4	0	0	3.10
Aug.	85.7	52.5	69.1	0	0	1.60		80.5	52.0	66.3	0	0	2.29
Sept.	61.5	37.2	49.4	0	0	1.76		60.8	38.8	49.8	0	0	3.00
Oct.	50.0	30.6	40.3	1.0	-	4.04		47.6	30.2	38.9	24.0	14	3.07
Nov.	39.5	27.5	33.5	10.5	5	2.99		37.7	27.8	32.8	3.0	8	1.00
Dec.	29.1	15.6	22.4	26.5	20	4.10		26.8	14.5	20.7	20.2	9	4.89

It snowed for some part of nearly every day from November through early February of 1971-72. Snow depths at camp across from the Little Creek cliffs reached 8 to 10 feet, and 30-foot cornices formed on the leeward side of ridgetops from drifted snows.

High winds kept some ridgetop outcroppings and a few cliff ledge areas almost entirely free from snow. Steepness of slope in association with high winds prevented snows from reaching depths of more than 2.5 to 3 feet on narrow cliff ledges or the outer portion of wider ledges. Snows accumulated in ravines and meadows on hillsides between cliffs to depths exceeding 10 feet, making travel in these habitats extremely difficult in loose snow conditions, and foraging next to impossible except on a few protruding shrubs and conifers. (Crossing from outcrop to outcrop, goats struggled neck-deep through avalanche tracks and ravines in powder snows. Avalanches were common during winter and spring months.)

Snows remained on cliffs through March and much of April both years. Persistence of snowfields throughout the range, along with the occurrence of streams in most ravines until August and the presence of some permanent streams and seeps in cliff areas, played an important role in determining daily movements. Fulfillment of water requirements did not neccessitate travelling more than a short distance from usual cliff haunts during any month.

Rains were frequent in spring, early summer, and fall. Goats generally ignored light rains and continued to feed or remain bedded in open areas. During moderate rains, goats continued activities

in the open , periodically shaking off water, then gradually moved toward more sheltered sites. Heavy rains and sudden cloudbursts caused goats to seek refuge beneath trees and ledges. During some violent downpours, goats huddled beneath shelters, temporarily ignoring interpersonal distances and tolerating one another in the manner of young goats or goats faced by a common threat. Heavy rains discouraged movements. Goats tended to remain bedded or near protected sites until rains diminished.

Fine rain probably cannot penetrate goats' wool to any extent, and the animal is able to dispel accumulated water by shaking. Medium-size raindrops are likely to eventually soak through the wool, and large drops probably wet the animal in a short time. This may account for variations in responses to rains of different intensities, and observations that goats continued activities in open areas during intense but fine rains, and trotted quickly to cover during downpours. Brandborg (1955) noted, as I did, considerable individual variation in response to rain squalls.

Wind was an important part of the cliff environment, redistributing snows and exposing forage. Chill factors may not have much effect on mountain goats. Goats were observed feeding and bedding in the open on all but the windiest days when fierce gusts sometimes caused goats to flee behind protective ledges or trees, and kids to run beneath their nannies. Roaring winds drove snow into the animals' eyes, and sometimes directed feeding movements and bedding positions as animals aligned their rumps toward the wind.

After blowing hard through the coldest months, winds were mild or non-existent in summer. Humid, windless, hot summer days, of which there were many in the Swans, were a burden to insect-plagued mountain goats and perspiring observers alike. On such days, comfort movements became dominant activities in mountain goat herds. Goats were generally inactive during hot days and performed all but early morning and evening activities in shaded areas.

CHAPTER II

NATURAL HISTORY - DAILY LIFE AND HABITS

Sign

Murie (1954) illustrates typical mountain goat hoof prints, and Brandborg (1955) and Casebeer et al. (1950) give good descriptions of hoof lengths for goats of various ages. Hoof measurements obtained from trapped animals are given in the section on trapping data. Probably the most distinctive quality of goat prints is the squarish appearance caused by spreading of the deeply cleft toes in a normal stance. When the animal travels downhill, divergence of toe tips generally equals or exceeds hoof length. Considerable use is made of dew claws in descent. Limbs are not lifted far above the substrate in the goat's plodding pace. In light snow this foot-dragging creates a more or less continuous trail which from a distance resembles a ski track and can readily be distinguished from the separate hoof marks of deer and elk.

Bedsites and Dusting Areas

Habitual use of selected sites, like traditional use of feeding areas and trail systems, seems to be characteristic of mountain goats. Summer beds were usually found in steep cliff regions which provided both difficult access to predators and an unobstructed view of the cliffs below. Security requirements were modified by thermo-regulatory demands. Mid-day summer beds were located on timbered portions of the cliffs and occasionally on north-facing hillsides. Much dustbathing

was performed in typical summer beds. Sites used almost exclusively for dustbathing, however, were most common on exposed hillsides, some distance from escape cover, where loose sandy soil was present. Both dusting and bedding areas became devoid of vegetation from continual scraping, and both were littered with pellets.

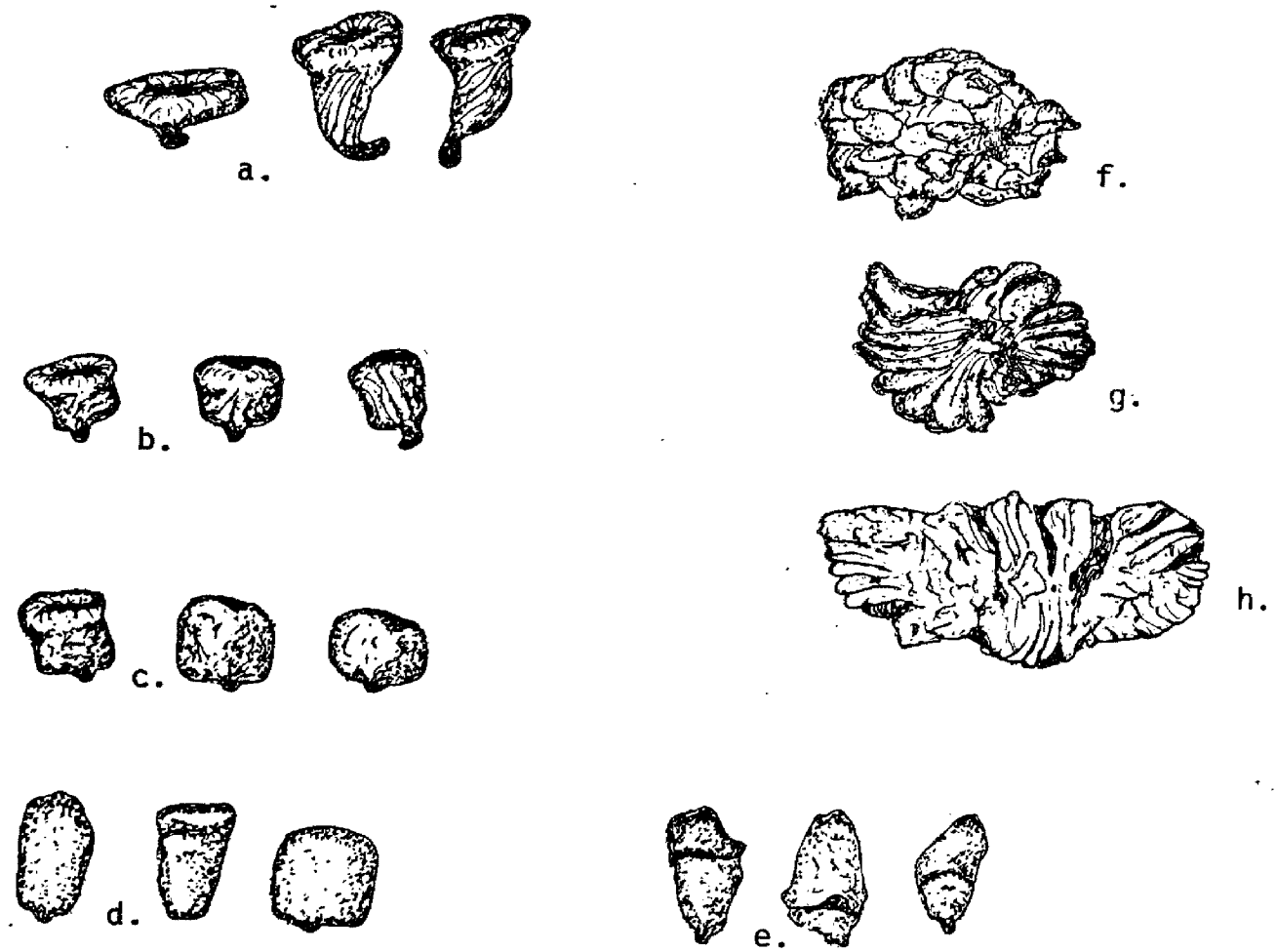
Rutting pits, resembling a summer dusting bed, were the result of vigorous, concentrated pawing by rutting males which usually exposed soil beneath fall snows. Most, but not all, pits were dug at previously used bedsites and were highly conspicuous at a time of year when bedsite pawing did not otherwise occur. The same winter bedsites are sometimes used for days at a time during storms and deep snows. Such beds, often in caves and beneath overhanging ledges, contain deep accumulations of pellets.

Goat pelage is described elsewhere. During the molt, loose wool becomes caught on projecting rocks and twigs and is scratched off in considerable quantities in bedding and dusting areas. The abundance and visibility of this fur make it an excellent indicator of overall extent of summer range and movements within it. I found goat hair wherever I observed goats in the shedding season, even at the periphery of the range. Snagged hair revealed actual routes on precipitous rock faces, and also through timbered areas and creek bottoms where activity was not previously observed. A few guard hairs become trapped in ice which forms beneath animals bedded for some time atop snow. These hairs sometimes remain after snows melt and are an additional aid in identifying goat bedsites.

Many goat cliffs in the Swan Mountains are essentially surrounded by mule deer habitat. Murie (1954) and Brandborg (1955) noted the similarity of mountain goat and mule deer pellets, and Murie stated that he was "...unable to distinguish with certainty between some deer pellets and those of a mountain goat." Murie found numbers of mule deer pellets per group to range from 68 to 128 in one study. In a small sample, I found the number of mule deer pellets per group to be consistently less than 100. Seton (1927) recorded a dozen evacuations each day of from 50 to 150 pellets in captive mountain goats maintained at the Bronx Zoo. I counted 70 fresh goat pellet groups at various times of the year. Numbers per group ranged from 57 to 205, with 70% between 90 and 150, and an average of 119. In a typical goat pellet group, the majority of pellets are in a single bunch with one or two dozen trailing off in the animal's path for several feet. Some of these peripheral pellets and those which had rolled or been blown over cliff ledges were missed in counts. The average number of goat pellets per group, 119, is therefore probably an underestimate. Yet this average is very near the highest number of mule deer pellets recorded by Murie and well above the mule deer average. Differences in pellet numbers, then, rather than size and shape, can be useful in distinguishing relative use of an area by these two species.

Pellet size was generally found to reflect that of the goat, ranging from 5mm. lengths in young kids to 15mm. in adult males. Larger animals had slightly greater numbers of pellets per group than

Figure 20. Pellet Types



younger goats, though there was considerable overlap. Winter pellets were somewhat larger than summer pellets.

Pellet shape varied with forage type. Highly irregular, soft, greenish early summer pellets (Fig. 20a) were often compacted in clusters which, depending largely on the succulence of ingested forage, ranged from aggregations of discrete pellets to amorphous fecal masses (Fig. 20f-h). During July, when pellet aggregations were common, I observed goats walking on after defecating with stringy fecal material hanging from the anus causing the animal to flick its tail frequently. I also noted a brief appearance of clusters of adhering pellets from both goats and elk atop the snow in October. The stringy, crenulated pellet of late spring-early summer became less dished and tapered by late July-August and was more typically acorn-shaped (Fig. 20b). In late summer-early fall, with the change to a diet consisting primarily of dried vegetation, pellets assumed a more rounded to squarish appearance, becoming harder and blackish-brown (Fig. 20c). Winter pellets had lost most of the apical indentation and basal projection characteristic of the goat pellet (Fig. 20d). Double pellets, such as Murie (1954) depicted were evident in February, and common in March and early April (Fig. 20e). Thereafter, as a greater proportion of succulent vegetation was included in the diet, pellets became more irregular, crenulated and softer with a distinct terminal projection until typical summer pellets were again prevalent. Grey to ochre clay-like pellets were found in warmer months in and near salt lick areas.

Pelage Characteristics and Shedding Patterns

The white guard hairs of the goat's shaggy coat are from 3 to 8 inches long on the adult. Cursory microscopic examination revealed a thin, transparent cuticle enclosing a reticulum of hollow cells, much as Couturier (1938) described for the chamois (Rupicapra rupicapra).

Longer guard hairs in the beard, pantaloons, and dorsal ridge contribute to the unique contours of the goat and enhance its apparent size. High intensity aggressive interactions assume a basic pattern of mutual lateral display involving erection of the dorsal ridge hairs and tense antiparallel circling.

The beard seems slightly better developed in adult males, and the pantaloons, or trousers, have a more flared appearance. The front knees, or radius-carpal articulation, are often marked with dirt from bedding activities. This soiled-knee area is more fully visible in adult females than adult males whose slightly longer guard hairs tend to obscure it. Sexual differences in coat development are poorly developed in 2-year-olds and indiscernible in younger animals. Full development of trousers, beard and dorsal ridge is not evident until about 3.3 years of age.

The thick undercoat is composed of twisted, interwoven hairs, the quality of which has been compared by Seton (1927), Wister (Whitney et al. 1904), and others to the finest cashmere. The depth and density of this wool, especially striking when handling trapped animals, make rapid heat loss extremely difficult. This partially explains the susceptibility of untranqilized goats to heat prostration during

trapping operations, as reported by experienced trappers such as Jim MacLucas of the Montana Department of Fish and Game (pers. comm.). Goats typically pant after sudden rapid exertions. Their thick, muscular build and short legs certainly favor climbing rather than sprinting abilities, but even goats walking slowly across cliffs in summer sunlight were seen panting continuously; goats bedded in direct summer sunlight exhibited the same open-mouthed and more rapid respiration.

It is not surprising, then, that I observed only very limited feeding and travelling activities during hot portions of summer days. Different investigators have quantified increased summer use of northern exposures (Saunders 1955, Kuck 1970, Peck 1972). This trend was also evident in the Swan Mountain goats and probably reflects habitat selection based on thermal qualities as well as forage composition and availability. Peck (1972) showed that mountain goats preferred shaded areas for all activities during July and August in the Spanish Peaks of Montana, and I found a preference for shade throughout most of the day, leading to increased summer use of timber types.

The goat's environment, particularly at higher elevations, includes frequent extremes of summer weather. Daytime temperatures of +90°F may plummet to freezing at night. Intense incident radiation plus that reflected from extensive rock surfaces and snowfields create high thermal inputs, yet snowstorms and prolonged foul weather can occur during any summer month.

Both Seton (1927) and Hanson (1950) noted the occurrence of brown hairs along the posterior dorsal ridge of some goats, particularly kids. Brandborg (1955) found scatterings of dark brown hairs in a kid and yearling, and Bruce Smith (pers. comm.), observing goats in the Bitterroot Mountains, noticed a dark dorsal ridge on one kid. That this brown stripe is progressively lost with age is considered evidence that it represents a vestige of the goat's ancestral coat. No other existing species of rupicaprid is white.

The goat's coloration most likely evolved as a camouflage in response to selective pressure from predators. Snow is present throughout the year in at least some portion of most goat ranges, and any observer can attest to the difficulties of picking out goats against a snowy background, or distinguishing goats from snow patches in summer. The fact that Dall sheep (Ovis dalli dalli), light-colored in summer, become snow-white in winter seems further evidence for selection of protective coloration. It is possible, however, that in a largely diurnal ungulate such as the goat which must maintain a very warm summer pelage, yet function at frequent high temperatures, there has also been some selection for light-colored pelage for its reflective properties during the warmest months.

During and immediately after spring and summer rains, goats may appear uniformly brown from bedding, pawing, and rubbing in dirt. Rutting males frequently dig pits, probably as a displacement activity, during the early rut, and can usually be recognized by the stain this leaves on the carpal joints and around the rump. By late winter, goat

pelage acquires a slight yellowish cast from accumulated stains and trapped particles. The yellowish tinge seems more pronounced in older animals, particularly males, and least distinct in kids.

Both inner and outer coats are fully replaced over summer except on kids, which continue juvenile growth of pelage. Signs of shedding appear as early as the first week of April. The process may not be completed until the end of August, though most animals have replaced the coat by mid-July-August first. Short yearlings have less conspicuous guard hairs, and their shedding pattern is less noticeable; but the sequence in which the old coat is shed is essentially similar for all age and sex classes. The rate at which the winter coat is replaced, however, varies.

Shedding patterns were sketched on a daily basis for purposes of individual identification as well as to describe the replacement process. Shedding is described in the following five stages, each of which is illustrated in Figures 21 and 22.

1) A rough or mottled area becomes noticeable in the foreshoulder region. Goats advance the shedding process by continual scratching, horning, rubbing, and biting; such comfort movements become frequent at that time. Reddish discoloration is often present at early molting sites. Brandborg (1955) discussed the opinion of Nicholas Kramis of the U.S. Public Health Service in Hamilton, Montana, that such discoloration is a stain produced by moistened tick excrement. Goats are known to carry large numbers of ticks. I found the border of shed and unshed area to be literally lined with ticks

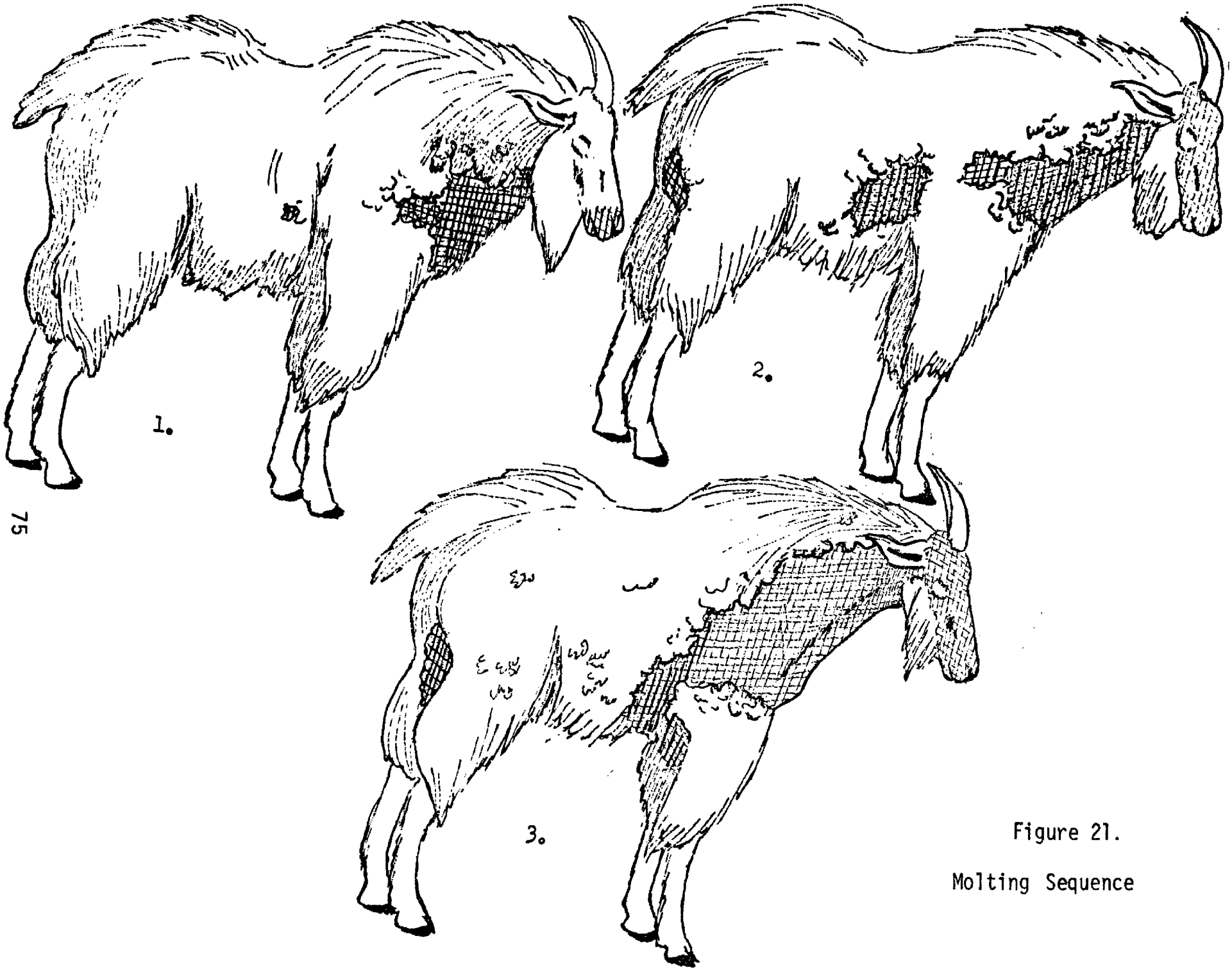
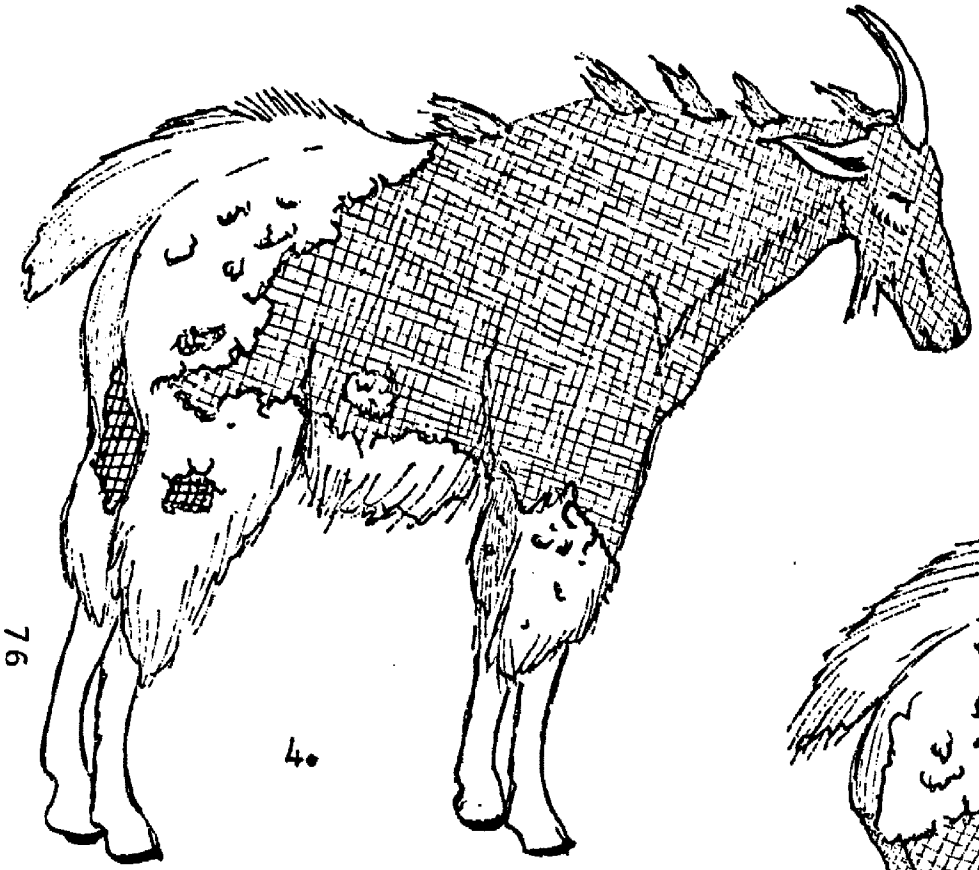


Figure 21.

Molting Sequence



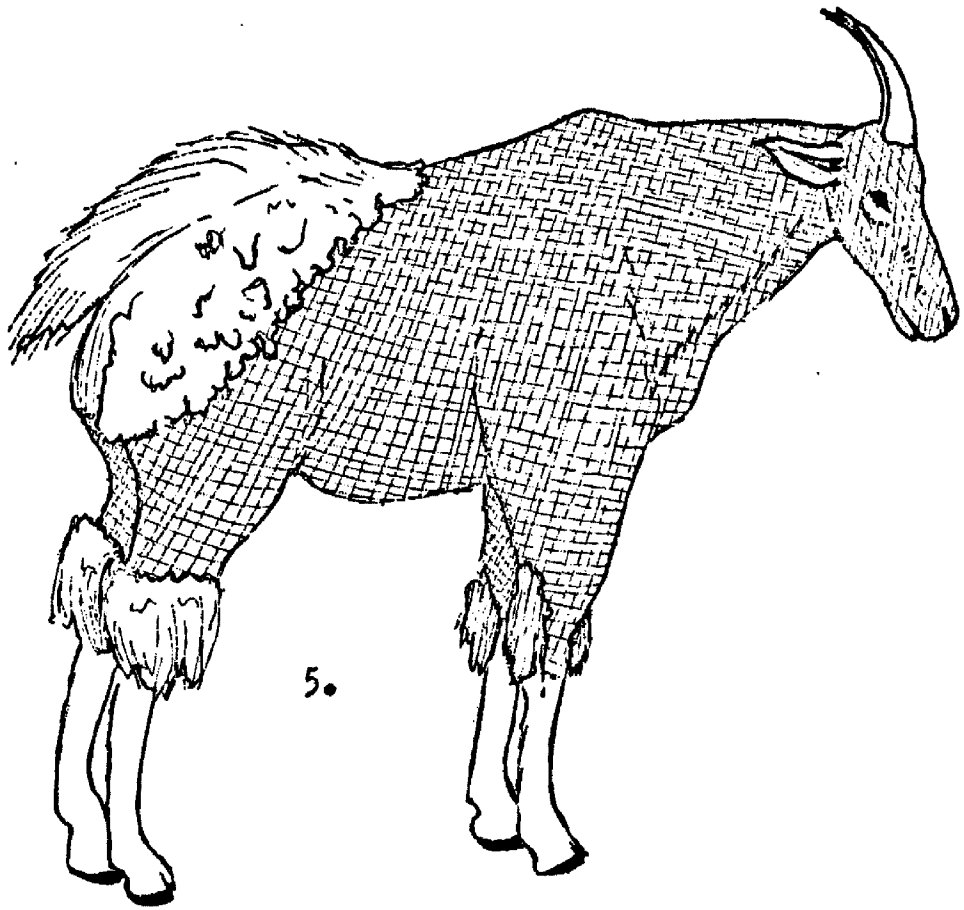


Figure 22. Molting Sequence

(Dermacentor andersonii). I removed as many as 100 ticks each day from my clothing when working in spring goat range. Red stains preceded actual shedding in other shoulder and neck areas, but were not observed once replacement was well underway. In its initial stages, coat replacement proceeds most slowly. Prolonged irritation from chafing hair, tick infestation, and continual scratching may cause some discoloration and local infection. Hair collected from vegetation and bedsites often retained patches of epidermis, scabby tissue, and dried blood as well as engorged ticks and pellets of tick excrement. Red coloration, then, may be derived from tick excrement, or it may be due to the presence of blood from local wounds, fluids from crushed tick bodies, or both.

The most extensive coloration appeared on 10-and 11-month-old kids. Mothers of some of the more seriously afflicted youngsters spent long periods, in one case, several hours, licking and nibbling hair from affected areas.

As more hair is shed from initial sites, bare skin becomes evident. Normally pinkish skin appears black where it has been impregnated with dirt from scratching and rubbing. As the bare foreshoulder area expands, mottling and small shed patches appear on the throat and sternal region. New white hair about the muzzle creates a sort of "minstrel mouth", and the beard is slightly diminished anteriorly.

2) Shedding extends throughout the foreshoulder. Rear shoulder patches develop. The throat area becomes bare, and patches are visible on the side of the neck, insides of the legs, and the chest. Ticks

continue to line the shed-unshed borderlines.

These first two stages require nearly half the total shedding time. Later stages proceed relatively quickly, and hair is lost in sheets and long strips. Short new hair rather than bare skin underlies newly shed surfaces.

3) Shoulder patches extend across the sternum up toward the dorsal ridge, so the animal is left with a floppy, yak-like mane. The beard is reduced to a goatee which, along with new chalk-white facial hair, imparts a striking countenance. Mottling (loose hair tufts) and patches appear posteriorly.

4) The anterior dorsal ridge is lost, though ragged remnants may continue to adhere. The beard disappears, and the underside is mostly shed. Contours of neck and shoulder musculature are visible beneath the new hair, and the scrotum is evident in males of all ages, including kids. Approximately half the old coat has been removed. The last half is rapidly replaced.

5) A goat in late phases of shedding has a "cottontail" appearance with fringes of guard hair remaining on the lower tibia and radius. The previous year's coat quickly becomes reduced to a few long hairs about the tail.

Brandborg (1955) noted that adult males and adult females without young completed shedding several weeks earlier that females with kids. Anderson (1940) stated that earliest signs of shedding were apparent about May 20th in Washington, and that the earliest date recorded was for a billy. In the Swan Mountains, I observed billies

and three barren nannies with very long horns, presumably older females, which lost the old coat 3 to 4 weeks before any other goats. Most adult males were completely bare by July, and some, by the first of June. Younger males were slightly more advanced than females of the same age. Short yearlings were the first to show signs of shedding among younger goats, but among the last to complete shedding. Older goats were generally more advanced than younger animals, with an important exception: pregnant nannies showed foreshoulder mottling about the same time as other females and subadults, but nannies with kids experienced very little further shedding during most of June and were, in nearly every case, the last goats to complete the molt.

In 1971, I found no exceptions to this disparity between adult females without kids and nannies which produced young in 11 to 13 mature females regularly observed in the Bunker-Little Creek range. In 1972, one adult apparently barren female, never seen to leave the herd to give birth, showed a replacement rate which paralleled that of productive nannies, but this was the only possible exception among 15 mature females. A 2-year-old female also showed a considerably delayed molt that year.

Lon Kuck (pers. comm.), studying goats in the Lemhi Mountains of Idaho, and Mike Vaughan (pers. comm.), observing a transplanted herd in the Wallowa Mountains of Oregon, both noticed a significant retardation of the molt in nannies with kids, and remarked that these were usually the last goats to become completely shed. It appears

that production and early maintenance of young is associated with significant retardation of the shedding process, and that this is a fairly widespread phenomenon. To the extent that this discrepancy is uniformly present in adult females, one could assume that those adult females without kids which are observed to be still largely unshed in the last part of June may have lost their young during birth or shortly thereafter. This might make possible some estimate of very early mortality within goat herds.

There are individual differences of considerable magnitude among goats of the same age and sex. Two 2-year-old females in the Bunker-Little Creek herd experienced the same diet and winter climate, yet were nearly 3 weeks apart in completion of molting. Other differences appear to be mediated by external conditions. In spring, the west side of the Swan Mountains is, in terms of snow depth, daily temperature, and plant development, about 2 to 3 weeks advanced over the east, or Bunker Creek, side. Accordingly, the molt for west-side goats proceeded about 2 to 3 weeks ahead of the Bunker-Little Creek herd. Members of a group first seen 29 July 1972 in the Middle Fork drainage exhibited shedding patterns seen nearly 3 weeks earlier in the Bunker-Little Creek herd. This group was assumed to have travelled from a higher altitude range in the Alcove Peak area. Similarly, goats observed 3 to 4 July 1972 at Sunburst Lake (elevation 7,000 to 9,000 feet) were considerably less shed than goats of corresponding age and sex classes from the Bunker-Little Creek herd (elevation 4,800 to 7,300 feet) at that time.

Couturier (1938) found both the onset of molting and pelage thickness in the chamois to be influenced by local habitat.

Coat growth is first evident anteriorly while the old coat is being shed posteriorly, and continues until undercoat and long guard hairs are fully replaced in about mid-October. Some beard regrowth was noticeable in males by mid-August. Regrowth of the dorsal ridge creates the impression of a cropped mane in all goats. Hair replacement is otherwise a gradual and inconspicuous process. New coats, particularly of subadults, appear very thick and bushy by fall. At that time, 3-year-old females without kids may look as large as or larger than nannies with kids whose regrowth began much later, and it becomes extremely difficult to separate 3- and 4-year-old females from a distance after full coat development. Pelage growth continues from birth in kids whose initial growth of dorsal ridge guard hairs is evident as a spiny projection in August.

Trap Data

Some physical measurements from trapped animals are presented in Table 6. Brandborg (1955) and Lentfer (1955) provide information on horn length and general physical characteristics. Although no permanent ring is formed the first winter, I noticed a distinct indentation approximately 2 to 2.5 inches from the horn tip in trapped yearlings and 2-year-olds. This sulcus, marking the length to which kids' horns had grown by winter, disappears in older goats.

Horns of trapped animals were quite warm near the skull. Several

Table 6. Trap Data

Date Captured	Age	Sex	Neck Circumference	Front Hoof Length	Horn Length	Tip Spread	Marking* Status	Designation
6-15-71	24 Mo.	F	--	--	6-1/4 In.	3-3/8 In.	TX	#10
8- 1-71	26 Mo.	F	13-1/2 In.	2-7/8 In.	7-1/2 In.	5 In.	TX	#100
8- 3-71	14 Mo.	F	13-1/4 In.	2-1/4 In.	4 In.	3-1/2 In.	Nylon Collar	#101
8-11-71	14 Mo.	M	14 In.	1-7/8 In.	4 In.	3-1/2 In.	Nylon Collar	#104
8-12-71	38 Mo.	F	17 In.	2-1/2 In.	7-7/8 In.	4-1/8 In.	TX	#103

*TX indicates radio transmitter designed by Cochrane (no date) and collar designed by Ream et al.(1971).

Nylon collars provided by the Montana Cooperative Wildlife Research Unit were of the type designed by Craighead et al.(1969) for marking elk. Plastic tape, 1 inch wide, was wound around one or both horns. Such colors as white and yellow were readily visible from a distance with the aid of a telescope and are still evident on all marked animals after 2.8 years.

5 additional animals captured recently during summer of 1973 have not been included. Radio transmitters were placed on a 2-year-old female and a 2-year-old male. Braided nylon collars were placed on a 2-year-old male and two yearling females. As in 1971, older animals appeared more reluctant to lick salt near or in traps.

horns were slightly movable on the bony core, perhaps loosened during struggles in the trap, though all trapped animals continued normal horn development. Broken and asymmetric horns were observed in several other animals. One hunter reported a 4-year-old female taken from the area with horn lengths of 7.5 and 8.25 inches. The influence of the crescent gland on horn growth, if any, is unknown. Descriptions of post-cornual glands examined are given in Table 9.

Rumination

Goats usually begin ruminating soon after bedding, though preceeding conditions of disturbance, irregular feeding periods, or other factors may delay its commencement. Onset of rumination is typically presaged by relaxation from an alert posture. One or both forelegs are then extended and the body weight shifted to one side while the goat yawns; the tongue flickers in and out several times, a few partial chews are made, then regular rumination begins. Sometimes several convulsive regurgitation movements are made before a bolus is successfully brought up.

In the absence of disturbance or general discomfort due to insects and the irritations of shedding, rumination is a monotonous event which generally continues from 20 to 45 minutes. Goats recommence rumination after intervals of approximately 30 to 60 minutes throughout the bedding period. In a usual bedding period of 1.5 to 3 hours, there are usually two or three rumination sequences.

