Behavior of Mountain Goats, Elk and Other Wildlife in Relation to U.S. Highway 2, Glacier National Park

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TABLE OF CONTENTS

INTRODUCTION

Reconstruction of U.S. Highway 2 between Walton and Nimrod in Glacier National Park is proposed by the Federal Highway Administration. This 5.2 km (3.2 mile) stretch traverses a winter range for elk (*Cervus canadensis*) and mule deer (*Odocoileus hemionus*) and a movement route for mountain goats (*Oreamnos americanus*) travelling to a natural mineral lick along the banks of the Middle Fork of the Flathead River (Figure 1). The purpose of this study was to obtain quantitative data relating to use of the Walton Goat Lick by mountain goats and to obtain data on the surrounding environment to form a basis for evaluation of highway construction options. Study design included; 1) a review of the scientific literature, 2) collection of data in a computer - retrievable format, 3) a basic inventory of the area, 4) intensive observations of mountain goats on Running Rabbit Mountain, 5) collection of supplemental data in peripheral areas, and 6) recording data on human-mountain goat relationships. Field studies were conducted from February 20 - September 15, 1975.

Previous Study. A number of researchers have concluded that ungulates visit natural licks to obtain sodium compounds (Knight and Mudge 1967; Beath 1942; Herbert and Cowan 1971:607), and selection trials support a sodium compound preference (Stockstad *et. al* 1953:252). The inconsistency in the chemical composition between licks (Dalke *et. al* 1967:331), lack of sodium in some licks (Allred 1942:87), and comparable levels of elements between licks and nearby non-lick soils (Stockstad *et. al* 1953:254) render questionable the likelihood of key lick elements. Furthermore, Henshaw and Ayeni (1971:79) found that licks richest in minerals in Nigeria were the least used by wildlife.

Various reasons have been suggested for the use of natural licks by ungulates including an acquired taste for salt (Murie 1951:310, 311) and a social response and attraction to other animals at the lick (Kindel 1958; Knight and Mudge 1967:298). Metabolic adjustments resulting from a diet change to green forages in the spring or lactation and/or molting might result in plasma deficiencies and increased sodium need and taste drive (Herbert and Cowan 1971:609; Stevenson 1971). Use of licks without a need for their contents could be explained by evolution of a general lick habit and its taste associations (Knight and Mudge 1967:298). Mountain goats do not visit licks in a mountainous desert range in Idaho (Lonn Kuck pers. corres.), and in central Glacier National Park, goats apparently satisfy their lick needs by licking rocks at a number of cliff areas in their summer range (Douglas Chadwick pers. corres.).

Use of natural licks by ungulates in North America usually occurs shortly after the animals shift to a diet of green forages in the spring (Dalke *et. al* 1965:326; Knight and Mudge 1967:297), and in East Africa during the rainy season (Henshaw and Ayeni 1971:74). Mountain goats have been reported to use natural licks primarily in May, June and July, with earlier use by male groups than by female/young groups (McCrory 1965; Herbert and Cowan 1971:606; DeBock 1970).

Use during other seasons, including winter, has been observed (DeBock 1970:59).

Visits by ungulates to a natural lick in Nigeria were more numerous in the daytime, with the peak use at 1400 h (Henshaw and Ayeni 1971:75). Mountain goat visits to a lick along the Snake Indian River in Jasper National Park occurred throughout the daylight hours primarily from 1000-1500 h (McCrory 1965). DeBock (1970) observed arrivals by mountain goats at a mineral lick primarily in the evening and at dawn. Chadwick (1973) observed primarily evening arrival by mountain goats to a lick in the Swan Mountains of Montana. Number of lick visits by elk and deer to a lick complex in Jasper National Park were found to be highly negatively correlated to humidity (Carbyn 1975).

Herbert and Cowan (1971:605) felt that all or most mountain goat individuals over one year of age used licks; marked goats were observed to make only one visit of several days to a lick area. Carbyn (1975: 382) found evidence that at least some elk visited licks throughout the entire summer season.

History. Marias Pass and the John F. Stevens were first traversed by a railroad in 1893. In June 1930, U.S. Highway 2 was opened through Marias Pass upon the present roadbed. The Karsetter brothers of Whitefish, Montana built a cabin near the mouth of Java Creek in the 1920's and reported heavy use of the Walton Goat Lick by mountain goats in the summer months. Counts of 20-40 mountain goats were regularly made at both Walton Goat Lick and the Little Dog Licks by National Park Service Rangers, 1930-1970's (Glacier National Park records). On July 9, 1933 Ranger H. O. Krause saw 57 goats at the Little Dog Licks, and on July 3, 1937 he saw a total of 79 goats at the two licks.

Observations of goats at the Walton Goat Lick outside of the April-August period are considered exceptional. Ranger Art Sedlack (pers. corres.) observed an adult male in poor condition at the Walton Goat Lick throughout December 1970, and observed 12 goats there during the mild winter of 1972-73.

Goats were observed to cross the Middle Fork of the Flathead River from Flathead National Forest lands to the Walton Goat Lick (Tom Baldwin, Art Sedlack, Sheridan Stone, Ursula Bansner pers. corres.).

ACKNOWLEDGEMENTS

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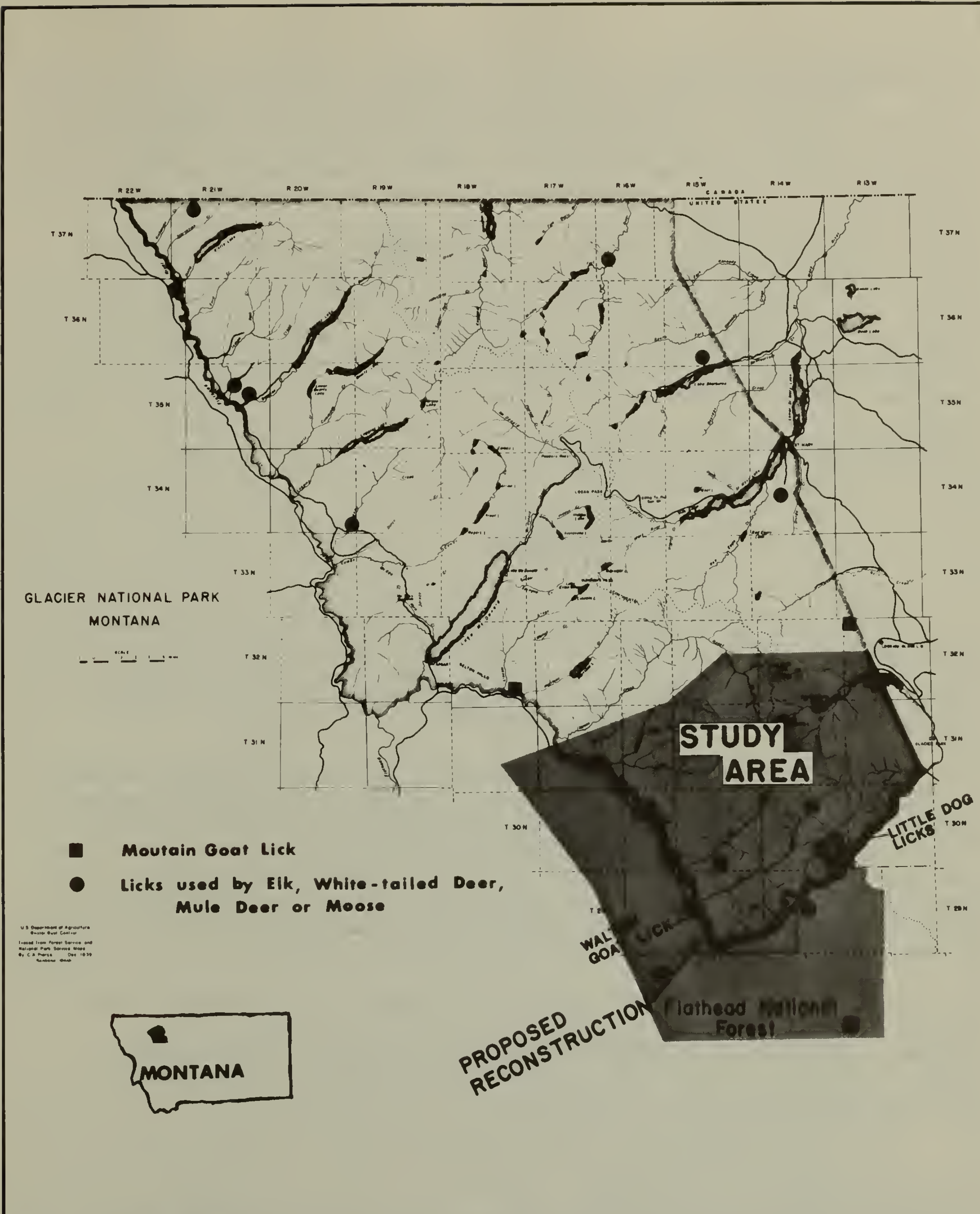


Figure 1. Map of study area in Glacier National Park and the Flathead National Forest showing natural mineral licks used by artiodactyls.

provided field assistance; Ms. Guhman sampled the vegetation, while Bruce Ackerman performed statistical and computer analysis of the data. Robert Keiss, Colorado Division of Wildlife, analyzed lick samples. National Park Service personnel Richard J. Munro, Jerry Ross, Jack Fewlass, Douglas Erskine and James Simpson provided key logistics. Beth Lucas and Teri Carter typed the manuscript, and the Denver Service Center provided graphics. LeRoy Hayes of Stockhill Aviation provided safe piloting. Special thanks go to personnel of Parks Canada for access to their files on highway statistics and for their assistance and advice; in particular to Ed Carleton and Hallé Flygare of Banff National Park; Bob Haney of Jasper National Park; Oliver Hensen, Ed Hendersen, and Gordon Peyto of Glacier National Park (B.C.); Max Winkler of Waterton Lakes National Park; personnel of Yoho National Park; and Constable Doug Bates of the Royal Canadian Mounted Police (Jasper). Robert Burns and Art Sedlack (Glacier National Park) provided five 1975 poaching records and historical information, respectively, and Chuck Brooks (Flathead National Forest) provided use of cabins.

METHODS

Census of mountain goats, elk, mule deer, and moose (*Alces alces*) was conducted during 21 trips in a winter study area (361 km^2) and 53 trips in a larger, spring-summer study area (1440 km^2). Census trips included 4 aerial flights and totaled 1256 km of vehicle travel and 665 km of backcountry travel (skis, foot, saddle horse).

Habitat relationships of artiodactyls on winter range were evaluated by application of the gradient concept and nomograms developed by Kessell (1974) for vegetation. Nomograms were developed from observed use of cover/vegetation type and outcrops of various heights, from direct environmental gradients including elevation, slope, exposure, time since burn and snowdepth, and from two environmental gradients established through indirect ordination by Kessell (1974) for vegetation in Glacier National Park: primary succession and topographic/moisture.

Elk and mountain goat reactions to Highway 2 was evaluated by comparing flight distances and flight behavior in the vicinity of the highway with behavior observations in undisturbed areas during backcountry censuses. Only observations on winter range were evaluated. Behavior was categorized as unaffected, alert, or flight.

Goat lick observations were made during 90 days (280 hours) at the Walton Goat Lick and during 27 visits to a control lick, the isolated, undisturbed Little Dog Licks. Mountain goats at the licks were classified as kid, yearling, two-year old female, two-year old male, adult female (nanny), adult male (billy) (DeBock 1970; Chadwick 1974), and groups categorized as female, young, yearling, adult male, female with young or combinations of those types. All observations at the Walton Goat Lick were made while inside a vehicle parked in the exhibit with use of a 20-60x spotting scope. Twenty-seven mountain goats were recognizable at the Walton Goat Lick, including 14 naturally marked by deformities, and 13 artificially marked with clothing dye from a marking dart. Marking efforts and goat reactions to marking were minimal. Only five marking attempts were made, and usually several goats in a group could be marked in one attempt.

Licking times and dominance/subordinance interactions were recorded for each sex and age class of mountain goats at the Walton Goat Lick. Dominance displays included present-threat, horn-threat, rush-threat and attacking (Geist 1964:555-559). Only decisive aggressive encounters where one animal retreated were recorded as indicators of dominance. Round-the-clock activity patterns were sampled in a 72-hour period when moonlight illuminated the lick, following Walther (1973).

Visitor use at the Walton Goat Lick exhibit was recorded through counts of the number of vehicles and people stopping at the exhibit during 161 hours, counts of traffic volumes during 18 hours, and counts of human safety hazards during 280 hours. Human-goat interactions were observed following Bansner (1974) by recording approach distances, locations, behavior, and an additional indicator of goat reaction-tail position. Tail position of tucked was associated with aggression, normal-no reaction, partially erect-anxiety, and totally erect-fear. A total of 271 radar readings of vehicle speeds were made at six points along the section of Highway 2 proposed for reconstruction and at two points along the adjacent improved sections.