As each bolus is coughed up, the ears tip forward, and skin

over the brows and cheek bulges. Chewing begins slowly, reaches a constant rate for most of the bout, then becomes fairly rapid toward the end as vegetable matter is reduced. There is generally a 4 to 10 second interval between chewing bouts, younger goats requiring shorter times than older animals.

Constancy of chewing rate within bouts leads to consistency of rumination rate from bout to bout. As an example, a typical series of 28 chewing bouts during a rumination sequence of an undisturbed 2-year-old female yielded an average rumination rate of 1.56 chews/second with maximum and minimum rates of 1.71 and 1.40, respectively, and a standard deviation of 0.085 chews/second. Extreme regularity of rumination was often seen as in a relaxed 3-year-old male for which a count of eight chewing bouts revealed precisely the same number of chews (30) in each bout with only a 3 second variation in durations. Mastication is slowed when a goat is alerted by low-intensity stimuli, and temporarily halted in more pronounced alert responses and during some comfort movements. The bolus is abruptly swallowed when the animal is suddenly alarmed. Very alert goats chew more rapidly than usual, and drowsy animals tend to chew more slowly. Also, at the beginning of a rumination sequence, bouts tend to be more irregular and slower than average. On the whole, however, rumination rates were found to be reasonably constant. An average chewing rate derived from four to six bouts of a relaxed animal, excluding first bouts of a sequence and those interrupted by alert responses and comfort movements, provided a

representative rumination rate for that animal.

Kids were first seen ruminating shortly after they began taking forage in the first week after birth. Rumination rates of kids are quite rapid and thereafter decline in a regular fashion with increasing age. Figure 23 illustrates the relationships between mean rumination rate and age. Though the means are separate, considerable overlap of individual rates results from the arbitrary separation into distinct age classes of animals only a month apart. This can be partially adjusted by presenting rumination rates on a monthly basis as in Figure 24. A better segregation of age classes results, but there is still frequent overlap. More sampling of different age classes is needed to determine whether significant differences exist. Incomplete information provided may still prove useful in conjunction with other field-aging criteria. I found that rumination rates could be observed from considerable distances and were helpful in establishing at least adult or subadult status where horn length or size, as in a bedded goat against a dark background, were not apparent.

No particular preference was shown for one particular direction in the sideways, or pterygoid, component of mastication. Nearly equal numbers of animals chewed from left to right as right to left, and the same individuals were observed chewing different direction in different sequences, eliminating this trait as a possible means of separating two similar individuals.

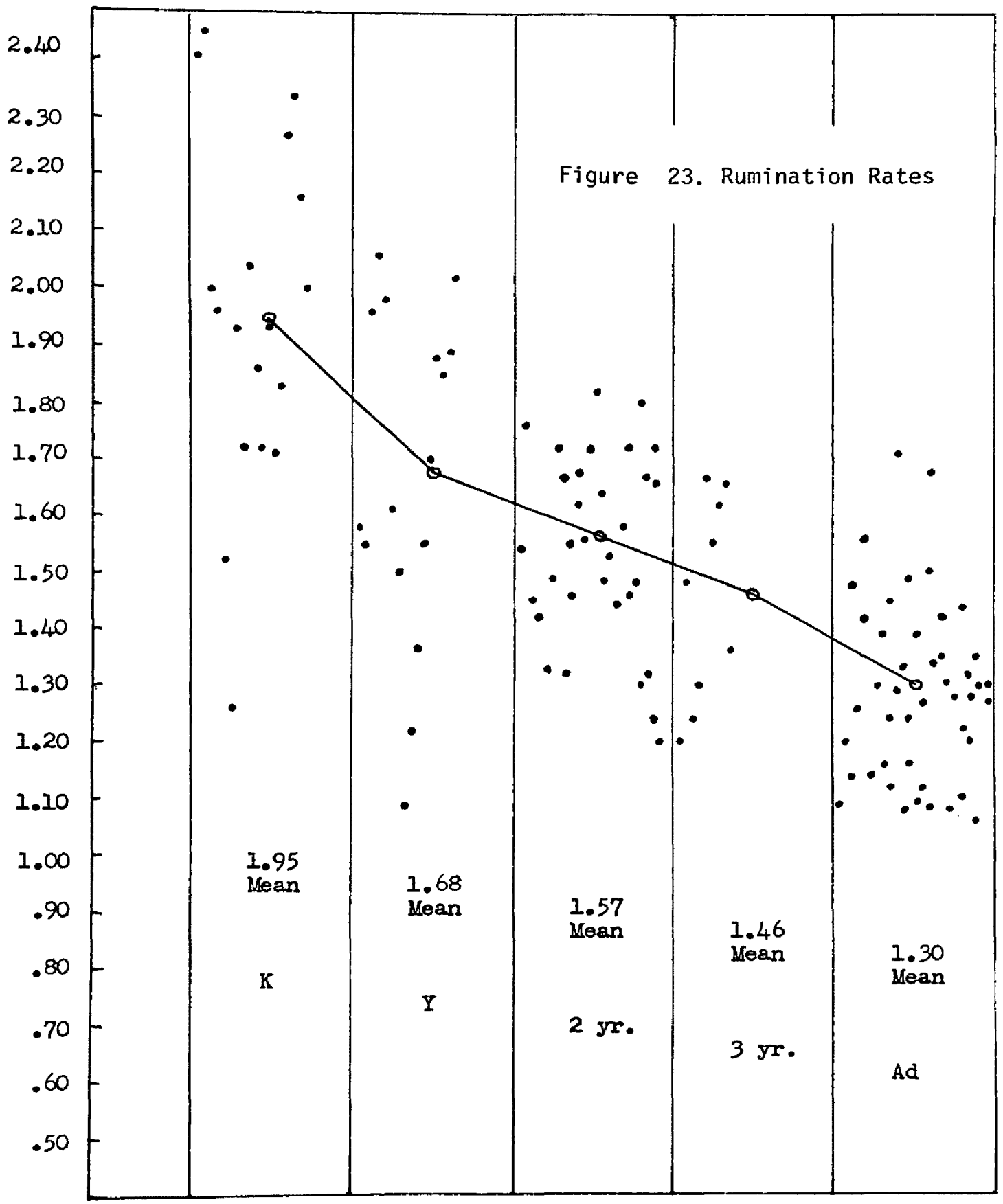


Figure 23. Rumination Rates

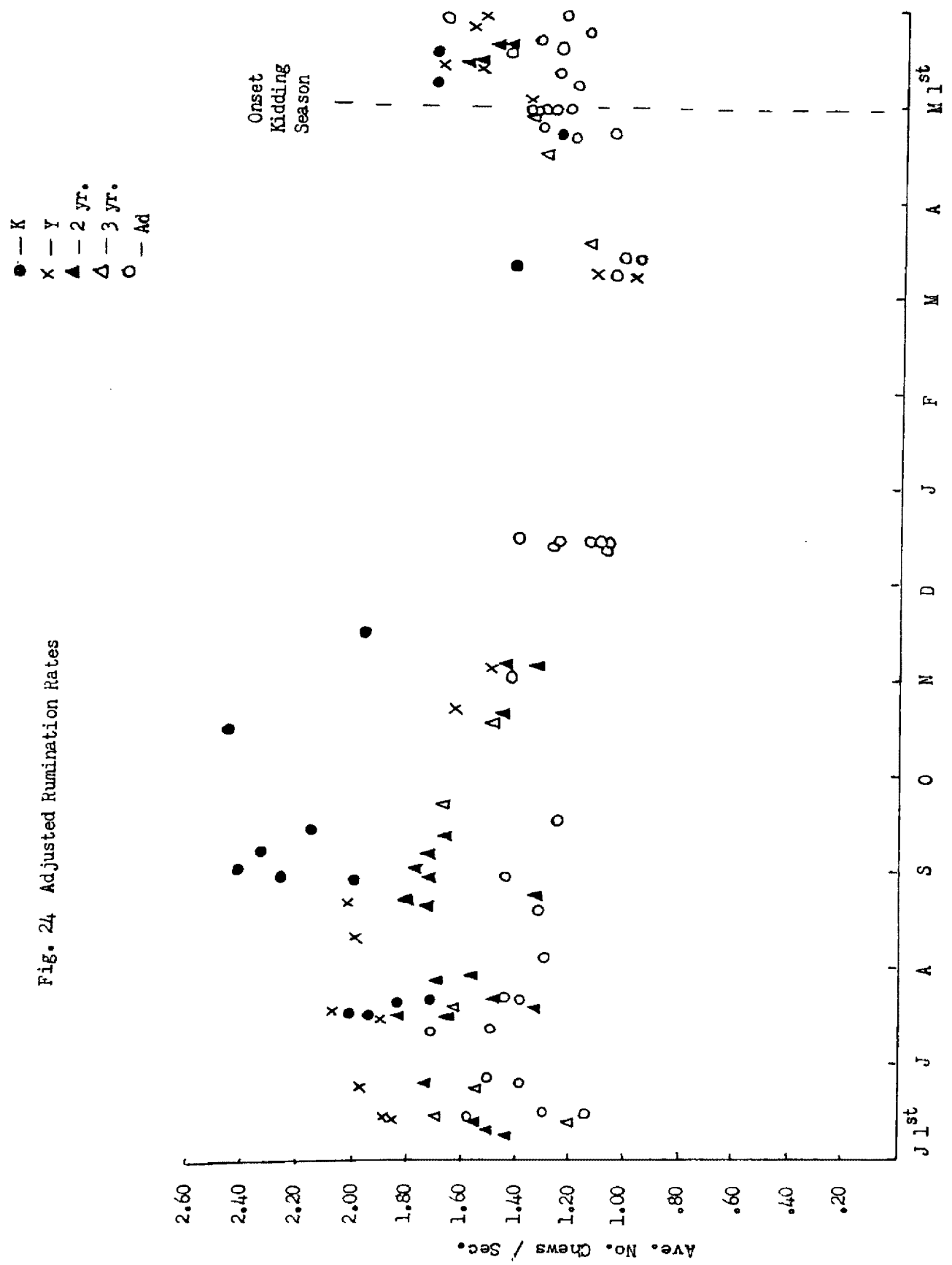


Fig. 24 Adjusted Rumination Rates

Climbing Ability

The form of the mountain goat is well suited to a habitat of narrow ledges and promontories. Short cannon bones, which alone readily distinguish a mountain goat skeleton from those of other other ungulates in its range, bring the body close to its points of support. When viewed anteroposteriorly, the legs appear bowed toward a common base; and when viewed laterally, the rear and front legs are directed toward one another; so a typical stance requires only a limited pivotal area.

The anterior musculature is highly developed; the rump is small by comparison, and the center of gravity is well toward the forequarters. As a result, goats can easily pivot their hindquarters about in a limited space. The culmination of this ability is perhaps seen when goats unable to turn around on narrow, tapering ledges literally perform handstands and walk their hindquarters completely over their heads until they face the opposite direction. Goats are also able to hook forelegs over ledges and pull themselves up as the rear legs spin until a foothold is caught.

When descending precipitous areas, goats squat on their haunches and extend forelegs tentatively down the wall in search of a foothold. The rump and rear legs provide traction, and a marked use of dewclaws is evident from tracks on loose soil and snow. The toes spread widely to direct pressure laterally in opposing directions. A measure of this separation can be seen in bedded goats which extend a foreleg while yawning and spread the toes under considerable tension. Rough pads

which protrude past the horny portion of the hoof provide important traction and some flexibility. This major adaptation, coupled with other climbing abilities, is quite important in allowing mountain goats to exploit the windblown outer edges of steep ledges while foraging in winter.

The goat's pace is normally a deliberate, plodding walk, and, consistent with good mountaineering practice, only one leg at a time is removed from the substrate when proceeding in difficult areas. The head is generally carried at the level of, or just slightly above, the knees. In addition to their mastery of conventional climbing skills, goats are capable of leaping from foothold to foothold. They occasionally traverse areas they are unable to climb gradually in spectacular, largely aerial, maneuvers, bounding off sheer walls to direct their momentum.

Goats frequently appeared to assess a climbing situation before proceeding. Individuals commonly stood in an attention posture or with forelegs braced on an overhead ledge to survey their prospective route before proceeding or, as often happened, rejecting that route and backtracking. In critically steep situations, goats showed signs of fear; flattened ears, erect tail, and a crouched posture. Goats of all ages showed signs of frustration upon reaching temporary impasses. Young animals in particular tossed their heads and pawed. Temporarily trapped animals exhibited head-swinging, pawing, and erratic feeding and bedding.

A female first observed in Bunker Creek as a 3-year-old (#103)

showed a certain reticence to proceed in steep areas. Her general behavior was somewhat atypical in that she spent many hours making hesitant and apparently aimless movements on cliff faces, standing for long periods sniffing rocks and rubbing her head along them. Such meanderings were also seen at times in other individuals, particularly when travelling alone, but they were characteristic of #103. She also behaved in a subordinate manner to aggressive yearlings and 2-year-olds, an unusual occurrence, before producing a kid in 1972. On different occasions, she became trapped for hours in precipitous areas other goats quickly extracted themselves from. She would make hesitant runs and as many as 50 aborted leaps before finally freeing herself.

The role of climbing accidents in mortality is difficult to assess. Goats spent less than 25% of their time feeding and travelling in cliff areas judged to be dangerously steep. Mountain goats have been observed falling to their deaths (Seton 1927), and it is tempting to speculate on the probability of a serious misstep during a lifetime of climbing, the chances of encountering a flimsy snow cornice, a loose or crumbling rock, wet, mossy rocks, or icy ledges with lethal results. In winter, goats fed at the very edges of most ledges where snows were least deep. As also noted by Brandborg (1955) and Hjeljord (1971), goats exhibited a propensity for walking on overhanging cornices, probably because this afforded the best view of the area below. Broken horns, most likely indicative of falls, are not uncommon in this species. I observed a yearling and three

adult females with broken horns in the general Swan Mountain study area, and one young billy with highly asymmetrical horns was seen. Four females were observed limping for periods of a few days during the course of the study. In 1973, a nanny was observed walking on only three legs for over 3 weeks. Brandborg (1955) reported that nearly half of the 25 carcasses found during his investigation were at the bases of cliffs.

I recorded each slip or fall witnessed during daily observation. Any misstep, whether on wet logs or talus slopes, open, flat meadows or steep rock faces, was counted if it caused a goat to lose its balance and stumble. (Goats frequently misplaced or lost their footing beneath a single leg, yet maintained overall balance). An accidental misstep does not include scrambling, leaping maneuvers resulting from direct assaults on difficult routes and does not include slips and falls resulting from aggressive encounters. In some 4,400 goat-hours of observations of non-bedded animals, I witnessed only 29 missteps with a distribution as shown in Table 7 below. Kids were

Table 7. Climbing Missteps

	Class									
	K	Y	2♀	2♂	3♀	3♂	Ad♀	Ad♂	Unid	Total
No. Slips	5	5		3			9		7	29

not included until autumn (3 months of age) to avoid inclusion of missteps during early development.) Table 7 is not adjusted to account

for the fact that age and sex classes were not equally represented. None of the observed missteps was injurious; only 5 occurred in critically steep terrain, and the majority (17) resulted from adverse climbing conditions on ice, snow, and wet terrain. This tabulation is a result of arbitrary judgements, but even the most generous interpretation of a misstep would still bespeak a remarkable sure-footedness in these animals. Brandborg (1955) commented on the paucity of climbing accidents seen in many hours of observation.

Whereas older goats usually approached difficult climbing situations in the methodical manner described, subadults exhibited more direct assaults and less caution in climbing, and provided most of the frantic mid-air reversals and leaps to safety witnessed. Younger goats, kids in particular, tended to negotiate areas in an all-or-nothing fashion. This sometimes amounted to little more than a scarcely controlled fall. Young goats lacked both the physical ability and experience neccessary to encounter formidable routes in the deliberate fashion of older animals. It was my impression also that younger goats, whether through experimentation or lack of familiarity with local cliff terrain, most frequently placed themselves in difficult mountaineering situations. Kids and yearlings experienced the greatest difficulty with crusted and granular snow on steep terrain as they lacked sufficient weight to penetrate it and gain good footing. New kids often refused to follow their nannies across steeply sloping snow patches.

Relationships with Non-predatory Animals

Mountain goats followed the scurrying of familiar small mammals and the flights of birds with limited interest. Drowsy bedded goats scarcely paid any attention to squirrels or jays passing close to their noses, though one bedded goat which had been run across by a bold or unobservant ground squirrel sprang to its feet with violent horn thrusts. As might be expected, solitary goats or animals in tense situations were most likely to be startled by the activities of small animals. Nannies with newborn kids reacted most intently to disturbances of any type. One nanny with a 2-day-old kid charged a Columbian ground squirrel as it neared their bed. Another rushed to her infant as a Clark's Nutcracker (Nucifraga columbiana) flew close to it. As mentioned in the section on Predation, goats often showed strong defensive reactions to sudden overhead flights of familiar birds. Goats otherwise seemed habituated to the presence of resident birds. Clark's Nutcrackers were the most active and prominent birds on cliff areas throughout the year, particularly on winter range where they fed in close association with goats, much as they and Black-billed magpies (Pica pica) often accompany mountain sheep. Nutcrackers repeatedly signalled our presence on cliffs by mobbing. I was unable to satisfactorily determine whether goats made use of this signal or the warning whistle of Columbian ground squirrels.

A confrontation occurred one May morning between a booming blue grouse (Dendragapus obscurus) and a young billy in a small opening

above a cliff face. The grouse refused to yield right of way as the billy proceeded toward it, then continued to display as the billy made false starts toward the grouse. The young male began a war dance (a series of twisting, leaping horn-thrusts) in the direction of the grouse, and the bird at last began a slow retreat. At this point, the goat slashed its horns against a large log balanced precariously on the cliff edge. The log, loosened from its moorings, went crashing down the cliff, startling the billy and considerably hastening the grouse's departure.

On the North Fork of Bunker Creek, a herd of at least 25 to 30 elk regularly used south-facing cliff areas in spring and early summer of 1971 where forage was most abundant. They shared major trails and many feeding areas with goats, though they bedded more often in brushy and timbered habitats whereas goats bedded near the edge of exposed outcroppings. Goats and elk often fed within 200 feet of each other, and neither species behaved as if it were aware of the other. On Little Creek, elk range overlapped that of goats in lower ravine areas near timber in spring and summer, and in dry meadow habitat in fall. Both species used subalpine-alpine meadows throughout the study area in summer and early fall, but interactions were not observed there. In Little Creek, as in Bunker Creek, the two species paid little attention to one another. Two exceptions were considered noteworthy. In the presence of a large bull elk, three nannies trotted quickly away to round up their playing youngsters and flee, but they were almost entirely unsuccessful, as the kids continued

to play, and the bull eventually wandered away. In July, a cow elk walked into a group of eight bedded goats atop a cliff area. She fed back and forth amidst the goats which, after initially retreating, returned to their bedsite. Some goats showed only limited interest in the intruder, while others displayed and performed displacement pawing and war dancing. A yearling and adult female appeared most excited. Both made mock charges at the elk and bedded with vigorous pawing in its path. Kids regarded the elk briefly, then returned to playing with one another. The yearling trotted a short distance after the elk as it left the group after about 2 minutes.

Elk utilized a lick site separate from goats on the North Fork of Bunker Creek. Cow elk, mule deer, and goats used the same salt lick throughout June and July near Little Creek. Each species directed frequent aggressive activity toward conspecifics. In inter-specific conflict, goats were easily dominated by elk, but goats successfully routed deer from the lick in most cases. One adult female goat left the lick as a mule deer approached, and the deer followed her for several feet, then returned to lick. Elk usually walked or trotted at goats impinging on the lick, though direct stares were often sufficient to discourage the mountain goats from approaching. Nannies with kids were seldom seen near licks when elk were present. Younger animals and adult females often stood or bedded at the periphery within 20 feet of the elk, making occasional forays to the edge before being chased away. One yearling ran playfully at an elk, then retreated as the elk turned to give chase.

As snows melted in creek bottoms and on ridgetops, elk ceased to use cliff areas for feeding. They could be considered real competitors of goats only for a short time in fall as they fed with them in dry bunchgrass meadows, consuming a good deal of available forage there. But because elk wintered on different ranges, and because goats in other months spent the bulk of their feeding time on cliffs rarely visited by elk, neither was thought to significantly influence the other's food supply. Mule deer were present in limited numbers throughout goat range except in winter months when they shared other ranges with elk. Though they were occasionally seen in precipitous terrain, mule deer, like elk, were not considered important competitors of goats in the study area. Bighorn sheep, present on the east side of the Bob Marshall Wilderness, did not inhabit the Swan Range study area, possibly because nearly all of the higher range there is buried by deep snows during winter months except for south and west-facing precipitous areas occupied by goats.

Columbian ground squirrels removed large amounts of summer forage on the cliffs and in meadow areas, effectively harvesting nearly every stalk of certain favorite species such as the different herbaceous penstemons. No attempt was made to measure their net consumption.

Comfort Activities

Geist (1971) states that "Mountain goats show comfort movements exceedingly rarely, and when they do, they appear clumsy and inept." This is at variance with my observations in the Swan and Bitterroot

mountains of a variety of comfort movements exhibited by mountain goats throughout the year. During late spring and summer, comfort activities constituted a major occupation of goats in the Swans.

An upsurge of comfort movements came as a prelude to the first signs of shedding in late March and April. Thereafter, the twin irritations of shedding and insects compelled frequent body care behavior. The average time spent performing non-bedded comfort movements during 171 intensive 5-minute observations of feeding individuals taken at random intervals from late May until September is shown in Table 8. These figures do not include dustbathing or typical

Table 8. Average Time (Seconds) of Comfort Activities in 5- Minute Feeding Interval

MAY	JUNE	JULY	AUG	SEPT
5.8	4.4	3.7	2.0	1.2

comfort movements performed in bed, both of which were significant summer activities. Feeding and bedded comfort movements declined throughout the summer, remained at low levels during winter months, and probably reached a peak in early May which was considerably higher than that shown in the table above taken during late May. Since average performance time for most comfort movements varied from 2 to 4 seconds, the May figure given implies from 17 to 35 individual comfort activities per goat per hour. When one is observing a large group of animals with corresponding rates, comfort movements appear to be quite common.

Ticks infest goats throughout fall and winter months. Scratching, horning and rubbing were seen in winter. Limited observations of goats on winter ranges in the Bitterroots during the light snow winter of 1972-1973 revealed high rates of scratching, comparable to late summer in the Swan Mountains.

Three general statements can be made concerning comfort activities: 1) young animals were usually more active than older goats in this regard; 2) a contagious element caused the performance of comfort movements to spread throughout groups in visual contact; and 3) nearly all specific comfort movements seemed to reflect general activity levels and also occurred in conjunction with many conflict situations as displacement activities. High frequencies of activities such as scratching, horning, and rubbing or shaking occurred in conjunction with low-intensity approach-withdrawl situations. For example, a young goat hesitating to pass a dominant animal on a narrow ledge would alternate between staring at the older goat and scratching; and, when stared at by the dominant goat, might turn its head quickly away and engage in a concentrated bout of head-shaking and scratching. Bedded goats would suddenly begin pawing and horning or scratching intently as other goats approached aggressively. In high-intensity agonistic conflicts, goats often bedded and dustbathed vigorously, then rose and war-danced and slashed vegetation. Trapped goats pawed (stamped) violently when approached by us. Two animals trapped in a cage suddenly terminated aggressive threats toward us and placidly licked salt or nibbled vegetation for several seconds.

Goats stretch after rising from bed to begin feeding or sometimes before simply rebedding. The back becomes curved downward as the goat walks forward a bit with its front legs while leaving the hind legs in place. The tail is stiffly extended or upraised and sometimes jerked stiffly from side to side. The neck is also extended while the chin is either drawn inward toward the neck, as in bighorn sheep (Geist 1971) and domestic goats, or protruded with curling of the upper lip. The duration of this muscle toning activity is generally about 3 seconds. It may be prolonged as much as 10 seconds and performed with considerable muscular tension, especially in males.

The goat performs a short, vigorous body shake in a slightly crouched position. Head-shaking is an independent movement, though it quite often follows immediately after body-shaking. This activity is important in reordering the long shaggy hair after bedding and after comfort movements. Head-shaking is also employed to disperse insects. Shaking occurs with the greatest frequency during rains, dispelling water and restoring the loft of insulating pelage.

Vertical flicking of the tail occurs in stress situations and shifts of position. This was also observed in elk and mule deer. Linsdale and Tomich (1953) note that tail-switching in mule deer is a sign of impending action. I have also observed this mannerism in domestic goats. Wagging of the tail from side to side appeared in response to irritations of the anal region and was seen in mountain goats during peaks of insect abundance and occasionally after defecation.

The ears are batted forward alternately or simultaneously to dispel insects from the eyes and ears. This activity appeared with head-shaking when insects were especially bothersome. By way of addition to the annals of scientific detail, I counted the number of ear bats in 60-second intervals for 3 goats of different ages on extremely buggy days. Number of ear bats per minute were 90, 40, and 79.

Goats licked their lips from time to time while feeding and drinking. As a prelude to rumination, bedded goats typically yawned and licked their lips several times. Goats under stress evidenced tongue-flicking. Goats on the verge of fleeing disturbing stimuli or negotiating a difficult rock wall flicked their tongues in and out. I also observed rapid darting of the tongue in and out of the mouth in mule deer and elk in association with excitement and apprehension. Tongue-flicking appeared during courtship by males and was described in that context by Geist (1964).

Goats licked and nibbled loose fur during shedding. Inguinal and flank areas, rear legs, and rump were often groomed by licking and rubbing with the muzzle. Loose hair was removed by pulling with the lips in a circular fashion. Males in particular seemed to lick their forelegs when excited.

All observations of social grooming involved licking or nibbling activities. Mother-infant relationships involved licking and nuzzling, quite frequent at first, as discussed in the section on the kidding season, and continuing throughout the year. In spring, some nannies

were seen licking and nibbling hair from reddish-stained neck and shoulder areas of kids. Nanny A ministered in this manner to her youngster for 2 continuous hours in May. Adult females licked and nuzzled adopted yearlings. One adopted yearling regularly returned its nanny's attentions and was observed on June 20 in a group of bedded goats licking the faces and necks of 2 other yearlings which accepted its attentions passively for several minutes before giving mild horn threats. Social grooming plays an important role in courtship. On 25 June, #104, a 2-year-old billy, courted a 2-year-old female much of the day. In the afternoon he bedded close behind her, leaning his chin on her back, then licked her back and nibbled hair from her shedding dorsal ridge for 15 minutes despite mild horn threats by the female. Males commonly nuzzled and licked the back, neck, and face of bedded females during the rut; and most courtship approaches involved nudging and licking of the female vulva.

Scratching is the most common comfort activity. It was observed frequently throughout the year and became a dominant activity during the shedding period. Rear legs were employed to reach most areas of the forequarters, neck, and head. Inanimate objects such as rocks and projecting twigs were rubbed against, and the face was rubbed between the legs, in loose soils, and in vegetation. Neonates often fell while attempting to scratch difficult areas, and all goats bedded to scratch at times. Even after many hours of observation, it was always disconserting to watch goats balanced at the edge of a chasm calmly lift a rear foot and scratch the top of their head.

Horns are used to reach areas on the back and sides, particularly when bedded. Cotton-like tufts of wool remaining on horn tips gave further evidence of this type of horning.

Goats were observed rubbing and slashing their horns in shrubbery, hummocks of grass, and sometimes in loose soil and snow. It needs to be determined whether scent-marking with the post cornual, or cresent, gland is the primary function of such activities, and what role, if any, the spreading of such secretions plays, particularly during the rut.

Horn-slashing, i.e. rapid rubbing or butting, in vegetaion was first noticed in a 4-day-old kid. A kid observed on June 23 rubbed its horns in a grass clump where another goat had performed the same activity, though it is doubtful that the crescent gland is functional, or even evident, at this age. Some external descriptions of cresent glands from goats of various ages are presented in Table 9. Hunter kills were not examined personally.

All animals older than 4 years of age examined or reported by hunters and checking station attendants had typical adult post-cornual glands: hard, dark, and growing in close contact with the posterior basal portion of the horns.

Table 10 represents all instances of horn-slashing or rubbing observed, from slow rubbing of head and horns to violent slashing, with all intermediate degrees included. This activity was not always recorded for kids; kids therefore have not been included with other age groups. On the whole, kids exhibited this behavior less often

Table 9. External Appearance of Cresent Glands

Age	Sex	Source of Information	Description
Fetus	-	Brandborg	Not present
1 Day	-	Brandborg	Not evident
13 Mo.	M	Trap '73	Grey-black, small, soft, thin, set back from horns
14 Mo.	M	Trap '72	Blackish, small, thin, set back from horns
13 Mo.	M	Trap '73	Light grey, small, soft, set back from horns
14 Mo.	M	Trap '72	Pinkish, small, soft, set back from horns
24 Mo.	M	Trap '73	Grey-black, soft, small and separate from horns, but less so than in yearlings
25 Mo.	M	Trap '73	Grey-black, soft, small and separate from horns, but less so than in yearlings
24 Mo.	F	Trap '72	Pinkish, soft, larger and closer to horns than in yearlings
26 Mo.	F	Trap '72	Pinkish, soft
38 Mo.	F	Trap '72	Pinkish, soft, medium-sized, in contact with posterior horn base
40 Mo.	F	O'Gara	Dark, adult appearance
51 Mo.		Hunter kill	Pinkish center, dark edges, soft

than other classes of goats.

Table 10. Instances of Horn Rubbing
March 1971-Sept. 1972

Month	Class										
	Ad♂	3♂	2♂	Y♂	Nwk	Ad♀	3♀	2♀	Y♀	Y?	Total
Mar. '71											0
Apr.											0
May	1	2									3
June	3	3	4								10
July		1	4		2		2			1	10
Aug.									4	1	5
Sept.											0
Oct.							2				2
Nov.											0
Dec.										1	1
Jan. '72											0
Feb.											0
Mar.											0
Apr.										1	1
May			2	1		5	2	2		3	15
June	1	3	4		4	24	5	7		8	56
July			3	11	5	4	6	6	3	3	41
Aug.			1								1
Sept.								1			1
TOTAL	5	9	18	12	11	33	17	16	7	18	146

Total of Males=44; Total of Females=124; Total Y? = 18

Seton (1927) and Anderson (1940) associated increased secretion by the horn gland with the rutting period and Seton described frequent horn-slashing at that time. Geist (1964) noted vegetation-slashing and marking by rutting males in association with agonistic displays and by solitary billies, and felt that this might serve as an olfactory intimidation mechanism. In contrast, Brandborg (1955) states that "...male mountain goats were not observed rubbing their horns against

shrubs during the rut in the manner described by Seton, nor on more than a few occasions at other times." Couturier (1938) established a relationship between post-cornual gland activity and sexual activity in the chamois, but I found no evidence of increased gland activity as expressed through horn-rubbing and slashing by mountain goats during the rut.

All but five records of horn-rubbing came from May through August. Although males were poorly represented on the range during most observations, it is apparent that females performed a significant percentage of horn-rubbing. Differences in color and other qualities of the cresent gland described in Table 9 were not evident as differences in horn-rubbing rates by various age classes in Table 10. If rapid summer horn growth or related secretions at the time were a primary cause, then younger goats experiencing the greatest amount of horn growth would be expected to perform these activities most frequently, and this was not evident. Young goats did appear to scratch the crescent gland area more often than older goats, but young goats tended to do more scratching in general.

Concentration of horn-rubbing and slashing in summer months could be correlated with an increase in general activity, and increased group sizes and rates of aggression. As Geist (1971) noted, such behavior was often associated with agonistic activity. Even as a spontaneous event in solitary animals, horn-rubbing, like war-dancing, could be considered to represent aggressive potential.

Slashing of snow occurred with war-dancing on snow patches in summer. Most horn-rubbing occurred in large and unstable groups as a contagious activity while feeding, and during dominance fights.

Geist (1971) noted that bighorn sheep of all age and sex classes horn vegetation. Similarly, some of the activities in question might be viewed as a form of horn-tossing by mountain goats toward inanimate objects. However, some horn-rubbing would seem to have an olfactory role as implied by Geist's (1964) observations of different males not in visual contact with each other rubbing horns at the same location. Similarly, our observations revealed a large percentage of horning by goats of all age and sex classes occurring at sites known to have been previously horned by one or more individuals. In addition, many individuals sniffed and pawed bushes or grass clumps before and after horn-rubbing, and some appeared to rub their faces in the horned vegetation. On only two occasions, however, could goats have been considered as carefully marking a twig or grass stem by drawing the crescent gland slowly across it as Geist (1964) observed.

During summer, before bedding on loose substrate, goats usually scraped the site with their forefeet. This activity removed surface litter and exposed a cooler layer of soil, whether or not it was primarily intended for such purposes. Most scraping was accomplished with the uphill forefoot, and on sloping areas this created a more level bedding depression. A few individuals pawed beds in loose snow, creating a more level and sheltered site. In nearly all spring and

summer beds, goats regularly pawed immediately after bedding with the downhill forefoot and performed some dustbathing movements. In some high-intensity conflict situations goats stamped their forefeet, and it appeared that this was a modified and extremely forceful scraping or pawing movement. Intermediate strengths of pawing were evident in lower-intensity conflicts. Pawing occurs in a different context during winter to expose vegetation beneath snow.

Dustbathing is a specialized behavior which occurred almost exclusively in late spring and summer. Extensive pawing, primarily with the downhill forefoot, was done while bedded in loose, sandy soil. The downhill rear leg was lifted outward to expose the groin to showers of dirt thrown across the rear and ventral portions of the body. Horning, rubbing, shaking, or scratching immediately followed pawing in most cases. Goats remained in these dusty beds alternately pawing and performing other comfort movements. Goats also occasionally sniffed freshly pawed soil and rubbed their faces in it. Frequent rebedding allowed both sides of the animal to become impregnated with soil particles.

Dustbathing occurred as a distinct activity in open areas with loose sandy soil used exclusively for that purpose. Here goats occasionally remained bedded to ruminate and sleep, but more often left, after dustbathing. Dustbathing also occurred in normal bedding areas with adequate loose soil. In these sites, goats periodically dustbathed and performed related comfort movements, ruminated, and

slept. Anderson (1940) and Brandborg (1955) reported some dust-bathing-type activities in snow patches on summer days.

In many instances, goats pawed forcefully with alternate fore-feet while in a squatting position. The forcefulness, extent, and position of the pawing component of such dustbathing activity could not be distinguished from pawing of rutting pits by males and a few females during the rut. Dustbathing was a dominant activity throughout many summer days. At times, it seemed that the sum of sensory input from shedding irritations, insect annoyance, and self-stimulation through related comfort movements combined to release a frenzy of activity. Goats sometimes increased dustbathing movements to a frantic pace, then leapt from bed and began war-dancing and slashing vegetation. This occurred in goats of all ages and sex classes. At times the presence of other goats seemed to stimulate such outbursts, but they were also observed in solitary animals. Whether humidity itself or concomitant hordes of insects influenced such eruptions of aggressive and body care behavior is hard to determine. Harper et al. (1967) described erratic aggressive behavior in Roosevelt elk in association with humid summer conditions.

Upon rising from bed, mountain goats usually eliminated both feces and urine before travelling more than 50 to 75 feet. During long bedding periods, some animals temporarily left their bed, travelled a short distance and excreted waste material, then returned to rebed at the same site. Well-used bedding areas were littered with pellets, and some winter beds had pellet accumulations nearly 2 inches thick.

Similarly, as bowels were voided while feeding and travelling, major trail systems were more or less paved with pellets.

In both sexes, pellets were usually observed passing from the anus while the animal remained in normal feeding postures with only a raised tail and perhaps a brief cessation of other activities to signal the event. Goats occasionally squatted to various extents while defecating, usually at the beginning of that activity. More crouched postures were associated with longer defecation times and, presumably, with increased difficulty in voiding fecal matter. Defecation usually took 5 to 20 seconds, and occasionally much longer to be performed.

Urination lasted from 20 to 30 seconds, and several instances of over 50 seconds were recorded. The longest continuous flow recorded was 80 seconds; all in adult females. The urination posture itself was assumed from 7 seconds to 2 minutes. Not surprisingly, younger

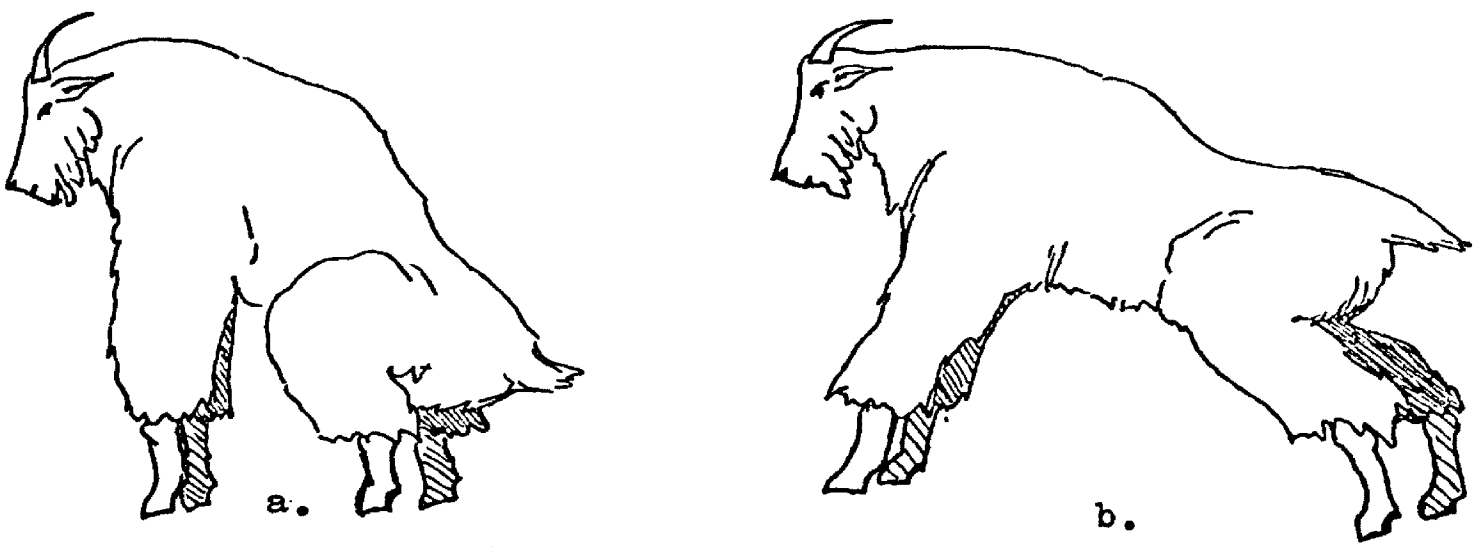


Figure 25. Urination Postures

animals had shorter urination times. Females squat with the tail partially upraised to urinate. The male urination posture (Fig. 25b) differs from that of the female (Fig. 25a) in much the same fashion as in bighorn sheep (Geist 1971). The males's rear legs are stretched backwards, slightly flexed, and splayed a bit to the side.

There are problems in interpreting elimination postures because of variations in defecation positions and the difficulty of identifying actual waste material being passed from a distance. Two statements, however, may be made with reasonable certainty: 1) Only two males were ever observed in squatting positions, and both instances involved defecation. 2) Males always stretched to urinate while females never did. Only one male exhibited a sufficiently crouched posture during urination to create possible confusion with females. Both sexes stretch after rising from bed, and although this involves unique components, it could cause occasional confusion. In summary, if a goat is observed squatting under normal circumstances, it is very likely to be a female, and if it assumes a stretched urination posture at some time other than rising from bed, it can be considered a male. The distinctive male urination posture is helpful in identification when, because of distances involved in observations or youth of animals observed, other distinguishing sexual characteristics are inconspicuous.

Mountain goats urinated and defecated when approached by us on the cliffs and in the trap. Different observers (Anderson 1940; Brandborg 1955) have commented on the squatting response of goats surprised by them at short distances. In such situations, goats

often squat until their rump rests on the ground. This has been observed in response to harrassment by eagles (Brandborg 1955). A squatting position is assumed by subordinate goats trapped by dominant animals and unable to flee, and also by goats surprised by others within their critical interpersonal space. As discussed under Aggression, squatting appears to inhibit attack and quite frequently elicits simultaneous squatting by the aggressor. Whether actual urination or defecation occurred in most cases, I was unable to tell. Even during normal urination and defecation there appeared to be a strong coincidence of performance among members of a group in visual contact. Squatting also removes the rump and flank, primary targets of horn thrusts, from an aggressor, and places the goat in close contact with the ground; and important function in precipitous terrain.

After sniffing the female's urine, flehmen was exhibited by rutting billies and during occasional courtships outside the rut. In several instances, an anestrous female being vigorously courted urinated, and her suitor paused to test the urine rather than continuing his pursuit. Geist (1971) suggested that female urination in such circumstances may serve as a distractant in bighorn sheep. During mid-summer, a 2-year-old billy urinated 15 seconds in a typical stretched posture, then appeared to lick or nibble soil on which he had urinated.

CHAPTER IV

POPULATION CHARACTERISTICS

Society and Grouping

One of the most striking aspects of mountain goat biology is the social hierarchy through which their society is organized. Many observations of this fascinating social system are not directly concerned with this particular study of the ecology of the Bunker Creek herd and so ethology of the mountain goat will not be discussed in this report in any detail. Social organization will be considered as it affects group leadership, size, composition, and movements.

Rank or status in mountain goat society is determined among females primarily by age and size. Larger animals generally dominate smaller ones, and size is largely a function of age. Among adult females, where considerable size variation was evident, a few older-looking individuals with longer horns were dominant to larger females. Younger (smaller) females temporarily dominated older individuals on a few occasions, but this, too, was exceptional.

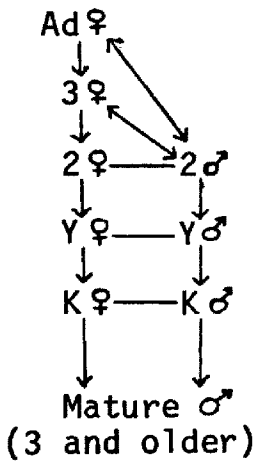
Males were usually slightly larger than females of corresponding ages as subadults, and adult males were often conspicuously larger than adult females. As kids and yearlings, males increasingly dominated females of their age class, but were subordinate to most older females. Before their first rutting season, 2-year-old billies actively courted and occasionally dominated females of all ages. At

other times, they behaved in subordinate subadult fashion. During the rut, 2-year-old billies dominated and courted females of all ages, but less successfully than older males. Thereafter, increasingly inhibited from exerting their dominance, these young billies became more and more independent of female-subadult bands. They followed feeding bands at a distance and bedded on the periphery of groups, or else travelled alone. About the time billies became 3-year-olds, they were sufficiently inhibited from directing aggressive behavior toward females and subadults as to be effectively subordinate. Females of all ages, including yearlings and older kids, and subadult males forced adult billies from bedsites and drove them from feeding areas. Many adult females and subadults appeared to go out of their way to harrass mature billies.

Adult males might be considered to occupy a pseudo-subordinate status in society. They left groups when harrassed by other animals, but did not respond in truly subordinate fashion by fleeing or evincing fear. Instead, they appeared inhibited from responding aggressively. Males assumed a characteristic pose when threatened which incorporated elements of threat and withdrawal. Males also exhibited frequent, vigorous displacement activities in social situations; further evidence of conflict, or inhibition, rather than submission. This is in accordance with Geist's (1964) observations of male conflict postures during male-female interactions. Adult males were often dominant to other classes at salt licks on some occasions, and were subordinate on other occasions. One important result of this transition from dominant to pseudo-subordinate status

after the first breeding season is that the inability of mature males to interact successfully in female-subadult bands encourages a largely solitary existence and extensive travelling by older males. The lethal potential of powerful adult males is effectively neutralized outside the rut in social situations.

Though males appear to be largely solitary as adults, they were observed travelling in pairs on several occasions during spring and early summer. Kuck (pers. comm.) observed bachelor herds of up to nine adult males in spring, and Vaughan (pers. comm.) noted associations of three adult males during that time. In pairs which I observed, the large male appeared to lead the pair, but considerable tension was evident between them, and dominance was not clear. In a group including a 2-year-old billy and two 3-year-old males, observed on 27 May, the 2-year-old actively dominated both older billies, but followed behind them as they fed. A general outline of the social hierarchy could be schematically described as follows:



The dominant animal in any group of two or more mountain goats is almost always the leader in that it determines the type, direction, and timing of activities. Subordinates, although often chased and threatened by the leader, followed of their own volition and actively sought to attach themselves to such groups. As an important exception to dominance-leadership equivalencies, a nanny with a kid,

though clearly subordinate to some older or larger adult females without young, was always the undisputed leader of a group when present. Dominant adult females often harassed leading nannies and forced them to hurry ahead, but they refused to assume the lead and remained behind the nanny. Females with kids elicited a stronger following response than other goats, for others in the group, particularly younger goats, sometimes competed with one another to follow or bed in closest association with the nanny. This was not so evident in groups led by other classes. When two or more nannies joined in a group, the dominant nanny assumed leadership.

Adult males, when present in groups, generally followed behind leaders and bedded at the periphery of bands. The importance of leadership is emphasized by the lack of direction or obviously purposeful activity observed in solitary individuals and bands of leaderless newly-independent kids and yearlings. These animals characteristically meandered across portions of the range either seeking other goats or wandering without apparent purpose. Both feeding and bedding patterns were somewhat irregular in solitary and leaderless subadults, and in many solitary older animals. This sort of information is at variance with Brandborg's statement (1955) that "No particular age or sex group assumes the leadership of a band in its movements over the range." Composition of transplanted bands may prove important in influencing types of leadership and early movements and dispersion.

Another partial result of dominance and leadership is the

typical mode of single file travelling in groups. This is partially neccessitated by the nature of cliff terrain. Even where ledges widen, however, subordinates are hesitant to pass within 5 to 6 feet of higher-ranking individuals for fear of violating their personal space and thereby inviting retaliation. Travelling groups often become arranged in a regular descending rank order from first to last since dominant animals may pass subordinates but lower-ranking goats must remain behind. Goat range, and well-used cliff areas in particular, are traversed by a network of established trails and bedsites devoid of vegetation and nearly paved with pellets. Goats nearly always travelled on established trails. When they moved between one outcrop or feeding area and another, I could usually successfully predict their route. When feeding, groups fanned out and leadership was not immediately apparent. Feeding groups still remained in fairly close association. Groups as large as 10 to 12 animals usually remained within an area no more than 75 to 100 feet in diameter.

In social interactions, individual mountain goats might be viewed as having a sphere of influence with a radius of 5 to 8 feet with its focus at the animal's head. Intrusion by any goat within this personal sphere, whether accidental or intentional, generated an encounter with assertion of relative rank. Much attention was devoted to the maintenance of personal space, directly, through aggressive action, and through movements and postures designed to avoid potential conflict. Mech (1970) wrote "Social control is asserted by wolves of higher status merely by listening, smelling,

"or looking intently at animals of low rank, the looking control being seen most often." Among goats a prolonged stare was sufficient to remove subordinates from a lick site or shaded bedding spot. Most interactions involved more active expressions of rank, from low-intensity chases to high-intensity circling with butting threats.

I found consistently high levels of aggressive activity, from 2 to 10 interactions/goat/hour in groups of animals which had remained in almost daily contact for months; many, for over a year. Rates as high as 18 interactions/goat/hour were recorded at salt licks. I at first considered the possibility that logging and road-building disturbances in the Bunker Creek area and resulting emigration had contributed to overall herd instability through crowding, though goats from Bunker and Little Creeks have probably always been in contact. Limited observations of mountain goats in the Bitterroot Mountains and on the west side of the Swan Mountains revealed similar aggression rates, averaging 3 to 6 encounters/goat/hour while feeding and travelling.

Goats in the Bunker-Little Creek herd aggressively asserted rank while feeding, bedding, and licking salt. For example, at bedsites, an incoming goat would usually force up the next-lowest-ranking individual, who would in turn displace its immediate subordinate, and so forth, until the least dominant member was left standing to choose a new bed. In temporarily established groups, the majority of aggressive interactions were usually reduced, slightly in frequency, but primarily in intensity, to stares and short chases.

When goats from different groups met, relative rank was established, or re-established, and this involved higher-intensity threats and displays. The more similar the status of two contestants, the more vigorous and prolonged were initial encounters. Dominance was quickly established between goats of obviously disparate status through a quick threat or chase. At times, groups met, and individuals would perhaps spend up to 20 minutes in elaborate avoidance of one another before beginning the inevitable contest of status. Aggressive interactions occurred at high intensities even if contestants had performed similar rituals with one another the previous day, or even several hours before, and then separated.

What is the value of high rates of aggression in goat herds between individuals which are probably familiar with one another? During the first 18 months of field work, 3,435 aggressive encounters, exclusive of courtship-related activities, were recorded; almost all of them between members of the Bunker-Little Creek herd. Social hierarchies are generally supposed to organize groups and contribute to an overall social stability and resolution of priorities. Yet I observed continual instability within groups. Although dominant animals enjoyed occasional privileges at salt licks and sometimes usurped shaded or protected bedsites and select feeding areas, it was not immediately obvious that the possession of high rank carried a great many advantages by comparison with energy spent continually reasserting status, even toward animals which high-ranking individuals had just recently encountered.

Mortality among rutting males from horn blows has been recorded (Seton 1927, Geist 1964). Lentfer (1955), Geist (1967), and other investigators have reported mortality due to stab wounds among animals confined at close quarters in traps. I observed females striking males with hard horn thrusts on a few occasions during the rut, as did Geist (1964). For the most part, however, aggressive encounters consisted mainly of threats performed in a ritualized manner. I observed 192 extra-rut horn contacts, and most of these involved low-intensity prods and blows to the thickened dermal shield area of the rump and flank. It should be noted that most horn contact shown in Table 11 was directed toward kids and yearlings.

No direct injuries from horn contact were observed in any encounter, but aggressive interactions did have an indirect and potentially injurious effect. Table 12 presents accidents resulting from 291 aggressive interactions in steep to very steep areas. It is again evident that this had its greatest effect on kids and yearlings. That none of the falls observed led to visible injury seems remarkable in view of the fact that several youngsters were pushed over drops of 20 and 30 feet. Table 7 provides a comparison with natural climbing missteps. It is worth noting that total climbing accidents due to aggression exceeded the number of natural climbing accidents observed.

On an individual basis, aggressive interaction may be something of an end in itself. Goats actively sought encounters. Individuals commonly forced subordinates from beds or lick sites, then failed to

Table 11. Summary of Horn Contact

Based on 3,435 aggressive interactions, excluding courtship-related encounters.

AREA RECEIVING HORN CONTACT	RECIPIENT OF HORN CONTACT									
	K	Y	2♀	2♂	3♀	3♂	Ad♀	NwK	Ad♂	TOTAL
Head	17	10					2			29
Side			2	1		1		1	1	6
Flank	2	7	4				1	1		15
Rump	52	78	6	3	2		1			142
TOTAL	71	95	12	4	2	1	4	2	1	192

AGGRESSOR	RECIPIENT OF HORN CONTACT									
	K	Y	2♀	2♂	3♀	3♂	Ad♀	NwK	Ad♂	TOTAL
K	**	1								1
Y	40	43							1	84
2♀	1	31								32
2♂	4	4	7	1						16
3♀	3	8	1	2						14
3♂		2								2
Ad♀	6	5	2	1	1	1		1		17
NwK	17	1	2		1		4	1		26
Ad♂	--	--	--	--	--	--	--	--	--	0
TOTAL	71	95	12	4	2	1	4	2	1	192

** Kid-kid encounters are not included because of frequent horn contact during play battles.

Y (yearling) category includes newly independent kids - 10 and 11 months old.

Table 12. Climbing Accidents and Aggression

Aggressive encounters leading to serious potential accidental injury (interactions generating slips, falls, and sudden forced leaps of at least 5 vertical feet in the most hazardous and precipitous cliff areas).

Based on 291 aggressive interactions observed on very steep to extremely steep terrain.

Class	Knocked Directly Over Edge by Blow	Pushed or Prodded Over Edge	Forced to Leap Over Edge to Avoid Aggressor	Forced to Leap or Knocked Over edge as Result of Another Encounter (Innocent Bystander)	Aggressor Falls Over Edge During Pursuit	Total
K		7	10			17
Y	2	7	5			14
2♀				1		1
2♂	1		1			2
3♀				1		1
3♂						0
Ad♀		1	2		1	4
Ad♂						0
Total	3	15	18	2	1	39

Figures are not adjusted to a per goat basis; i.e. the number of adult females in the herd was nearly twice that of yearlings (see Productivity).

utilize them. A good deal of aggression bordered on play and mutual stimulation. On a long-term basis, it appears that aggression in goat herds acts in part to regulate the size and composition of groups within the herd. Large groups, or bands, of goats are uncommon; few reports of more than 15 animals in a band have been made. Lentfer (1955) noted that most groups seen during the year included less than 10 animals. Kuck (1970) found average group size throughout the year to be consistently less than five. Brandborg (1955) recorded average group sizes in Idaho between three and four, and occasionally five. We found group sizes to vary between three and six. As previously noted by Brandborg (1955), group sizes were smallest in May, just prior to kidding, and largest during summer as groups of nannies with kids joined. Groups were also larger in fall prior to and during the rut, and again in winter, as snows restricted animals to a common area.

Detailed analyses of ways in which aggressive rates are related to group size have not been completed, but it is clear from preliminary figures that they do increase with increased group size and become markedly higher in groups larger than six or eight. Also, observations consistently revealed considerable instability in larger groups. When feeding, aggressive interactions and avoidance of potential conflicts often kept large groups walking rapidly across areas they would have fed slowly over in smaller groups. Large groups were similarly agitated in bedded situations, with frequent bed turnovers as dominants usurped those of subordinates, and irregular bedding periods resulted. General instability often caused

large groups to feed less and rest less when bedded. In most cases, groups larger than six to eight split into smaller bands with lower rates of aggression within a short time after joining.

As a corollary of aggression partially mediating group size, it appeared that group composition was to some extent determined by the same mechanism. Observers often report the typical goat herd to be composed of family bands, usually excluding older males. Indeed, most groups larger than two consisted of a nanny and kid followed by one or more subadults, usually of different ages, and strongly resembling a family unit. We did not mark kids and so were unable to determine whether their attachments in successive years were primarily to their original nanny and siblings or more indiscriminate. Marked yearlings and 2-year-olds showed no discernible allegiance to a particular leader or associate. Known individuals often changed leaders, usually daily. Some groups or subgroups remained together for longer periods, and a few goats demonstrated marked attachments. A yearling male (#104) associated with Nanny Patch through August and September of 1971. A large adult female and a 3-year-old female were regularly seen together in winter of 1971, often accompanied by a 2-year-old male. On the whole, goats of all age and sex classes shifted from one group to another regularly, and the only permanent associations appeared to be 10 to 11 month-long attachments of nannies and kids.

Within bands, rank was most bitterly contested by animals of the same general age (size) and sex class. Kids were very tolerant of one another, and yearlings associated closely, but in general,

the inclusion of two or more older goats of the same class led to marked increases in aggressive tension, which spread quickly throughout the group, and aggressive interaction. I would tentatively suggest, then, that the family-like structure of female-subadult bands may be partly the result of a settling out process, mediated by aggression, to effect the most stable composition. This optimum composition would be a linear hierarchy of, at most, a nanny, 2-year-old, yearling, and kid. With the occasional addition of other adult females, including 3-year-olds, or perhaps another young subadult, this would create group sizes of from three to six which is what most observers have noted.

The overall structure of the Little Creek herd was one of periodically interchanging bands, each consisting of usually from three to six animals with a more or less linear rank order. These groups seemed to occupy the same general portion of the range at the same time. Bands frequently sought one another, interacted, and usually joined for a short time. Eventually, these larger groups were resolved into smaller groups with their original composition, or, more often, after having exchanged members to some extent.

Now we are faced with suggesting an ultimate value for high rates of aggression and consequent limited group size. I can propose some possible values of small band sizes within a loosely interwoven herd structure.

1. Sheer physical crowding in precipitous areas would be counteracted by selection for smaller groups. Seton (1927) cites an

observation of goats crowding onto a ledge and, unable to turn past one another, falling to their deaths. Similarly, when avoiding predators, crowding would be disadvantageous during flight on precipitous areas, and highly inaccessible refugia might provide space for only a few goats.

2. Loose associations would help avoid wholesale losses to avalanches and rockfalls, and, perhaps, severe winter storms. During serious storms, small groups might be able to find shelter and limited food supplies in a restricted area where a larger group would be at a disadvantage. Avalanches are thought by some to be the primary source of mortality to mountain goat populations. As such, they might represent a prominent selective force for band dispersion.

3. Given the habitual use of range which seems to be characteristic of mountain goats, small, separated groups would help diminish the impact of a herd on fragile habitats. At high densities, this might become important both from the standpoint of forage use and physical trampling of favorite feeding areas which goats return to regularly.

4. Because of traditional usage patterns on feeding areas, trails, and bedsites, scattered groups would attract fewer predators than larger concentrations which would create artificially high densities in limited areas. Along the same lines of reasoning, the spread of parasites and infectious diseases might be slightly retarded in loosely associated groups.

5. Finally, if some of these suggestions may be considered possible adaptive values, then the same principle might be applied to herds within larger populations. Aggressive interaction and instability of large groups might act to limit population densities and help disperse herds onto different ranges. This would be especially important as it might affect the distribution of herds to different winter ranges.

Most of these possibilities consider two evolutionary strategies. First, isolated herds, if subjected to accident, predation, disease, and starvation as a single unit with an artificially high density, could be entirely eliminated. Goats seem to be poor at colonizing vacant ranges. Secondly, small, loosely-interwoven bands are a means of distributing not only survival potential, but use by a population of a fragile yet extremely demanding physical environment.

Productivity

Before June of 1971, I observed goats primarily on the North Fork of Bunker Creek. After discovering that members of the herd moved back and forth between Bunker and Little Creeks, I censused the entire herd in late June and July when large post-kidding groups travelled over the range. The Bunker-Little Creek herd was found to have the following composition at that time:

Ad♂	3♂	2♂	Y♂	N	Ad♀	3♀	2♀	Y♀	K	
2	1	2	2	4	2	3	3	2	4	Total = 25 goats

Numbers of adult males are from occasional sightings and observations

of billies on female ranges during the rutting season. One 3-year-old female disappeared in September. We were told by hunters that she had been shot from the Little Creek logging spur road on opening day of hunting season, 15 September. (The Little Creek spur road was closed shortly thereafter). A yearling male disappeared from the herd in October, and a kid was lost sometime during late winter. No additional losses were noted that year. No carcasses were found in the course of the study, and only a few weathered skeletal remains of goats.

In June and July of 1972, large post-kidding groups gave the following herd structure:

Ad♂	3♂	2♂	Y♂	N	Ad♀	3♀	2♀	Y♀	K	
2	1	2	2	8	1	2	2	1	8	Total = 29 goats

One nanny and kid were never accounted for after the immediate post-kidding period and were thought to have possibly come from some other portion of the range, or from another herd. In late July, I missed one nanny-kid association and noticed an additional adult female in counts, indicating probable loss of a youngster. As in the previous year, the 3-year-old male became independent of the herd. This male, and two, or at most three, different adult males were occasionally seen in the area. Field work was terminated before male concentrations on female range during the rut could be seen in 1972. Both yearling males left the area in summer, and only one was located later in the year. When regular censusing was terminated in September, 22 females and subadults were present in the herd. On

opening day of hunting season, two nannies were killed on Bunker Creek and a young billy reportedly wounded. Short, and probably incomplete surveys of the range during January and March revealed a maximum of 17 possibly different females and subadults in traditional winter range areas. Three nannies with kids were observed, and two orphaned kids which survived the very mild winter. Unusually open winter conditions probably led to dispersal over a more general wintering area.

Recent observations during the 1973 kidding season indicated the following herd structure:

Ad♂	3♂	2♂	Y♂	N	Ad♀	3♀	2♀	Y♀	K	
3	2	1	3?	7	1	1	1	4?	8	Total = 31 goats

To some extent, population estimates for 1971, 1972, and 1973 reflect progressive refinement of census techniques and familiarity with the area. Perhaps as a partial result of the exceptionally mild 1972-73 winter, one nanny gave birth to the first twins observed in the area, and all but one of the previous year's kids were present as yearlings. Both #10 and #100 produced kids in 1972 and 1973. Number 103 was not observed during 1973. Number 104 was present on the range, travelling apart from female-subadult bands, alone, or with another 3-year-old male, then moved to a different area.

Such limited population data as I was able to gather from this and other small herds points out an unequal sex ratio of adult animals as shown in Table 13. Hibbs (1966) provides a summary of information from different investigators on sex ratios in mountain goat populations.

Table 13. Sex Ratios in the Bunker-Little Creek Herd

	Total No. Males	Total No. Females	Ratio M : F	Total No. Mature Males (incl. 3-Yr.)	Total No. Mature Females (incl. 3-Yr.)	Ratio M : F
1971	7	14	.50 : 1	3	9	.33 : 1
1972	7	14	.50 : 1	3	11	.27 : 1
1973	9	14	.64 : 1	5	9	.56 : 1

In native populations from Montana, Idaho, and Washington, male : female ratios varied from .72:1 to .83:1, and were higher in introduced populations in South Dakota. Because males tended to be solitary and range widely through little-used cliffy areas, they were difficult to observe. Males may have used timber types to a greater extent than females. However, we observed no more than eight different males 3-years-old and older in the combined areas of the Bunker-Little Creek range and adjacent west-side Swan drainages censused during any year. Table 21 in Populations in Related Areas shows a decline in the percentage of males harvested by hunters over recent years.

A total of 19 kids was known to be produced by nannies using the Little Creek area during the kidding season. Nine breeding age females produced 4 offspring in 1971; 10 (11) mature females produced 7 (8) kids in 1972; and 9 mature females produced 8 kids (one set of twins) in 1973. Productivity in 1971 was much lower than in 1972 or 1973. Poor breeding success may have been related to initial logging disturbances during fall of 1970, hunting and poaching pressures,

or other disturbances before and during the fall rutting season. Small losses occurred each year among kid and yearling classes. Summer censuses in adjacent areas showed fairly low numbers of kids each year:

Drainage	Maximum No. Goats Seen	Maximum No. Kids Seen
Middle Fork Creek	9	2
String Creek Area (Includes Alcove and Middle Fork Creek Herd; Razzle, Late, Feather Creeks Also)	21	3
Sunburst Lake Area	13	1
West Side of Swans (Bond Creek to Goat Creek)	17	3

Low kid and yearling survival in non-expanding populations was noted by Anderson (1940), Cowan (1944), and Brandborg (1955). Mountain goat populations in the Swan Mountains appear to be lower than in previous years, and overuse of range areas by other small herds in the study area was not obvious. It is possible that mortality in young mountain goats is mainly a result of factors such as very severe winters, predation, avalanches, rockfalls, or climbing accidents. It is demonstrated elsewhere in this report that kids are the least alert age class, and the most likely to fall or be forced over steep areas by dominant goats.

A small possibility exists that some females are not being bred each year in the Swan Mountain area. In the section on the rutting season, it is noted that 52% of groups on Little Creek containing one or more mature females were not attended by billies during the

height of the rut. Though a few males are generally supposed to be capable of servicing much larger numbers of females, mountain goat males must contend with several difficulties. The estrous period appears to be less than 72 hours long in individual females, and deep snows separated groups on different parts of the range and on different ranges. In addition, many large and potentially dangerous females may require cautious and prolonged courtship on the part of the male.

Kidding Season

During most of the 1971 kidding season, we remained on the North Fork of Bunker Creek to obtain pre-logging data on use of the area by resident goats. I observed kids for the first time that year on 19 June in the Little Creek drainage and so did not obtain information on pre- and early post-partum activities. Two mature females continued using the North Fork during early kidding season. A 3-year-old, #103, remained there most of June and did not produce a kid. The older female, N#1, was last observed on the North Fork on 3 June and was next sighted on 26 June near Little Creek with a new kid. A group including two mature females without kids visited the North Fork from 12 through 16 June, travelled to Little Creek where they were seen on 19 June, and then returned to the North Fork on 22 June with other goats from Little Creek. This large group, which included the only nanny and kid observed on the North Fork during June, used salt licks in the evening, then apparently departed from the area the following day. In the 1972 kidding season,

the only mature females known to frequent the North Fork were a 3-year-old and #103. Number 103, however, appeared to have given birth near Little Creek where she was first seen on 22 June with a kid 1 to 2 weeks old and where she remained until 9 July. No goats were observed during either kidding season on Middle Fork Creek.

Most kidding observations are from Little Creek in 1972. This drainage provided the most extensive precipitous cliff areas in the study region. From three to four more mature females were recorded in the Little Creek drainage during the kidding season than were commonly seen there the remainder of the year. Little Creek may have been a kidding area for females from Bunker Creek, and it may have included still others from isolated portions of the range or peripheral herds during the kidding season. Further studies are needed to elucidate long-term relationships between female components of herds in different areas of the Swan Mountains and possible attachment to traditional kidding areas.

The peak of rutting activity in 1971 occurred around 23 to 28 November. Following Seton's (1927) record of approximately 178 days gestation in captive mountain goats, this would place the expected arrival of most kids around the last week of May. Judging from nursing durations and relative development of kids when first observed, most appeared to have been born sometime in the last week of May and first week of June. The first kid, estimated to be 4 to 6 days old, was seen on 26 May. A nanny was sighted with a few-day-old kid on 23 June, and another nanny was briefly seen on 1 July with a very small

and new-looking kid. There appeared to be a spread of at least 1 month between births; Anderson (1940), Hanson (1950), and Brandborg (1955) reported the same. This distribution may reflect considerable individual variation in either the onset of estrus or gestation periods, or it may indicate recurrent estrus.

Only in 3-year-olds could I detect an apparent size difference due to pregnancy at a distance. Prolonged retention of winter coat, as discussed under Pelage Characteristics and Shedding Patterns, was a useful indication of pregnancy. Pregnant females became largely solitary 1 to 3 weeks before parturition. Mature female associations were rare from mid-May until early June when nannies with kids rejoined bands. Females sought complete isolation 3 to 4 days prior to birth, remaining in limited areas and rejecting the company of other goats. Pre-partum feeding movements were increasingly restricted, and feeding durations shortened slightly in relation to bedding periods. The day before she gave birth, NA moved less than 200 feet and remained bedded much of the day near what was to be the birthsite.

Birthsites are reported to be chosen in the most rugged terrain within the range (Seton 1927, Brandborg 1955). NA gave birth on a moderately steep cliff with scattered trees. Other nannies were first seen with kids near lightly timbered ridgetop areas, but no females used the steepest negotiable cliff faces as kidding grounds. The need for protection from predators must be balanced against the need for kids to safely develop climbing skills and coordination. During the days spent in seclusion just before and after parturition, nannies were exceptionally difficult to locate, and most were observed

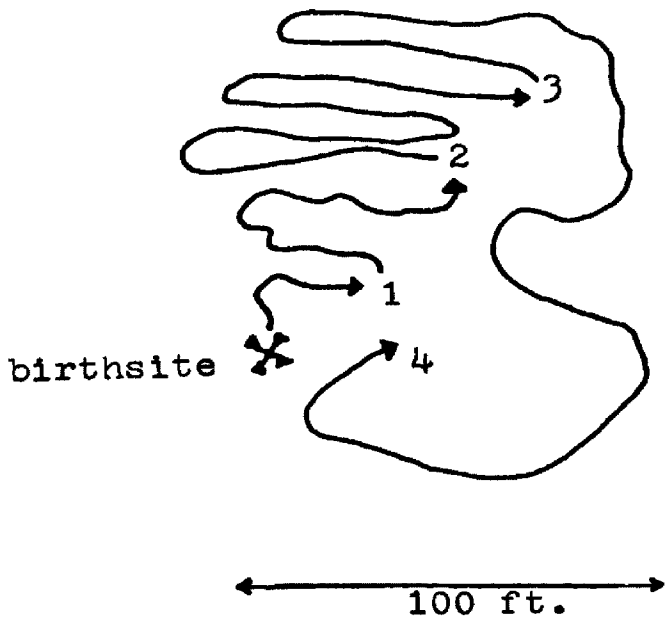
after they returned to cliffy, open areas. Seclusion sites of the few nannies observed during this time were associated with light to moderate timber cover. Increased use of more densely timbered areas may have been partly responsible for failure to observe other females during this time. Peck (1972) found increased use of timbered areas in May and June, and observed nannies leaving timber with newborn kids. Saunders (1955) also reported increased use of timber during kidding season.

Post-partum movements of NA, given in Figure 26, were quite restricted for the first few days. She appeared restless and spent many hours of the second and third day pacing in the shade near her bedded youngster. This would indicate that post-partum confinement was voluntary rather than due to weakness. The limited nature of post-partum movements might make the nearby presence of snow or water a factor influencing choice of birthsites. NA remained within 400 feet of the birthsite until 13 June, 18 days after parturition, before resuming normal travels, though she was often in the company of other goats. She remained another week around the particular segment of the cliffs where she had given birth. NA was not marked, but in May of 1973, a similar-looking female gave birth to twins in precisely the same site and followed basically the same pattern of post-partum movement. Other nannies left birthsites somewhat sooner, usually 8 to 12 days post-partum, judging by infant development. Females and young of the Siberian ibex (Capra ibex siberica), another mountain-dwelling species, are reported to remain hidden in

Figure 26. Post-Partum Movements of Nanny A and Kid

Day	Total Movement	Straight Line Movement
1st	35 ft.	20 ft.
2	85	35
3	135	35
4	200	100

Position of number represents end of that day's movements



cliffs for 2 to 3 days after birth before rejoining the herd (Savinov 1962).

I did not witness parturition, but NA was first observed a 0600 on 27 May, licking a still-wet infant which was unable to stand. At 0645 the afterbirth was visible hanging from the female's vulva. From 0710 to 0730, NA consumed the afterbirth, and at 0900 appeared to be licking dirt or further discharges around the bedsite. Placentophagy is common to ungulate species which maintain their offspring close to the birthsite in the early post-partum period and is probably an adaptation to predation on neonates (Fraser 1968).