Crossings of Highway 2 by mountain goats travelling to and from the Walton Goat Lick were observed and the crossing route, sex and age of leader, type of human presence, and behavioral responses of goats to human disturbances during crossings were recorded. Categories of human presence included no passing traffic or visitors at the exhibit, traffic only (light = 1-3, moderate = 3-10, heavy = 10+ passing vehicles), visitors at the main exhibit, visitors at the west parking lot, and combinations of the above categories during a crossing by goats. Distance to the nearest oncoming vehicle was measured for each goat as it crossed traffic lanes.

Plant species were sampled at eight representative stations including six conifer forest stands and two shrub stands, along the section of Highway 2 proposed for reconstruction. Plots were 100 x 30 m in size. Tree species were tabulated into categories by diameter at base height (dbh) similar to Kessell(1975). Coverage of shrub and tree species 1 m in height was sampled along 100 m lines (line-intercept method), and species less than 1 m sampled in 4 rings of 1 m^2 in the corner of each plot by the canopy-coverage method (Daubenmire 1959). Nomenclature for plant species follows Hitchcock and Cronquist (1973).

Soil samples from the Walton Goat Lick, Little Dog Goat Licks and three North Fork elk licks were collected, dried at 70° C for 24 hours, then put through a .0331 inch Tyler Seine, and minerals were extracted with .1 N HCl for 24 hours. All determinations were made using atomic absorption spectrophotometer (Perkin-Elmer 303) at the Wildlife Research Center, Fort Collins, Colorado.

Statistical procedures for analysis of data include the Students' *t*-test for significance of differences, linear regression, and Chi-square test of independence of two properties. With more than two rows and columns, the Chi-square statistic was computed by the G-test and an additional test for heterogeneity (Sokal and Rolf 1969a;1969b). Analysis of highway crossing data followed Child (1973) for crossings of a simulated pipeline by caribou (*Rangifer tarandus granti*).

Highway/wildlife situations similar to those encountered in the Walton Nimrod section of Highway 2 were inspected first hand in six Canadian National Parks in the Rocky Mountains; Waterton, Banff, Jasper, Kootenay, Yoho, and Glacier National Parks.

DESCRIPTION OF STUDY AREA

"Fewer outcrops are exposed in the Flathead Range and west of the thrust zone in the Lewis Range. Large stretches of the valley sides are mantled by soil, talus and glacial debris, and outcrops are topical, often occurring only at higher elevations on peaks and ridges."

The study area comprises 1440 km^2, of which 62 percent is in the southern portion of Glacier National Park, and 38 percent in adjacent Flathead National Forest. The study sector in Glacier National Park is recommended for wilderness classification, with the exception of a management zone along the boundary (¼ mile wide) which includes the majority of the proposed reconstruction (U.S. Dept. of Interior 1974). The Middle Fork of the Flathead River upstream from Bear Creek is recommended for classification as "wild" and the section downstream from Bear Creek as "recreational" by the U.S. Forest Service under the Wild and Scenic Rivers Act of 1969. The study area included approximately 30 percent of the proposed Great Bear Wilderness. The study sector in the Flathead National Forest differed from the Glacier National Park sector in that legal hunting of big game is allowed, private inholdings and residences occur among National Forest lands at Essex, Pinnacle, Fielding and Giefer Creek, and 39 km of access vehicle roads are present.

Topography is precipitous with the floors of steep, narrow valleys at 1030 to 1280 m (3380-4200 feet) elevation, and the peaks and ridges of uplands at 2133 to 2048 m (7000-10,000 feet) elevation. Tributary valleys of the Middle Fork flow straight southwest or northeast. Drainage pattern is so regular as to suggest structural control, with drainage development along zones of weakness and fracture (Ross 1959:92). Glaciation of the study area resulted in extensively denuded peaks, and numerous cirques on the north and east slopes of the higher ridges.

Peaks of the Lewis Range are greatly exposed as the thrust zone of the Lewis overthrust. Massive outcrops are primarily Grinnell and Appekunny argillites. Ledges are abundant at all elevations on the outcrops due to the existence of parallel, horizontal bedding planes and extensive weathering of exposed rocks.

Fewer outcrops are exposed in the Flathead Range and west of the thrust zone in the Lewis Range. Large stretches of the valley sides are mantled by soil, talus and glacial debris, and outcrops are topical, often occurring only at the higher elevations on peaks and ridges. Exposed outcrops are Siyeh limestone or limestones of (Conophyton zone) the Missoula group (Ross 1959). Ledges are less common on the outcrops because of less weathering and because of extensive crumpling, and folding of the exposed strata.

The Walton Goat Lick is an exposure of the Roosevelt Fault which parallels the Middle Fork and is composed primarily of gypsum, kieserite, and other sulfates (Figure 1). The Little Dog Goat Licks are located in wet gullies, cuts and seeps in the crushed and broken cretaceous strata which underlie the exposed Lewis overthrust. The Mad Wolf Lick is geologically similar. The Harrison Lick is a river cut which appears similar to the Walton Goat Lick. Many of the elk and deer mud licks occur where oil rises along fault fractures from Cambrian deposits. All licks were high in calcium, phosphorous and sodium, although adjacent non-lick soil samples were also high in these elements (Table 29).

Average annual precipitation ranges from about 43 to 76 cm (17 to 30 inches) at lower elevations east and west of the Continental Divide, respectively,to 178 cm (70 inches) or more along the Flathead Range Divide. From 50-80 percent of the annual precipitation falls as snow, depending upon site factors. Westerly winds reach sustained speeds of 30 miles (48 km) per hour along Bear Creek and 50 to 60 miles (80-96 km) per hour on the Continental Divide during winter and spring. Wind distributes the snow off of peaks, ridges and exposed slopes, thereby altering local moisture regimes (Schallenberger 1974).

The study area is heavily forested with mixed conifer stands of subalpine fir (*Abies lasiocarpa*), Englemann spruce (*Picea engelmanii*), lodgepole pine (*Pinus contorta*), Douglas fir (*Pseudotsuga menziesii*) and western larch (*Larix occidentalis*). Exceptions are outcrops, fell fields, talus slopes, cirques, burned areas and dry, exposed slopes which are dominated by a combination of scattered trees, shrubs and grasses. Post-fire conifer succession has been very slow or non-existent since the last fire (1910) on the steep south and west facing exposures of Ole Creek, Bear Creek and Running Rabbit Mountain. These areas are shrub or mixed grass/shrub lands. The lack of tree skeletons indicates that many of these areas did not support a conifer forest prior to 1910. The steep, poorly developed soils are probably too dry to support more than scattered trees.

The Walton-Nimrod section of Highway 2 proposed for reconstruction contains conifer forest and shrubfields. Forest stands are variously dominated by lodgepole pine (Station 6), western larch (Station 2), paper birch (*Betula papyrifera*)(Station 3), or by co-dominance of eight tree species (Table 27). Abundant species in the shrub stands are mountain maple (*Acer glabrum*), serviceberry (*Amelanchier alnifolia*), Douglas fir, lodgepole pine, aspen (*Populus tremuloides*), Ceanothus (*Ceanothus velutina*), common chokecherry (*Prunus virginiana*), snowberry (*Symphoricarpos albus*), and elk sedge (*Carex geyeri*) (Table 25 and 26).

Mammals observed along the section proposed for reconstruction in 1975 included elk, mule deer, mountain goat, moose, black bear (*Ursus americanus*), pine marten (*Martex americana*), coyote (*Canis latrans*), porcupine (*Erethizon dorsatum*), bushy-tailed woodrat (*Neotoma cinerea*), Columbian ground squirrel (*Spermophilus columbianus*), snowshoe hare (*Lepus americanus*), red squirrel (*Tamiasciuras hudsonicus*), northern flying squirrel (*Glaucomys sabrinus*), yellow pine chipmunk (*Eutamias amoenus*), least chipmunk (*Eutamias minimus*), western jumping mouse (*Zapus princeps*), deer mouse (*Peromyscus maniculatus*), and golden-mantled ground squirrel (*Spermophilus lateralis*).

Birds known to be breeding along this section of the highway in 1975 were kestrel (*Falco sparverius*), western bluebird (*Sialia mexicana*), great-horned owl (*Bubo virginianus*), dipper (*Cinclus mexicanus*), raven (*Corvus corax*), ruffed grouse (*Bonasa umbellus*), pileated woodpecker (*Dryocopus pileatus*), varied thrush (*Ixoreus naevius*), gray jay (*Perisoreus *canadensis*), and Steller's jay (*Cyanocitta stelleri*). A pair of golden eagles (*Aquila chrysaetos*) successfully nested on a cliff along Lower Ole Creek, 4.0 km away.

RESULTS

Endangered Species

The Endangered Species Act of 1973 (Public Law 93-205), Section 7, states as follows:

*"The Secretary*1/ *shall review other programs administered by him and utilize such programs in furtherance of the purposes of this Act. All other Federal departments and agencies shall, in consultation with and with the assistance of the Secretary, utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species listed pursuant to Section 4 of this Act and by taking such action necessary to insure that actions authorized, funded, or carried out by them do not jeopardize the continued existence of such endangered species and threatened species or result in the destruction or modification of habitat of such species which is determined by the Secretary, after consultation as appropriate with the affected States to be critical."*

Two wildlife species which are included in Section 4 of this Act are found in the study area: the endangered Northern Rocky Mountain Timber Wolf (*Canis lupus irremotus*) and the threatened grizzly bear (*Ursus arctos*).

Grizzly bears frequent drainages adjacent to the Walton-Nimrod section but none were observed along this section in 1975. Grizzly bears killed three artiodactyls and fed upon the carcasses of two others along Lower Ole Creek in late winter of 1975 only 1.7-4.5 km from the Walton-Nimrod highway. I made three separate observations of grizzly bears in a single day (July 25, 1975) along Sheep and Elk Creeks in the Flathead National Forest, 5.2 to 9.8 km from the Walton-Nimrod highway. Eleven of the grizzly observations (n = 20) were in coniferous forest, 4 in shrub fields, 2 in avalanche paths, 2 in sub-alpine basins, and 1 in an old logging road (Figure 17). Elevations ranged from 1341-1889 m. Two grizzly bears were trapped and relocated after breaking into cabins, one at the Walton-Nimrod Ranger Station and one near Giefer Creek.

From 1971 through 1975 there were 25 sightings of timber wolves made on the study area by reliable observers (Table 23, Figure 17). These included one observation of a pair (one gray and one black),

1/ Secretary of Commerce or Interior

four observations of a single wolf (dark gray), and one observation of three wolves (all gray). No activity centers or travelways were located, but wolf observations were incidental to this study and such activity areas may exist in more remote sections of the study area. Observations suggested that the Giefer-Fielding Pass area may be important for movement in and out of Glacier National Park; this is the only such pass for 24 km. The Nimrod area was the site of frequent observations of one or two black wolves during certain periods in the winters of 1969-70, 1970-71, and 1971-72. Elk are often hit by trains in this area, and repeated visits to the carrion source would account for the frequent observations. John Bartlett (pers. corres.) reported that these wolves often traveled down the plowed highway near Bear Creek. No such activity was observed along the highway in 1975.

None of the two endangered or eight threatened plant species of Montana were located in our sampling or collections along the section of Highway 2 proposed for reconstruction.

Artiodactyl Populations and Mortality

Highest counts of artiodactyls from unduplicated census of the winter study area were 185 elk, 42 mule deer, 50 mountain goats and 4 moose. Ratios among the four artiodactyls for the area were elk 1.00: mountain goat .27: mule deer .14: moose .02. A total of 17 vehicle census trips were conducted along Lower Bear Creek, an open, isolated goat winter range, from February to May. Counts of goats ranged from 0-29 with the mean count 13.06 goats (SD = 9.17). Repeated censuses indicated that 29 goats were present in the Bear Creek area, and 41 total on the Running Rabbit Mountain upland (.84 goats/km^2). This suggests that on the average census trip in this terrain, only 45 percent of the mountain goats present in a drainage would be observed. Total counts on census were difficult due to the mountainous terrain, forest cover, logistic problems and unpredictable weather conditions.

Summer counts for each drainage totalled 182 for the portion of the study area in Glacier National Park (62%) and 28 for the portion of the study area in the Flathead National Forest (38%) yielding a relative density ratio of 4.1:1. Assuming that only 45 percent of the mountain goats present in this rugged terrain would be observed in a census trip, approximately 490 mountain goats inhabited the 1440 km^2 study area (.34 goats/km^2). Estimates of mountain goats using known licks in the study area strengthened the estimate of 490 goats.

Sex and age ratios of elk during winter and mountain goats in summer, gathered during census trips and visits to the Walton Goat Lick, are provided in Table 1.

Table 1. Ratios of sex and age classes of mountain goats and elk: 100 adult females.

Class	Mountain Goats: Walton Goat Lick 1974[1/]	Mountain Goats: Walton Goat Lick 1975	Mountain Goats: Census Summer 1975	Elk: Census Winter 1975
Young	39.4	74.9	66.3	28.9
Yearlings	6.0	33.1	21.3	8.4[2/]
Two-year old Females	10.6	8.4	16.9	
Two-year old Males	30.3	13.0	1.1	
Adult Females	100.0	100.0	100.0	100.0
Adult Males	47.0	51.5	37.0	46.0
Unclassified Adults	13.6	25.5	67.4	
Unclassified Juveniles	12.1	5.4	23.6	
TOTAL	171	745	297	152

1/ Bansner, U. unpublished data.

2/ Yearling bulls only (spikes).

A low productivity of goat kids for 1974 is indicated (39.4 kids:100 nannies), with a higher productivity in 1975 (66.3-79.4 kids:100 nannies). The large number of unclassified adults in 1975 probably resulted in an overestimate of kid to nanny ratio.

Mortality records are incomplete for artiodactyls on the study area; however, a suggestion of the types of mortality are provided in Table 2. Elk are known to be killed by legal hunting, poaching along Highway 2, trains, highway traffic, avalanches, and predators including grizzly bears, coyotes and probably timber wolves and mountain lions. Mountain goat losses are to avalanches, legal hunting on a permit basis, poaching, highway traffic, and probably predation. During severe winters such as 1975, many artiodactyls are in poor condition and are predisposed to predation or death by exposure . From April 1 to May 15, 1975, 5 (3%) of 166 elk and 2 (6.3%) of 32 mule deer observed were obviously in poor condition by their behavior and external appearance. As an example, a mule deer buck in poor condition was observed at close range in a group of 11 deer on February 28, 1975. The buck was thin, could only walk, fell twice in rough areas, and elected to go around a snowbank which the rest of the band crossed. Tracks in the snow which revealed a very short chase, and bloody bone marrow indicated that the two mule deer killed by grizzly bears during this period were predisposed.

No mountain goats were known to be hit by vehicles while crossing Highway 2 in 1975. Two mountain goats were hit in 1974. Since no official records are kept, it can only be suggested that losses are similar, i.e. 0-2 goats, in other years.

Table 2. A partial list of artiodactyl mortality on the study area from 1970 through 1975 based upon records, personal correspondence and field studies. Records are incomplete and do not suggest relative magnitudes.

Source of Mortality	Mountain Goats	Elk	Mule Deer
Hunting	6	2572	983
Avalanches	10	3	-
Poaching	2	15	-
Highway 2	2	1	1
Railroad	-	10	-
Wolves	-	one chase	-
Grizzly Bears	-	1	2
Coyote	-	1	-

1/ These kills are listed for hunting District 140, of which the study area comprised 15%.

Winter Habitat of Artiodactyls

Winter observations of elk, mountain goats, mule deer and moose plotted on nomograms along five environmental gradients--elevation, topographic/moisture, primary succession, slope, and snow depth--are provided in Figure 2, 3, and 4. Time since burn was not presented since the majority of the study area was last burned in a single 1910 fire, and the gradient indicates little pattern. Number of groups observed and the section of Highway 2 under study are presented in the lower right figure of each nomogram series. Contour lines represent percent of total artiodactyl groups observed.

Mountain goats were observed more frequently in the early stages of primary succession, at higher elevations, on steeper slopes, and in lesser snow depths than other species. Moose observations were restricted to the lower elevations, the moist end of the topographic/moisture gradient (bottomlands), and to advanced soil succession or typical forest. This combination of gradients was uncommon on the study area, which might explain the low relative abundance of moose. Elk were the dominant artiodactyl at moderate snow depths (25-50 cm) and slopes (15°-30°), and were again dominant in deep snows (95-120 cm) and steep slopes (40°-50°). Elk habitat use patterns show graphically as a bimode. Mule deer, like moose, achieved low relative abundance on the study area, but unlike moose, mule deer observations were along combinations of gradients that were common on the study area.

Mountain goats used outcrops far more often than did elk or mule deer (Table 3). Elk and mule deer were observed on outcrops less than 28 m in height, while mountain goats utilized outcrops up to 300 m in height.

Table 3. Use of outcrops by elk, mule deer and mountain goats on the study area, winter of 1975.

Species	Total observations	Number on outcrops (%)	Outcrop height range (m)
Elk	88	17 (19.8)	2-25
Mule deer	13	3 (23.1)	2-28
Mountain goats	48	35 (72.9)	4-300

Winter Habitat-Highway Relations

Highway 2 passes below artiodactyl winter ranges, primarily of elk and mule deer, for several stretches along the southern boundary of Glacier National Park (Belton Hills winter range, Double Mountain - Rampage range, and the Lower Bear Creek winter range) but only in the

Figure 2. Nomogram presenting winter observations of artiodactyls along topographic/moisture gradient from mesic (bottomlands) to xeric (ridges and peaks) and along elevation gradient. Position of the Walton-Nimrod section of Highway 2 and total artiodactyl observations are presented in the lower right figure. Contour lines represent percent of the total artiodactyl observations which were that particular species.

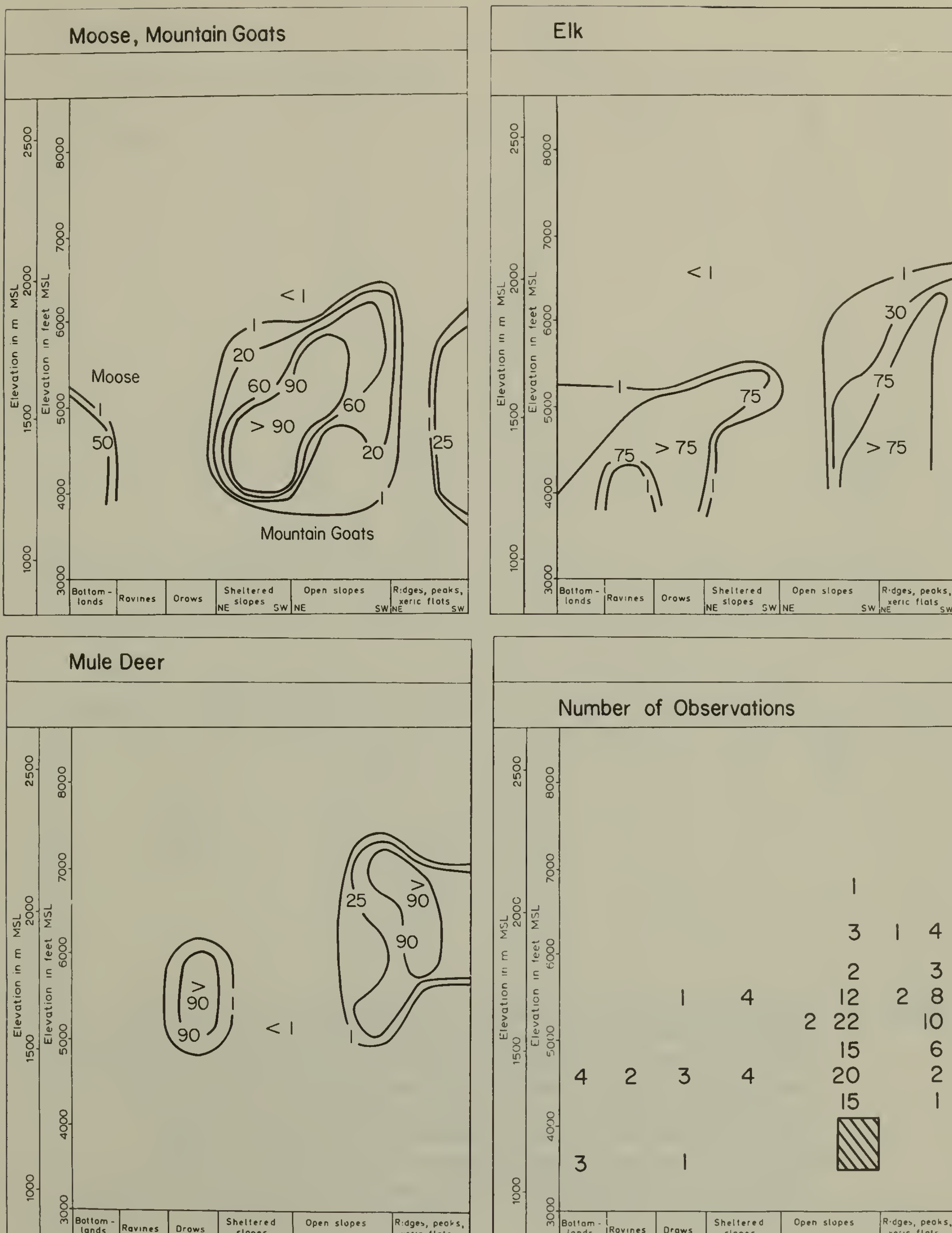

Moose, Mountain Goats
Elevation in m MSL
Elevation in feet MSL
Moose
Mountain Goats
< 1
> 90
Elk
> 75
Mule Deer
Number of Observations
Bottom-lands
Ravines
Draws
Sheltered slopes
NE
SW
Open slopes
Ridges, peaks, xeric flats

Figure 3. Nomograms presenting winter observations of artiodactyls along gradient of topographic/moisture from mesic (bottomlands) to xeric (ridges and peaks) and gradient of primary succession from glacier to typical forest. Position of the Walton-Nimrod section of Highway 2 and total artiodactyl observations are presented in the lower right figure. Contour lines represent percent of the total artiodactyl observations which were that particular species.

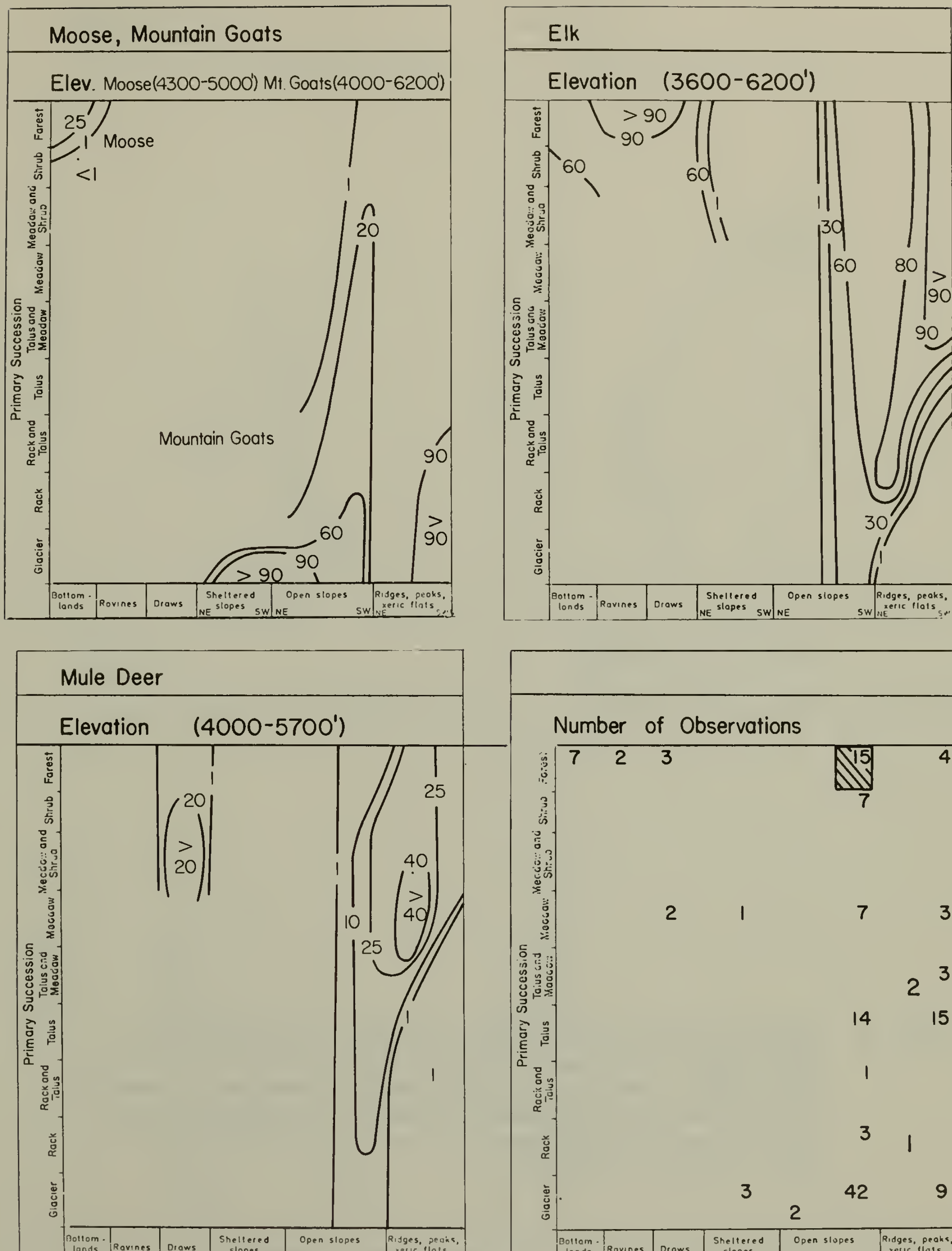

Moose, Mountain Goats
Elev. Moose(4300-5000') Mt. Goats(4000-6200')
Moose
Mountain Goats
Elk
Elevation (3600-6200')
Mule Deer
Elevation (4000-5700')
Number of Observations
Primary Succession
Forest
Shrub
Meadow and Shrub
Meadow
Talus and Meadow
Talus
Rock and Talus
Rock
Glacier
Bottom-lands
Ravines
Draws
Sheltered slopes
Open slopes
Ridges, peaks, xeric flats
NE
SW

Figure 4. Nomogram presenting winter artiodactyl observations on unforested open slopes along gradients of slope and of snow depth. Position of total observations are presented in the lower right figure. Contour lines represent percent of the total artiodactyl observations which were that particular species.