The immediate post-partum period is devoted primarily to grooming and suckling the infant. Initial maternal grooming stimulates the infant and removes adhesive tissues and fluids to help mitigate cooling. Continued grooming and suckling activities are important in establishing mother-infant bonds. Perhaps the most essential activity in this regard is licking and sniffing of the kid's anal region by its nanny as it nurses with upraised tail. Table 14 summarizes maternal contact for the first 3 days as observed in NA. More complete observations of NA and her youngster are presented in Appendix III to provide means of estimating early age in neonates. Olfactory contact was high at first but dropped off rapidly by the third day. By afternoon of the second day, NA began to substitute sniffing for licking of the anal area. Post-partum isolation enables the infant to develop sufficient strength, coordination, and climbing skills in relative safety so that it can follow, and, if need be, flee rapidly behind its mother when they join groups and

Table 14. Nanny A and Kid - Summary of Early Post-Partum Maternal Contact

	Day of Birth	2nd Day	3rd Day
No. Nursing Bouts Observed	17	10	6
Total Nursing Time	57:37 (min.:sec.)	31:06	19:36
No. Times Lick Anal Region While Kid Nurses	38	21	5
Total Licking Time While Kid Nurses	8:11	4:55	0:40
No. Times Nanny Noses Kid (Sniff-Nuzzle)	33	19	3
Total Time Nosing Kid	1:29	0:59	0:09
No. Times Nanny Lick Kid While Not Nursing	67	6	2
Total Licking Time While Not Nursing	12:16	1:26	0:06
No. Times Nanny Rubs Chin Over Back of Kid	10	2	3
Total Time Placing Chin Over Kid	0:37	0:06	0:10
Total Time of Active Maternal Contact With Kid	1:20:10	38:32	20:41
Total Active Contact With Direct Olfactory Association	21:56	7:20	0:55
% Olfactory Contact/ Total Contact Time	27.4	19.0	4.4

travel over the range. Post-partum isolation also provides an important opportunity for mother-infant bonds to become firmly established.

Nursing is usually accomplished from the uphill side of the nanny, though kids also nurse from below the nanny, between her front legs, and between her rear legs. Maternal leniency in nursing is widespread among artiodactyls in early lactation and is characteristic of the mountain goat. Kids butt at the teat hard enough to shake the nanny and occasionally throw her off balance. As typical examples, one kid butted vigorously 34 times in 1 minute 38 seconds of nursing; another youngster made 14 butts in 34 seconds of nursing. As nursing durations became limited to about 10 seconds, kids still butted two or three times before the nanny ended the kid's suckling. Figure 27 gives an average time for all nursing bouts observed on successive days and shows that weaning occurred between 3 and 4 weeks after the height of the kidding season. Nannies first began to reject nursing attempts sometime in the second week. By the third week, nannies regularly ended nursing bouts by walking over kids, sometimes bowling them over in the process. Persistent kids forced the nanny to wheel her hindquarters away after terminating nursing, and especially insistent youngsters were sometimes given mild horn threats or blows. By the fourth week, nursing durations had stabilized at less than 15 seconds, and kids were considered effectively weaned at this point because nursing attempts were sporadic and usually rejected. Nursing was occasionally seen until mid-November, and kids attempted to suckle in January.

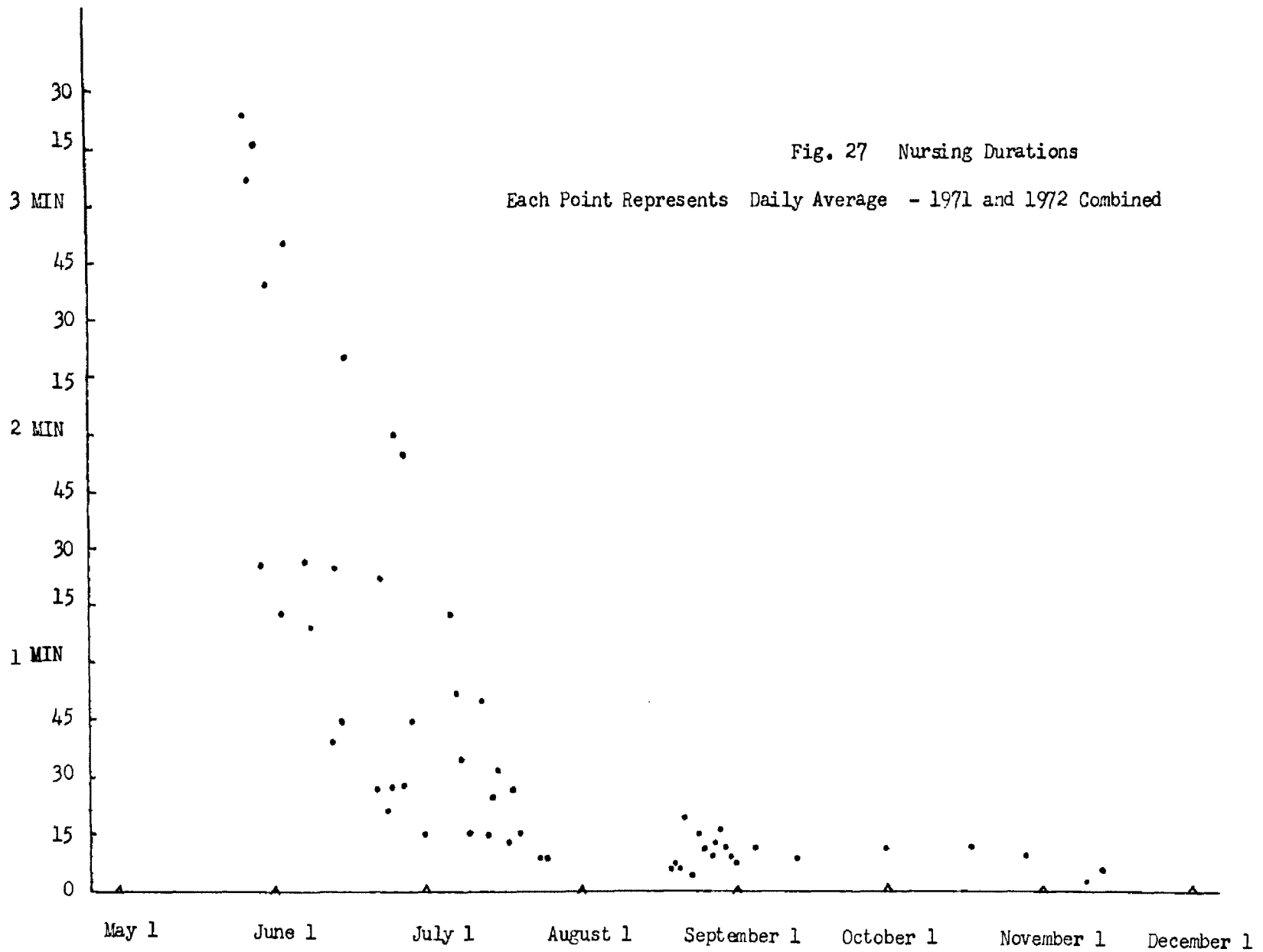


Fig. 27 Nursing Durations

Each Point Represents Daily Average - 1971 and 1972 Combined

Numbers of nursing periods per day were accurately determined only for KA in the early post-partum period. Some high frequencies of nursing were reported by Brandborg (1955), but he notes that his presence may have disturbed the goats. Fraser (1968) states that domestic lambs (Ovis aries) nurse more frequently when alarmed. Mountain goat mothers allowed kids to nurse in unstable situations such as the approach of aggressive goats or predators. Frightened kids showed a tendency, present from the first days, to run beneath their nanny's legs. They were allowed to nurse under such circumstances, which helped maintain the youngster in a protected position. Kids were also allowed to suckle after being separated from the nanny and sought after by her. The youngsters soon learned to associate nursing with disturbance and reunion and exploited minor events of these types to gain access to a teat, particularly as they became older and were usually rejected under normal circumstances.

Because of exploratory and play activities of kids, aggressive disruptions in bands of goats, and occasional flights from predators, kids became separated from their nannies. Kids showed a tendency to follow at the heels of the nearest rapidly moving large goat, and on several occasions, kids ran after subordinate females being chased by their own nanny. It was perhaps for this reason that NA, when approached by other goats during her second day of post-partum isolation, was reluctant to charge the intruders and risk becoming separated from her infant. NA made only abortive rushes at bold

subadults she would normally have chased severely, then immediately ran back to her youngster. Without at least a brief post-partum isolation to forge and strengthen mother-young bonds, kids would probably become more easily separated from their nannies. Since mountain goat bands within the herd are not constant, and subgroups become widely separated, even temporary nanny-young separations could have serious consequences. As it was, only two instances of prolonged separation were observed in the study; one less than 3 hours, and the other for a day. The latter instance resulted from an attempt to dye-mark goats causing the group to flee in two directions and the kid to flee behind its playmate's nanny.

That nannies rely primarily on olfactory information to definitely identify their youngster is inferred from observations of nannies retrieving kids. Similar-appearing kids playing together were sometimes both carefully inspected through sniffing of the anal region by a nanny before she nudged one toward her and butted the other one away. Three nannies made erroneous decisions. One even nursed another's youngster while threatening her own. After further sniffing, these nannies butted away the kid they had initially chosen and trotted to gather up their rightful heir.

Mountain goat mothers may be generally characterized as markedly attentive and protective. Nannies remained within 10 feet of their young during the first 2 weeks. Kids generally followed closely of their own accord, but if they strayed during initial explorations, the nanny trotted immediately to retrieve them. Youngsters manifested

a strong tendency to avoid edges and remain on the uphill side of their mother while feeding. They also bedded on the nanny's uphill side in nearly every case. Nannies reinforced this uphill tendency by nudging youngsters away from the cliff edge. As a result, a leaping, galloping, often stumbling young kid would fall against its mother on sloping cliff ledges rather than into a more dangerous situation.

Mothers regularly licked and nuzzled infants in passing during early days, and would run to groom the infant whenever it stumbled seriously in its early, uncoordinated activities or returned from a short foray. Not until kids were several months old did nannies fail to move toward them each time they lagged behind, or retrace their path whenever the youngster was unable to proceed. Brandborg (1955) cites an instance of a kid trapped in a steep area whose mother returned to nurse it for 5 days before it discovered an avenue of escape.

After any alarming stimulus, nannies looked to the source, then immediately looked to their kid. Disturbed mothers nudged kids behind or under them if they were not already there. Nannies repelled other goats during post-partum isolation. When nannies with new kids entered the herd, rates of aggression soared as the highly protective nannies drove one goat after another from the proximity of their kids. This activity was compounded by the curiosity of other goats, particularly yearlings, which of course had never before seen such small members of the herd. At the same time, a mutual

curiosity began replacing initial withdrawal in kids.

Kids which attempted to play with other youngsters were at first rebuffed by the other kids' belligerent nannies. By the second or third week, nannies grudgingly allowed their kids to associate with other kids, partly because kids actively sought the company of other youngsters, and partly because the presence of other nannies discouraged aggression toward other kids by protective mothers. Still, nannies sometimes butted other kids away when their mothers were not close by, and they butted away playmates which consistently shoved, butted, and mounted their own kids. Interactions between kids and older goats were not tolerated by nannies.

Brandborg (1955), Holyrod (1967), and Geist (1971) all remark on the extreme protectiveness of nannies in groups. Geist attributes it to a need to defend vulnerable kids from other goats which possess lethal potential with their dagger-like horns even as yearlings. Table 11 in the section on Social Organization reveals that most horn contacts were directed toward youngsters. Vigorous horn contact was rare, however, and no injuries were observed as a result of horn thrusts. Table 12 shows that forced leaps and falls, as a consequence of aggression in potentially dangerous steep terrain, were also perpetrated most often on kids. It seems that maternal protection may well be warranted in what appears to be a harsh social environment for youngsters. The kid becomes associated to some extent with its nanny's status, and subordinates generally looked first to the mother before interacting with a youngster. In a few

cases, older goats displayed to or fled from kids whose nannies were nearby but apparently unaware of their presence.

Nannies exhibited limited aggression, or negative reinforcement, toward their young under the following conditions: 1) as kids persistently fed near the nanny's face or pushed against her side, a common activity which kids pursued as a sort of game; 2) as kids played extensively on bedded nannies, though this was usually tolerated; 3) as kids persisted in nursing attempts or tried to mount the nanny after nursing was terminated; 4) as kids ran suddenly up to the nanny, startling her; and 5) as kids halted in the nanny's path or otherwise obstructed her movements. High intensity threats by nannies toward kids were noticed only where nannies were in stressful situations such as conflict with another goat and kids performed one of the above-mentioned activities.

In the presence of predators, if nannies chose not to flee, they nudged kids behind or under them and stood to defend them. One nanny broke away from a fleeing group which my nearby presence had set in motion and returned to gather her kid which had remained behind, looking about and scratching itself. On another occasion, while her kid fled above her to a steep refuge, the Goat Creek Nanny remained on a lower ledge, trotting back and forth, stamping, and swinging her head; and it seemed that she was deliberately placing herself between Beth, who had approached to photograph them, and the kid.

Nannies continue their attentive and protective role throughout most of the kid's first year. This close and prolonged mother-young

union is likely an adaptation to rigors of both physical and social environments. Nannies allow kids to bed in the most sheltered spots during inclement weather. In winter, kids depend to a considerable degree upon nannies to paw snow from forage and plow trails through deep powder snow.

Following distance of kids increased during the year, but nannies continued to remain near their kids and defend them from other goats. Mothers also continued to lick and nose older kids. One nanny whose young male kid exhibited a frenzy of horning, dustbathing, and groin-licking in March, trotted to her agitated youngster and nosed it as though to assure herself of its welfare. Nannies were also seen grooming infected or tick-infested areas on kids in early spring.

Low-intensity maternal antagonism was most evident in late winter, but the dissociation of nannies and kids about April was basically a passive phenomenon. Nannies simply failed to wait for or pay attention to following kids. Youngsters soon became separated and followed various females or subadults as maternal interest waned.

In each of the first two kidding seasons, an old-looking nanny adopted a yearling. Both females shed much earlier than other females and appeared to be barren. One distinctively small yearling was thought to have been reaccepted by its mother. I was not certain of the other yearling's origin. During June of 1973, a young-looking female (3- or possibly 4-year-old) was seen travelling regularly with a 2-year-old male which she tolerated closely. Geist (1971)

observed that poorly developed yearling mountain sheep received some mothering in the absence of lambs. Adopted mountain goat yearlings were treated like kids in most respects, being allowed to travel and bed in close association with the female which defended it against other goats and occasionally groomed it. One female and adopted yearling remained together briefly during the kidding season. The other female and small yearling remained together from 26 May until 20 August, then gradually began travelling in separate groups.

For 3 days in January, I observed a large, aggressive adult female in excellent coat condition with a yearling which she treated as an older kid. She once butted at it, and the yearling increased its following distance for the remainder of the day, though it still remained close to the female, which no yearling would normally attempt. The following day, the yearling had returned to its original close following distance, feeding and bedding next to the female. This female was thought to be one which was previously observed without a kid, and not a nanny which had recently lost her youngster. She was not observed with a yearling at any other time during the winter or spring.

These observations bring up the subject of the adoption of kids which may bear importantly on the survival of kids orphaned during the hunting season or as a result of natural cirumstances. Two kids orphaned in fall of 1972 by hunters survived the exceptionally mild winter and were observed on 20 March and for several days thereafter travelling on their own from group to group. It is possible, however,

that they had been accepted by some female, or at least tolerated, and were already becoming independent in March when I observed them. Adoption of yearlings during kidding seasons may have relected seasonal increases in maternal drive. Nannies with kids did not appear to tolerate alien kids at any time of year. Brandborg (1955) felt that kids separated from their nannies were left largely to their own devices and had a poor chance of surviving. Though effectively weaned by autumn, kids entering their first winter weigh, on the average, about 20 to 30 pounds, and, as noted in the section on Alertness, are the least alert class of goats. Orphaned kids may have decreased survival abilities during normal and severe winters without the nanny's leadership, alertness, aid, and protection. This in turn may lead to undesirable increases in actual mortality related to hunting. In recent years, more females than males have been harvested in hunting districts 130 and 140. I did not observe any females other than a known nanny with twins to have more than one kid in the study region.

Recent observations of two orphaned kids have been made during fall of 1973. One orphan has been seen travelling with different groups on Little Creek. It was often chased by dominant goats, frequently changed groups, and was seen alone on several occasions. The other orphan has remained alone within 500 feet of a central area within a single cliff outcropping for over 2 months. The orphan was observed feeding at the periphery of groups passing through the area and was often chased by dominant goats before withdrawing and eventually resuming its solitary existence.

Development of Kids

The first activities of Kid A, born on May 27, after gaining its feet and suckling were weak hops and horn tosses. Seton (1927) reported a mountain goat kid jumping about within 10 minutes of birth. We rarely observed neonates walking from one point to another. Instead, the infants galloped, stotted, and war-danced from place to place, though they often collapsed in the process as accompanying horn tosses threw them off balance or their legs buckled beneath them. KA was seen attempting to climb a small rock wall within 5 hours after birth and became increasingly active as the day progressed. Nevertheless, by the day's end KA still stumbled and fell during vigorous activities and obviously lacked sufficient strength and skill to negotiate even moderately steep terrain or follow its nanny at a rapid pace.

By the second day, KA was more adept at following its nanny, though it still fell frequently as it attempted to clamber up steeper rocks and leap from higher ledges. Also by the end of the second day, KA had manifested most basic action patterns of the adult behavioral repertoire, from comfort movements like scratching and pawing to aggressive sequences such as vegetation-slashing and rapid circular pivoting with lateral horn-thrusts. On the fourth day, KA was able to follow over all but the more difficult terrain. This youngster was first observed to mouth vegetation regularly, having sniffed it for the most part earlier, and briefly ruminate in bed on the fifth day. Percentage of time spent feeding while following the nanny there-

after increased to approximately 25% by June 3 and 35-40% by June 8. Kids were first observed licking from seeps at natural lick areas between 1 and 2 weeks after birth.

From the first day, kids displayed a pronounced tendency to explore and climb obstacles in their immediate surroundings. However, of their own volition, new kids usually remained on the nanny's uphill side during feeding and bedding and showed little inclination to investigate the outer portions of ledges in steep areas.

On its second day of life, KA ran immediately beneath its mother's legs as she was startled by a ground squirrel and again that evening as other goats approached. I was not close enough to determine whether maternal vocalization played a part in such early responses, though the resonant bleat of kids was often heard. Youngsters at first followed just at the nanny's heels and were often underfoot during the first 2 weeks. Before making contact with other goats, new kids seldom explored further that 10 feet before racing back to their mother. Following distances gradually increased throughout the year, but as a rule, kids maintained distances of less than 15 feet from the nanny and almost always bedded within 5 feet of her uphill side throughout their 10-to 11-month association. In aggressive and other unsettled situations, kids remained somewhat closer to their nannies. When playing with other kids or exploring, youngsters regularly strayed up to 30 or 50 feet. Separations of more than 100 feet occurred, but their rarity emphasized the prolonged intimate nature of mountain goat mother-infant associations.

In post-partum isolation, kids directed much of their play toward the nanny. A favorite activity consisted of clambering across the bedded nanny and leaping while astride her back. After frequent pawing and nuzzling by the kids, nannies sometimes rose to suckle them. As related in Seton (1927), Charles A. Chapman of the Bronx Zoo stated that mountain goat kids pawed him when hungry, and Geist (1971) noted pawing of the mother by a bighorn lamb whose dam lay ill with a broken leg and could not rise to suckle it. Play on bedded nannies remained a major activity during the first 2 months. From the first week, kids assumed mounted positions on different parts of the bedded nanny and rested their chins on her rump, but specific sexual postures could not always be distinguished from positions resulting from attempts to climb atop her. By 1 month of age, about the time nursing durations were sharply curtailed and frequent rejections were noted, some kids began following their nanny after she ended suckling, nudged and sniffed or licked her anal-genital region, and sometimes leapt up to place their chin over her rump and assume a mounted position. Pre-pubertal mounting of the mother is also characteristic of young domestic goats, sheep, and cattle (Bos taurus).

New kids avoided the approaches of other goats, including other kids, and fled to their nanny until their second week. At the age of 2 to 3 weeks, kids first tentatively make contact with other kids and began playing, and thereafter regularly sought one another's company. In late June and early July, kids spent the greatest amount

of time playing together, and their nannies had limited success separating them. As kids directed more of their play activities toward companions, they showed less inclination to frolic when alone with the nanny. By fall, little spontaneous play was seen in the absence of playmates, and the amount of play activity declined.

Descriptions of the development of specific play actions will not be presented, but major developments can be outlined as follows. Play with other kids took the basic forms of: 1) head-on butting and jousting; 2) shoving with neck and shoulder when standing parallel; 3) anti-parallel circling and butting; and 4) mounting, by first placing the chin over the other's back or rump. During the early weeks, sexual activity patterns dominated play. Mounting was often incomplete and incorrectly focused, but on several occasions I witnessed correct performance of most components of copulation; mounting, clasping, and conspicuous arching of the back followed by rapid, rhythmic pelvic thrusts. The scrotal sac was evident in male kids during summer so I could determine that complete copulation patterns were initiated by both sexes as Collias (1956) found in immature domestic goats. I could not determine at what point mounting became an exclusively male activity, but it is probably hazardous to identify males by copulatory postures even in young yearlings. Other evidence of sexual behavior comes from isolated observations, one in July and one in August, of kids licking the perianal region of other kids for several seconds before resuming normal play. Mounting continued as a common form of interaction between

young yearlings, though yearling males began to direct some courtship attempts without play elements toward older females. No evidence has been found to indicate that mountain goats of either sex are capable of breeding before at least 1 year of age (Brandborg 1955, Lentfer 1955).

By late July and August, aggressive circling and butting replaced sexual behavior as the major form of interaction among kids. By fall, kids spent less time together, and the youngsters began to treat one another in more dominant-subordinate fashion at times, assuming stiff aggressive postures upon meeting. Young goats still continued to seek out playmates and tolerated each other closely, but the frequent generalized contacts of bumping, shoving and mounting which characterized early associations were replaced by more formalized encounters.

The introduction of infants generated a good deal of curiosity among other members of goat bands, especially among subadults. Even #10, a 3-year-old who was herself to give birth for the first time two weeks later, stared for 40 seconds in a tentative approach posture upon first seeing a newborn kid that season. Aside from other kids, kids most often approached and interacted with yearlings, which, as a class, were also most responsive to kids. Head-on sparring contests usually resulted from kid-yearling encounters, with occasional circling and butting contest as kids became older. Beginning in their third and fourth weeks, kids were often seen

approaching older goats, sometimes to playfully threaten them, then flee. Kids would also stand in the path of older animals until they came quite close, then race away, usually leaping and horn-tossing. Maternal intolerance of older animals in the vicinity of their youngsters and its possible function are discussed under Maternal Behavior.

A contagious spread of excitement through a band of goats was a common occurrence, and young goats seemed most receptive to this phenomenon. In an atmosphere of aggressive tension between other goats, kids often began galloping and war-dancing, particularly if their mother was involved. In a small band being approached by two coyotes, a kid emerged from beneath its mother and suddenly began frolicking and war-dancing in front of her. The sight of kids playing together often caused yearlings and some older goats to begin war-dancing or initiate aggressive interactions.

Rutting Season

The onset of rutting activity in late October and its decline in early December corresponded to durations reported by Brandborg (1955) and Geist (1964). Courtship activity reached a peak between 20 and 30 November of 1971. Geist (1964) reported the height of the rut to be toward the end of November in the Cassiars of British Columbia, and Mike Vaughan (pers. comm.) observed copulation on 20 November in the Wallowa Mountains of Oregon.

I observed a small number of males in the Little Creek drainage

during 1971 where I observed most of the rutting period; one 2-year-old billy, a medium-sized male (3 or possibly 4 years old), and two adult males. Only once were all four observed to simultaneously occupy the range. Usually all but one adult male were present. No males were seen on the North Fork of Bunker Creek, and one adult billy attended a nanny, kid, and 2-year-old female on Middle Fork Creek.

The first evidence of courtship in 1971 was exhibited by a 2-year-old male on 29 October. Our only observations during the rut in 1972 were on 28 October. At that time, a marked 2-year-old male (#104) was seen courting a 3-year-old female, and no adult males were noted in the Little Creek area.

Table 15. Summary of Male Courtship in 1971

	No. Courtships Directed to Female Classes							
Classes	NwK	Ad♀	3♀	2♀	Y♀	K	Total	Total Before 11/15/71
2 ♂	23	12	28	44	23	2	132	90
3 ♂	2	0	42	4	0	0	48	2
Ad ♂	27	31	0	16	0	0	74	5
Total	52	43	70	64	23	2	254	97

As seen in Table 15, nearly all courtships prior to 15 November were initiated by the 2-year-old male. Many of the early approaches by older males resembled their extra-rut courtships in which

the male generally behaved in a psuedo-subordinate fashion, and none of these approaches involved contact with females. Specific courtship behavior will not be discussed in this paper, but differences in male participation seem noteworthy.

Rutting 2-year-old billies asserted their increasingly dominant status in female groups whereas older males were required to overcome the subordinate role they assumed outside the rut. Young billies actively dominated older males during initial stages of the rut, driving them from female bands. Until mid-November, rutting males 3-years-old and older typically surveyed female groups from a distance of 50 feet or more, stared nearly immobile for long periods, then sniffed female tracks and bedsites and lipcurled. Older males were rarely observed feeding from the time they first appeared on the range in late October until early December. The 2-year-old billy, by contrast, remained with different female groups throughout the rut and fed intermittently with them.

Geist (1964) described rutting pits and gave the average extent of pits in frozen ground as about 18 inches long and 12 inches wide. I measured three freshly-dug pits on poorly consolidated soil beneath light snow as 36 by 33, 43 by 30, and 52 by 28 inches, respectively, with maximum depths of 1.0 to 3.5 inches. Fecal material was present in two of three pits examined; urine smelled strongly in one, faintly in one other, and could not be detected in the third. During the early rut, males could be distinguished by dark soiling on the rump,

belly, and carpal joints which resulted from frequent pit-digging. Also during that time, yellowish stains were noticed in male tracks, presumably where the trousers had brushed against the snow.

Table 16. Rutting Pits

Class	No. Present	No. Pits Dug	No. Hours Obs. (before 11/12/71)	No. Pits Dug/ Hour Obs.
2♂	1	4	32.76	0.122
3♂	1	1	3.92	0.255
Ad ♂	2	11	27.08	0.406

Males were observed digging 16 rutting pits. A single adult male seen on 11 November, 1971, the date on which this activity was last recorded, moved gradually up a ridgeline and stopped to paw pits at 1218, 1222, 1300, 1350, 1411, and 1525 hours. This behavior is possibly a symptom of frustration, a redirected expression of energies, which appeared in various conflict situations outside the rut as well. Older males, inhibited from approaching females in the early rut, showed the greatest tendency to paw pits (Table 16). Pit digging was not recorded during the later rut as older males remained in female company.

Goats of all age and sex classes showed displacement pawing outside the rut. Two females vigorously pawed pits during the rut in the presence of a 2-year-old billy who was also pawing. Geist (1964) observed an instance of female rutting pit-digging and considered it part of a sexual behavior reversal by an estrous female.

After mid-November, the time adult males spent in close association with females increased sharply to nearly 100%. However, because of the disproportionate sex ratio of the rutting herd (usually 2-3 mature males, including the 2-year-old : 8 mature females, also including 2-year-olds), males were not present in most female groups. Eighteen (52.9%) of 34 female groups, containing from one to five mature females observed from 15-30 November, considered the height of the rut, were unattended by adult males. Female associations changed almost daily, and males moved readily from one female group to another, so that all but one infrequently observed female were seen at least once during this critical period in the presence of a courting male. Although a few promiscuous males are capable of breeding a large number of females under most conditions, the 52.9% figure implies that male competition is possibly more intense in areas where males are proportionately more numerous.

Adult males typically followed different female groups throughout the day in the early rut. As courtship activities intensified, males tended to remain with the same female or group for longer periods, the longest recorded being 3 successive days. So far as I could determine, courting males persistently followed but made no attempts to direct the movements of females, though they continually disrupted normal activities by forcing bedded females to rise, hurrying feeding females along, and occasionally chasing them while attempting to leap to a mounted position. Several prolonged chases, all involv-

-ing the young billy and 2-or 3-year-old females, ensued after repeated mounting attempts. Geist (1964) noted a 2-year-old male chasing a young female for over an hour in what he considered an attempt to prevent her from moving up a mountainside.

Billies ran to challenge other males in the vicinity of female groups which they attended. The few male confrontations witnessed involved billies of unequal size, consisted entirely of threat displays, and were of short duration. After 30 November, older males permitted the young billy to remain in female groups they were attending. The 2-year-old male was not seen courting in these groups and was subject to short chases by the older males.

At the beginning of the rut, inexperienced 2-year-old females exhibited signs of fear during persistent courtship and mounting attempts by the young billy. Older females generally showed withdrawal but also displayed agonistic behavior. Females became less agonistic later in the rut, but still threatened males during courtship. In 254 courtship approaches throughout the rutting period, females threatened males with their horns 43 times and struck males 10 times, though no apparent injuries resulted. Male courtship activity seemed to reach a peak around 25 November. Heavy snowstorms limited observations during that time, but 58 courtship approaches were observed from 20-30 November, and none appeared to lead to copulation. One 3-year-old female stood very briefly in a position resembling lordosis, and an adult female actively approached and licked the face of a 2-year-

-old billy. Other females remained in close proximity to their suitors and sniffed the billies' heads upon occasion. On the whole, however, females showed very limited active participation in rutting activities. No evidence was found that females, often alone in the peak of the rut, sought out male company. Female goats may have a very short estrous period. If this is the case, then a limited number of males may experience difficulty in reaching all female groups while they are in estrous condition, particularly if bands are separated some distance by deep snows.

It can be seen from Table 15 that male courtship attempts were directed primarily toward females of similar ages. On several occasions, large males ignored the presence of #10, a 2-year-old female, or bypassed her in favor of older females. She was courted on 16 and 17 November and throughout the day of 7 December by adult suitors. Both 2-year-old females in the herd produced kids the following spring. Two yearling females were courted by the young billy, but they showed no signs of estrus, and no older males attempted to court them. Two yearling males present gave no signs of participation in the rut.

An adult male was first observed feeding in a female group on 1 December. The intensity of courtship waned quickly in early December, and by 9 December, the day on which the last courtship was observed, only the 3-year-old male remained with female groups through 11 December, participating in normal feeding activities. Thereafter, he was observed alone on the range until 16 December when I

left the area. My next observations on Little Creek were on 20 January 1972, and I found no males other than the young billy present on the winter range. It is not known whether estrus recurs in mountain goats.

Extra-Rut Courtship

Records of courtship outside the rut come exclusively from spring and summer months (Table 17). This circumstance could be correlated with increased observational times, heightened general activity, or larger group sizes, or it may reflect physiological changes related to reproduction.

Extra-rut courtship records help point out the course of male status relationships during maturation. Yearling males were generally subordinate to females 3-years-old and older in all social interactions. Their extra-rut courtships were directed toward other yearlings and 2-year-old females nearly their own size (Table 17). Billies remained in association with female-subadult groups through their second year, becoming increasingly dominant to older females. As evident from Table 18, a 2-year-old billy persistently courted a nanny, her kid, and a 2-year-old female one day, which accounts for all extra-rut courtships of kids. The only male to mount kids during the rut was also a 2-year-old. Two-year-old males courted females of all ages.

Males 3 years of age and older contributed only 3.6% of extra-rut courtships. Two related factors, the pseudo-subordinate status of males and their infrequent presence in female groups, probably account for this. As in the rut, males primarily courted females of corresponding ages.

Mortality-Predation

Primarily on the basis of tracks, I determined wolverine (Gulo

Table 17. Occurrence of Extra-Rut Courtship [1]

MONTH	OBSERVATION TIME (Goat Hrs.)	MALE CLASS Ad	3-Yr.	2-Yr.	Y	Y?*	TOTAL COURTSHIPS	# COURTSHIPS/ GOAT-HOUR (x 100)
JAN.	119.76						0	0
FEB.	84.52						0	0
MAR.	176.60						0	0
APR.	289.59				27		27	9.32
MAY	662.59			12	6	1	19	2.87
JUNE	825.50	1		18	1	13	33	4.00
JULY	647.38	2	1	2	4	1	10	1.54
AUG.	574.52			20			20	3.48
SEPT.	178.65						0	0
OCT.	363.41						0	0
NOV.	302.69						0	0
DEC.	177.31						0	0
TOTAL		3	1	52	38	15	109	

Hours for October, November and December are for all goat observations, including rutting activities.

[1] Figures represent active courtship approaches involving specific sexual postures by the male.

* Y? denotes a yearling of undetermined sex. Kids, not included, continued to mount each other fairly often throughout the year.

Table 18. Distribution of Extra-Rut Courtship Approaches

FEMALE CLASS	MALE CLASS A	3-Yr.	2-Yr.	Y	Y?	TOTAL
NwK			10			10
Ad	2	1	9			12
3-Yr.	1		6	1		8
2-Yr.			20	10		30
Y♀			2	27		29
Y?			3		15	18
K			6			6
TOTAL	3	1	52	38	15	109

gulo) to be present in valley bottoms and around the bases of cliffs during spring and at least occasionally on ridgetop areas in late summer and early fall. Some wolverine tracks were encountered in cliffy areas. Guiguet (1951) described an attack on mountain goats by a wolverine, and guides report wolverines chasing mountain goats in the adjacent Bob Marshall Wilderness. Their relationship to goats in the study area is unknown.

Black bears regularly used lower avalanche slopes and brushy areas near the bases of cliffs throughout the later spring and summer months. They frequented more accessible lower ledges and were able to negotiate some surprisingly narrow ledges as well. Five or six different black bears utilized the cliff and meadow areas on the North Fork of Bunker Creek in the vicinity of our camp and we encountered them often. Because both natural lick areas there were near the lowest cliffy areas, goats using them were regularly exposed to these bears. Licking goats showed only occasional interest in black bears foraging as close as 150 feet beneath them. One black bear which we frightened ran off in the direction of several goats at a lick. As the bear lumbered toward them, they moved casually uphill to a steep area 50 feet away, then returned as soon as the bear passed by. On Little Creek, too, black bear sign and sightings occurred in lower avalanche ravines, but only one black bear was seen on the cliff area proper. Nowhere were black bears seen harassing goats or showing particular interest in them, though they are thought to be capable of

ambushing an occasional animal.

Grizzly bears were common in Little Creek - three to four animals used it as part of their range, and four to six animals used Bunker Creek as part of their range, with perhaps one grizzly duplicated in sightings from the two drainages. Grizzly sign and observations were recorded in lower cliffy regions and valley bottoms in spring and fall, but nearly all later spring and summer observations occurred in higher and more open areas than those used by black bears, primarily in subalpine meadows and ridgetops. Grizzlies were seen several times within 400 feet of goats which seemed unaware of their presence. When goats did become aware of grizzlies, they usually fled considerable distances, then continued to survey the surrounding area for upwards of one-half hour. In late October, one grizzly thoroughly sniffed the recently vacated bed of a nanny and kid, then either purposely or fortuitously travelled to another bedding area where it flushed out and passed within 15 feet of three badly frightened yearlings floundering through deep powder snow to escape. No direct predatory attempts by grizzly bears were witnessed, but the contrast between responses shown by mountain goats to black and grizzly bears may indicate that grizzlies actively pursue goats at times. Their regular use of many portions of goat habitat would certainly increase the probabilities of goat-grizzly encounters. Following goat sign, we stumbled upon grizzlies on several occasions, and I was charged by a sow with yearling cubs while tracking goat hair along a ridgetop. Grizzlies are thought to prey to some extent upon goats in other regions (Cowan 1944).

Coyotes (Canis latrans) were present but not abundant on cliffy areas. Those observed travelling there consistently selected courses which avoided steep areas. A large billy fled uphill at a moderate pace after smelling a solitary coyote some distance below. A sub-adult male reacted similarly to the presence of a single coyote. Owen Wister (Whitney et al. 1904) remarked that large groups of goats were easily routed by coyotes, but we observed a nanny and kid with two other females stand to face two approaching coyotes. The nanny exhibited much stamping and head-swinging as the coyotes trotted in a detour around the goats about 30 feet distant. One of the females, #103, which appeared characteristically timid in intraspecific aggressive and dangerous climbing situations, trotted a few feet toward the coyotes as they approached. Seton (1927), Brandborg (1955), and local residents related stories in which cornered mountain goats with their dagger-sharp horns handily dispatched attacking dogs (Canis familiaris).

Occasional cougar (Felis concolor) and lynx (Lynx canadensis) tracks and one lynx sighting constituted the only evidence of felid predators on steep portions of the cliffs. Cowan (1944), Young and Goldman (1946), Cowan and Brink (1949), Brandborg (1955) and Hornocker (1970), note instances of cougar predation on mountain goats. Both bobcat (Lynx rufus) and lynx are capable of killing at least younger goats. Lynx tracks were regularly seen in forested areas near the cliffs and one trapper caught 23 lynx in the Spotted Bear area during winter 1972-1973.

Bald eagles (Haliaeetus leucocephalus) were infrequent visitors to the study area, but golden eagles (Aquila chrysaetos) were observed daily from late February until October. These predators were attracted to the cliffy areas by thermal uplifts, open hunting conditions, and an abundance of Columbian ground squirrels, though resident Clark's Nutcrackers often mobbed hunting eagles. Golden eagles were seen harrying goats in dozens of instances, circling above, then swooping toward the animals, sometimes to within a few feet. No actual strikes were observed in eagle-goat encounters.

Observations of eagles knocking large goats from cliffs were reported by Anderson (1940) and Parratt (1964). Records of eagles carrying off kids are given by Brandborg (1955), Seton (1927), and many hunters and local residents. Correspondingly, in Europe, Couturier (1938) credited the golden eagle with taking the young of chamois and wild and domestic goats, and also with the ability to knock adults from perilous passages. Like the eagle, the Lammergeier or Bearded Vulture (Gypaetus barbatus) is said to bat ungulates from precipices (Brown and Amadon 1968). Together these aerial predators were considered by Couturier to take an important toll of the cliff-dwelling chamois. Because of their ability to strike at goats on the cliffs, and because of frequent and highly visible interactions with mountain goats, eagles have been considered by many popular writers to be the goat's most serious predator.

That eagles prey on mountain goats is indisputable, but the actual intent and effectiveness of harassment such as I observed is difficult

to judge. Eagles displayed some circling and occasional diving toward us as we climbed the cliffs, and swooped toward elk on the ridgetop, though they never came so close as to the goats. As with the goats, eagles sometimes perched nearby after harrying us. By comparison with their response to most other noises, goats seemed very sensitive to the sound of rushing wings. A sudden overhead flight by a Clark's Nutcracker, Steller's Jay (Cyanocitta stelleri), or grouse elicited immediate crouching or, more strongly, squatting responses, though these birds commonly associated with goats throughout their range. The same responses were evoked by severe eagle harassment. Goats generally kept watch of circling eagles and would at times jump up from bed or run a short distance as the birds swooped toward them. Two nannies trotted with lowered horns at an eagle perched close by, putting the bird to flight. Goats reacted to fixed-wing aircraft by fleeing in most cases, and helicopters caused very intensive flight and hiding responses.

Evidence necessary to measure the significance of predation in mountain goat mortality has not been accumulated. Eagles seem to be the most visible diurnal predator. Considering the ease with which I was able to steal within jumping distance of goats, it is tempting to postulate some degree of success by felid predators, which possess considerable stealth and climbing ability. Coyotes, bears, and wolverines share portions of goat range at certain times of the year, but they would seem to pose a threat primarily to animals travelling away from or between cliffs over exposed ridgetops and through forested

habitat. These predators, and in earlier times the wolf (Canis lupus), probably provided significant selective pressure toward traditional use of limited cliffy home ranges by mountain goats.

Older goats appear capable of defending themselves against some predators. Popular accounts have them disemboweling cougars and bears. I found even yearlings, adept and persistent in charging with rapid horn thrusts, a formidable animal when caught in traps. Kids flee from danger at their mother's heels and are usually the last in a group of fleeing goats. Kids also exhibit non-adaptive activities when excited on occasion, and they are the least alert goats. Both kids and yearlings share the qualities of small size, comparative inattentiveness and inexperience, and curiosity, all of which would make these younger animals susceptible to predation, though kids can be defended by their nanny (see Kidding Season).

CHAPTER V

SHORT- AND LONG- TERM RESPONSES TO DISTURBANCE

Alertness

Investigations into short- and long-term effects of various man-made disturbances on mountain goat populations require an initial description of general alertness and reactions to natural disturbances.

While travelling in a typical deliberate pace across cliff areas, the head was usually carried at the level of the knees. If moving directly without taking forage, goats usually raised their heads to survey their surroundings upon reaching a high point on the trail or a projecting ledge. In addition, goats regularly paused every 50 or 75 feet to survey for at least a few seconds.

When actively feeding, goats did not raise their heads at predictable intervals, but looked up irregularly and remained visually alert for durations which varied with age, group size, and group composition. To gain some quantitative estimate of visual awareness, these durations were timed and totalled in 5-minute periods for animals in different age and sex classes from May through September of 1972. Results are presented in Table 19. Precautions were taken to ensure that all 5-minute durations were taken during approximately equivalent feeding conditions. Records

Table 19. Relationships Between Alertness and Group Size and Composition

(Figures represent Average Surveying Time in seconds for 5-minute intervals.)

NO. OBS.	CLASS*	GROUP COMPOSITION A.S.T. WHEN OLDEST IN GROUP	WITH PREDOM. YOUNGER GOATS	WITH AT LEAST 1 OLDER GOAT	WITH PREDOM. OLDER GOATS	GROUP SIZE A.S.T. 1	2	3	4	5	6	7	8	9	10	11 or More
3	Ad♂	-	-	-	-	58	-	-	-	-	-	-	-	-	6	-
33	Ad♀	20	17	17	-	62	25	23	18	5	8	-	12	2	-	-
27	NwK	44	16	13	-	42	**	43	26	15	0	17	2	-	0	0
13	3♀wK	-	24	24	-	39	**	-	14	38	-	-	-	-	-	-
19	All 3♀s	-	20	42	-	41	-	-	14	58	-	-	-	-	-	-
15	2♂	-	-	17	23	32	-		8	16	37	-	-	-	-	10
39	2♀	34	30	16	19	35	32	18	26	10	15	6	14	-	0	0
31	Y	-	-	21	23	25	41	17	45	0	12	6	4	-	-	-
Average		33	21	20	22	42	33	23	19	27	9	10	8	2	2	3

* Because of characteristic lack of alertness in kids, they were not included as a class for comparison.

** Nannies with kids were considered to effectively be in group size 1. In the presence of an additional goat they were placed in group size 3. This allows the best comparison with other figures since in all other cases kids were counted in determination of group size.

are from animals feeding in similar terrain, under moderate weather conditions, without recent histories of disturbance, which had not recently risen from bed or shown pre-bedding activities. Because of difficulties in equating observations and because of the number of different categories involved, some values were based on quite limited data. The data were therefore modified before presentation in two ways. Class values representing single observations were discarded, and intervals during which goats surveyed for more than 3 of the 5 minutes were also discarded. The latter case was not uncommon in solitary individuals. Such animals surveyed in alert postures not only as a protective measure, but to locate other goats. Though they fed sporadically, I felt that individuals in such cases were not representative of animals in a typical feeding situation.

Many more observations are needed to describe degrees of alertness in different situations, but Table 19 is helpful in pointing out general trends.

1.) There seems to be a good correlation of alertness with increasing age in solitary goats (group size 1). If surveying time of solitary animals is averaged for age without regard to sex or the presence of kids, the proportionality is even more evident. (Numbers are from original figures before rounding off.)

No. Observations	Class	A.S.T. (Sec./5 Min.)
63	Adult	58.3
19	3-Yr.	41.4
54	2-Tr.	33.8
31	Y	25.4

Solitary individuals were often intensely alert to the point of sensitivity to very slight disturbances. "Jumpy" is a good word to describe these goats since individuals sometimes literally jumped or trotted several feet in response to a passing ground squirrel or tumbling rocks which they had loosened. Figures reveal that adult animals were more than twice as watchful as yearlings. Kids were the least alert, and since they rarely showed any initiative in surveying while feeding or bedded, they were not included in quantitative comparisons. Youngsters would continue to frisk about their nanny's heels as she stood in rigid alert postures while observing the approach of a predator or human investigators. Nine- and 10-month-old kids still evinced scant concern for their security as measured by overall alertness. As yearlings, young goats found themselves suddenly independent and often alone. Their alertness improved, but remained the lowest of all classes except kids while their curiosity seemed the best developed. The goats which most often investigated us at close range were younger animals. A yearling was the first goat to use the lick area again on the North Fork of Bunker Creek following disturbance-related emigration of residents. A yearling and 2-year-old female were the first to investigate our blind on the Little Creek cliffs.

2.) There is a fairly constant reduction of individual alertness with increased group size occurring in each class of goats. This tendency is most evident as Average Surveying Times for all classes are averaged for each group size (bottom row, group size 1-11).

3.) An increase in surveying time appears in goats which were the oldest members of the group in which they were observed. Although the table is somewhat incomplete in this regard, the increase appears in each of the three classes to which this criterion applies. Surveying times for individuals in predominantly older and predominantly younger groups were similar, and the effect of the presence of at least one older goat in a group could not be distinguished from either of these categories. This confirms general observations that the leader of a group was generally the most watchful. Once a leader was present, relative proportions of younger and older goats in a group did not seem to affect individual alertness. Leadership is discussed under Social Organization.

Younger kids and yearlings sometimes became startled and fled into the midst of groups. At times, other goats became alarmed and trotted a few feet, but were seldom routed without further disturbance. On most occasions, the youngsters were largely ignored. One new yearling ran fearfully from my wife, returning to his companions while showing every sign of fright, and was forced to retreat through them on a narrow ledge. His older companions nevertheless continued on toward my wife until they became directly aware of her. Alarm in older goats, particularly the leader, was generally heeded by others once visual contact with the alarmed animal was established. I was unable to detect a scent or vocalization employed to signal danger. It appeared that goats relied primarily on visual transmission, as most goats seemed to become aware of a disturbance at

various times in the same group. Even in visual contact with an alarmed animal, goats exhibited independence of reaction and usually attempted to locate the source of disturbance themselves before fleeing.

When bedding, goats selected sites with steep walls behind them, mostly within the top third of cliff areas. The very tops of outcrops and promontories were favored in moderate weather. Night beds were selected with greater provision for security than most day beds. Other factors are discussed under Bedding.

An analysis of sleeping durations was made to test three hypotheses. I had conjectured that: 1) younger goats have longer sleep durations than older animals; 2) younger goats sleep for proportionately greater total time than older goats during bedding periods; and 3) sleep durations are longer for all classes in larger groups. Data relevant to the first hypothesis, based on 227 records of sleep durations are presented in Table 20. A sleep duration is defined as the time spent in a position of sleep with the eyes closed (see Bedding). Results were inconclusive. Significantly, average sleep durations of nannies with kids were less than one-half as

Table 20. Sleep Durations

Class	No. Obs.	Ave. Duration Sleep
Y	60	2.68
2	29	2.37
2	23	6.19
3	24	3.53
Ad	31	2.77
NwK	60	1.09

long as that of any other class. Sleep durations of 2-year-old males were unusually high, but data were drawn from a small number of individuals and may not be representative. Yearlings had unexpectedly short sleep durations. This is partially explained by the fact that yearlings frequently changed positions in bed and so curtailed sleep durations. Younger goats were usually the first to begin dozing after rumination. Also, alert intervals between sleep durations were shorter in young goats. As a result, yearlings and 2-year-olds tended to have greater total sleeping times than older goats, substantiating the second hypothesis. Finally, limited data did not appear to support the hypothesis that all goats sleep more in larger groups. Aggressive instability may have partially counteracted increased security in large groups. Because kids were so often obscured as they bedded behind their mothers, they were not included in analyses.

Alertness and Flight

Ears of adult goats are long (5-6 in.) and flexible. Ears were pricked up when alert and rapidly rotated to locate sounds, but goats seemed not to rely heavily on auditory clues to detect danger. Some impairment of hearing may result from ticks becoming lodged in the external auditory meatus (Anderson 1940). Reliance upon discrimination of low intensity auditory information against background noise from high winds, cascading streams, and frequent rock and ice falls would seem to be an undesirable strategy for detecting danger in any case. As we or goats climbed close above

goats, loosing small showers of gravel and litter, most paid little attention.

Goats appear to have good visual acuity, but do not seem responsive to stationary objects, as was also noted by Anderson (1940) and Klein (1953). I am fairly certain that goats observed me at times with interest from at least 1 mile. An alarming stimulus usually elicited a staring response in which the goat orients toward the stimulus and remains immobile, staring fixedly for 2 to 5 minutes, and occasionally as long as 15 minutes. Goats exhibited a shorter staring response of 15 to 30 seconds when initially encountering one another. The mountain goat's stare is usually directed across a hillside or to the cliffs below. Other investigators have also noted that goats rarely concern themselves with what might be above them. A protruding supraorbital ridge also discourages upward-directed vision to some degree.

Most authors agree that olfaction is perhaps the goat's best developed sense. It plays an important role in foraging and social activities as discussed elsewhere. Winds blew from valley bottoms upward to ridgetops during warm days in the study region. This factor, in addition to the goat's visual orientation, made it virtually impossible to approach them from below and fairly simple to come upon them from above.

Goats almost always attempted to ascertain the nature and location of a potential threat before they fled. It is in part the habit of remaining in a fixed location or approaching some distance

toward a disturbing stimulus after sensing it that has given the mountain goat a reputation for curiosity. Because the goat relies on its mountaineering abilities and familiarity with its precipitous home range rather than speed in escape, it is probably more important for a goat to confirm the precise nature and position of a threat than to begin immediate flight away from it. Some goats stood in one position for more than 30 minutes or bedded after becoming aware of a disturbing stimulus, reluctant to move before they localized the source.

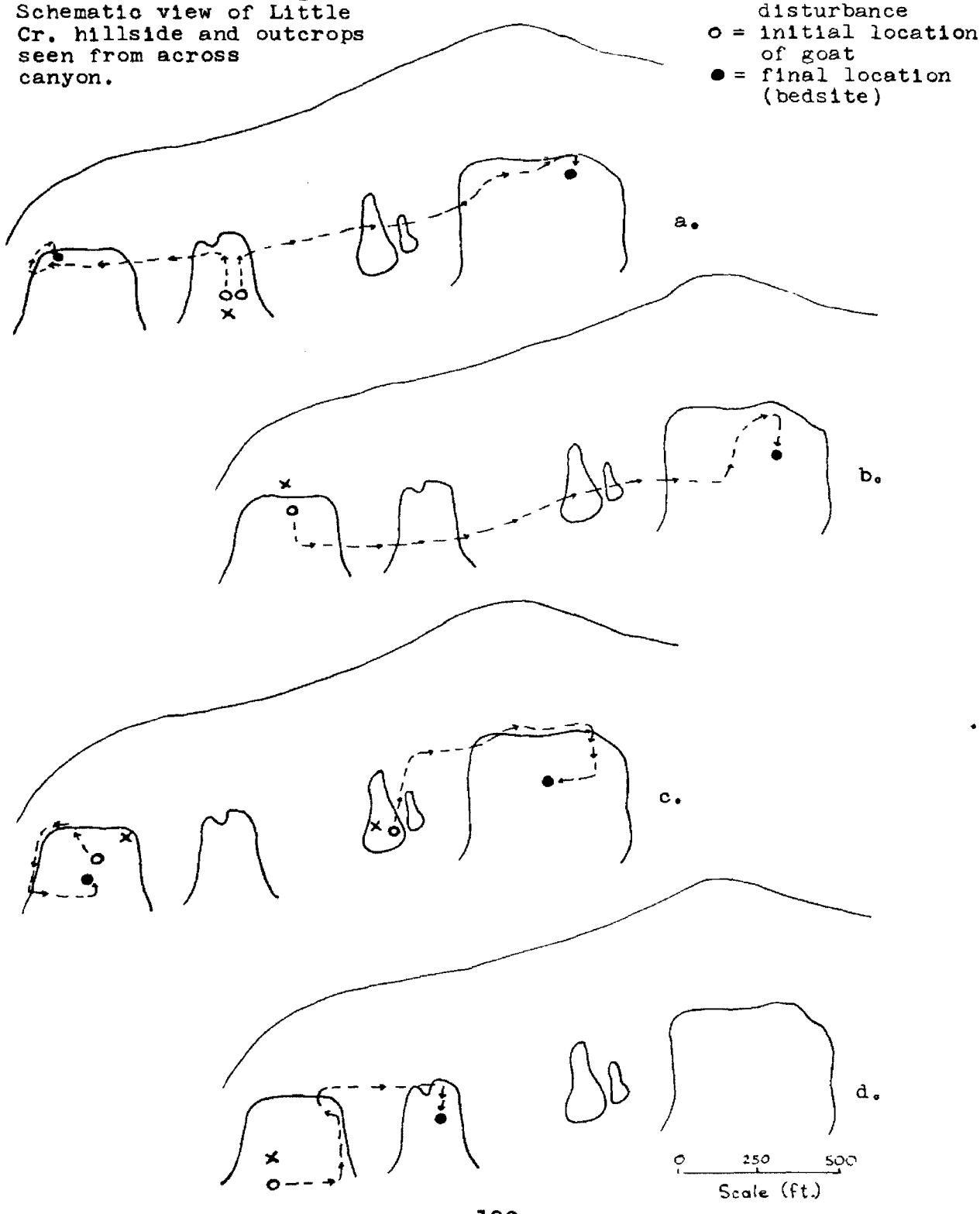
Goats showed a tendency to approach novel and partially revealed objects. One goat was drawn to within 30 feet for dye-marking as I protruded only a hand or empty sleeve from time to time from my position behind a rock. Brandborg (1955) lured these animals toward him for close observation by waving a cloth while concealed. A nanny and new kid approached to within 6 feet of Beth, who was partially obscured by a ledge, to investigate her. Young goats, characteristically inquisitive, several times approached to observe us at close distances. Perhaps due in part to lack of experience with hunters and other predators, kids, yearlings, and some 2-year-olds remained at times in an area even when aware of our presence. Small groups of yearlings seemed to compete with one another while exploring strange objects, including us, to approach most closely.

In conjunction with their proclivity to confirm the nature and location of a threat before fleeing, goats did not usually begin flight immediately upon recognizing a threat. Instead, they walked

deliberately for 30 or 40 feet, or until out of view, then began rapid flight. Many predators will begin chasing a rapidly moving object, while a slowly moving one may fail to elicit a chasing response. An adult male, aware of me but apparently thinking himself unobserved, was seen slinking away in a crouched position, slowly picking up and replacing one foot at a time. Kids usually fled at their nanny's heels, but several showed nonadaptive behavior in flight situations. Some frolicked by their mother as predators or observers approached, others failed to heed maternal anxiety while playing with other kids, and a few failed altogether to flee when the remainder of the group, including their nanny, fled.

Flight in moderate terrain was usually directed toward the nearest cliff area. Once within precipitous terrain, goats generally fled uphill. Lateral movements were first used if predators or observers were discovered approaching from above. Goats fleeing uphill, if not directly chased, proceeded at a moderate pace and often stopped to search below for several seconds. Even relatively short flights left goats panting. On the North Fork of Bunker Creek, goats using the lower cliff belts fled most often toward higher belts or the ridgetop even though this frequently involved passage through non-precipitous terrain. On the more extensive cliffs in the Little Creek drainage, goats usually fled toward the cliff top, then moved laterally, remaining within the cliff area (Fig. 28a through d). Afterward, goats surveyed for long periods, then usually bedded on

Figure 28. Patterns of Flight Schematic view of Little Cr. hillside and outcrops seen from across canyon.



a vantage point and remained alert for some time. Goats occasionally made use of timber as escape cover within cliff areas, and, in a few instances, in less preciptous terrain.

Response to Specific Natural and Artificial Disturbances

Responses of mountain goats to thunder were similar to mine. Rolling thunder had little effect other than alerting some animals, but sharp thunderclaps startled them. Walking goats sometimes broke into a trot, and feeding goats jumped to an alert posture during sudden thunder. Bedded goats raised their head and stopped ruminating. Magnitude and frequency of responses were greater in younger, more inexperienced animals. Kid A, only a few days old when it experienced its first thunderstorm, began a series of excited leaps as thunder boomed. Kids reacted to rolling thunders which older animals ignored, and at the sound of thunderclaps often ran to their mothers. During a May thunderstorm, a newly-independent 11-month-old kid trotted back and forth beneath a ledge with its tail up and ears back, signifying fear, as thunder intensified. Yearlings were also fairly responsive to thunder, but older goats were noticeably less affected. I observed some older females calmly bedded during severe storms in which I was cringing as thunder cracked over the ridgetop. A few appeared alert, perhaps anxious, but most were comparatively phlegmatic, unruffled by bolts which shook the mountainside.

Rock, snow, and ice falls are a constant phenomenon of mountain cliffs throughout most of the year. Goats sometimes

appear to pay scant attention to such noises, a fact which has led various authors to comment on their habitual indifference to rockfalls and avalanches. Most goats observed seemed reasonably alert to these events. Dozens of instances were recorded of goats fleeing partway across cliffs at the sound of a rockfall. Others showed constant attention and anxiety until they localized the sound of a rolling rock. In groups, individuals seemed adept at discovering and avoiding rocks loosened by others above them. They occasionally paid attention to rocks they dislodged themselves as the rocks struck and made a substantial noise.

I observed some animals on warm spring days of continual avalanche and rockfall which appeared habituated to these disturbances to the point of ignoring clods of ice and snow falling directly onto their back. One would not expect the animal to maintain a constant high response capacity throughout the day in such a tumultous environment. This is consistent with Brandborg's (1955) observations that goats' reactions to noises varied with the familiarity of the auditory stimulus. Brandborg also cites an example of a goat running for several hundred yards after being startled by a small snowslide a few hundred feet away. As an avalanche thundered nearby, three newly-independent kids ran rapidly after an adult female. An adult female jumped up from bed as an avalanche roared down a ravine a few hundred feet away. This same female jumped up from bed again 30 minutes later in response to another slide and thereafter paced about her bedsite for nearly 2 hours as continual snow and ice slides tumbled down the cliff. Other

avalanches elicited only brief attention from goats in the vicinity.

Helicopters seem to present a terrifying stimulus to mountain goats. All goats observed from a helicopter ran at full speed to take refuge in a crevice or under a tree, wedging themselves tightly against their shelter or pacing nervously within its confines. Bill Davidson (pers. comm.) of the Idaho Fish and Game Department noted that movements of mountain goats out of the White Cloud area appeared to occur at the time of frequent helicopter use by the mining exploration company there, though other factors such as heavy motorcycle use may have been responsible. The Forest Service closed the area to motorcycles in 1972. Pengelly (pers. comm.), who had not observed goats there the previous year, saw goats on trips to the area in June and September of 1972. The immediate flight and hiding response of goats limits the effectiveness of helicopter surveys where broken terrain and timber provide escape cover.

Goats were seen orienting toward fixed wing aircraft in alert defensive postures and were put to flight by some airplane approaches, but showed none of the intense avoidance exhibited in the presence of helicopters.

In many drainages on the west side of the Swan Mountains, roads run quite near goat cliffs, and, in several drainages, goats were observed within 300 to 500 feet of roads. An old nanny with conspicuously long horns, observed for several months near Goat

Creek and reported by residents and hunters to have inhabited the drainage for at least two years previously, was seen on two occasions bedded in plain view within 200 feet of the road, despite occasional use of the road by cars during the day. She remained bedded as I drove and walked beneath her. Despite her reported long residence there, and despite regular use of the road during non-winter months, she still stopped feeding or ruminating to follow the progress of autos up and down the road with her gaze, even from over 1,000 feet away. She sometimes moved to the outside of a ledge to gain a better view of passing cars, but otherwise continued her normal activities. In other drainages, and on the North Fork of Bunker Creek, which has goat cliffs about 850 feet from the road at its nearest point, goats showed essentially the same response. Some broke off all activities to watch cars for as long as 5 minutes or bedded to observe them for longer periods. Others largely ignored the presence of cars as did goats seen near popular highways in Glacier National Park. So far as could be determined, the occasional presence of automobiles did not disturb general activity patterns or promote immediate movements out of an area, but did, in some cases, cause temporary suspension of ongoing activities.

Sonic booms occurred a few times each week during spring and summer of 1971 while we were at Bunker Creek. Thereafter, they occurred occasionally throughout the study area. Goats responded much as they did to sudden thunderclaps. If feeding, they jumped

to an alert position and followed the sound of the jet with their head. John Craighead (pers. comm.) observed a nanny and kid run for about 30 feet and take refuge beneath a ledge overhang after a sonic boom. Responses by bedded goats were variable. Most remained bedded and paid attention to the post-boom roar of the jet, ceasing rumination from 30 to 60 seconds. A nanny and kid jumped up from bed and stood in an alert position for 2 minutes following a sonic boom.

Continual exposure to sonic booms may have partially conditioned mountain goats to similar disturbances such as gunfire and blasting. The report of my .44 magnum pistol fired 300 feet from a group of goats elicited virtually no response other than a temporary halt in movement toward a lick. Hunters variously report marked reactions to gunfire - "Drives 'em right over the hill." - and relative insensitivity to it - "They just stand there while the bullets bounce on the rocks around 'em." Reactions to gunfire probably vary to the extent that goats are alerted by other stimuli associated with the presence of hunters.

On the North Fork of Bunker Creek, blasting during road construction was almost indistinguishable from sonic booms , though blasts were often much stronger in intensity. Goats responded with crouching startled reactions and subsequent surveying of their surroundings, then resumed activities after 1 to 3 minutes. A 2-year-old female approaching a salt lick crouched in a startled

posture and surveyed 3 minutes after a blast was detonated 1,000 feet distant, then changed directions and proceeded to the other lick. On Little Creek, 3 miles distant, blasts from Bunker Creek caused only a temporary suspension of activities and brief surveying, from 15 to 30 seconds. Seton (1927) noted that ".... goats paid little attention to the reports that sent sheep off a-bounding." during road construction in Glacier National Park. Long-term effects of blasting are discussed in the section concerning Bunker Creek History.

Populations in Related Areas

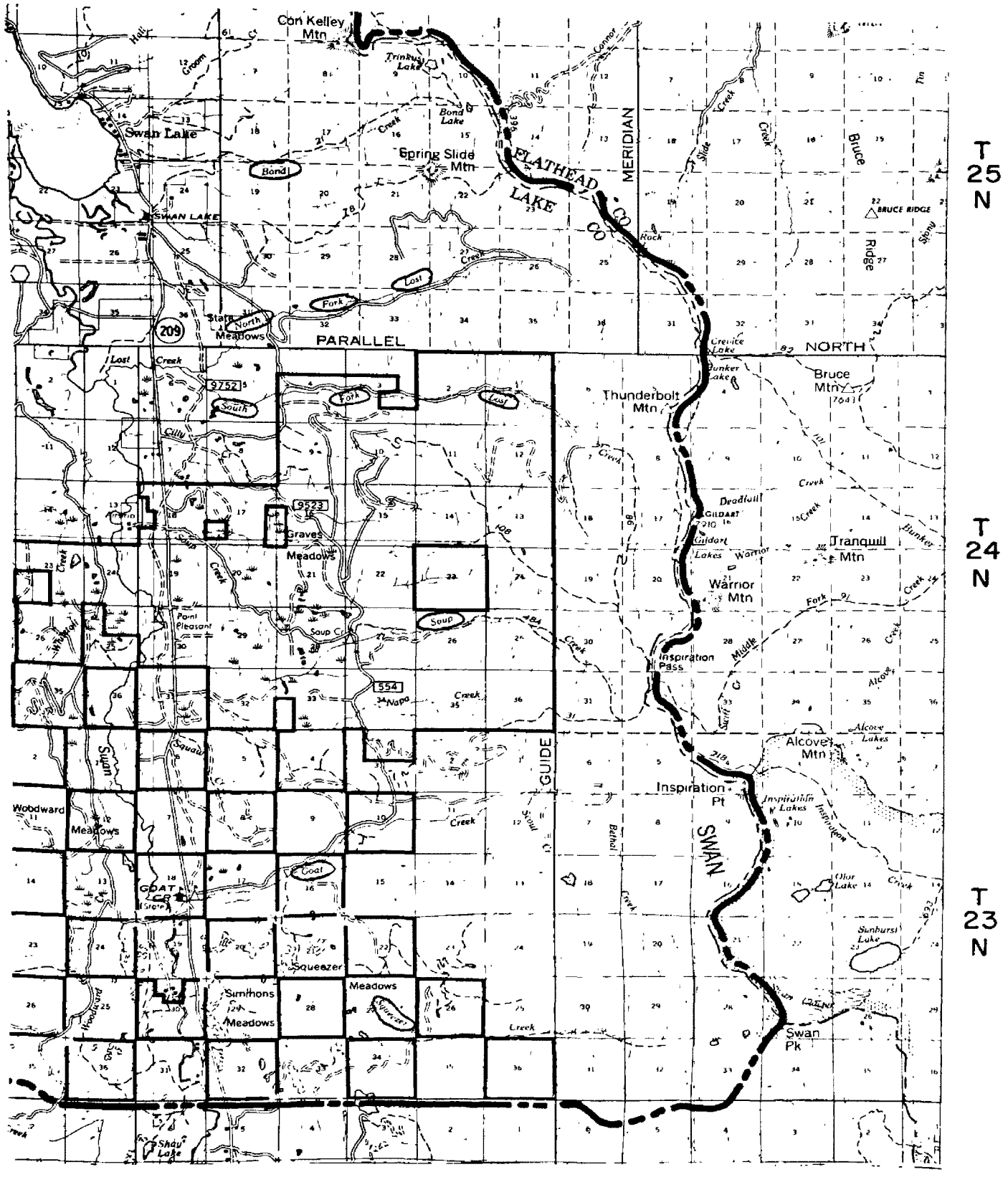
To help determine the history of goat populations in related areas, and to establish comparisons with the Bunker-Little Creek herd, we regularly censused five drainages on the other side of the Swan Mountains, directly west of the Bunker Creek study area. These included Bond Creek on the north to Goat Creek on the south end. Goats from these areas were said by local residents and hunters to share portions of the Swan Mountains crest with goats from the east (Bunker and Sullivan Creeks) side. Summer explorations revealed tracks and goat hair on paths crossing ridgetop areas from Bond to Connor Creek and between Bunker and Lost Creeks in the Thunderbolt Mountain vicinity. At least one adult male was known to have travelled from the Bunker-Little Creek range to North Lost Creek. However, no marked or otherwise identifiable female or subadult was known to leave the Bunker-Little Creek range during the

course of the study.

A herd of at least 13 animals is thought to regularly inhabit the Swan Peak region in summer and fall. Goats were regularly observed there during summer censuses. Approximately 20 goats were regularly observed throughout the String Creek region. Goats were seen travelling between String and Alcove Creeks, and between adjacent String, Razzle, Late and Feather Creeks. A female with a broken horn travelled between Alcove Peak and Late Creek, a distance of 5 miles, in less than 36 hours.Goats which moved in and out of Middle Fork Creek very likely travelled there along a ridge extending from the Alcove Peak area. Tracks and hair were followed along this ridge to within .5 miles of primary cliff areas on Middle Fork Creek. Groups observed there contained different distributions of age and sex classes and had quite different shedding rates than members of the Bunker-Little Creek herd.

Four different censuses of each of the west-side drainages from Bond to Goat Creeks were conducted during spring of 1971. It was felt that spring counts could more successfully locate resident goats before movements to higher and more diffuse summer range occurred. Two days were spent in each drainage during each census, and cliff areas throughout the length of each drainage were searched. These areas are similar to one another, flowing essentially parallel east to west from the Swan Mountain crest to the Swan Valley. In habitat composition and type and exposure of cliff

Fig. 29 Map of Swan Lake Area



outcroppings, these drainages also resemble Bunker Creek, with the exception of Soup Creek which has only limited cliff exposure. Figure 29 shows the relationship of west-side drainages. Census results are as follows in Table 21.

Table 21. Census Results in Selected West-Side Drainages

Bond Cr.		N.Fk. Lost Cr.		S.Fk. Lost Cr.		Soup Cr.		Goat Cr.	
Ave.	Max.	Ave.	Max.	Ave.	Max.	Ave.	Max.	Ave.	Max.
4	7	0	0	2	4	0	0	2	3

Observations were probably incomplete, but Jack Whitney, a long-time Bigfork resident and well-known goat archer familiar with these drainages estimated that they contained a total of no more than 15 to 20 goats. Intensive censusing during the summer of 1973 confirmed these earlier results, locating fewer individuals in these drainages than in 1971.

A review of hunter questionnaires sent out by the Montana Fish and Game department from 1959 to 1970 provided additional information. Some successful hunters failed to return questionnaires and others provided incomplete information, but this review revealed highest hunting success in the Bond Creek and South Fork of Lost Creek drainages. This was consistent with my observations of higher numbers there and with information provided by local residents. Table 22 summarizes questionnaire results for selected west-side drainages.

Table 22. Hunter Success in Selected West-Side Drainages (1959-70 from questionnaire results)

	"Above Swan Lake"	Bond Cr.	N.Fk. Lost Cr.	S.Fk. Lost Cr.	"Lost Cr."	Soup Cr.	Goat Cr.	Total
1959	1	1						2
1960	2	1		2				5
1961		1						1
1962	1	1		4				6
1963		1						1
1964		2	1		1			4
1965		1						1
1966		2						2
1967		3		2				5
1968		1	1	1				3
1969		1	1	1				3
1970			1	1				2
Total	4	15	4	11	1	0	0	35

No authoritative early or contemporary records of goat numbers exist for this area or any other portion of the Swan Mountains, and it is difficult to estimate trends from scanty information available. Long-time residents such as Buster Redd who resides on the South Fork of Lost Creek observed large herds on cliffs in Bond Creek and South Fork of Lost Creek during the 1940's. I was told of herds exceeding 30 animals in a single drainage. Such high counts may have involved temporary accumulation of groups from adjacent drainages during kidding and rutting seasons. I noticed tracks and a few animals crossing between drainages in this area, though most groups were repeatedly observed in the same drainage. In early days, herds of from 5 to 12 individuals were reportedly seen on Goat and North Fork of Lost Creeks. There is no

evidence, so far as I could determine, that goats regularly inhabited Soup Creek which has restricted cliffy areas.