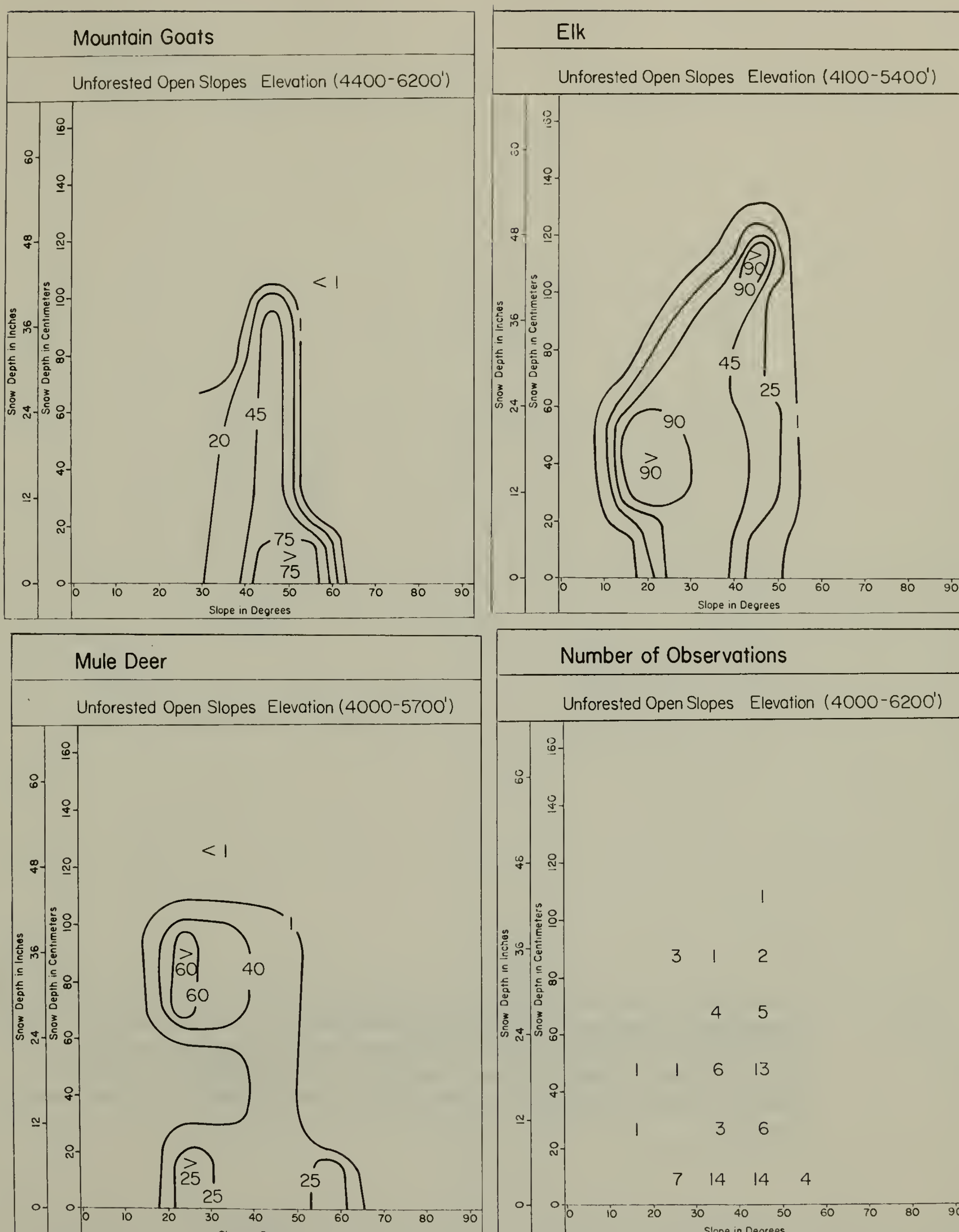
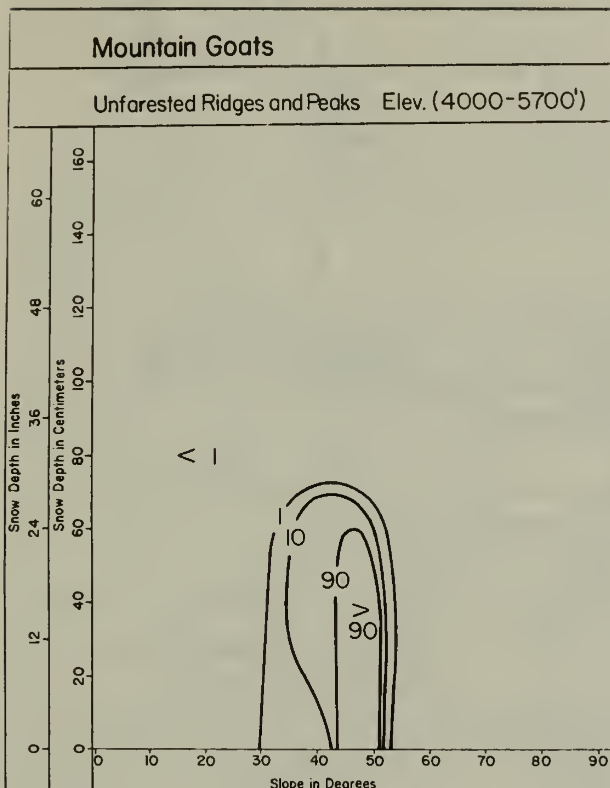
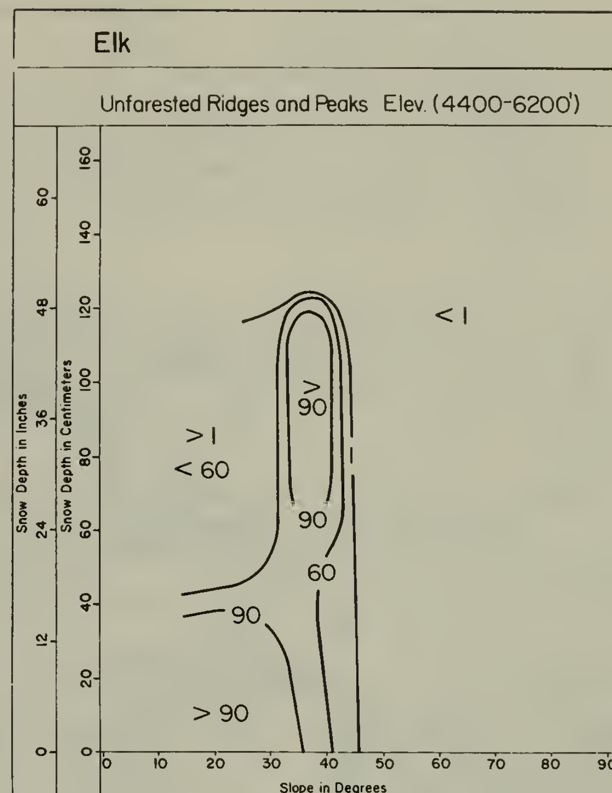
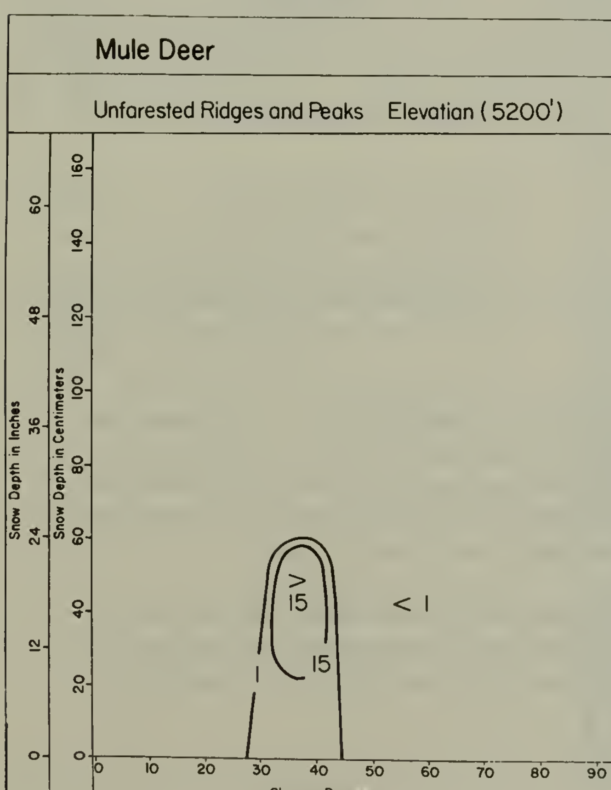
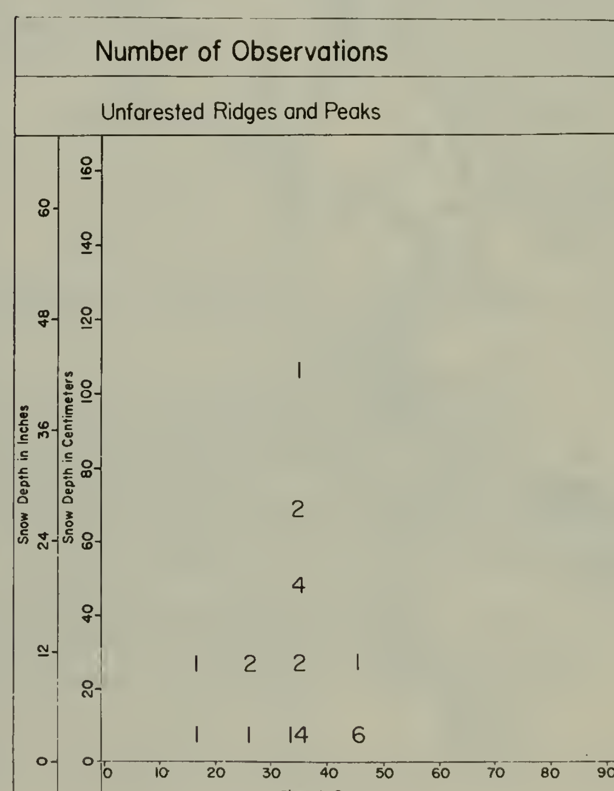

Mountain Goats
Unforested Open Slopes Elevation (4400-6200')
Snow Depth in Inches
Snow Depth in Centimeters
Slope in Degrees
< 1
20
45
75
> 75
Elk
Unforested Open Slopes Elevation (4100-5400')
Snow Depth in Inches
Snow Depth in Centimeters
Slope in Degrees
> 90
90
45
25
1
Mule Deer
Unforested Open Slopes Elevation (4000-5700')
Snow Depth in Inches
Snow Depth in Centimeters
Slope in Degrees
< 1
> 60
60
40
> 25
25
Number of Observations
Unforested Open Slopes Elevation (4000-6200')
Snow Depth in Inches
Snow Depth in Centimeters
Slope in Degrees
1
3 1 2
4 5
1 1 6 13
1 3 6
7 14 14 4

Figure 5. Nomogram presenting winter artiodactyl observations on unforested ridges and peaks along gradients of slope and of snow depth. Position of total observations are presented in the lower right figure. Contour lines represent percent of the total artiodactyl observations which were that particular species.