I was unable to uncover reports of large or frequently observed groups in any of these drainages in recent years. Roads were constructed for logging in all but Bond Creek beginning in the 1950's. Roads and clearcuts passed within rifle range of major goat cliffs in the other drainages and extended to within 1 or 2 miles of the Swan crest. This may have had some effect on resident goat herds.

Harvest information for hunting districts 130 and 140 (Figure 30) from earliest records in 1958 until 1972 is presented in Table 23. Goat hunting was restricted to a permit basis in 1965 in these districts. A reorganization of goat hunting districts was accomplished for the 1972 season. Table 23 illustrates a drop in annual kill figures through the 1958-72 period, particularly in District 140. From the first record in 1959 through 1963, numbers of males harvested annually were about twice those of females (M:F = 1.82:1.00). From 1964 through 1972, sex ratios of harvested animals averaged slightly lower for males (M:F = .92:1.00). In the last three seasons, the number of females harvested was about 2.4 times that of males (M:F = .42:1.00). This may be related to low numbers of males observed throughout the Bunker-Little Creek range and west-side drainages censused. Of the maximum total of 14 animals observed from Bond to Goat Creek, three were kids, and three, or at most four, were breeding age males in the 1971

Figure 30. Location of Hunting Districts 130 and 140

1971 Season

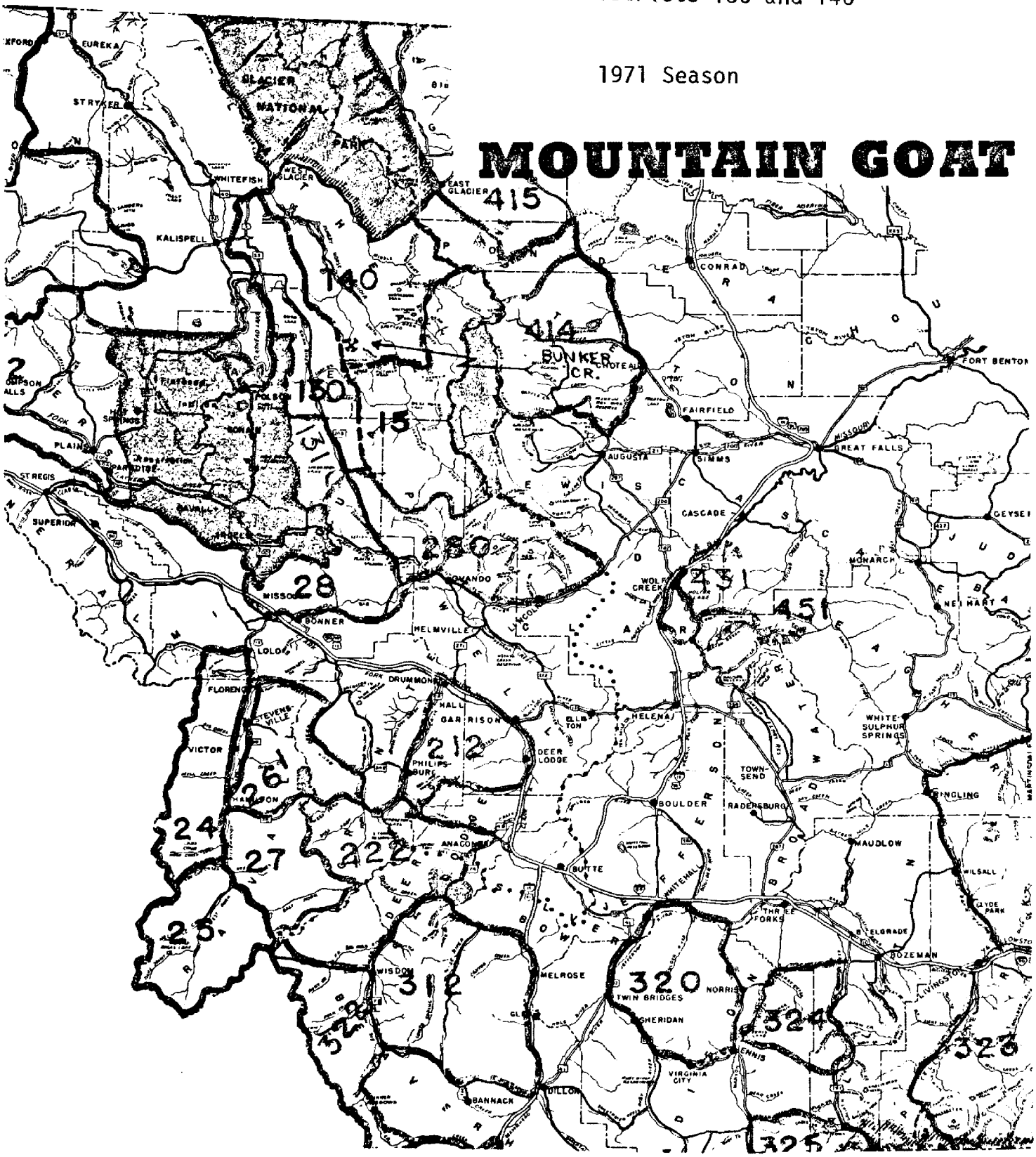


Table 23. Harvest Data for Hunting Districts 130 and 140

Year	District 130				District 140				
	No. Permits	No. * Hunters	No. Killed	% Success	No. Permits	No. Hunters	No. Killed	% Success	Ratio Male:Female
1958	-	-	38	-	-	-	74	-	-
1959	-	-	7	-	-	-	20	-	1.12 : 1.00
1960	52	-	22	42	110	-	22	20	1.82 : 1
1961	54	-	16	30	107	-	28	26	1.70 : 1
1962	86	-	36	42	126	-	35	28	2.09 : 1
1963	80	-	18	23	187	-	59	32	2.36 : 1
1964	90	-	20	22	157	-	22	14	.95 : 1
1965	50(Lim.)	31	11	35	75(Lim.)	59	19	32	.76 : 1
1966	35(Lim.)	26	7	27	50(Lim.)	40	21	51	1.55 : 1
1967	"	28	14	50	35(Lim.)	29	7	23	1 10 : 1
1968	"	29	10	33	25(Lim.)	24	10	42	-
1969	"	29	16	55	"	23	11	48	1.75 : 1
1970	"	24	5	24	"	21	10	48	.66 : 1
1971	"	31	14	45	"	22	8	36	.62 : 1
1972	25(Lim.)	18	5	28	-	-	-	-	0 : 1

* No. hunters is number returning questionnaire.
**Ratios from 1959-61 were available only as aggregate figures including District 150.

census. Intensive 1973 censusing located three kids and breeding age males in the same drainages.

During the past two decades, goat populations in portions of the Swan Mountains and other areas in District 140 were subject to moderate to heavy hunting pressures and increased accessibility through road-building for logging. In district 140, the lower portion of the South Fork of the Flathead River, road mileage increased from 158 miles in 1957 to 617 miles by 1971 (Richard Weckwerth pers. comm.). Whether or not these factors were directly responsible for an apparent decline in goat populations has not been definitely determined. In Sullivan Creek Drainage which borders Bunker and Addition Creeks on the north and Bond Creek on the east, there appears to have been some relationship between road-building, logging, and goat population decline. According to the woods boss of that operation, other loggers, and Forest Service employees, 15-20 goats regularly used cliffs near the logging camp as road-building and clearcutting proceeded within rifle range, 100 to 400 yards distant. Since fall of that year, no more than two or three goats have been reported in that cliff area. I was unable to locate any goats in several censuses in major Sullivan Creek cliff areas and elsewhere throughout the drainage.

Brandborg (1955) wrote that depletion of goat populations occurred in the more accessible ranges of Idaho. Goat populations are thought to have declined in accessible portions of the Sun River area in Montana, District 414, possibly through overharvest

(Watts et. al. 1972). Goat herds rapidly disappeared from the Mission Mountains of Montana following a period of unlimited hunting. Mark Quaedvlieg, Wildlife Inventory Biologist for the Department of Lands and Forests in Alberta, attributes a drastic decline in Alberta's mountain goat populations largely to improved access provided by logging and mining industries and resulting overharvest by hunters (pers. comm.) (see Appendix IV).

Bunker Creek History

A bark beetle infestation, detected during 1953 in large Engelmann spruce along the bottoms of Bunker and Gorge Creeks, gave rise to Forest Service plans to begin timber extraction from the area. This proposal aroused very strong local opposition by sportsman's and conservation groups. Like many other de facto wilderness areas, Bunker Creek was noted for its hunting, fishing, and scenic qualities. It was, in addition, an ecological buffer zone bordering the northwest corner of the Bob Marshall Wilderness. To log Bunker Creek, roads would have to be built as far as 25 miles past Spotted Bear, long considered the end of the road up the South Fork of the Flathead River. A bitter controversy over the future of this drainage eventually resulted in suspension of logging plans.

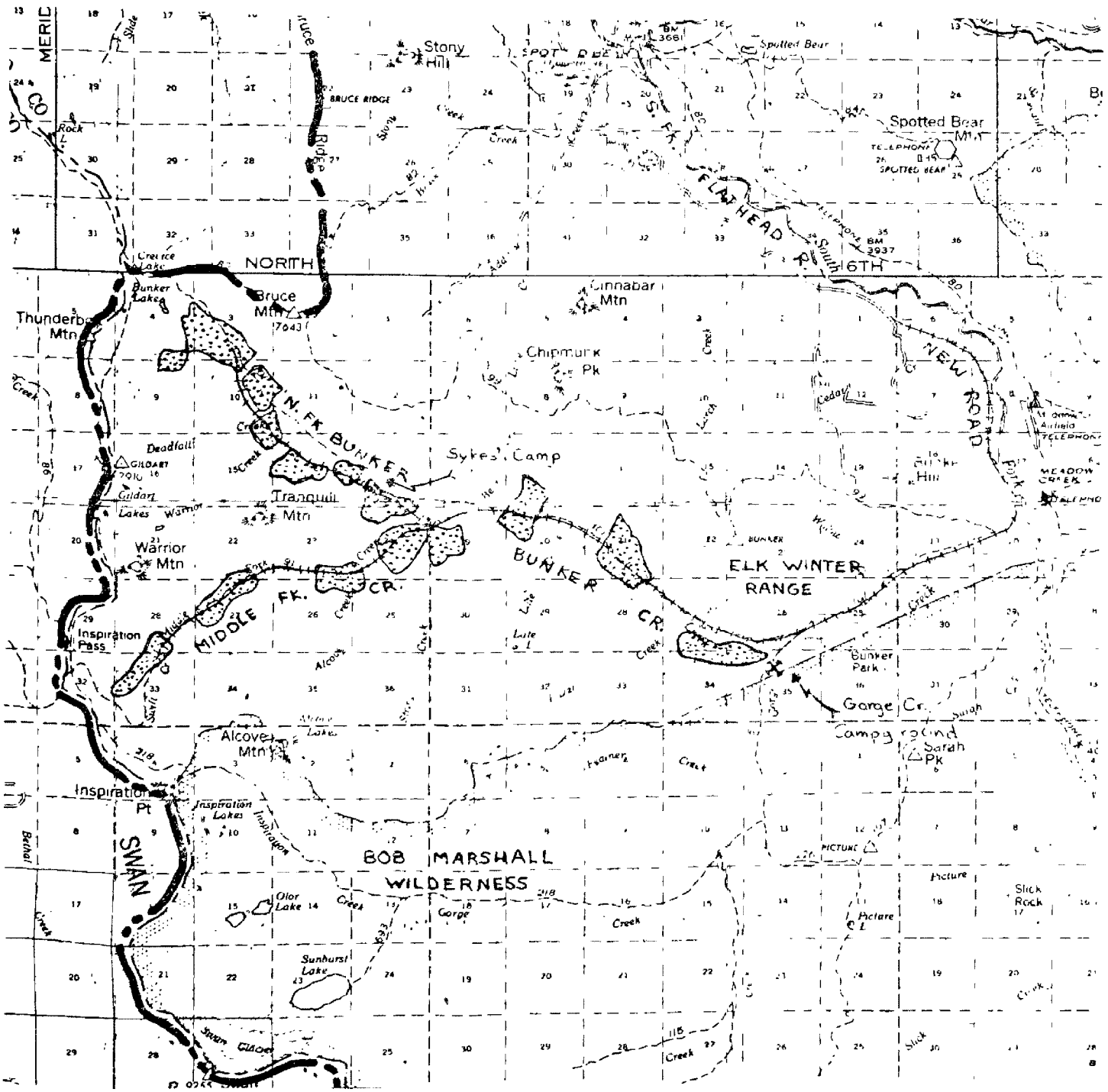
In succeeding years, efforts were made by conservationists to have Bunker Creek appended to the Bob Marshall Wilderness. The proposed Bunker Creek timber sale was placed in the Flathead Forest 5-Year Plan in 1964. In April of 1968, a multiple-use plan

pertaining to this drainage was completed and presented as a report. On page one (Flathead Forest Multiple Use Survey Report, April 25, 1968) some implications of the Bunker Creek sale are discussed: "Several out-service groups and individuals are interested in this project as this will be the initial development of quite large areas of back country." Rocky Mountain Goats were mentioned, and it was noted that hunter use of the road "... may have quite an impact on this herd." Specific information and censuses of game and non-game species were not presented and no stream surveys were conducted, making post-logging comparisons difficult. On 13 March, 1969, the Bunker Creek sale was awarded to Plum Creek Lumber Company. Figure 31 shows the initial sale layout.

My wife and I began field work in March of 1971. At that time, a permanent dirt road had been constructed about 3 miles upstream from Gorge Creek, and a rough dirt road built from there , ending in a bulldozer trail about 1.5 miles up Middle Fork Creek and the North Fork of Bunker Creek. On the North Fork of Bunker Creek, the bulldozer trail ended almost directly across from the major goat cliff area, known as Sykes' Camp.

Prior to road-building, mountain goats were hunted by only a few outfitters and elk hunters in the Bunker Creek drainage. Hunter questionnaires from 1959 to 1969 showed only three goats killed in Bunker Creek. In the fall of 1970, the new road was closed to hunters about 2 miles below the confluence of the forks. Lawrence Deist, a Region 1 Montana Fish and Game Warden, was told

Figure 31. 1967 Sale Layout - Bunker Creek



of heavy poaching on Bunker Creek, but this could not be documented. Three goats were legally taken from Bunker Creek that fall.

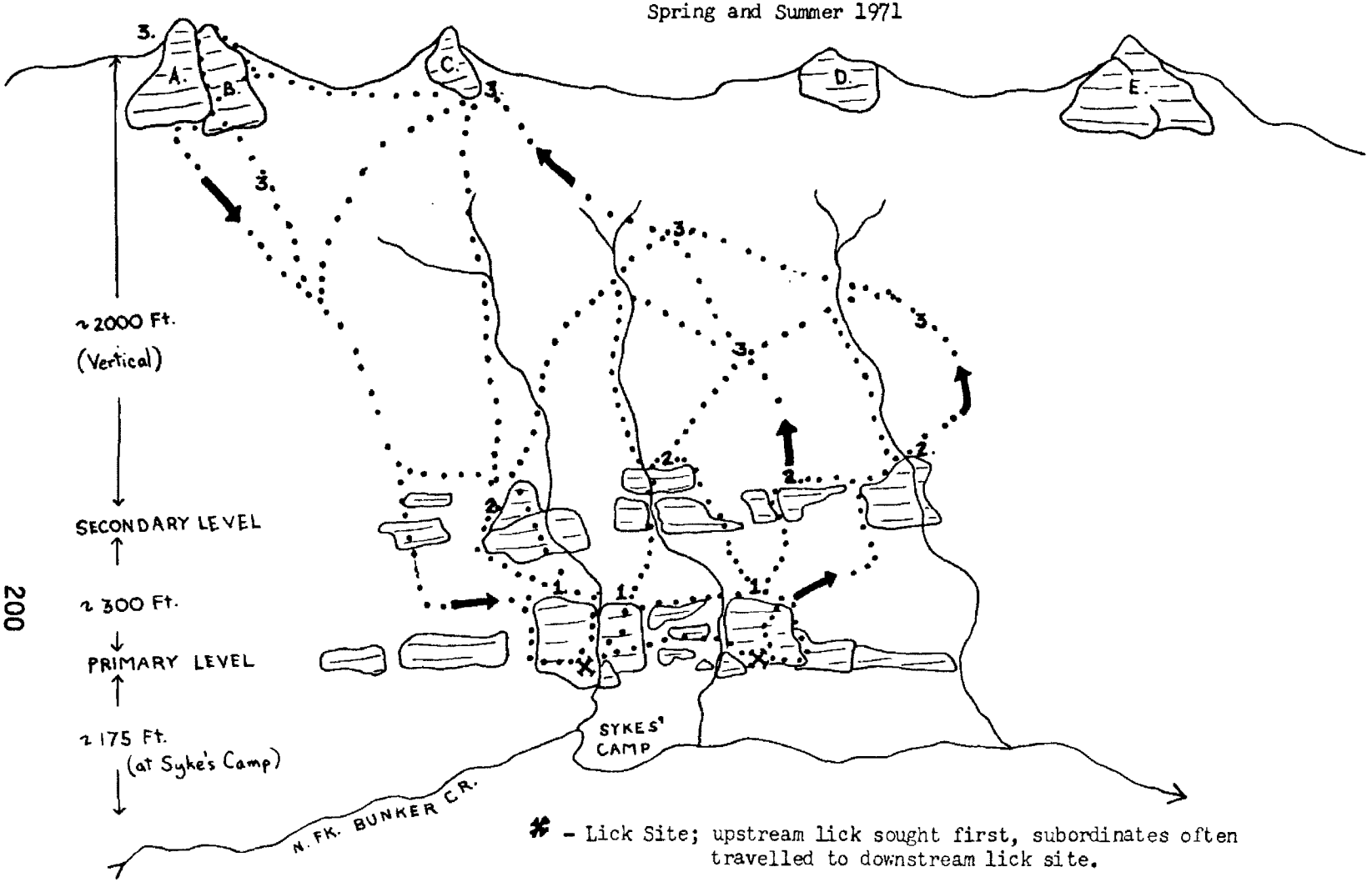
I gathered goat censuses for Bunker Creek from a variety of sources in an attempt to estimate pre-logging populations. It is not known to what extent counts by other individuals represent seasonal aggregations of goats possibly due to the presence of three natural licks on the North Fork of Bunker Creek, or how thoroughly individuals searched for goats. Counts made by individuals early in the 1970 hunting season are also included in Table 24.

I arrived on Bunker Creek on 26 March 1971 and observed six goats (#1, an old nanny; her kid; #103, a 3-year-old female; a 2-year-old male; and two yearlings) on the North Fork above Sykes' Camp. Extensive searches including a helicopter survey revealed no additional goats anywhere else on the North Fork, on Middle Fork Creek, or in the main part of the Bunker Creek drainage. These six goats remained in the major cliff region through April. During May, individuals were occasionally missing for short periods, and a few new animals visited the North Fork for several days at a time. Though the Little Creek area was not monitored until June, fluctuations in the North Fork group were probably due to movements between these drainages as were shown to occur during the remainder of the study. No more than eight goats were observed at one time from March until June on the North Fork, and I usually counted five or six. General pre-logging movement patterns of goats using the North Fork of Bunker Creek are depicted in Figure 32.

Table 24. Pre-Roading Estimates of Bunker Creek Goat Populations

Source	Position	No. Goats Observed	Season & Year	Description
Buster Redd	Long-time S. Fk. Lost Cr. resident	+50	Summer 1940's	N. Fk. Bunker and Bruce Mt. area
-	Hunter, from Questionnaire	6	Fall 1962	Bunker Cr. 2 Mi. N.W. of Gorge Cr.
-	Hunter, from Questionnaire	11	Fall 1962	"Bunker Cr. over Inspiration" (Md.Fk.)
-	"	35	Fall 1962	Bunker-Crevice Lake Area
Otis Robbins	Dist. 1 F & G	5-6	Fall 1960's early	Middle Fk. Bunker not seen past few yrs.
Dick Weckwerth	Dist. 1 F & G Game Biologist	33	June 1969	N. Fk., mostly Sykes' Camp area
Bill Armstrong	Hungry Horse Dist. U.S.F.S. Engineer	11	Summer 1969	Bunker across from Gorge Cr. as built rd.
	"	21	Summer 1970	N. Fk. Sykes' Camp
	"	8	Summer 1970	Middle Fk. Cr. occasionally
Rolland Saylor	Spotted Bear District Ranger	8	Summer 1970	Bruce Ridge
	"	17	Summer 1970	N. Fk. Bunker, Deadfall Cr. area
Les Marcum	U. of Mont. School of Forestry, Grad. Student	9-10	Summer 1970	N. Fk. Sykes' Camp 3 Different Trips
		14, Probably 19	Sept. 27th 1970	2 across from Gorge Cr. 12 (17) N. Fk. ridge above Sykes' camp
Ralph Wilson	U.S.D.A. Forestry Science Lab, Msla.	15-20	Sept. 15 1969	N. Fk. by Sykes' Camp
		10-19	Sept. 15-18 1970	N. Fk. by Sykes' Camp
Robert Ream	U of M School of Forestry, Prof.	9-10	July 1970	N. Fk. by Sykes' Camp

FIG. 32 PRE-LOGGING MOVEMENTS IN MAJOR CLIFF AREA OF N.FK. BUNKER CREEK
Spring and Summer 1971



A - E - Outcrop designations on ridgetop.

1.- Late evening and night beds; atop primary cliffs.

2.- mid-morning beds; atop secondary cliffs at edge of timber.

3.- Day (early afternoon) beds; in timber or atop ridge.

Note that the general pattern is one of descent toward lick areas in afternoons and ascent toward the ridgetop during the day. Arrows indicate typical one-way travel; other paths had travel both directions.

By the first of June, construction noises from the confluence of the forks could be heard on the cliffs above Sykes' Camp. N#1 left the area and remained on Little Creek for as long as I was able to distinguish her during the remainder of the summer and fall. Number 103 and the three original subadults stayed on the North Fork and used salt licks during late afternoon and evening through most of June. A group from Little Creek visited the North Fork from 11 to 18 June, spending most of the late afternoon and evening at salt licks, making a total of 11 goats there. We captured a 2-year-old female from this group on 15 June and fitted her with a radio collar. Another, smaller group, including the only kid observed on the North Fork during kidding season, visited on 22 and 23 June.

By the first of July, heavy machinery and blasting had proceeded to a point almost directly across from Sykes' Camp. At that time, no goats were evident on the North Fork or anywhere else in the Bunker Creek drainage. When referring to Bunker Creek Drainage, Bunker Creek proper and its two forks, I do not include tributaries with separate names at some distance from disturbed areas such as Gorge, Feather, Alcove Creeks, etc.. These are discussed elsewhere.

In mid-June, #10, the captured 2-year-old female, was followed to Little Creek. On Little Creek, I also recognized N#1 with her conspicuous dorsal notch and a new kid. In the same area I observed an old barren nanny with an adopted yearling along with other members of a group which had visited the North Fork of Bunker Creek

earlier in June. A single yearling was observed on A, the highest ridgetop outcrop on the North Fork, one day, but no other goats were seen on the North Fork until 25 July.

During summer of 1971, road construction often continued for 14 hours or more from sunrise until twilight. As the road passed within 1,000 feet of the lower cliffs at Sykes' Camp, where two natural traditional goat licks occurred, dynamite blasts were discharged as often as 10 to 15 times daily. General noise levels were not measured, but even from outcrop A on the highest ridge, the din from blasts, drills, bulldozers, chain saws, and trucks was very loud. In human terms, the noise was distracting. Goats may have left because they viewed such disturbances as direct threats. Alternately, goats may simply have been unable to rest or sleep during normal bedding periods at any time from dawn until dark. Furthermore, the distractions of sudden noise and continual cacophony would have made it difficult to remain alert to other sounds, detect predators, or hear the bleat of a kid. Finally, blasts shook rocks loose from cliffs, and intense shocks made climbing more hazardous than usual. One blast hurled a rock across the creek which crushed our coffeepot, and another charge shook me from a precarious perch on a ledge to another ledge 20 feet below.

On 25 July 1971, two separate groups totalling 11 animals appeared on the North Fork after travelling from Little Creek. One group which included two yearlings and #10 descended to use licks in late afternoon, as had been a typical pattern before road-building.

Two nannies with kids did not descend past the secondary cliff level and were last seen bedded there at twilight. It may have been significant that this temporary influx of goats occurred on a Sunday when disturbances were not present. The next day, as construction was renewed, three animals were observed on the ridgetop and one yearling male appeared at a lick. This male continued licking despite construction and slash-burning, and showed no overt signs of anxiety. He turned periodically to regard his surroundings, but no more frequently than goats timed before disturbances. He responded primarily to changes in noise levels or types of noise, but seemed not to react directly to continued disturbance. He was seen again early the next morning at the lick, the first time licking was observed there at that time of day. Two goats were seen on the ridgetop that day, and in the afternoon, a yearling male accompanied a nanny with a distinctive shoulder patch and her kid to the primary lick. Nanny Patch, her kid, and the yearling male continued to use the lick during evenings of successive days.

No other goats were seen on primary cliff levels until the week-end of 30 and 31 July when road-building was again absent. Eight goats, including the Nanny Patch, kid, and yearling male group were seen that week-end on primary and secondary levels. Late that night, we trapped a 2-year-old female, #100, from this group. On 1 an 2 August, two animals, including #10, used lick areas after

dark, and we captured a yearling female late at night. For the remainder of August, I continued to record very occasional ridgetop sightings of solitary individuals. The only goats known to use lower cliffs were the Nanny patch, kid, and yearling male group, and #103 of the original North Fork herd. The yearling male, #104, and #103 were trapped on 11 and 12 August, respectively, a short time after midnight.

After mid-August, only the Nanny Patch, kid, and yearling male group remained on the North Fork. Decline in use of lower cliffs could have been partially related to diminished salt requirements, or drying of streams and vegetation at lower levels with consequent increased selection of ridgetop habitat for foraging. Water was still available from seeps on lower cliffs, however, and succulent vegetation still occurred in ravines. In early falls of 1969 and 1970, 10 to 20 mountain goats were regularly seen in the Sykes' Camp area from the lowest to highest cliffs by other observers. In 1971, the new road was closed to hunters at the confluence of the North Fork and Middle Fork Creek. Logging, slash-burning, and road construction continued across from the cliffs and progressed upstream until October. With the exception of the Nanny Patch group, all marked and known animals remained on the Little Creek portion of the range. Then Nanny Patch, her kid, and #104 joined the Little Creek herd in September and remained there through the winter. In September of 1971, I noted a single group of four goats from Little Creek, including #100, on the North Fork from the 26th to the 29th.

A nanny, kid, and #103 were sighted at A outcrop on 21 October, and a nanny and kid at E outcrop on 7 November. Regular censusing revealed no other goats there during fall of 1971. Winter censuses located #103, a 3-year-old female, a 2-year-old female, yearling, and possibly a 2-year-old male on ridgetop winter range on the North Fork of Bunker Creek.

Elsewhere on Bunker Creek Drainage, two adult males were observed for a week in May on cliffs across from Gorge Creek, and a group of four females and subadults was sighted there on 16 July by a Forest Service employee. No other goats were recorded using this part of the range, despite regular censusing. Goats were seen on Middle Fork Creek for the first time that year by a hunter who saw three near the new road on 20 September. On 18 November 1971, I observed a group of three accompanied by a courting male. No goats were found wintering on Middle Fork Creek that year.

Number 103, and probably the other goats which wintered near Bunker Creek, joined groups in the Little Creek area for part of the 1972 kidding season. Number 103, her kid, and two subadults, a 2-year-old male and female, were occasionally seen using the North Fork during June and July 1972. I observed the subadults descending to lower cliff levels during evenings, but #103 and her kid remained on the ridgetop. The focus of road-building passed to upper portions of the North Fork during summer of 1972, but disturbances were audible throughout cliffy areas on both forks, and dozens of trucks passed on the road across from Sykes' Camp each day. Number 103 and

her kid, and both subadults continued to use the North Fork throughout August and September of 1972.

A group of eight goats, including #10, travelled from Little Creek to the North Fork ridgetop on 31 July, remaining there for a few days. The Bunker Creek road was closed at Gorge Creek during fall of 1972, and the Addition Creek road to the backside of Bunker Creek was closed 1.5 miles from its end. Another group of 10 goats from Little Creek, again including #10, journeyed on 15 September to the North Fork ridgetop. The following day, two adult females were killed there by hunters, and a young billy, probably the resident 2-year-old, was reportedly wounded.

A trip to the study area in January 1973 revealed no goats on lower North Fork cliffs which supported available forage due to light snow conditions. Fog and snow prevented observations of the ridgetop. Don Brown of the Montana Fish and Game Department reported 12 goats there on a 24 February survey. I found 11 goats along the North Fork ridgetop, including #100, in late March. This group moved to Little Creek 3 days later, so I do not know whether such use of Bunker Creek winter range was frequent, or an occasional extension from Little Creek permitted by unusually mild winter conditions. A 4-day survey in April 1973 located four goats on the North Fork, all using cliff areas the first day at lower levels; none were seen the following 3 days. During May, six different mountain goats were observed in the Bunker Creek area; five on the North Fork, and a solitary billy across from Gorge Creek. Observations

made on 19 June, 4 days after the road opened and preparatory logging operations began, revealed only a billy across from Gorge Creek. No goats were observed on the North Fork. Since then, frequent observations during summer and fall of 1973 have failed to locate any mountain goats regularly inhabiting or using lick areas on the North Fork of Bunker Creek.

In 1972, nine goats were seen the latter part of July and the first of August on Middle Fork Creek, though they did not remain. The March 1973 winter survey revealed six animals using Middle Fork Creek cliffs which had been buried by snows during winter of 1971-72. During early summer of 1973, occasional use of Middle Fork Creek cliffs was noted, as in 1972. No goats were observed during later summer or fall months as the focus of blasting and logging moved from the North Fork to Middle Fork Creek. No goats were observed elsewhere in the lower Bunker Creek drainage during 1973 except the billy observed across from Gorge Creek in early summer.

In summary, I was not able to do more than piece together a history of goat populations on Bunker Creek for post-logging comparisons.Road-building and logging seemed to influence goat movements and use of range areas. Utilization of lower cliff regions on the North Fork declined significantly after June 1971, and increasingly limited use of salt licks there became largely crepuscular and nocturnal. Well-used trails, some of which were worn into the rock ledges, and traditional bedsites and dusting

areas became overgrown with vegetation in 1972 and scarcely visible by summer of 1973. Utilization of major cliff areas became restricted to ridgetops on the North Fork, and that portion of the range showed scarcely any use. Goats from Little Creek continued to use the North Fork as part of their range on a few occasions throughout the remainder of the study. Recent surveys showed at least some use of lower cliffs on the North Fork in the absence of any disturbance before the road reopened. It is possible that mountain goats will begin using cliffy areas on the North Fork more extensively and in greater numbers after logging operations are concluded. The Bunker Creek sale was modified in 1971 and again in 1972. Emphasis was shifted from clearcutting toward more selective timber harvest and some protection of the creek with its native population of West Slope Cutthroat Trout (Salmo clarki). In 1974, cutting units at the head of the North Fork near subalpine meadows around Bunker Lake were redesigned. Road closure was maintained across from Gorge Creek from 15 September to 15 June. The possible return of goats to Bunker Creek may depend on whether or not disturbances are minimized, particularly during critical kidding and rutting periods, and whether hunting is carefully regulated or suspended until it can be demonstrated that this herd can sustain hunting disturbances and mortality while recovering its initial range.

Regarding population levels, it seems that fewer goats were using Bunker Creek (average 5 or 6 with intensive observation) when I began work in 1971 than were reported up to and including

1970 (10 to 20 minimum per casual observation). Whether this was due to partial egress resulting from early disturbances, hunting, or possible poaching mortality cannot be determined from existing data. Goats were seen in the extensive Little Creek cliff areas for many years prior to the study, but no census figures exist to permit detection of an increment from groups primarily using the Bunker Creek portion of the range before roading in 1970. Although at least seven goats were legally harvested since initial roading in 1970 through 1973 on Bunker Creek, compared to three goats shot between 1959 and 1969, the overall number of goats censused throughout the Bunker-Little Creek range remained fairly constant during the study period.

One observation given in Table 24 indicates that goats at least occasionally used the range across from Gorge Creek in larger numbers than were observed after road-building. We recorded only three sightings there during the study. It appeared that goats continued to utilize Middle Fork Creek periodically, as seems to have been the pattern in previous years, during the study. Goats there were generally seen on cliff areas further removed from construction and logging disruptions than goats on lower North Fork cliffs. No goats were observed in Middle Fork Creek after early summer of 1973 as logging and road-building operations intensified below major cliffy areas.

Effects of Disturbance on Other Species

Population estimates and relationships of selected species with mountain goats were discussed in sections on Predation and Relationships with Non-predatory Animals. A party led by Dr. Ream observed three different black bears near Sykes' Camp and one grizzly bear on the pass at the head of the North Fork of Bunker Creek trail from 3 to 5 June 1970. I estimated, in spring 1971, that at least five or six black bears regularly inhabited the North Fork and four to six grizzlies used it as part of their range. From limited data involving sightings and locations of tracks, scats, bedsites and feeding sites, it appeared that road-building disturbances did not significantly alter general movements or use of the area by black bears. Even during the height of blasting directly across the creek, black bears continued to frequent lower avalanche meadows in the Sykes' Camp area, and I located beds within 1,000 feet of the new road. Grizzly bears still traversed the area, but were found for the most part in upper reaches of the drainage and ridgetop areas. Consequently, disturbance-induced movements could not be distinguished from normal seasonal patterns involving increased summer utilization of subalpine areas. One group of three grizzlies, a sow with two yearling cubs, remained primarily on the North Fork ridgetop above the major cliff area during spring and summer of 1971. We observed them from a distance several times and encountered them at close range on the ridgetop on four different occasions. Jonkel and Cowan (1971) showed that black bears in the Big Creek drainage of the

Whitefish range, which shares many characteristics with the nearby Swan Range, exhibited limited movements (average maximum distance between captures or sightings: females, 1.6 miles; males, 3.9 miles) over several years. They also noted a decline in black bear populations during a period of increased clearcut logging and poor berry crops. Numbers of black bears observed on the North Fork declined from at least five or six before and during the first summer of intensive road-building, to an estimated three in spring of 1972. Undocumented reports of black bear poaching in the Bunker Creek drainage were related to me. I was also informed that black bears invaded the logging camp there, as they had our tent sites, seeking garbage and other food. During spring and early summer of 1973, three different black bears were seen in Bunker Creek Drainage, all of them near or on the North Fork. As in spring of 1972, they were observed foraging primarily in ravine areas and also along roadsides and in other recently disturbed sites. Both black and grizzly bears seemed to make extensive use of trails in Bunker Creek and elsewhere. Tracks showed that both species also commonly travelled along the Bunker Creek roads during spring, prior to regular human use.