Mountain Goats
Unforested Ridges and Peaks Elev. (4000-5700')
Snow Depth in Inches
Snow Depth in Centimeters
Slope in Degrees
< 1
1
10
90
>
90


Elk
Unforested Ridges and Peaks Elev. (4400-6200')
Snow Depth in Inches
Snow Depth in Centimeters
Slope in Degrees
< 1
>
90
> 1
< 60
90
60
90
1
> 90


Mule Deer
Unforested Ridges and Peaks Elevation (5200')
Snow Depth in Inches
Snow Depth in Centimeters
Slope in Degrees
>
15
15
1
< 1


Number of Observations
Unforested Ridges and Peaks
Snow Depth in Inches
Snow Depth in Centimeters
Slope in Degrees
1
2
4
1 2 2 1
1 1 14 6

section proposed for reconstruction does the highway actually traverse a winter range. Elk were frequently observed feeding and bedded in the shrub and conifer stands above the highway along the section proposed for reconstruction (Figure 6). Movement areas for elk crossing the highway occur in conifer forest stands at both ends of the section proposed for reconstruction. Crossings in these areas and use of the stands below or west of the highway were mostly nocturnal. Crossing routes and frequency were variable. Mule deer were only observed twice along the Walton-Nimrod section, although deer tracks indicated frequent use of the area.

Wintering elk were habituated to Highway 2 along the Running Rabbit and Lower Bear Creek ranges. Flight reactions were found to be highly significantly correlated with location in the backcountry or along the highway ($X^2 = 24.63 > X^2_{.05(1)} = 3.84$, $P < .001$) (Table 4).

Table 4. A comparison between elk flight distances in the backcountry and along Highway 2 during the winter of 1975.

Distance (M)	Highway observations percent flight (n)	Backcountry observations percent flight (n)
0-100	75 (4)	100 (1)
101-300	0 (7)	68 (19)
301-500	0 (6)	40 (5)
501-998	0 (8)	60 (5)
999+	0 (14)	0 (1)

Habituation of elk to Highway 2 and the proximity of elk winter habitat to the highway make elk susceptible to poaching. A minimum of 15 elk were poached along Highway 2 in the winter of 1974-75 between Walton and Summit; the highest actual count of elk in the same stretch was 78. Nine of the poached elk were taken along the section proposed for reconstruction where the highest actual count was 26 elk.

Mountain goat observations were at higher elevations and greater distances from the observer than elk during both backcountry and vehicle census, suggesting that goats would not be in a position for habitua-

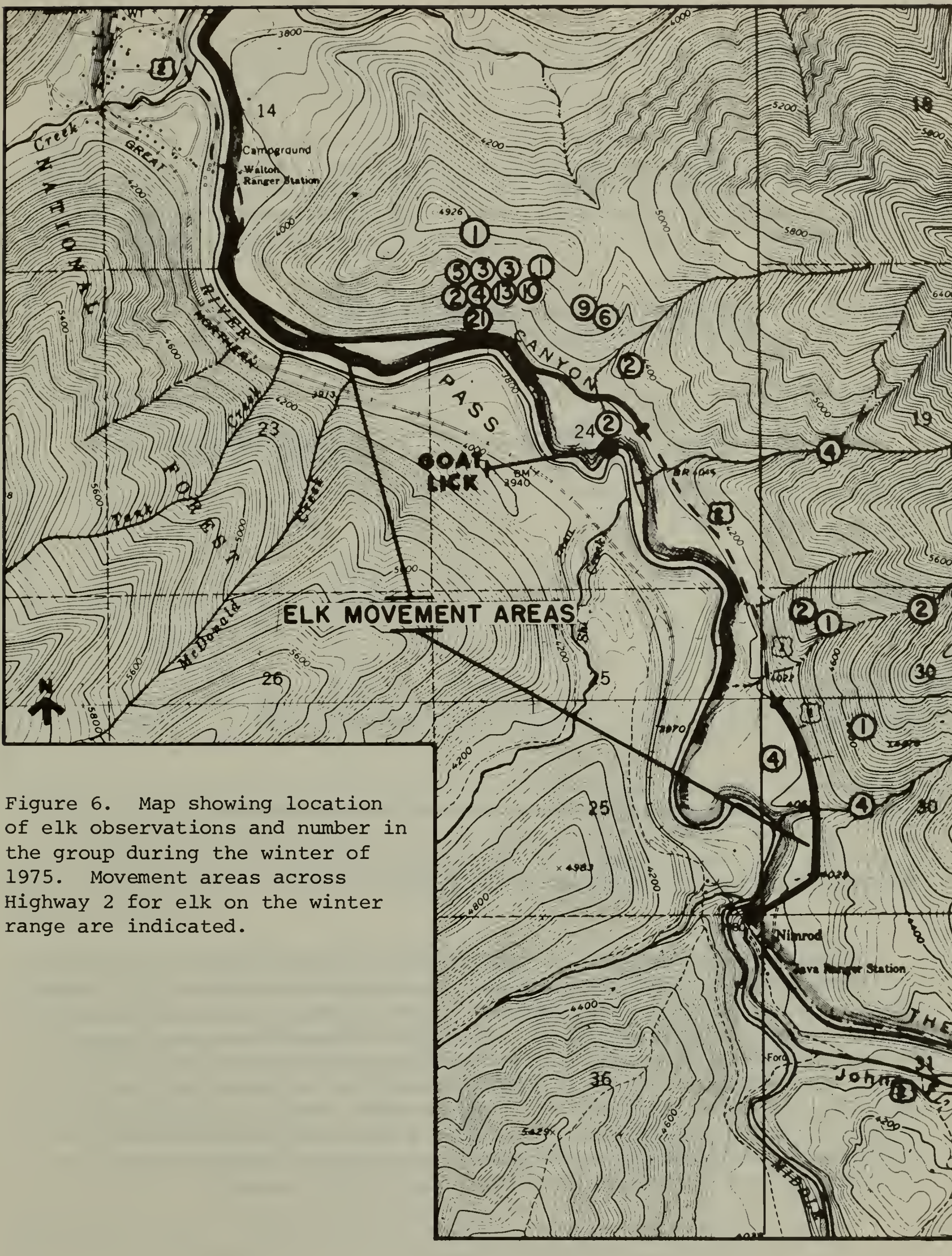


Figure 6. Map showing location of elk observations and number in the group during the winter of 1975. Movement areas across Highway 2 for elk on the winter range are indicated.

tion to the highway. On the other hand, mountain goats were less likely to react by flight than elk at comparable distances (Table 5). It is suggested that mountain goats do not appear wary in comparison to other artiodactyls, but that remaining in steep, rocky terrain when disturbed is an adaptation to natural predators. On July 2, a black bear was observed to ambush and chase a band of mountain goats. Ten of the goats remained on a steep outcrop, even though the bear was quite close, while three goats caught in a meadow area ran full speed for an outcrop 300 m distance, passing through minor rocky areas in between. The bear was forced to slow to a walk in the first rough area and lost the chase.

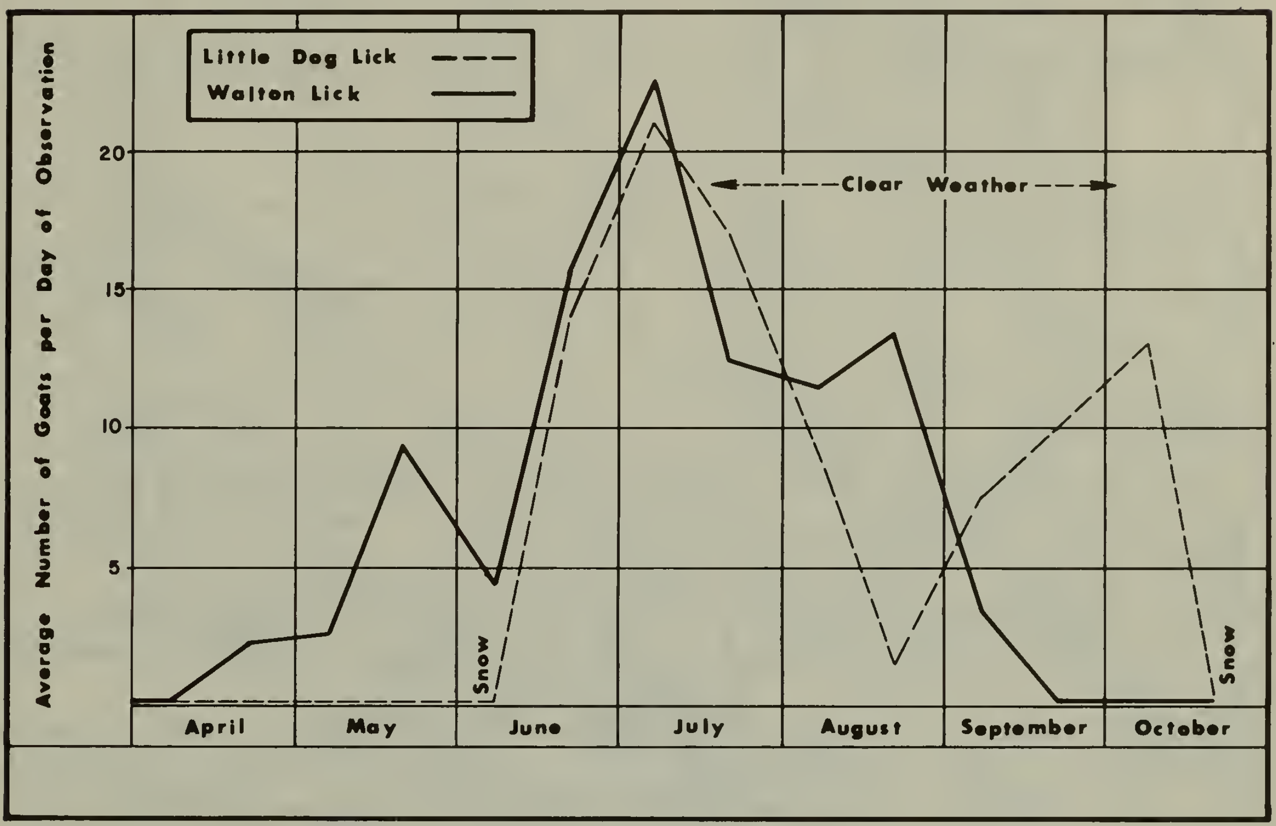
Table 5. A comparison between flight distances of elk and mountain goats for combined highway and backcountry census.

	ELK			MOUNTAIN GOATS		
Distance (m)	Unaffected	Alert	Flight	Unaffected	Alert	Flight
0-100	7		4			
101-300	8	4	11	7	1	
301-500	4	1	3	11		
501-700	2		4	8		
701-998	13	2	2	6		
999+		1		17		

Mountain Goat Visits to the Walton Goat Lick

Mountain goats visited the Walton Goat Lick from April 15 - September 15, 1975, with the peak use occurring in late June and early July (Figure 7). Use of the Walton Goat Lick began and ended one month earlier than use of the remote, undisturbed Little Dog Licks. Restrictive snow depths determined length of season at the Little Dog Licks, which are 579 m higher in elevation. Earlier termination of use at the Walton Goat Lick may have been motivated by highway and visitor disturbances in face of a waning lick drive. The Little Dog Licks are further from the nearest winter range, so movements to the winter range do not explain the earlier termination at the Walton Goat Lick.

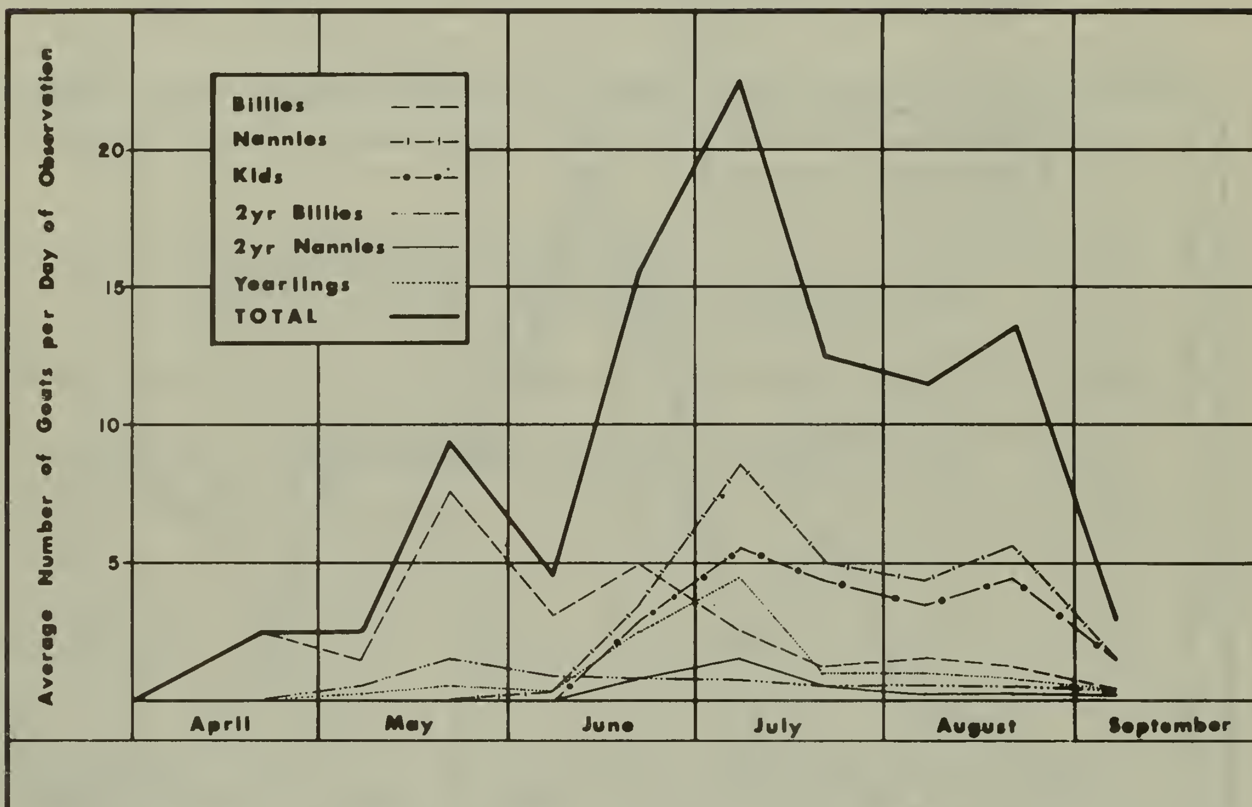
Figure 7. Average number of goats per day of observation at the Walton Goat Lick and the Little Dog Licks, 1975. Period of snow cover on the higher Little Dog Licks is indicated.



Early lick visits, prior to June 7, were by all classes of males, including yearling males, and later visits were predominately by females and kids (Figure 8). Some use by males was observed for the duration of the season.

The number of different mountain goats visiting the Walton Goat Lick was felt to have important application to the highway construction and several estimations were made. A minimum of 89 different goats was determined on two separate days, July 17 and August 21, when respectively, 67 and 68 goats were present at the lick. In addition, 22 and 21 of the recognizable goats, respectively, were not present at the lick on those dates. The value of 105 goats was conservative, however, since recognizable goats were only observed at the lick for an average period of 8.6 days (n = 62 observations, range 1-35, SD = 8.19). If the remainder of the goat population also used the lick for short periods, then an estimated 200 or more different goats visited the lick in 1975. Observations of goats arriving and departing from other regions throughout the summer supported this estimate.

Figure 8. Average number of mountain goats in each sex and age class at the Walton Goat Lick, 1975.



The proportion of mountain goats visiting the Walton Goat Lick from the Flathead National Forest is important since they are hunted, and their population could be more sensitive to highway losses. Sixteen mountain goats arrived at the Walton Goat Lick from the National Forest by crossing the Middle Fork. Many more National Forest goats could have crossed the river when no observer was present at the lick, or could have crossed into the park at some other point. For example, a group of five goats was observed crossing Highway 2 into the park along Lower Bear Creek on June 12, and a two-year old male was observed leaving the park in the same area on August 27.

If as many as 200 different goats visit the lick, then a very large region of goat range was affected by the Walton Goat Lick. Twelve different observations were made of goats travelling 4-10 km to licks, and longer movements were suspected. Traditional trails along the crests of adjacent uplands, to both Walton and Little Dog Licks, were well used and distinguishable for distances of 7-10 km (Figure 9).

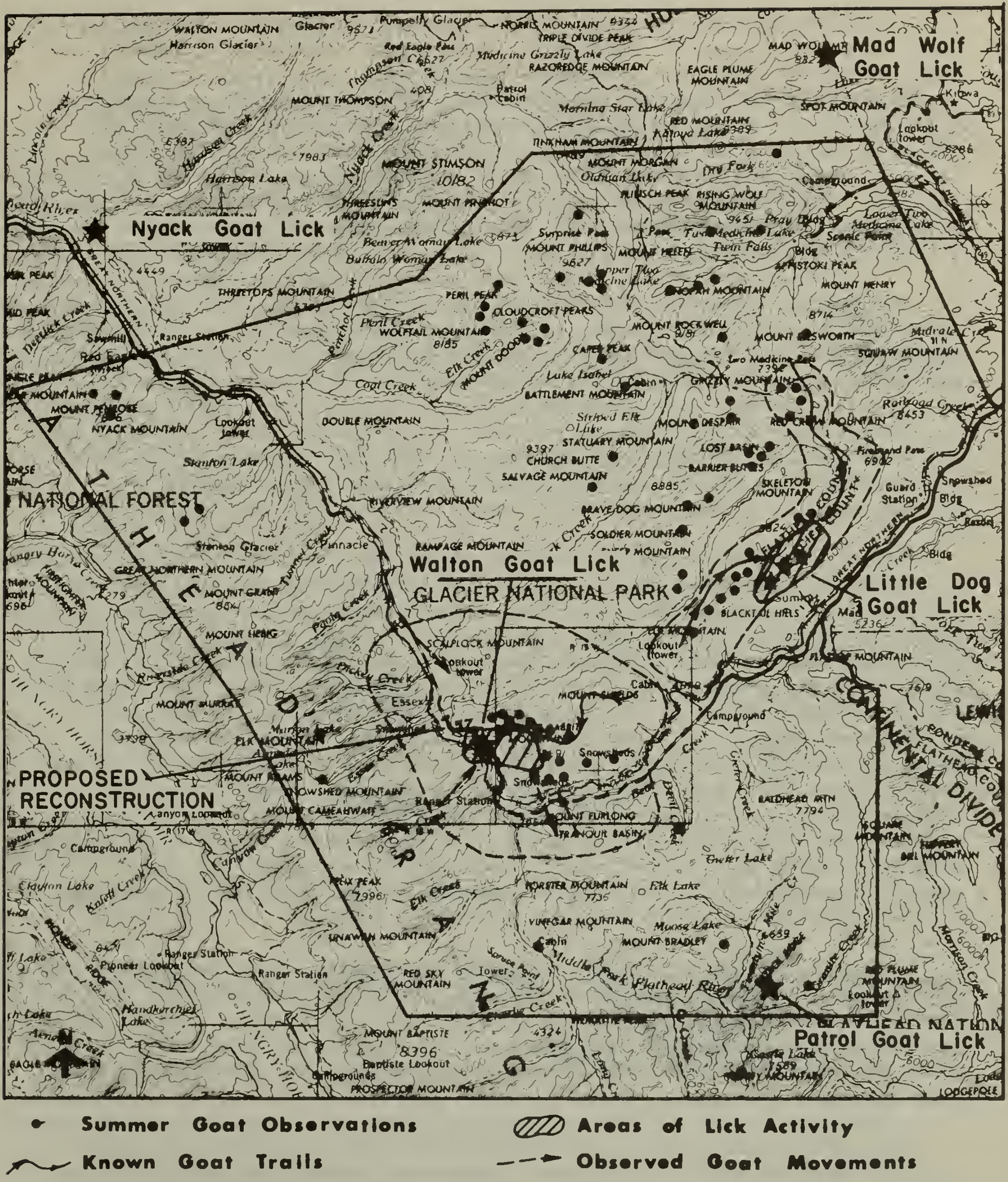


Figure 9. Map indicating known mountain goat licks, areas of goat activity associated with licks, known goat trails along upland crests, observed goat movements to licks and corresponding minimum lick regions. Summer goat observations from census are also indicated.

Orientation cues employed in movements along crest trails to both licks could be visual, or olfactory. Memory or additional cues must be employed in the observed movements through trailless cover. Visual orientation to the lick was characteristic of most goats arriving at the lick vicinity. Mountain goats arriving at the crossing area and the majority of goats crossing the highway kept the lick in their vision. Goats arriving at the lick from across the Middle Fork (n = 16) also kept the lick in their vision. Goats moved up and down the river for 2-25 hours searching for a way around, but in all observed crossings of the river (n = 6) goats kept the lick in their vision and swam directly to it.

Most goats traveled to and from the lick in groups, but moved independently at the lick area. Individual licking periods were highly variable, ranging from 1-300 minutes (n = 209 periods), and goats were constantly moving on and off of the lick. Mountain goats were on the lick for 77 percent of 72 continuous hours, July 21-24. Goats known to be making their first visit to the lick in the season (n = 14 goats) did not move with the groups, but remained at the lick for the entire 24 hour periods and licked for 4-6 periods in a day. Many yearlings did not move with the groups and remained at the lick for long periods.

Goats spent more time in feeding after the first day of their visit to the lick. Prior to June 10, goats fed upon browse and green grasses and forbs in forest stands below the highway and in lower elevation shrub stands above the highway. Movements to feeding areas were short during this spring period. These lower elevation forages dried out after early June and goats began to travel distances of 3-6 km to the peaks and sheltered cirques of the adjacent upland. Succulent young growth of forbs and grasses was available throughout the summer on subalpine sites and around retreating snowfields. Mountain goats traveled the upland on a single trail along the crest to the north peak of Running Rabbit Mountain, and from this peak moved downslope on two major trails to the Walton Goat Lick 1107 m below. In steep areas, these slope trails were worn 30-45 cm into the soil. One trail slope meets the 400 m crossing area on the north side of Snowslide Gulch and the second trail on the crest of the slope directly above the exhibit.

Presence of water in the lick material appeared to be important for utilization. After or during a rain the entire lick deposit was utilized, but during dry spells, seep areas were centers of activity. Dalke *et. al* (1965:328, 330) reported that water was the carrier of minerals at elk licks in Idaho, and that elk no longer used licks when water ceased to flow during dry periods.

Use of the Walton Goat Lick by mountain goats is known from the earliest descriptions of the area. Depth and subsurface qualities of the Walton Goat Lick are unknown. Large losses of the lick deposit occur through erosion by rains and floods and through utilization by the goats, as indicated by licking craters up to 1 m deep. However, the size and structure of the lick deposit suggests a natural lick will be present into the foreseeable future.

Human Presence at the Walton Goat Lick

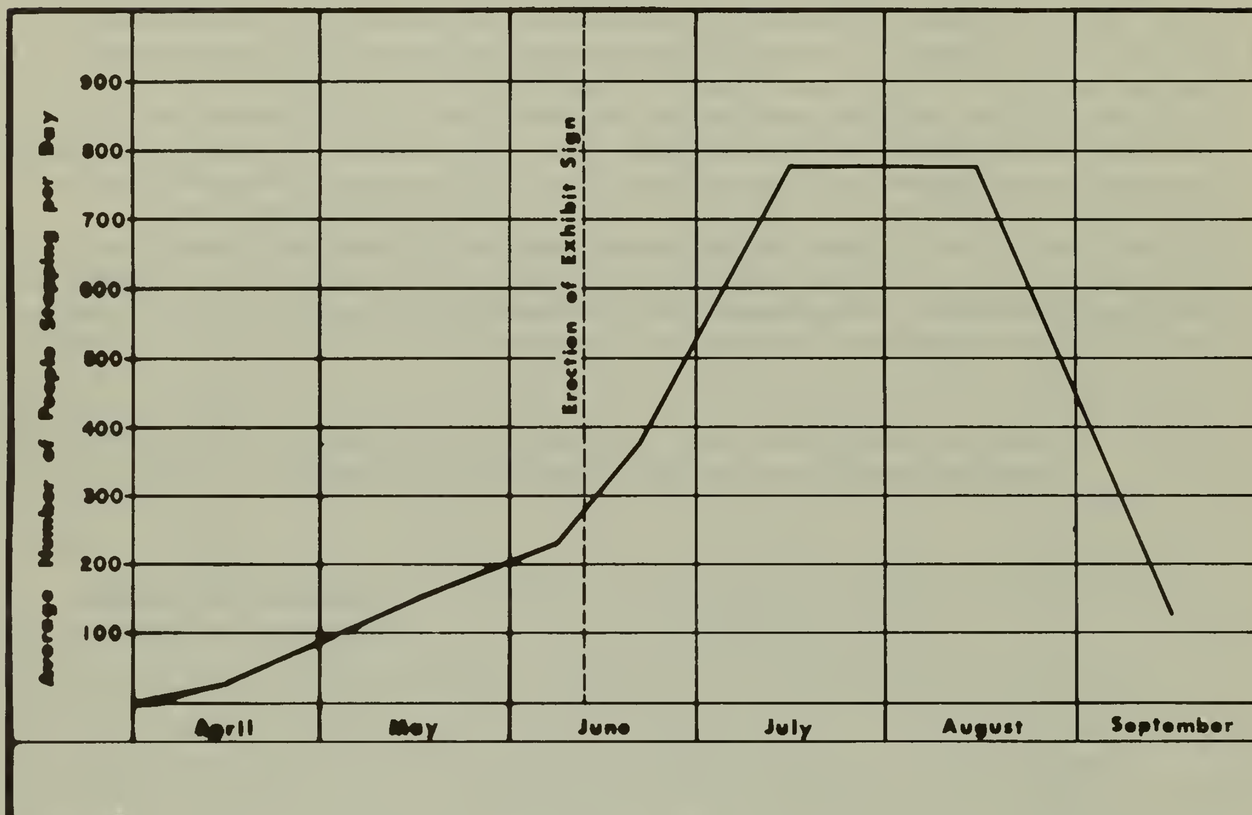
Average traffic volume was 932 vehicles per day past the Walton Goat Lick, with peak flow occurring in the afternoon (Table 6). Percentage of vehicles stopping at the exhibit was also highest in the afternoon hours, although visits were observed from 0645 h on (Table 6). An estimated 24,000 vehicles and 66,000 visitors stopped at the Walton Goat Lick from April through September 15, 1975. Since mountain goats were on the lick 60 percent of the daylight hours, as many as 60 percent of the visitors stopping (39,000 people) were present while goats were on the lick in 1975. Some people experienced difficulty in detecting the goats on the lick from the exhibit. The majority of stops at the exhibit were brief. The average stop was only 3.3 minutes (n = 40 stops), and the range was from 12 seconds to 3 hours.