During 1972, four grizzlies were illegally killed in the study area; three, a sow with two cubs, on Swift Creek at the head of Middle Fork Creek, and one on Bunker Creek across from Gorge Creek. One grizzly was legally killed near Gorge Creek, and another poached on Tin Soldier Creek, between the Bunker and Sullivan Creek

drainages. These kills were verified by the Montana Fish and Game Department. Two unverified illegal grizzly kills were reported to me by reliable sources; one on Bond Creek and another on Inspiration Creek, part of the Gorge Creek drainage, though I saw no direct evidence of these. The Inspiration kill was reported by Charles Snyder, a former Forest Service employee at Spotted Bear. The Bond Creek kill was reported by Rogers Guest Ranch outfitters and James Love, both of Swan Lake, Montana. Only one grizzly was seen in the Bunker-Little Creek goat range during spring and summer of 1973. This bear was shot during fall on Addition Creek. Kills were also reported from the Gorge Creek area, but have not yet been included in follow-up research.

I regularly observed wolverine tracks on both forks of Bunker Creek during spring of 1971, and a wolverine destroyed our camp in the Sykes' Camp area. Most tracks were found along creek bottoms, and it was thought that two different animals were present. A guide informed me that a member of his party killed a wolverine on the North Fork during fall 1971. I did not observe wolverine sign on North or Middle Fork Creeks during spring of 1972, but in 1973, tracks were again evident. I followed them in March and April for considerable distances where the animal(s) had travelled along the road and through clearcut areas as well as along creek bottoms of both forks. Their direct response to construction disturbances was not determined.

Few elk were taken in 1970 from Bunker Creek. In 1971, a high harvest resulted from increased use of the area, early heavy snows, and better accessibility. The Bunker Creek road passes through a major elk winter range across from Gorge Creek. In 1971, the road was closed several miles above this range, making it possible for hunters to intercept migrating elk and to hunt them on the winter range. More than twice as many elk were killed near Bunker Creek in 1971 as in any other South Fork of the Flathead tributary. During 1972, the new road was closed across from Gorge Creek, just before the winter range area and migrations to winter ranges were somewhat later than usual due to lack of snows. Hunter success was similar to that of the previous year. I noted an apparent decline in use of North Fork cliffy areas by elk in early spring from 1971 to 1972. Less than one-half as many elk were observed on Bunker Creek winter range in 1972 as in 1971, but most censusing of this species was not rigorous, and differences could be accounted for by weather conditions or other natural factors. During a survey conducted in spring of 1973, elk were observed on south-facing cliffy areas on the North Fork, and sign was plentiful on many ledges and trails. Pellets, trail use, and signs of foraging were never so abundant as those noted during spring and early summer of 1971, however. Road-building and logging operations were conducted within a few hundred feet of a well-known and well-used salt lick in the upper portion of the North Fork. Elk have not been seen near the lick area since

early summer of 1971. Other responses of elk to disturbances could not be distinguished from seasonal movements to higher elevations.

Although no quantitative assessment was made, it seemed that winter windstorms were very evident in clearcut areas as in other exposed mountain habitats. Extensive timber cutting in large patches may have an important effect on overall wind velocities, particularly in subalpine areas. This may in turn affect some wildlife directly, or indirectly through snow distribution and effective temperature changes. On the North Fork of Bunker Creek, powerful windstorms snapped or uprooted many smaller trees left in cutting areas where larger, protecting trees had been removed.

In summary, to the extent that bears remain within their home ranges as roads intersect them, despite attendant disturbances, they may become more susceptible to hunting and poaching mortality. Bears may also be attracted to disturbed areas by preferred forage on roadsides as Shaffer (1971) found in Glacier National Park, primarily for black bears. I was not able to gather conclusive information pertaining to the responses of elk to road-building and logging, but it did appear that elk hunting pressure and hunting mortality has increased since introduction of the road into Bunker Creek, and use of a major lick area declined during disturbances.

CHAPTER VI

SUMMARY

Use of different habitats by mountain goats appeared to be largely determined by seasonal changes in forage palatability and accessibility. Examination of 203 feeding sites revealed 163 different forage species utilized by mountain goats and demonstrated an ability to exploit a variety of forage under different conditions. Goats generally bedded on steep cliffy areas throughout the year. During spring, vegetation was first exposed on south- and west-facing cliffs. Goats fed primarily on available grasses and sedges there. Use of cliffy areas for foraging declined as other habitats became more accessible. During early summer, goats selected a succession of newly blossomed forbs in meadows and ravines, and on cliffs. Succulent forbs and shrubs in ravines and moist meadows were increasingly selected during late summer. Bunchgrasses in dry meadows were favored during fall months until deep snows once again restricted goats to cliffs and a diet consisting mainly of grasses and sedges. During late winter, goats were mostly observed feeding on windblown ridgetops, though they continued to utilize cliffs where winds and the precipitous nature of the terrain prevented accumulations of deep snow.

Goats were observed feeding during all hours of the day and on many nights, but feeding occurred mostly in the hours just before darkness during all months. Bedding usually peaked during mid-morning. In the absence of foul weather or high temperatures, feeding and bedding periods alternated at approximately 1.5 to 3.0

hour intervals throughout the day. High temperatures significantly curtailed non-bedded midday activities and acted to synchronize feeding times of different groups by promoting late evening feeding periods. Accordingly, best census results were obtained in the hours before darkness following high afternoon temperatures. Goats were often less visible in late summer as they fed in brushy ravines, so evening censuses during early summer proved most rewarding. Severe rain and snow storms also restricted feeding activities. Travel and feeding were observed in most months during moonlit portions of the night.

Rates of travel while feeding varied from 8-15 feet/minute during June and July, as goats selectively snipped forbs across open cliffs and meadows, to 1-2 feet/minute during December as goats pawed through deep snow to obtain food. Snow depths and forage preferences similarly influenced the average distance travelled during a single feeding period. This varied from 535 feet during June to 100 feet during December. Average distances between successive days' sightings, taken as an indicator of overall daily movements, rose steadily from 101 feet during January to 2,778 feet during October.

Females and subadults in the Bunker-Little Creek herd spent over 95 percent of their time within two major cliff areas, each of which encompasses about 2 square miles. Maximum extent of known summer range for marked females and subadults was approximately 25 square miles. Occasional travel occurred between the two major

cliff areas, a distance of about 3 miles, during non-winter months. Known winter range areas were entirely within summer range in each major cliff area. Travel between winter ranges on Little Creek and the North Fork of Bunker Creek was not observed during the deep-snow winter of 1971-72, but is thought to have occurred during the unusually light-snow winter of 1972-73. Goats did not winter on the snowbound cliffs of Middle Fork Creek during 1971-72, but several were observed there during winter 1972-73 when considerably more cliff area was exposed. Logging and road-building disturbances may have acted to restrict range use by the Bunker-Little Creek herd, but observations of herds in similar areas indicated correspondingly limited movements of females and subadults on traditional range. Males travelled greater distances. Limited data from marked males showed individuals travelling at least 9 and 11 airline miles in two cases; one of these involved crossing the South Fork of the Flathead River. Males were often observed in locations seldom or never used by females and subadults (see Appendix V).

Natural history of mountain goats, particularly sign and details of daily life, were discussed. The number of pellets in a group averaged at least 119 for mountain goats and less than 100 for mule deer. Individual deer pellets are often indistinguishable from those of the goat on the same range. Bedding, dustbathing, and feeding sites, trail systems, and salt licks were mapped. Subsequent observations showed habitual use of such areas by all herd members and infrequent use of different sites.

The molt was similar for all age and sex classes except kids, which continued juvenile pelage growth. However, shedding rates differed and aided in field identification. Adult males were completely shed from 2 to 6 weeks before other goats. Pregnancy and lactation appeared to retard molting in females from 3 to 4 weeks beyond other classes.

Rumination during bedding periods generally lasted from 30 to 45 minutes and was repeated at 30 to 50 minute intervals between periods of intermittent sleep. Goats masticated each bolus in a highly regular fashion. Mastication rates were most rapid in kids and thereafter declined with increasing age, providing a possible criterion for age determination in conjunction with other field ageing techniques.

Climbing techniques were described. Younger goats exhibited less skill and more frequent hazardous maneuvers in precipitous areas than older goats. Few missteps (29) causing a goat to lose its balance in the course of non-aggressive activities were observed during nearly 3,000 hours of observation of goats in all types of terrain.

Body care behavior became an important late spring and early summer activity. Horn rubbing and slashing also occurred primarily during summer months and was performed by all age and sex classes, including young kids whose post-cornual glands were not yet evident. Dustbathing activities occupied a large portion of summer bedding periods and were in many cases similar to pit-digging by males

during the early rut. Sexual differences in urination posture provide an additional means of distinguishing the two similar-appearing sexes, particularly as subadults.

Males occupied an increasingly dominant social position until sometime late in their second or early in their third year when they began to assume a pseudo-subordinate role in social encounters, yielding feeding areas and bedsites even to kids and yearlings. As yearlings and 2-year-olds, males showed more independence and mobility than females of corresponding ages. By their third year, males were unable to interact successfully in groups and began a largely solitary existence outside of the rut.

Within female-subadult groups, older and larger animals dominated younger and smaller individuals. The highest-ranking female or subadult generally assumed leadership of a particular band of goats. As an important exception, dominant adult females without kids followed nannies with kids, so that females with young most often determined the direction and sequence of activities. The importance of leadership in social life was suggested by irregular activities and prolonged searching by females and sub-adults and leaderless bands of yearlings and newly-independent kids.

Consistently high rates of aggressive activity were recorded among goats which remained in daily association with one another. Most horn contact was performed with low intensity, directed toward the thickened dermal shield area of the rump or flank, and directed toward kids and yearlings. Potentially injurious climbing accidents

which resulted from aggression exceeded climbing accidents seen during daily travel and feeding activities. Kids and yearlings were most often affected. The overall structure of the Bunker-Little Creek herd was one of loose association of periodically interchanging bands, each consisting of three to six animals with a more or less linear rank. It appeared that aggression acted in part to mediate the size and composition of these groups. Records of marked animals revealed that, with few exceptions, the only permanent associations were 10- to 11-month-long nanny-kid pairs. Individual membership in different bands changed frequently, often several times a day. The family-like structure of female-subadult bands seemed to be simply the most stable group composition within a herd.

Detailed descriptions of maternal behavior and the early development of kids might be summarized by stating that mountain goat mothers exhibited marked attentiveness and protectiveness toward their precocious youngsters in a rigorous social and physical environment.

Both sexes first showed signs of participation in the rut as 2-year-olds. Young billies actively dominated older males during initial stages of the rut. Digging of rutting pits was performed mainly by older males during the early rut and declined as older males began to approach and court females more readily. Billies travelled continuously throughout female ranges during the rut. The estrous period appeared to be no longer than 2 or possibly

3 days' duration. Males, separated into 2-year-old, 3-year-old, and adult classes, tended to court females primarily their own age.

Descriptions of predators in the study area and their relationships to resident goats were given, but the role of predation in mortality could not be determined.

Measurements showed individual alertness to increase significantly with age and decreasing group size. Kids were by far the least alert class of goats, and group leaders were typically the most watchful. Goats responded to most alarming stimuli by attempting to localize the source of disturbance rather than beginning immediate flight. Many individuals, particularly younger, inexperienced animals, approached novel or partially revealed objects.

On the North Fork of Bunker Creek, resident goats remained on traditional range and continued to utilize cliffy areas and two major salt licks during initial road-building and logging disturbances. By mid-summer of 1971, road-building with frequent blasting progressed to a point directly across from primary goat habitat, within 1,000 feet of lower cliffy regions and the two salt licks. All resident goats left the area at that time, moving to cliffy areas near Little Creek, 3 miles distant. Goats were subsequently observed on lower cliffy areas and at licks on the North Fork of Bunker Creek in a few instances, mainly on weekends, in the absence of disturbances. Goats were seen on lower cliffs during spring of 1973 prior to commencement of logging, but left the area as disturbances began. Well-worn trails, dusting sites, and beds became

overgrown during 1972 and were scarcely visible by 1973. Goats were occasionally observed on ridgetops on the North Fork of Bunker Creek after travelling from Little Creek during non-winter months, and some ridgetop winter use was recorded, but no permanent residents were recorded in this drainage after mid-summer of 1971.

Permanent goat herds were not found in the Middle Fork Creek drainage. Occasional use of cliffs there by goats from the Alcove Mountain area was noted during fall of 1971 and during most months of 1972, despite road-building and logging disturbances. During summer 1973, however, the focus of disturbances, particularly blasting, was shifted to Middle Fork Creek, and goats were not observed there during the remainder of the summer or fall.

The number of mountain goats observed throughout the Bunker-Little Creek range remained approximately stable during the 1971-73 study period at about 30 animals. Some decline is thought to have occurred during fall of 1970 in the North Fork of Bunker Creek before the study began. Prior to 1970, the year during which road-building began in the North Fork of Bunker Creek, a variety of individuals in official and unofficial capacities counted between 10 and 40 mountain goats on the North Fork of Bunker Creek at different times of year. (No regular censuses exist for mountain goats in northwestern Montana.) Goats were also observed on Bunker Creek across from Gorge Creek. In 1971, I found no more than six goats regularly using the North Fork of Bunker Creek and no permanent residents across from Gorge Creek. Causes of this apparent

reduction could not be determined from existing data.

Populations throughout portions of the Swan Mountains which were censused, including the Bunker Creek area, included from one-third to one-half as many males as females. Male:female ratios in native populations elsewhere are reportedly much higher, from 72:100 to 83:100. Small numbers of goats were observed in extensive cliffy areas in several physiographically similar drainages censused on the west side of the Swan Mountains. The largest number of goats (6-8) was consistently found on Bond Creek, the only unroaded drainage. Other censused drainages had roads and clearcuts within close proximity of major cliffy areas. Pre-roading estimates of herds in these drainages, available from long-time residents, were two to three times higher than present numbers.

In Hunting District 140 (Lower South Fork of the Flathead River), road mileage for logging in the National Forest increased from 158 miles in 1957 to 617 miles by 1971. Similar increases occurred on the west side of the Swan Mountains in Hunting District 130. Unlimited hunting in both districts was restricted to a permit basis in 1965. Hunter harvest records from 1959 through 1972 show large numbers of goats taken during early years, followed by substantial declines. Similarly, until 1964. the number of males harvested averaged twice that of females. A period of equal harvest of the sexes followed. Recently, from 1970 through 1973, fewer than one-half as many males as females were killed.

Numbers of black bears, grizzly bears, and elk casually observed on the North Fork of Bunker Creek declined during the study. Elk discontinued use of a traditional lick area after disturbances reached that portion of the drainage. Black bears, less frequently observed, directly and indirectly through records of sign, continued to utilize habitat in close proximity to ongoing disturbances. Seasonal movements of grizzly bears could not be distinguished from possible responses to disturbance. Some poaching of grizzly bears occurred in the study area and adjacent portions of the Swan Mountains.

In view of apparent declines of mountain goat populations in the Swan Mountains and nearby areas, a conservative approach to harvesting is recommended until more is known about those factors naturally limiting mountain goat populations and their relationship to hunting. Future resource extraction operations should take into account the mountain goat's response to related disturbances and its vulnerability where readily accessible.

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APPENDIX I

SPECIES LIST

SPECIES	COLLECTION LOCATION
POLYPODIACEAE	
1. Adiantum pedatum	1. Bunker Creek, dry drainage channel
2. Athyrium felix-femina	2. Bunker Creek, moist woods
3. Cheilanthes gracillima	3. Little Creek, dry meadow
4. Cystopteris fragilis	4. Little Creek, dry ledge
5. Polystichum lonchitis	5. Little Creek, moist ravine
SELAGINACEAE	
1. Selaginella sp.	1. Little Creek, dry meadow, dry ledge
TAXACEAE	
1. Taxus brevifolia	1. Little Creek, ravines, timbered N-facing slopes
PINACEAE	
1. Abies grandis	1. Little Creek, creek bottoms, N-facing slopes
2. Abies lasiocarpa	2. Little Creek, N-facing slopes, above Abies grandis
3. Juniperus scopulorum	3. Bunker Creek, cliff face
4. Juniperus communis	4. Little Creek, dry ledges
5. Larix occidentalis	5. Little Creek, West-facing slopes, damp
6. Picea engelmannii	6. Little Creek, damp, timbered slopes
7. Pinus albicaulis	7. Little Creek, exposed sites near 7,000'
8. Pseudotsuga menziesii	8. Little Creek, xeric slopes
GRAMINEAE	
1. Agropyron spicatum	1. Little Creek, dry meadow, dry ledge
2. Agrostis scabra	2. Bunker Creek, dry ledge
3. Bromus carinatus	3. Bunker Creek, ravine, medium-wet to dry ledge
4. Bromus ciliatus	4. Bunker Creek, ravine

Species List Continued

SPECIES	COLLECTION LOCATION
5. Bromus tectorum	5. Bunker Creek, dry ledge
6. Bromus vulgaris	6. Bunker Creek, ravine
7. Calamogrostis canadensis	7. Little Creek, stream bed
8. Calamagrostis purpurescens	8. Little Creek, ledges, dry meadow
9. Cinna latifolia	9. Little Creek, ravines
10. Deschampsia atropurpurea	10. Little Creek, ravine
11. Deschampsia elongata	11. Bunker Creek, wet ledge
12. Elymus glaucus	12. Little Creek, ravine
13. Festuca idahoensis	13. Little Creek, dry ledges, dry meadow
14. Festuca subulata	14. Little Creek, ravines
15. Festuca viridula	15. Little Creek, mesic spot in dry meadow, ridges
16. Glyceria striata	16. Bunker Creek, dry streambed-seep
17. Melica subulata	17. Little Creek, ravines
18. Muhlenbergia andina	18. Bunker Creek, dry streambed
19. Oryzopsis exigua	19. Little Creek, cliff ledge and dry meadow
20. Phleum pratense	20. Bunker Creek, cliff ledge and dry meadow
21. Poa compressa	21. Little Creek, streambed
22. Poa gracillima	22. Little Creek, dry ledges, meadow
23. Poa nevadensis	23. Little Creek, dry ledges, meadow
24. Poa sandbergii	24. Little Creek, dry ledge, meadow
25. Poa scabrella	25. Bunker Creek, dry ledge
26. Poa interior	26. Bunker Creek, cliff ledges
27. Stipa occidentalis	27. Little Creek, ravine
28. Trisetum canescens	28. Little Creek, ravine
CYPERACEAE	
1. Carex aurea	1. Bunker Creek, dry stream bed
2. Carex geyeri	2. Little Creek, dry ledges, dry meadow
3. Carex mertensii	3. Little Creek, stream bank
4. Carex pachystachya	4. Little Creek, ridge
5. Carex scripoidea	5. Bunker Creek, wet areas below cliffs
JUNACEAE	
1. Juncus parryi	1. Little Creek, ridge top

Species List Continued

SPECIES	COLLECTION LOCATION
2. Luzula glabrata	2. Little Creek, ravine, wet meadows
3. Luzula parviflora	3. Little Creek, ravine, wet meadow
LILACEAE	
1. Allium cernuum	1. Little Creek, dry ledge, wet and dry meadow
2. Allium schoenoprasum	2. Bunker Creek, seep areas, stream banks
3. Calochortus apiculatus	3. Bunker Creek, damp ledges
4. Clintonia uniflora	4. Little Creek, damp woods
5. Disporum trachycarpum	5. Bunker Creek, ravines
6. Erythronium grandiflorum	6. Little Creek, ledges, meadows
7. Fritillaria pudica	7. Bunker Creek, wet ledges
8. Smilacina racemosa	8. Little Creek, ravine, wet meadow
9. Smilacina stellata	9. Bunker Creek, wet ledge, ravine
10. Streptopus amplexifolius	10. Little Creek, stream bank, moist woods
11. Veratrum viride	11. Little Creek, ravine, wet ledge
12. Zigadenus elegans	12. Bunker Creek, ravine, wet ledge
13. Zigadenus venenosus	13. Bunker Creek, ravine, wet ledge
ORCHIDACEAE	
1. Corallorhiza wisteriana	1. Little Creek, damp woods
2. Goodyera oblongifolia	2. Little Creek, timber-brush
3. Habenaria dilitata	3. Little Creek, stream bank, wet woods
4. Habenaria saccata	4. Little Creek, stream bank, wet woods
5. Habenaria unalascensis	5. Little Creek, stream bank, wet woods
6. Listera cordata	6. Little Creek, wet woods
SALICACEAE	
1. Populus tremuloides	1. Bunker Creek, ravine
2. Populus trichocarpa	2. Bunker Creek, ravine
3. Salix sp.	3. Little Creek, dry meadow, ravine

Species List Continued

SPECIES	COLLECTION LOCATION
BETULACEAE	
1. Alnus sinuata	1. Little Creek, ravines
POLYGONACEAE	
1. Eriogonum flavum	1. Little Creek, dry ledge, dry meadow
2. Eriogonum ovalifolium	2. Little Creek, dry ledge, dry meadow
3. Eriogonum umbellatum	3. Bunker Creek, dry ledge
4. Polygonum douglasii	4. Little Creek, dry ledge, dry meadow
4. Rumex sp.	5. Bunker Creek, meadow
PORTULACACEAE	
1. Claytonia lanceolata	1. Little Creek, wet woods, cliff, meadow
CARYOPHYLLACEAE	
1. Arenaria capillaris	1. Little Creek, dry ledge, winter range
2. Cerastium arvense	2. Little Creek, winter range
3. Lychnis alba	3. Bunker Creek, avalanche meadow
CELASTRACEAE	
1. Pachistima myrsinites	1. Little Creek, timber-brush
RANUNCULACEAE	
1. Actaea rubra	1. Little Creek, ravine
2. Aquilegia flavescens	2. Bunker Creek, stream bank
3. Clematis columbiana	3. Bunker Creek, shrubby ravine
4. Delphinium bicolor	4. Bunker Creek, moist ledges
5. Ranunculus glaberrimum	5. Little Creek, wet rocky ravine
6. Ranunculus inamoenus	6. Bunker Creek, cliff
7. Ranunculus repens	7. Bunker Creek, wet meadow
8. Thalictrum occidentale	8. Bunker Creek, ravine and wet woods

Species List Continued

SPECIES	COLLECTION LOCATION
BERBERIDACEAE	
1. Berberis repens	1. Bunker Creek, ledges
CRUCIFERAE	
1. Arabis sp.	1. Little Creek, ravine
2. Arabis holboellii	2. Little Creek, dry ledge and dry meadow
3. Arabis nuttallii	3. Bunker Creek, rock ledge
4. Arabis sparsiflora	4. Bunker Creek, dry ledge
5. Draba paysonii	5. Little Creek, winter range
6. Draba sparsiflora	6. Bunker Creek, dry ledge
CRASSULACEAE	
1. Sedum stenopetalum	1. Bunker Creek, dry ledge, dry meadow
SAXIFRAGACEAE	
1. Heuchera cylindrica	1. Bunker Creek, dry ledge
2. Lithophragma parviflora	2. Bunker Creek, dry ledge
3. Mitella breweri	3. Little Creek, wet woods. stream banks
4. Parnassia fimbriata	4. Little Creek, stream
5. Ribes lacustre	5. Little Creek, woods, ravine
6. Ribes viscosissimum	6. Little Creek, woods, ravine
7. Saxifraga arguta	7. Little Creek, woods, ravine
8. Saxifraga bronchialis	8. Little Creek, dry ledges
9. Saxifraga integrifolia	9. Bunker Creek, wet ledge
10. Saxifraga occidentalis	10. Bunker Creek, ledge
11. Suksdorfia ranunculifolia	11. Bunker Creek, rocky, moist ledge
12. Tiarella unifoliata	12. Little Creek, moist woods
ROSACEAE	
1. Amelanchier alnifolia	1. Little Creek, ravine
2. Crataegus douglasii	2. Bunker Creek, shrubby areas, ravines
3. Fragaria vesca	3. Bunker Creek, cliff and meadow
4. Fragaria virginiana	4. Bunker Creek, cliff and meadow
5. Geum macrophyllum	5. Little Creek, ravine, stream bank

Species List Continued

SPECIES	COLLECTION LOCATION
6. Geum triflorum	6. Little Creek, ledge, meadow, winter range
7. Holodiscus discolor	7. Bunker Creek, ravine
8. Potentilla diversifolia	8. Little Creek, rocky, damp ravine
9. Potentilla fruticosa	9. Bunker Creek, medium-wet-dry ledges
10. Potentilla glandulosa	10. Bunker Creek, ledges
11. Potentilla ovina	11. Little Creek, winter range
12. Philadelphus lewisii	12. Bunker Creek, between rock outcrops
13. Prunus emarginata	13. Bunker Creek, ravine
14. Prunus virginiana	14. Bunker Creek, ravine
15. Rosa woodsii	15. Little Creek, drainage channel
16. Rubus idaeus	16. Little Creek, woods
17. Rubus parviflorus	17. Little Creek, ravines
18. Sorbus scopulina	18. Little Creek, ravines
19. Spirea betulifolia	19. Little Creek, ravines, dry meadow
20. Spirea densifolia	20. Little Creek, ravines
LEGUMINOSAE	
1. Astragalus sp.	1. Little Creek, high dry meadow
2. Hedysarum occidentale	2. Little Creek, dry meadow
3. Lupinus sp.	3. Little Creek, dry meadow
4. Oxytropis compestris	4. Little Creek, winter range
ACERACEAE	
1. Acer glabrum	1. Little Creek, ravines, ledges
RHAMNACEAE	
1. Rhamnus alnifolia	1. Bunker Creek, avalanche meadow
HYPERICACEAE	
1. Hypericum formosum	1. Bunker Creek, seep areas, drainage channel
VIOLACEAE	
1. Viola adunca	1. Bunker Creek, moist ledge
2. Viola glabella	2. Little Creek, ravine, woods

Species List Continued

SPECIES	COLLECTION LOCATION
ARALIACEAE	
1. Oplopanax horridum	1. Little Creek, creek bottom
ONAGRACEAE	
1. Circaea alpinum	1. Little Creek, wet woods, ravine
2. Epilobium alpinum	2. Little Creek, moist ravines, stream banks, ledges
3. Epilobium angustifolium	3. Little Creek, ravines, moist meadows
4. Epilobium glandulosum	4. Little Creek, stream bank
5. Epilobium minutium	5. Bunker Creek, dry ledge
6. Epilobium paniculatum	6. Little Creek, dry ledges
UMBELLIFERAE	
1. Angelica arguta	1. Bunker Creek, ravines
2. Heracleum lanatum	2. Bunker Creek, ravines
3. Lomatium dissectuum	3. Little Creek, dry meadow, dry ledge
4. Lomatium macrocarpum	4. Little Creek, high dry meadows
5. Lomatium sandbergii	5. Little Creek, winter range, dry meadow
6. Lomatium triternatum	6. Bunker Creek, ledges
7. Osmorhiza chilensis	7. Little Creek, ravine
8. Osmorhiza occidentalis	8. Little Creek, moist woods
9. Sanicula graveolens	9. Bunker Creek, medium-wet ledge
CORNACEAE	
1. Cornus canadensis	1. Bunker Creek, ravines
PYROLACEAE	
1. Pyrola secunda	1. Little Creek, woods
2. Pyrola uniflora	2. Little Creek, woods
ERICACEAE	
1. Arctostaphylos uva-ursi	1. Little Creek, dry ledge
2. Menziesia ferruginea	2. Little Creek, timber-brush
3. Vaccinium membranaceum	3. Little Creek, ravines
4. Vaccinium scoparium	4. Little Creek, timbered areas

Species List Continued

SPECIES	COLLECTION LOCATION
PRIMULACEAE	
1. Dodecatheon pauciflorum	1. Bunker Creek, wet ledge
GENTIANACEAE	
1. Gentiana calycosa	1. Little Creek, ravine
APOCYNACEAE	
1. Apocynum androsaemifolium	1. Little Creek, ravines, dry meadows
POLEMONIACEAE	
1. Collomia linearis	1. Bunker Creek, wet ledge
2. Polemonium pulcherrimum	2. Little Creek, dry meadow, winter range
HYDROPHYLLACEAE	
1. Hydrophyllum capitatum	1. Bunker Creek, ravines, wet ledges
2. Phacelia hastata	2. Little Creek, dry meadow, winter range
3. Phacelia sericea	3. Little Creek, winter range
BORAGINACEAE	
1. Cryptantha affinis	1. Little Creek, dry ledge
2. Hackelia jessicae	2. Bunker Creek, ravine
3. Mertensia longiflora	3. Little Creek, dry ledge
LABIATAE	
1. Agastache urtififolia	1. Bunker Creek, wet ledges, ravine
2. Mentha arvensis	2. Bunker Creek, dry drainage channel
3. Prunella vulgaris	3. Bunker Creek, medium-wet ledge, ravine
SCROPHULARIACEAE	
1. Castilleja hispida	1. Bunker Creek, wet ledge, ravines
2. Castilleja miniata	2. Bunker Creek, ravines, wet ledges

Species List Continued

SPECIES	COLLECTION LOCATION
3. Collinsia parviflora	3. Bunker Creek, ledges
4. Mimulus floribundus	4. Bunker Creek, seep below cliffs
5. Mimulus guttatus	5. Bunker Creek, seep below cliff
6. Mimulus lewisii	6. Little Creek, stream bank
7. Pedicularis bracteosa	7. Little Creek, ravine
8. Pedicularis contorta	8. Little Creek, medium-dry meadow
9. Pedicularis racemosa	9. Little Creek, medium-wet meadow
10. Penstemon albertinus	10. Bunker Creek, ledges
11. Penstemon fruticosus	11. Little Creek, ledges
12. Penstemon lyallii	12. Little Creek, high dry meadow
OROBRANCHEAE	
1. Orobranche uniflora	1. Bunker Creek, wet ledges
RUBIACEAE	
1. Galium triflorum	1. Little Creek, waste places
CAPRIFOLIACEAE	
1. Lonicera utahensis	1. Little Creek, ravine
2. Sambucus racemosa	2. Little Creek, ravine
3. Symphoricarpos albus	3. Little Creek, ravine
VALERIANACEAE	
1. Valeriana dioica	1. Little Creek, winter range
2. Valeriana occidentalis	2. Bunker Creek, wet ledge, ravine
3. Valeriana sitchensis	3. Little Creek, ravine
CAMPANULACEAE	
1. Campanula rotundifolia	1. Little Creek, ravine
COMPOSITAE	
1. Achillea millefolium	1. Bunker Creek, dry ledge
2. Anaphalis margaritacea	2. Little Creek, ravine
3. Antennaria parviflora	3. Little Creek, dry meadow, dry ledge
4. Antennaria racemosa	4. Little Creek, dry meadow, dry ledge

Species List Continued

SPECIES	COLLECTION LOCATION
5. Antennaria rosea	5. Little Creek, dry meadow, dry ledge
6. Arnica cordifolia	6. Little Creek, dry meadow, drainage channel
7. Arnica diversifolia	7. Little Creek, medium-wet meadow, drainage channel
8. Arnica latifolia	8. Little Creek, medium-wet meadow, drainage channel
9. Artemisia ludoviciana	9. Bunker Creek, medium-wet ledge
10. Artemisia michauxiana	10. Bunker Creek, dry ledge, drainage channel
11. Aster conspicuus	11. Bunker Creek, timber-brush
12. Aster engelmanii	12. Little Creek, ravine
13. Aster foliaceus	13. Little Creek, ravine
14. Aster laevis	14. Bunker Creek, wet ledges, ravines
15. Balsamorhiza sagittata	15. Little Creek, dry meadow
16. Cirisium arvense	16. Bunker Creek, dry ledge
17. Erigeron compositus	17. Bunker Creek, dry ledge
18. Erigeron peregrinus	18. Little Creek, winter range, ravine
19. Erigeron speciosus	19. Bunker Creek, ledges
20. Erigeron strigosus	20. Bunker Creek, wet ledge
21. Hieracium albertinus	21. Little Creek, ledge
22. Hieracium albiflorum	22. Little Creek, woods, ledge
23. Hieracium canadense	23. Bunker Creek, wet ledge
24. Hieracium gracile	24. Little Creek, winter range
25. Microseris sp.	25. Bunker Creek, avalanche meadow
26. Microseris nutans	26. Bunker Creek, ledge
27. Senecio canus	27. Little Creek, winter range
28. Senecio integerrimus	28. Little Creek, dry meadow
29. Senecio megacephalus	29. Bunker Creek, avalanche meadow
30. Senecio pseudaureus	30. Bunker Creek, ravine, drainage channel
31. Senecio triangularis	31. Little Creek, ravine
32. Solidago multiradiata	32. Bunker Creek, wet ledge
33. Taraxacum officinale	33. Bunker Creek, dry ledge
34. Tragopogon dubius	34. Bunker Creek, wet ledge

Scientific names after Hitchcock, et. al. (1955-1969).

FOOD HABITS DATA FOR ALL PLANTS TAKEN IN FEBRUARY, 1971 AND FEBRUARY, 1972

No. of Plots	Total Bites	Species	% of Plots	Ave. Bites/Plot	Agg. %	Relative Bites
2	670	Carex sp.	50.0	167.5	10.4	10.9
1	75	Cystopteris fragilis	25.0	18.8	.9	1.2
4	175	Heuchera cylindrica	100.0	43.8	3.0	2.8
3	580	Poa sandbergii	75.0	145.0	8.0	9.4
2	480	Grass sp.	50.0	120.0	6.4	7.8
1	35	Penstemon albertinus	25.0	8.8	.4	.6
2	220	Saxifraga bronchialis	50.0	55.0	3.4	3.6
4	560	Festuca idahoensis	100.0	140.0	9.8	9.1
4	1,900	Calamogrostis purpurescens	100.0	475.0	32.3	30.9
1	2	Pseudotsuga menziesii	25.0	.5	.1	.0
1	6	Juniperus communis	25.0	1.5	.1	.1
4	1,055	Selaginella sp.	100.0	263.7	19.4	17.2
3	390	Moss and lichen	75.0	97.5	5.8	6.3
4	6,148	TOTALS	800.0	1,537.0	100.0	100.0

FOOD HABITS DATA FOR ALL PLANTS TAKEN IN MARCH, 1971 AND MARCH, 1972

No. of Plots	Total Bites	Species	% of Plots	Ave. Bites/Plot	Agg. %	Relative Bites
2	215	Agropyron spicatum	66.7	71.7	3.7	3.2
3	1,007	Carex sp.	100.0	335.7	15.0	15.2
1	25	Cystopteris fragilis	33.3	8.3	.3	.4
2	84	Heuchera cylindrica	66.7	28.0	1.3	1.3
2	65	Prunus sp.	66.7	21.7	.8	1.0
1	2,000	Acer glabrum	33.3	666.7	25.1	30.2
3	483	Amelanchier alnifolia	100.0	161.0	8.1	7.3
3	126	Penstemon fruticosus	100.0	42.0	2.0	1.9
2	125	Festuca idahoensis	66.7	41.7	2.2	1.9
3	535	Calamogrostis purpurescens	100.0	178.3	10.1	8.1
2	1,030	Juniperus communis	66.7	343.3	16.2	15.5
2	373	Selaginella sp.	66.7	124.3	6.3	5.6
2	565	Moss and lichen	66.7	188.3	8.8	8.5
3	6,633	TOTALS	933.3	2,211.0	100.0	100.0

FOOD HABITS DATA FOR ALL PLANTS TAKEN IN APRIL, 1971 AND APRIL, 1972

No. of Plots	Total Bites	Species	% of Plots	Ave. Bites/Plot	Agg. %	Relative Bites
4	45	Allium cernuum	44.4	5.0	.3	.4
2	65	Agropyron spicatum	22.2	7.2	.4	.5
7	3,225	Carex sp.	77.8	358.3	23.9	25.8
1	6	Cystopteris fragilis	11.1	.7	.1	.0
4	120	Heuchera cylindrica	44.4	13.3	1.2	1.0
9	6,319	Poa sandbergii sp.	100.0	702.1	52.0	50.6
1	20	Pachistima myrsinites	11.1	2.2	.1	.2
7	2,235	Festuca idahoensis	77.8	248.3	16.9	17.9
2	90	Calamogrostis purpurescens	22.2	10.0	.6	.7
3	150	Selaginella sp.	33.3	16.7	2.1	1.2
5	205	Moss and lichen	55.6	22.8	2.5	1.6
9	12,480	TOTALS	500.0	1,386.7	100.0	100.0

FOOD HABITS DATA FOR ALL PLANTS TAKEN IN MAY, 1971 AND MAY, 1972

No. of Plots	Total Bites	Species	% of Plots	Ave. Bites/Plot	Agg.%	Relative Bites
3	288	Bromus carinatus	15.8	15.2	6.8	2.6
2	51	Taraxacum officinale	10.5	2.7	.8	.5
2	6	Dodecatheon pauciflorum	10.5	.3	.2	.1
9	223	Allium cernuum	47.4	11.7	3.9	2.0
3	11	Calochortus apiculatus	15.8	.6	.2	.1
9	1,007	Agropyron spicatum	47.4	53.0	9.8	9.2
3	116	Hydrophyllum capitatum	15.8	6.1	3.7	1.1
2	117	Osmorhiza chilensis	10.5	6.2	1.7	1.1
2	16	Microseris nutans	10.5	.8	.7	.1
6	663	Carex sp.	31.6	34.9	5.7	6.0
1	11	Delphinium bicolor	5.3	.6	.5	.1
4	8	Potentilla glandulosa	21.1	4.2	2.9	.7
2	65	Cystopteris fragilis	10.5	3.4	1.2	.6
1	5	Sedum stenopetalum	5.3	.3	.2	.0
8	190	Heuchera cylindrica	42.1	10.0	1.5	1.7
1	6	Arabis nuttallii	5.3	.3	.3	.1
2	157	Erythronium grandiflorum	10.5	8.3	2.2	1.4
1	28	Agastache urticifolia	5.3	1.5	.4	.3
1	3	Philadelphus lewisii	5.3	.2	.0	.0
10	4,965	Poa sandbergii sp.	52.6	261.3	23.6	45.2
1	5	Achillea millefolium	5.3	.3	.1	.0
1	6	Penstemon albertinus	5.3	.3	.1	.1
1	12	Angelica arguta	5.3	.6	.7	.1
4	47	Saxifraga occidentalis	21.1	2.5	1.5	.4
2	15	Amelanchier alnifolia	10.5	.8	.3	.1
1	11	Senecio integerrimus	5.3	.6	.2	.1
3	108	Geum triflorum	15.8	5.7	4.5	1.0

FOOD HABITS FOR MAY Continued

No. of Plots	Total Bites	Species	% of Plots	Ave. Bites/Plot	Agg. %	Relative Bites
6	280	Lomatium dissectuum	31.6	14.7	4.7	2.5
1	1	Senecio triangularis	5.3	.1	.1	0
6	1,506	Festuca idahoensis	31.6	79.3	12.2	13.7
12	841	Calamogrostis purpurescens	63.2	44.3	7.6	7.7
3	23	Claytonia lanceolata	15.8	1.2	.2	.2
2	7	Mertensia longiflora	10.5	.4	.2	.1
1	11	Arabis holboellii	5.3	.3	.2	.1
2	102	Arenaria capillaris	10.5	5.4	1.1	.9
19	10,983	TOTALS	621.1	578.1	100.0	100.0

FOOD HABITS DATA FOR ALL PLANTS TAKEN IN JUNE, 1971 AND JUNE, 1972

No. of Plots	Total Bites	Species	% of Plots	Ave. Bites/Plot	Agg. %	Relative Bites
4	175	Bromus carinatus	15.4	6.7	2.3	1.8
9	330	Taraxacum officinale	34.6	12.7	8.0	3.4
2	26	Dodecatheon pauciflorum	7.7	1.0	.9	.3
9	131	Allium cernuum	34.6	5.0	3.2	1.3
8	37	Calochortus apiculatus	30.8	1.4	.6	.4
5	550	Agropyron spicatum	19.2	21.2	2.3	5.6
3	81	Hydrophyllum capitatum	11.5	3.1	.8	.8
1	6	Osmorhiza chilensis	3.8	.2	.3	.1
6	712	Carex sp.	23.1	27.4	3.1	7.3
7	95	Delphinium bicolor	26.9	3.7	2.8	1.0
4	302	Potentilla glandulosa	15.4	11.6	3.1	3.1
1	7	Cystopteris fragilis	3.8	.3	.0	.1
2	19	Sedum stenopetalum	7.7	.7	.2	.2
12	207	Heuchera cylindrica	46.2	8.0	4.1	2.1
2	6	Arabis nuttallii	7.7	.2	.3	.1
8	199	Erythronium grandiflorum	30.8	7.7	3.7	2.0
1	67	Agastache urticifolia	3.8	2.6	.7	.7
2	37	Philadelphus lewisii	7.7	1.4	.2	.4
10	604	Poa sandbergii sp.	38.5	23.2	4.7	6.2
4	150	Achillea millefolium	15.4	5.8	2.2	1.5
1	20	Aster laevis	3.8	.8	.2	.2
1	5	Symphoricarpos albus	3.8	.2	.2	.1
4	209	Grass sp.	15.4	8.0	1.8	2.1
4	53	Penstemon albertinus	15.4	2.0	.3	.5
1	41	Erigeron compositus	3.8	1.6	1.3	.4
2	44	Angelica arguta	7.7	1.7	1.7	.4
8	41	Saxifraga occidentalis	30.8	1.6	.5	.4
2	3	Fragaria vesca	7.7	.1	.1	.0
1	14	Sanicula graveolens	3.8	.5	.3	.1
2	115	Lomatium triternatum	7.7	4.4	2.4	1.2
2	31	Saxifraga integrifolia	7.7	1.2	.8	.3

FOOD HABITS FOR JUNE Continued

No. of Plots	Total Bites	Species	% of Plots	Ave. Bites/Plot	Agg. %	Relative Bites
2	103	Castilleja hispida	7.7	4.0	1.7	1.0
7	107	Hieracium albertinum	26.9	4.1	1.0	1.1
3	195	Xerophyllum tenax	11.5	7.5	3.8	2.0
1	5	Prunus sp.	3.8	.2	.1	.1
1	2	Lithophragma parviflora	3.8	.1	.1	.0
5	119	Arnica latifolia	19.2	4.6	1.8	1.2
10	386	Spirea betulifolia	38.5	14.8	4.0	3.9
3	27	Acer glabrum	11.5	1.0	.5	.3
1	63	Saxifraga bronchialis	3.8	2.4	.4	.6
8	1,088	Amelanchier alnifolia	30.8	41.8	11.4	11.1
3	67	Eriogonum flavum	11.5	2.6	.7	.7
1	43	Penstemon fruticosus	3.8	1.7	.3	.4
4	56	Senecio integerrimus	15.4	2.2	.5	.6
3	86	Lomatium dissectuum	11.5	3.3	1.4	.9
6	179	Aster engelmannii	23.1	6.9	1.9	1.8
7	574	Vaccinium membranaceum	26.9	22.1	3.6	5.8
3	14	Antennaria racemosa	11.5	.5	.1	.1
1	25	Arnica cordifolia	3.8	1.0	.2	.3
6	331	Epilobium angustifolium	23.1	12.7	1.5	3.4
1	47	Thalictrum occidentale	3.8	1.8	.3	.5
1	29	Heracleum lanatum	3.8	1.1	.3	.3
3	119	Sorbus scopulina	11.5	4.6	1.3	1.2
2	77	Hedysarum occidentale	7.7	3.0	.5	.8
1	41	Menziesia ferruginea	3.8	1.6	.1	.4
1	341	Ribes lacustre	3.8	13.1	1.2	3.5
1	1	Actea rubra	3.8	.0	.0	.0
1	69	Valeriana sitchensis	3.8	2.7	.2	.7
5	119	Pachistima myrsinites	19.2	4.6	.8	1.2

FOOD HABITS FOR JUNE Continued

No. of Plots	Total Bites	Species	% of Plots	Ave. Bites/Plot	Agg. %	Relative Bites
3	366	Festuca idahoensis	11.5	14.1	2.3	3.7
2	37	Elymus glaucus	7.7	1.4	.4	.4
2	15	Artemisia michauxiana	7.7	.6	.1	.2
4	32	Claytonia lanceolata	15.4	1.2	.7	.3
3	19	Arabis holboellii	11.5	.7	.1	.2
1	1	Veratrum viride	3.8	.0	.0	.0
3	21	Smilacina racemosa	11.5	.8	.3	.2
2	25	Balsamorhiza sagittata	7.7	1.0	.2	.3
4	447	Arenaria capillaris	15.4	17.2	1.5	4.6
2	61	Lonicera utahensis	7.7	2.3	.5	.6
2	28	Vaccinium scoparium	7.7	1.1	.2	.3
2	32	Luzula glabrata	7.7	1.2	.1	.3
2	53	Pedicularis contorta	7.7	2.0	.3	.5
1	45	Clematis columbiana	3.8	1.7	.2	.5
1	7	Suksdorfia ranunculifolia	3.8	.3	.3	.1
26	9,819	TOTALS	973.1	377.7	100.0	100.0

FOOD HABITS DATA FOR ALL PLANTS TAKEN IN JULY, 1971 AND JULY, 1972

No. of Plots	Total Bites	Species	% of Plots	Ave. Bites/Plot	Agg. %	Relative Bites
10	237	Bromus carinatus	20.4	4.8	1.5	.9
2	73	Taraxacum officinale	4.1	1.5	.6	.3
6	93	Allium cernuum	12.2	1.9	.4	.4
1	7	Calochortus apiculatus	2.0	.1	.3	.0
7	345	Agropyron spicatum	14.3	7.0	1.1	1.4
1	1	Osmorhiza chilensis	2.0	.0	.0	.0
2	30	Carex Sp.	4.1	.6	.3	.1
2	116	Erigeron speciosus	4.1	2.4	.3	.5
1	52	Delphinium bicolor	2.0	1.1	.2	.2
8	177	Potentilla glandulosa	16.3	3.6	.9	.7
2	38	Cystopteris fragilis	4.1	.8	.2	.1
11	180	Heuchera cylindrica	22.4	3.7	1.0	.7
5	142	Agastache urticifolia	10.2	2.9	.9	.6
3	273	Philadelphus lewisii	6.1	5.6	2.7	1.1
9	2,750	Poa sandbergii sp.	18.4	56.1	8.0	10.8
9	57	Achillea millefolium	18.4	1.2	.3	.2
2	84	Aster laevis	4.1	1.7	.7	.3
11	334	Symphoricarpos albus	22.4	6.8	1.9	1.3
4	301	Grass sp.	8.2	6.1	.6	1.2
8	145	Penstemon albertinus	16.3	3.0	.5	.6
1	20	Erigeron compositus	2.0	.4	.2	.1
2	18	Arabis sparsiflora	4.1	.4	.2	.1
3	297	Angelica arguta	6.1	6.1	1.4	1.2
4	31	Saxifraga occidentalis	8.2	.6	.2	.1
2	20	Castilleja hispida	4.1	.4	.2	.1
4	121	Hieracium albertinum	8.2	2.5	1.3	.5
2	5	Xerophyllum tenax	4.1	.1	.0	.0
16	721	Prunus sp.	32.7	14.7	3.9	2.8
1	7	Lithophragma parviflora	2.0	.1	.1	.0

FOOD HABITS FOR JULY Continued

No. of Plots	Total Bites	Species	% of Plots	Ave. Bites/Plot	Agg. %	Relative Bites
5	166	Arnica latifolia	10.2	3.4	.6	.7
8	260	Spirea betulifolia	16.3	5.3	1.1	1.0
12	796	Acer glabrum	24.5	16.2	5.9	3.1
4	156	Saxifraga bronchialis	8.2	3.2	1.2	.6
23	3,150	Amelanchier alnifolia	46.9	64.3	15.5	12.4
9	473	Eriogonum flavum	18.4	9.7	2.1	1.9
6	402	Penstemon fruticosus	12.2	8.2	2.2	1.6
5	94	Senecio integerrimus	10.2	1.9	.4	.4
2	36	Eriogonum ovalifolium	4.1	.7	.2	.1
4	66	Geum triflorum	8.2	1.3	.4	.3
16	368	Lomatium dissectuum	32.7	7.5	2.2	1.4
3	70	Aster engelmannii	6.1	1.4	.7	.3
4	176	Aster foliaceus	8.2	3.6	1.5	.7
8	1,615	Hackelia jessicae	16.3	33.0	6.7	6.4
8	795	Vaccinium membranaceum	16.3	16.2	4.8	3.1
4	42	Antennaria racemosa	8.2	.9	.2	.2
7	742	Arnica cordifolia	14.3	15.1	2.1	2.9
6	75	Epilobium angustifolium	12.2	1.5	.2	.3
1	15	Thalictrum occidentale	2.0	.3	.0	.1
2	27	Heracleum lanatum	4.1	.6	.4	.1
1	36	Rubus idaeus	2.0	.7	.2	.1
2	4	Habenaria sp.	4.1	.1	.1	.0
1	30	Senecio pseudaureus	2.0	.6	.5	.1
2	100	Campanula rotundifolia	4.1	2.0	.2	.4
3	173	Sorbus scopulina	6.1	3.5	.4	.7
3	134	Hedysarum occidentale	6.1	2.7	.5	.5
1	2	Senecio triangularis	2.0	.0	.0	.0
2	234	Parnassia fimbriata	4.1	4.8	1.2	.9

FOOD HABITS FOR JULY Continued

No. of Plots	Total Bites	Species	% of Plots	Ave. Bites/Plot	Agg. %	Relative Bites
1	20	Claytonia lanceolata	2.0	.4	.1	.1
2	8	Arabis holboellii	4.1	.2	.0	.0
2	18	Balsamorhiza sagittata	4.1	.4	.1	.1
3	251	Arenaria capillaris	6.1	5.1	.7	1.0
1	63	Lonicera utahensis	2.0	1.3	.3	.2
1	25	Vaccinium scoparium	2.0	.5	.1	.1
3	48	Gentiana calycosa	6.1	1.0	.2	.2
3	158	Menziesia ferruginea	6.1	3.2	.5	.6
1	35	Ribes lacustre	2.0	.7	.1	.1
5	850	Valeriana sitchensis	10.2	17.3	3.3	3.3
4	69	Rubus parviflorus	8.2	1.4	.3	.3
5	544	Festuca idahoensis	10.2	11.1	1.5	2.1
4	51	Calamogrostis purpurescens	8.2	1.0	.2	.2
6	974	Apocynum adrosaemifolium	12.2	19.9	4.6	3.8
1	69	Luzula glabrata	2.0	1.4	.2	.3
2	32	Pedicularis contorta	4.1	.7	.1	.1
1	4	Epilobium paniculatum	2.0	.1	.0	.0
7	862	Aster sp.	14.3	17.6	2.8	3.4
1	10	Antennaria parviflora	2.0	.2	.1	.0
4	4,202	Penstemon lyallii	2.0	85.8	2.6	16.5
1	2	Smilacina racemosa	2.0	.0	.0	.0
1	2	Lomatium sandbergii	2.0	.0	.0	.0
1	23	Salix sp.	2.0	.5	.1	.1
1	34	Pedicularis racemosa	2.0	.7	.1	.1
1	112	Lupinus sp.	2.0	2.3	.4	.4
1	5	Phacelia hastata	2.0	.1	.0	.0
1	14	Ranunculus inamoenus	2.0	.3	.0	.1
49	25,397	TOTALS	724.5	518.3	100.0	100.0

FOOD HABITS DATA FOR ALL PLANTS TAKEN IN AUGUST, 1971 AND AUGUST, 1972

No. of Plots	Total Bites	Species	% of Plots	Ave. Bites/Plot	Agg. %	Relative Bites
8	247	Bromus carinatus	28.6	8.8	1.9	1.9
3	154	Allium cernuum	10.7	5.5	1.7	1.2
5	297	Agropyron spicatum	17.9	10.6	2.4	2.3
1	5	Carex sp.	3.6	.2	.0	.0
3	80	Erigeron speciosus	10.7	2.9	1.0	.6
1	10	Heuchera cylindrica	3.6	.4	.1	.1
5	132	Agastache urticifolia	17.9	4.7	1.5	1.0
1	168	Philadelphus lewisii	3.6	6.0	2.2	1.3
3	1,069	Poa sandbergii	10.7	38.2	6.7	8.4
1	1	Achillea millefolium	3.6	.0	.0	.0
3	285	Aster laevis	10.7	10.2	2.9	2.2
7	148	Symphoricarpos albus	25.0	5.3	1.6	1.2
2	46	Angelica arguta	7.1	1.6	.5	.4
1	7	Fragaria vesca	3.6	.3	.1	.1
2	25	Castilleja hispida	7.1	.9	.2	.2
1	19	Arnica latifolia	3.6	.7	.2	.1
6	247	Spirea betulifolia	21.4	8.8	1.1	1.9
5	55	Xerophyllum tenax	17.9	2.0	.7	.4
7	1,210	Prunus sp.	25.0	43.2	8.8	9.5
6	138	Acer glabrum	21.4	4.9	1.6	1.1
11	384	Amelanchier alnifolia	39.3	13.7	2.8	3.0
10	671	Aster engelmannii	35.7	24.0	7.2	5.3
5	347	Aster foliaceus	17.9	12.4	3.9	2.7
2	54	Hackelia jessicae	7.1	1.9	.6	.4
9	654	Vaccinium membranaceum	32.1	23.4	7.2	5.1
1	2	Arnica cordifolia	3.6	.1	.0	.0
16	513	Epilobium angustifolium	57.1	18.3	4.9	4.0
2	43	Thalictrum occidentale	7.1	1.5	.4	.3
1	16	Potentilla fruticosa	3.6	.6	.2	.1
1	70	Prunella vulgaris	3.6	2.5	.9	.5

FOOD HABITS FOR AUGUST Continued

No. of Plots	Total Bites	Species	% of Plots	Ave. Bites/Plot	Agg. %	Relative Bites
2	16	Rosa sp.	7.1	.6	.2	.1
1	251	Campanula rotundifolia	3.6	9.0	1.6	2.0
16	2,711	Sorbus scopulina	57.1	96.8	12.7	21.3
6	137	Hedysarum occidentale	21.4	4.9	1.6	1.1
1	27	Athyrium felix-femina	3.6	1.0	.2	.2
2	60	Mimulus lewisii	7.1	2.1	.8	.5
7	356	Senecio triangularis	25.0	12.7	1.9	2.8
3	209	Streptopus amplexifolius	10.7	7.5	1.6	1.6
2	45	Epilobium glandulosum	7.1	1.6	.6	.4
2	373	Sambucus racemosa	7.1	13.3	1.1	2.9
1	14	Parnassia fimbriata	3.6	.5	.1	.1
5	143	Gentiana calycosa	17.9	5.1	1.7	1.1
4	280	Menziesia ferruginea	14.3	10.0	3.5	2.2
6	258	Ribes lucustre	21.4	9.2	3.2	2.0
1	6	Actea rubra	3.6	.2	.1	.0
4	73	Valeriana sitchensis	14.3	2.6	.8	.6
1	16	Pachistima myrsinites	3.6	.6	.2	.1
1	10	Rubus parviflorus	3.6	.4	.0	.1
1	30	Festuca idahoensis	3.6	1.1	.3	.2
3	101	Calamogrostis purpurescens	10.7	3.6	1.1	.8
1	20	Artemisia michauxiana	3.6	.7	.2	.2
1	10	Arabis holboellii	3.6	.4	.1	.1
1	2	Veratrum viride	3.6	.1	.0	.0
1	8	Lonicera utahensis	3.6	.3	.1	.1
1	5	Deschampsia atropupurea	3.6	.2	.0	.0
1	8	Pedicularis contorta	3.6	.3	.1	.1
3	162	Aster sp.	10.7	5.8	.6	1.3
2	89	Penstemon lyallii	7.1	3.2	1.0	.7
4	93	Smilacina racemosa	14.3	3.3	.4	.7
1	24	Circaea alpinum	3.6	.9	.3	.2
1	95	Luzula parviflora	3.6	3.4	.8	.7
28	12,729	TOTALS	767.9	454.6	100.0	100.0

FOOD HABITS DATA FOR ALL PLANTS TAKEN IN SEPTEMBER, 1971 AND SEPTEMBER, 1972

No. of Plots	Total Bites	Species	% of Plots	Ave. Bites/Plot	Agg. %	Relative Bites
5	1,136	Bromus carinatus	21.7	49.4	5.3	7.7
2	29	Allium cernuum	8.7	1.3	.4	.2
7	1,415	Agropyron spicatum	30.4	61.5	10.0	9.6
3	40	Carex sp.	13.0	1.7	.5	.3
1	54	Erigeron speciosus	4.3	2.3	1.8	.4
1	3	Heuchera cylindrica	4.3	.1	.0	.0
1	80	Philadelphus lewisii	4.3	3.5	1.2	.5
12	6,811	Poa sandbergii	52.2	296.1	25.8	46.3
1	1	Achillea millefolium	4.3	.0	.0	.0
1	130	Aster laevis	4.3	5.7	1.1	.9
3	100	Symphoricarpos albus	13.0	4.3	5.3	.7
2	275	Grass sp.	8.7	12.0	.5	1.9
2	16	Angelica arguta	8.7	.7	.3	.1
1	17	Castilleja hispida	4.3	.7	.6	.1
1	2	Hieracium albertinum	4.3	.1	.0	.0
1	22	Prunus sp.	4.3	1.0	.3	.1
3	77	Spirea betulifolia	13.0	3.3	3.1	.5
5	229	Acer glabrum	21.7	10.0	8.5	1.6
6	169	Amelanchier alnifolia	26.1	7.3	2.9	1.1
2	32	Penstemon fruticosus	8.7	1.4	.2	.2
4	168	Aster engelmannii	17.4	7.3	.9	1.1
2	92	Aster foliaceus	8.7	4.0	2.3	.6
1	55	Vaccinium membranaceum	4.3	2.4	.4	.4
1	70	Thalictrum occidentale	4.3	3.0	1.4	.5
1	12	Rosa sp.	4.3	.5	1.3	.1
3	457	Sorbus scopulina	13.0	19.9	5.0	3.1
1	30	Senecio triangularis	4.3	1.3	.6	.2

FOOD HABITS FOR SEPTEMBER Continued

No. of Plots	Total Bites	Species	% of Plots	Ave. Bites/Plot	Agg. %	Relative Bites
2	144	Ribes lucustre	8.7	6.3	2.5	1.0
1	24	Actea rubra	4.3	1.0	.5	.2
1	200	Valeriana sitchensis	4.3	8.7	.7	1.4
2	469	Pachistima myrsinites	8.7	20.4	2.6	3.2
2	16	Alnus sinuata	8.7	.7	.3	.1
1	23	Rubus parviflorus	4.3	1.0	.5	.2
8	825	Festuca idahoensis	34.8	35.9	4.2	5.6
9	861	Calmagrostis purpurescens	39.1	37.4	6.1	5.9
1	560	Elymus glaucus	4.3	24.3	2.4	3.8
1	30	Pedicularis contorta	4.3	1.3	.2	.2
1	30	Festucs idahoensis	4.3	1.3	.2	.2
23	14,704	TOTALS	443.5	639.3	100.0	100.0

FOOD HABITS DATA FOR ALL PLANTS TAKEN IN OCTOBER, 1971 AND OCTOBER, 1972

No. of Plots	Total Bites	Species	% of Plots	Ave. Bites/Plot	Agg. %	Relative Bites
1	273	Bromus carinatus	5.9	16.1	1.0	1.8
7	1,470	Agropyron spicatum	41.2	86.5	8.8	9.5
6	2,834	Carex sp.	35.3	166.7	14.2	18.2
6	145	Heuchera cylindrica	35.3	8.5	.7	.9
16	6,729	Poa sandbergii sp.	94.1	395.8	42.7	43.3
5	107	Symphoricarpos albus	29.4	6.3	.5	.7
1	30	Penstemon albertinus	5.9	1.8	.4	.2
1	58	Prunus sp.	5.9	3.4	.4	.4
2	17	Spirea betulifolia	11.8	1.0	.3	.1
4	41	Amelanchier alnifolia	23.5	2.4	.6	.3
2	8	Eriogonum flavum	11.8	.5	.1	.1
2	184	Penstemon fruticosus	11.8	10.8	2.4	1.2
1	8	Aster foliaceus	5.9	.5	.1	.1
1	20	Vaccinium membranaceum	5.9	1.2	.5	.1
5	170	Pachistima myrsinites	29.4	10.0	1.3	1.1
13	1,259	Festuca idahoensis	76.5	74.1	11.8	8.1
15	1,820	Calamogrostis purpurescens	88.2	107.1	12.1	11.7
3	31	Elymus glaucus	17.6	1.8	.2	.2
3	33	Apocynum androsaemifolium	17.6	1.9	.3	.2
1	80	Trisetum canescens	5.9	4.7	.6	.5
1	137	Artemisia michauxiana	5.9	8.1	.5	.9
1	80	Arenaria capillaris	5.9	4.7	.7	.5
17	15,534	TOTALS	570.6	913.8	100.0	100.0

FOOD HABITS DATA FOR ALL PLANTS TAKEN IN NOVEMBER, 1971 AND NOVEMBER, 1972

No. of Plots	Total Bites	Species	% of Plots	Ave. Bites/Plot	Agg. %	Relative Bites
9	2,933	Agropyron spicatum	47.4	154.4	15.3	9.5
7	12,274	Carex sp.	36.8	646.0	23.2	39.8
3	34	Cystopteris fragilis	15.8	1.8	.2	.1
6	164	Heuchera cylindrica	31.6	8.6	.8	.5
14	9,332	Poa sandbergii	73.7	491.2	34.6	30.3
1	20	Penstemon albertinus	5.3	1.1	.0	.1
1	2	Spirea betulifolia	5.3	.1	.0	.0
1	6	Eriogonum flavum	5.3	.3	.0	.0
2	195	Penstemon fruticosus	10.5	10.3	.5	.6
12	2,410	Festuca idahoensis	63.2	126.8	11.2	7.8
12	3,197	Calamogrostis purpurescens	63.2	168.3	13.3	10.4
2	51	Artemisia michauxiana	10.5	2.7	.2	.2
1	178	Taxus brevifolia	5.3	9.4	.4	.6
1	13	Berberis repens	5.3	.7	.1	.0
19	30,809	TOTALS	378.9	1,621.5	100.0	100.0

FOOD HABITS DATA FOR ALL PLANTS TAKEN IN DECEMBER, 1971 AND DECEMBER, 1972

No. of Plots	Total Bites	Species	% of Plots	Ave. Bites/Plot	Agg. %	Relative Bites
4	4,014	Carex sp.	80.0	802.8	44.1	52.7
3	89	Heuchera cylindrica	60.0	17.8	2.1	1.2
4	1,110	Poa sandbergii sp.	80.0	222.0	17.4	14.6
1	15	Grass sp.	20.0	3.0	.4	.2
1	34	Spirea betulifolia	20.0	6.8	.7	.4
2	31	Amelanchier ancifolia	40.0	6.2	.4	.4
1	15	Penstemon fruticosus	20.0	3.0	.1	.2
1	2	Sorbus scopulina	20.0	.4	.1	.0
1	5	Rubus parviflorus	20.0	1.0	.1	.1
3	485	Festuca idahoensis	60.0	97.0	9.2	6.4
4	1,025	Calamogrostis purpurescens	80.0	205.0	13.5	13.5
1	160	Taxus brevifolia	20.0	32.0	3.2	2.1
2	90	Berberis repens	40.0	18.0	2.0	1.2
2	502	Pseudotsuga menziesii	40.0	100.4	6.1	6.6
2	40	Juniperus communis	40.0	8.0	.5	.5
2	7,617	TOTALS	640.0	1,523.4	100.0	100.0

APPENDIX III

OBSERVATIONS OF NANNY A AND KID A

5/27/72 - KA, first seen within one-half hour of birth, was observed from 6:00 A.M. until 9:00 P.M. Nursing sequence and nursing durations: 3 min. 30 sec.; 2:10; 4:48; 0:20; 5:14; 0:45; 1:00; 8:35; 5:55; 0:30; 6:35; 4:30; 0:30; 1:40; 0:25; 3:15; 1:30; 0:50; 5:35 ------ Total (17 nursing bouts) = 57 min. 37 sec.. Nanny A licked her kid's anus 38 times while it nursed, for a total time of 8 min. 11 sec.. During the day, as the kid gained strength, she nosed it 33 times, all briefly, for a total duration of 1 min. 29 sec.. Aside from nursing sequences, she licked the kid 67 times, totalling 12 min. 16 sec. of contact, and rubbed her chin over its back 10 times, for a 37-sec. total.

In a total of 1 hr. 20 min. 10 sec. of active contact with the kid, 21 min. 56 sec. involved direct olfactory association. (27.4%).

5/28/72 - We observed N+ KA from 5:40 A.M. until 9:45 P.M., though they were partially obscured by trees for a few hours while bedded in the afternoon.

Nursing durations: 5:00; 1:35; 5:20; 0:52; 3:05; 0:60; 3:32; 4:17; 5:05; 2:20 ---------- Total (10) = 31 min. 06 sec..

Nanny licked the kid's anal region 21 times, a total of 4 min. 55 sec., as it nursed; during the latter part of the day, however, she often substituted close sniffing of the perianal region for licking. She nosed the kid 19 times, 59 sec. total; licked it 6 times, 1 min. 26 sec. total; and placed

her chin over its back 2 times, for a 6-sec. total.

On the second day, 38 min. 32 sec. of active maternal contact included 7 min. 20 sec. direct olfactory association (19.0%).

5/29/72 - We took notes on Nanny A and kid from 7:00 A.M. to 8:00 P.M., but they remained in shade trees throughout much of this hot day. Nursing durations: 0:35; 4:10; 3:48; 4:00; 4:00; 3:00 ------ Total (6) = 19 min. 36 sec.. NA sniffed or licked KA's anus during suckling 5 times, totalling 40 sec. She nosed it 3 times, 9 sec. total; licked it 2 times, 6 sec. total; and placed her chin over it 3 times for 10 sec.

In all, 20 min. 41 sec. active maternal contact involved 55 sec. olfactory association, or only 4.4%.

After this date, we observed NA+K throughout different days, but did not maintain comparable second by second records of maternal contact. Maternal contact, particularly olfactory association time, dropped off considerably in successive days. We did record nursing in KA until 6/15/72, after which we could no longer distinguish NA from other nannies with certainty. Such records may prove useful in estimating data of birth for other kids.

5/30/72 - Nurse 1:28; (NA licks anus 30 sec., and again 2 sec. during nursing bout.)

5/31/72 - 4:00 (lick 10); 1:30; 1:50 (NA noses anus of kid, sniffing, 2 sec.); 3:10, (lick 8, nose 2).

6/ 3/72 - 0:30, (nose 20); 3:13, (lick 15, 5); 1:18, (lick 15, 15, 3); 1:55, (lick 15, 13).

6/ 4/72 - 1:55, (lick 5, 10, 12); 3:45, (lick 20, 15, 20).

6/ 5/72 - 0:10, kid suckled briefly after disturbance.

6/ 8/72 - 1:16, (lick 2, 3); 3:17, (lick 7, 5).

6/ 9/72 - 0:52

6/13/72 - 1:00, NA steps over kid to end nursing for the first time; 0:18 (lick 10, N steps over); later in the day, we observed the first rejected nursing attempt by KA.

6/14/72 - KA was frequently rejected as it attempted to nurse this day. 1:15, (N steps over); 1:38, (lick 3, 4, 3, N steps over).

6/15/72 - 0:20, (nose 2, N steps over); 1:10, (nose 2, 3, N steps over); 1:30, (nose, 3, 4, N steps over); 0:47, (nose 2, N steps over).

APPENDIX IV

LETTER

GOVERNMENT OF THE PROVINCE OF ALBERTA

DEPARTMENT OF LANDS AND FORESTS

March 1, 1973

Mr. Doug Chadwick
School of Forestry
University of Montana
Missoula, Montana

Dear Mr. Chadwick:

In response to your letter, Eike Scheffler is no longer with our Division. Presently I am co-ordinating our efforts on mountain goat. The Alberta picture is somewhat depressing as we have mismanaged our goats. Presently we have in the neighborhood of 1,000 animals ranging outside the Federal Parks. In the southern portions of the Province, goats have been all but decimated. Our last general season was in 1968. In 1969 only a remote area was open and this only for a three week season. The season was closed in 1970 and 1971. This past 1972 season goats were put on permit and 75 permits were issued for a remote portion of the Willmore Wilderness Provincial Park.

As to the future, we hope to manage our goats on a herd or mountain complex basis. Any harvest will be governed by permit.

As to an explanation of our goat mismanagement, it is felt that goats are a sensitive big game animal and much is yet to be learned about their biology. The drastic decline in Alberta's population is attributed largely to improved access provided by the mining and logging industries and a resulting overharvest by hunters. Hunters are unable to make a trophy selection as made with bighorn sheep. All age classes excluding kids are thus vulnerable and hunters seek out the most accessible populations. The result has been that rather than evenly harvesting a management area specific populations have been decimated while others have been left untouched.

As to the future, it has been found that goats are not responding as was hoped when protection was provided. Populations reduced to a remnant have remained more or less static. This is an area we hope to continue researching and look to the literature for answers.

Mr. Doug Chadwick
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March 1, 1973

Our situation is not unique, as British Columbia has suffered a similar reduction in goat numbers and is also looking for answers.

As to your request for reports, we do not have much to offer. Presently little goat research is being conducted. I directed a transplant project this past summer and we feel that we have successfully reintroduced goats back into an area from which they had been totally removed. The study DeBock began has not yet been fully summarized. Bill Samuel of the University of Alberta will shortly be publishing the parasite data. I have enclosed a project outline and a couple of reference lists that may be of use. We have some preliminary reports and may be able to supply you with some specific information on request. Would appreciate receiving any information you have that may be of interest.

Hoping this rambling is of use.

Yours truly,

Mark Quaedvlieg,
Wildlife Inventory Biologist

MQ/bjm

Enclosure

APPENDIX V

ADDENDA

Recent observations from late summer and fall of 1973 revealed several items of interest related to statements in this report.

1.) A radio-collared 2-year-old male left the Little Creek area and crossed the South Fork of the Flathead River to take up residence in the Spotted Bear Mountain area, 9 miles from Little Creek, during summer.

2.) A marked male, #104, left the Bunker-Little Creek range upon reaching 3 years of age in spring of 1973. He was not observed within a 10-mile radius during regular summer censusing, but returned to Little Creek in October and participated in the rut.

3.) Males of all ages were observed carefully rubbing the post-cornual gland on twigs and grass hummocks during the 1973 rut on at least seven different occasions.

4.) Copulation was observed on 22 and 23 November. Female receptivity was evidenced by sexual behavior reversals in which estrous females mounted their own kids and courting males. Estrus appeared to last from 48 to 72 hours at most in individual females, and all females observed showed signs of receptivity at approximately the same time.