Table 6. Vehicles travelling past the Walton Goat Lick and percentages of vehicles stopping per hour in 1975 (n = 18 hours).

Time	Traffic (Vehicles/hour)	Percent of Traffic Stopping at Exhibit
0001 - 0400	3	0
0401 - 0800	20	12
0801 - 1200	49	27
1201 - 1600	68	35
1601 - 2000	76	40
2001 - 2400	17	6

Knowledge of the Walton Goat Lick is considerable, as evidenced by an average of 5.8 vehicles and 12.9 people stopping at the exhibit prior to the identification of the area on June 11. On this date, two highway approach signs reading "Exhibit Ahead", and a goat lick exhibit were erected. The peak of visitor activity at the lick exhibit was during July and August (Figure 10).

Figure 10. Average number of people stopping per day at the Walton Goat Lick before and after erection of signs indicating the exhibit, 1975.



Safety Hazards. A total of 130 safety hazards or .45 violations per hour were observed at the Walton Goat Lick (Table 7). Safety violations per hour increased to a peak in August corresponding to the peak in the visitor season. Rates per hour for each month were; April - 0, May - .08, June - .55, July - .45, August - .85, and September - 0. No actual accidents were observed, although 16 near accidents occurred where braking and/or swerving was required to avoid another car. Primary causes for safety problems were; 1) carelessness, 2) driver's attention diverted to the goats on lick or the exhibit sign, 3) incompatible speeds of commerical and through traffic and the slower park visitor, and 4) narrow road and frequent overflow of the exhibit parking lot.

Highway Speeds. Vehicle speeds were less on the Walton-Nimrod section of Highway 2 than on the adjacent sections which were reconstructed in the 1960's, (Figure 11). The lowest speeds were at the Nimrod underpass and along the exhibit area, which is also where goats cross the highway. In this exhibit and goat crossing area, mean vehicle speeds were only 25.3 to 29.3 mph (Figure 11), the standard deviations ranging from 3.7 to 6.7. Drivers reduced speeds in the

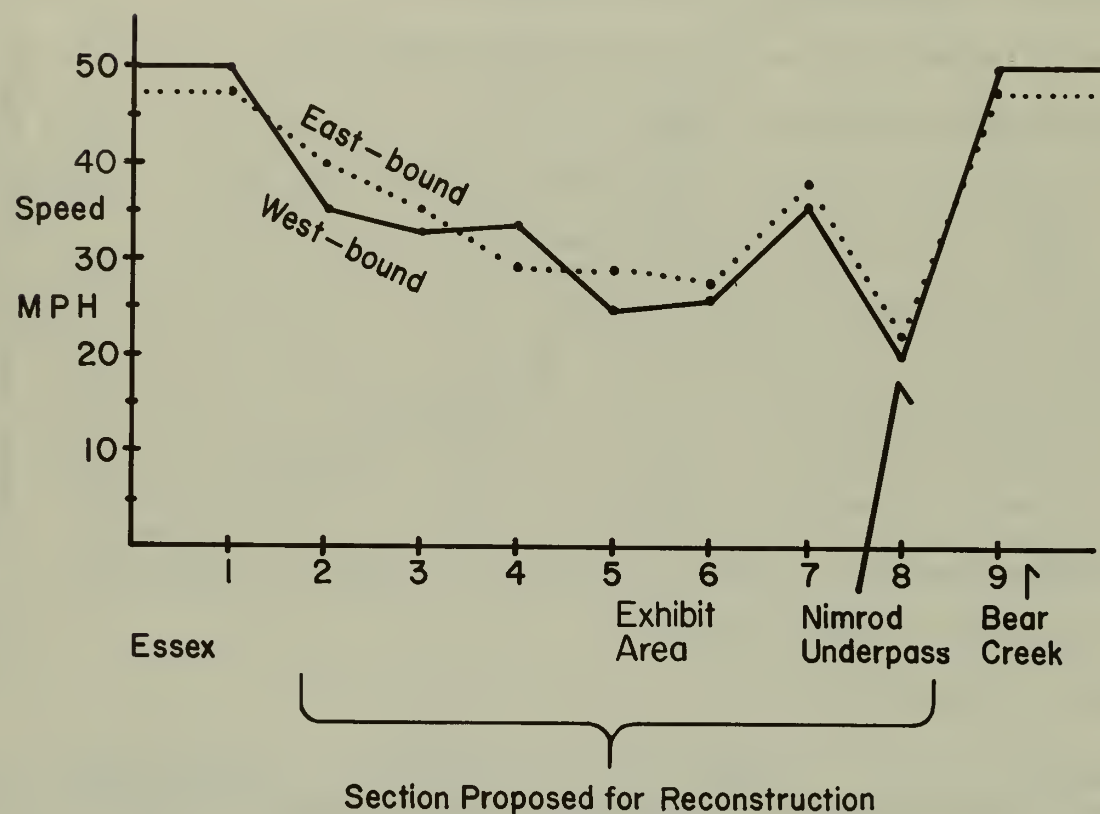
Table 7. Safety hazards at the Walton Goat Lick exhibit area during the 1975 season.

Hazards	Number
Car stopped in traffic lane to read exhibit sign	25
Car parked partially in lot and partially in traffic lane	23
Car parked in traffic lane - people out	22
Vehicle stopped at Snowslide Gulch Bridge to let another pass	17
Car stopped in lane and then backed into a lot	13
Vehicle in wrong lane to look at lick	11
Visitor stationary in a traffic lane	6
Dangerous exit from a lot	4
Vehicle caught in road due to full lot	3
Car U-turned in road	3
Car door open in a traffic lane	2
Dangerous entrance into a lot	1
TOTAL	130

exhibit area due to ; 1) a grade and narrow bridge on the west bound approach, 2) a grade and curves on the east bound approach, and 3) vehicles pulling in and out and visitor activity at the exhibit. Mean reduction in speed for 6 vehicles in the 300 m west bound approach to the exhibit area was 10.5 mph. Vehicle speeds were probably lower in summer due to a greater proportion of the slower driving park visitors and greater activity at the exhibit. Speeds of some local and commercial traffic were 43-48 mph in the exhibit area.

Slower highway speeds in the exhibit area are undoubtedly the primary reason for the absence of any accidents in the face of 130 observed safety hazards and an estimated 1,000 safety hazards for the entire season.

Figure 11. Mean vehicle speeds along the section of Highway 2 proposed for reconstruction. Radar Site 2 - 1.2 km, Site 3 - 2.2 km, and Site 4 - 2.5 km east of Walton, Sites 5 and 6 - exhibit area, Site 7 - 4.5 km east of Walton, Site 8 - Nimrod underpass. Sites 1 and 8 were outside of Glacier National Park in sections of Highway 2 reconstructed in the 1960's.



Human-mountain goat Interactions. Interactions of mountain goats and humans did not occur when visitors remained at the exhibit and when mountain goats remained at the lick. The majority (87%) of interactions occurred at distances less than 50 m, while 46 percent occurred at distances of less than 10 m. Goats and humans were brought into proximity when goats passed through the exhibit area during arrivals to and departures from the lick, and when visitors left the lick and descended towards goats on the lick. Licking mountain goats did not respond to humans at the exhibit because while on the lick they were separated by distances of 160 m and 210 m from exhibit viewing areas, and because of the apparent security offered by the steep, 50^{o}-60^{o} slope of the lick bank. Exceptions were when goats were beginning to depart uphill from the lick and when goats had just arrived at the lick in the season. In these situations, goats were alerted by people at the exhibit and followed passing traffic with their gaze.

Table 8. Comparison between approach distances and the behavior of mountain goats when visitors left the exhibit or goats moved through the exhibit area at the Walton Goat Lick in 1975.

Behavior of Goat	Human-Goat Distance (m)				
	0-11	11-50	51-150	151-300	300+
Unaffected					
Crossing Highway	2	1	1		
Licking		2		2	
Bedded		2	1		
Affected					
Alert	3	11		1	
Flight	11	6	1		
Crossing Held up	5				
Altered Crossing Route	11	6	2	1	—
TOTAL	32	28	5	4	0

Humans altered the behavior of the goats in 84 percent of the interactions. All observed goat reactions at the Walton Goat Lick involved avoidance of humans (Table 9). Goats did not approach humans at the Walton Goat Lick as they do for salts in the Sperry backcountry of Glacier National Park (Bansner 1974) and in the backcountry of Olympic National Park (Moorehead 1973).

Harrassments of goats by people at the Walton Goat Lick occurred at much higher rates in years prior to 1975 (Art Sedlack, Douglas Chadwick, Ursula Bansner pers. corres.). Our official vehicle and presence in the exhibit parking lot may have inhibited many harrassments. Visitors were curious to get a closer look at the goats, and often were disappointed by the inactivity of goats on the lick and yelled or threw rocks in order to stimulate the goats to move around.

Table 9. Interactions of mountain goats and visitors when visitors left the exhibit or goats moved through the exhibit area at the Walton Goat Lick in 1975.

	BEHAVIOR OF HUMAN				
Behavior of Goat	Unaware of Goat	Watching/ Photographing Goat	Approaching Goat	Harassing Goat	Driving on Highway
Unaffected					
Crossing Highway	2		1	1	
Licking		3	1		
Bedded	1	2			
Affected					
Alert	3	7	3	1	1
Flight	2	7	4		2
Crossing Held up		3			2
Alerted Crossing Route	3	8	4	1	4
TOTAL	9	32	14	3	11

Crossing of Highway 2 by Mountain Goats

A total of 87 successful crossings by 692 mountain goats and 31 unsuccessful crossing attempts by 101 mountain goats of Highway 2 were observed in 1975. Movements across the highway were considered successful, while movements by goats which approached the highway but failed to cross it were considered unsuccessful. Goat that were unsuccessful returned to lick or bed, but eventually at a later time were successful in crossing from the lick. The successful crossings included 43 departures uphill from the lick, and 44 arrivals downhill to the lick. All unsuccessful crossing attempts were departures uphill from the lick (42% of total departures); all movements downhill to the lick were successful. Based upon the number of crossings observed during the hours which were spent at the lick, an estimated 812 successful crossings by 2460 goats and 198 unsuccessful crossings occurred during the 1975 season.

Mountain goats used six crossing routes in a 400 m stretch of Highway 2 in movements to and from the Walton Goat Lick (Figure 12). Routes 2, 3 and 4 ascended and descended the highway cut, routes 4 and 5 were relatively level routes through forest cover, and route 1 passed under the bridge over Snowslide Gulch (Table 10). Use of the various routes was different than expected by chance ($X^2 = 12.187 > X^2_{.05(5)} = 11.07$, $P < .05$). The majority of crossings downhill to the lick, 86.5 percent, were on routes 4 and 5. Route 4 was used in 69.5 percent of the successful highway crossings uphill from the lick and 71.5 percent of the unsuccessful crossing attempts uphill from the lick. Route 4 provided: 1) the most direct route across the highway, 2) a clear view of the lick from conifer cover for goats hesitating on top of the highway cut, and 3) an uphill approach to the highway which is open but steep enough to shield goats from view of passing vehicles.

Table 10. Comparison between approach cover and use by mountain goats of six crossing routes over Highway 2 in 1975.

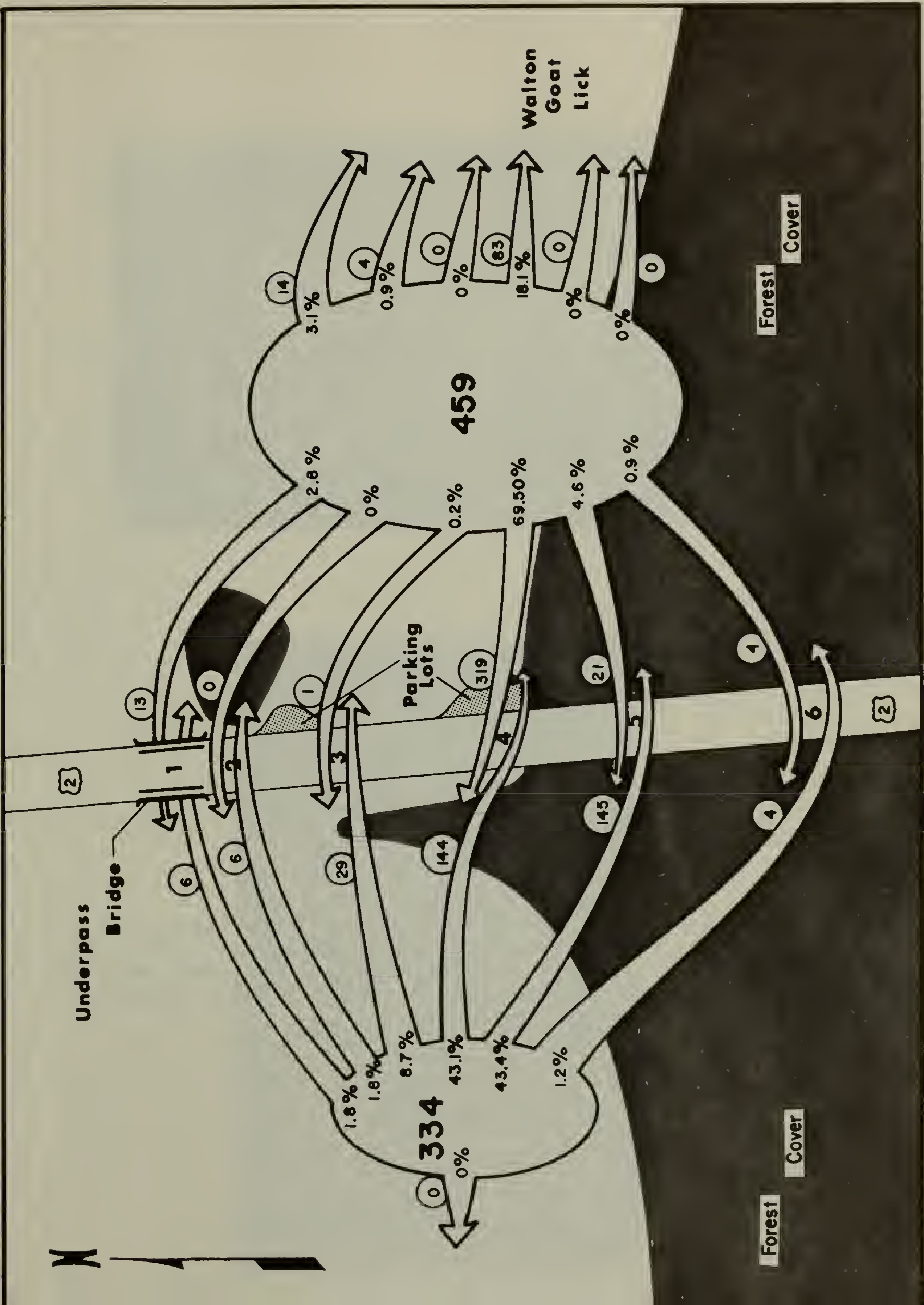
Approach Cover	Number of Routes	Number of Goats
Both approaches forested	2	174
Downhill approach forested uphill approach open	2	493
Both approaches open	2	25

Human Disturbances of Highway Crossing Attempts

Disturbance by visitors and traffic of mountain goats during highway crossing attempts was demonstrated by: 1) behavioral responses of individual goats during crossing attempts, 2) tail positions of individual goats during crossing attempts, 3) alterations of crossing routes during successful crossings, 4) separations of nannies and kids during crossings, 5) unsuccessful crossing attempts, 6) a crepuscular pattern of highway crossings, and 7) reactions of individual goats to highway sounds.

Behavioral responses to humans during crossing attempts included 401 hesitations by individual goats. Hesitations occurred in 52 (44.%) of 118 crossing attempts, and resulted in a total of 18 hours and 48 minutes of crossing delays during the season. Running on a trail

Figure 12. Crossings of Highway 2 by 334 mountain goats observed moving downhill to the Walton Goat Lick and 459 mountain goats departing uphill in 1975.


Walton
Goat
Lick
Forest Cover
Forest Cover
Underpass
Bridge
Parking
Lots
459
334
2.8%
0%
0.2%
69.50%
4.6%
0.9%
3.1%
0.9%
0%
18.1%
0%
0%
1.8%
1.8%
8.7%
43.1%
43.4%
1.2%
0%
14
4
0
83
0
0
13
0
1
319
21
4
6
6
29
144
145
4
0
1
2
3
4
5
6
2
2

"Route alterations were primarily from routes with open approaches to routes 1, 5 and 6 which provided the greater cover and security of forested or underpass approaches."

"Route 4 provided: 1) the most direct route across the highway, 2) a clear view of the lick from conifer cover for goats hesitating on top of the highway cut, and 3) an uphill approach to the highway which is open but steep enough to shield goats from view of passing vehicles."

occurred during 32 crossing attempts, and running across the highway during 33. Alteration of the crossing route occurred in 24 crossings. No behavioral responses to humans occurred in 19 successful crossings; 16 of these crossings occurred when no traffic or visitors were present. Some behavioral response to visitors and/or traffic was observed in 73.8 percent of the individual goats involved in highway crossings.

The high level of disturbance of goats during highway crossings was further suggested by a tail position of erect indicating fear in 70.3 percent of the goats involved in crossings. Tail position was partially erect indicating anxiety in an additional 19.5 percent of the goats, while undisturbed or normal tail position was noticed in only 10.2 percent of the goats. The tucked tail position indicating aggression was not observed during crossings.

The stimulus for behavioral responses of goats during 118 crossing attempts was passing vehicles in 38 attempts, visitors in 23 attempts, a combination of traffic and visitors in 41 attempts, while neither visitors nor traffic were present in 16 attempts.

In order to identify the relationships between behavioral responses in goats and disturbances by humans, simple linear regressions were performed on nine variables including type of human presence, number of visitors present, number of goats in the crossing, number of hesitations, number of cases of running back from the highway, type of behavioral response by goats, percent of the crossing goats that displayed a response to humans, number of minutes that crossing goats were delayed, and the tail position of the majority of goats in a crossing group. Positive correlations were found between the number of hesitations by goats and increasing levels of human presence ($P < .05$ $r^2 = .0974$), and between the number of minutes goats were delayed and increasing levels of human presence ($r^2 = .0743$), although less than 10% of the variation was explained by the coefficient. More meaningful correlations were found within goat responses between the number of hesitations and the number of cases of running back from the highway's edge ($r^2 = .4826$), between the number of hesitations and the number of minutes held up ($r^2 = .3418$), and between the percent of goats responding to human disturbances and increasing anxiety and fear demonstrated by the tail position of goats ($r^2 = .1381$).

Altered Crossing Routes. Mountain goats responded to human disturbances by crossing Highway 2 on a route different than their approach route in 24 crossings. Route alterations were primarily from routes with open approaches to routes 1, 5 and 6 which provided the greater cover and security of forested or underpass approaches (Table 11). Goats shifted over or circled back and around to the altered crossing routes. Stimulus for route alteration was visitors in 13 (54%) altered crossings, and passing vehicles in 7 (29%) altered crossings, while in 4 (17%) altered crossings the stimulus was not determined. Altered crossings involved goats which had split from larger groups of goats in nine (37.5%) cases.

Table 11. Comparison of approach cover between routes of initial approach and altered routes for highway crossing during 24 altered crossings in 1974.

Approach Cover	Initial Approach	Crossing Route
Both approaches forested	0	11
Downhill approach forested, uphill approach open	20	8
Both approaches open		
a) over road	4	0
b) underpass	0	5

Nanny/kid Separations. Nannies were separated from their kids three times by passing vehicles, three times by kids hesitating to cross the highway and once when a nanny with kid at side were crossing the Middle Fork (Table 2). In three separations the nanny returned for the kid, in two cases the kid rejoined the nanny and in two cases the nanny and kid were detached. One detached kid associated within a few hours with a two-year old goat and in the second case the detached kid was present at the lick for two days without associating with other goats.

Unsuccessful Highway Crossing Attempts. An additional demonstration of human disturbances of crossing attempts was the observation that 42 percent of attempted crossings uphill from the lick were unsuccessful. Successful crossings were highly significantly associated with no traffic or visitors or light traffic only, while unsuccessful crossings were associated with visitor presence in the west parking lot, visitor presence in both parking lots, and/or heavy traffic ($X^2 = 35.06 > X^2_{.05(5)} = 11.07$, $p < .001$) (Table 12). Unsuccessful crossings occurred in daytime hours when traffic and visitor activity was highest.

Behavioral responses of goats to human disturbances were high during unsuccessful crossings, reflecting the high levels of human presence. For example, the average number of hesitations for unsuccessful attempts was 4.5 (range 1-11). Running back from the edge of the highway in the face of an oncoming vehicle (range 1-7) occurred in 67.7 percent of the unsuccessful crossings. Unsuccessful crossing attempts varied from short movements along a trail and a single hesitation, to attempts lasting 95 minutes, involving several route alterations, and involving three separate approaches of less than 10 m from the highway. Mountain goats

Table 12. A comparison between successful and unsuccessful crossing attempts with increasing human presence at the Walton Goat Lick, 1975.

Human Presence	No. of Successful Crossings	No. of Unsuccessful Crossings	Percent Successful
None	18	0	100.0
Passing vehicle(s) only	26	1	96.3
Viewing visitor(s) only	5	6	45.5
Visitor(s) in east lot and traffic	17	4	81.0
Visitor(s) in west lot and traffic	9	8	52.9
Visitor(s) in both lots and traffic	12	12	50.0
TOTAL	87	31	

approached to less than 50 m from the highway in 20 (64.5%) unsuccessful crossing attempts (Table 13). After an unsuccessful attempt to depart from the lick and cross the highway, goats returned on their crossing trail to bed near the lick or to lick again.

Crossing success was highly significantly associated with the size of groups ($X^2 = 9.73 > X^2_{.05(5)} = 5.99$, $P < .05$). Groups of 11-55 goats were more successful than groups of 2-10 goats, while individuals were the least successful (Table 14). A test for heterogeneity indicated that differences were significant between individuals and groups of all sizes (2-55 goats).

Crossing success was found to be highly significantly associated ($X^2 = 8.39 > X^2_{.05(2)} = 5.99$, $P < .025$) with the sex and age of the leader goat. Nannies with kid at side were the most successful leaders, billies were less successful, and other classes including nannies, two-year-old females, yearlings and kids were the least successful leaders (Table 15).

Table 13. Distance of nearest approach to Highway 2 in 31 unsuccessful crossing attempts, 1975.

Nearest Approach to Highway (m)	Number of Unsuccessful Crossings	(%)
1-9	7	(22.5)
10-24	3	(9.7)
25-49	10	(32.2)
50-99	1	(3.2)
100-149	5	(16.2)
150-200	5	(16.2)
TOTAL	31	(100.0)

Table 14. A comparison between highway crossing success for different size groups of mountain goats, 1975.

Size of Group	No. of Groups	Successful Crossings	(%)	Unsuccessful Crossings	(%)
1	35	19	(54)	16	(46)
2-10	61	49	(80)	12	(20)
11-55	22	19	(86)	3	(14)
TOTALS	118	87		31	

Crepuscular Crossing Pattern. The time of highway crossings suggested a regular, crepuscular pattern of crossings (Figure 13). It was hypothesized that highway crossings were crepuscular and use of the lick primarily nocturnal, and that this pattern was a response to visitor activity and highway traffic patterns near the Walton Goat Lick. In order to establish

Table 15. A comparison between highway crossing success across Highway 2 for leaders of different sex and age class in 1975. "Other classes" include nannies, two-year-old males, two-year-old females, yearlings and kids.

Sex of Leader	No. of Crossings	Successful Crossings (%)	Unsuccessful Crossings (%)
Adult nanny with kid at side	56	48 (86)	8 (14)
Adult billy	30	20 (67)	10 (33)
Other classes	31	18 (58)	13 (42)

the existence of this pattern, the hypothesis was stated as follows:

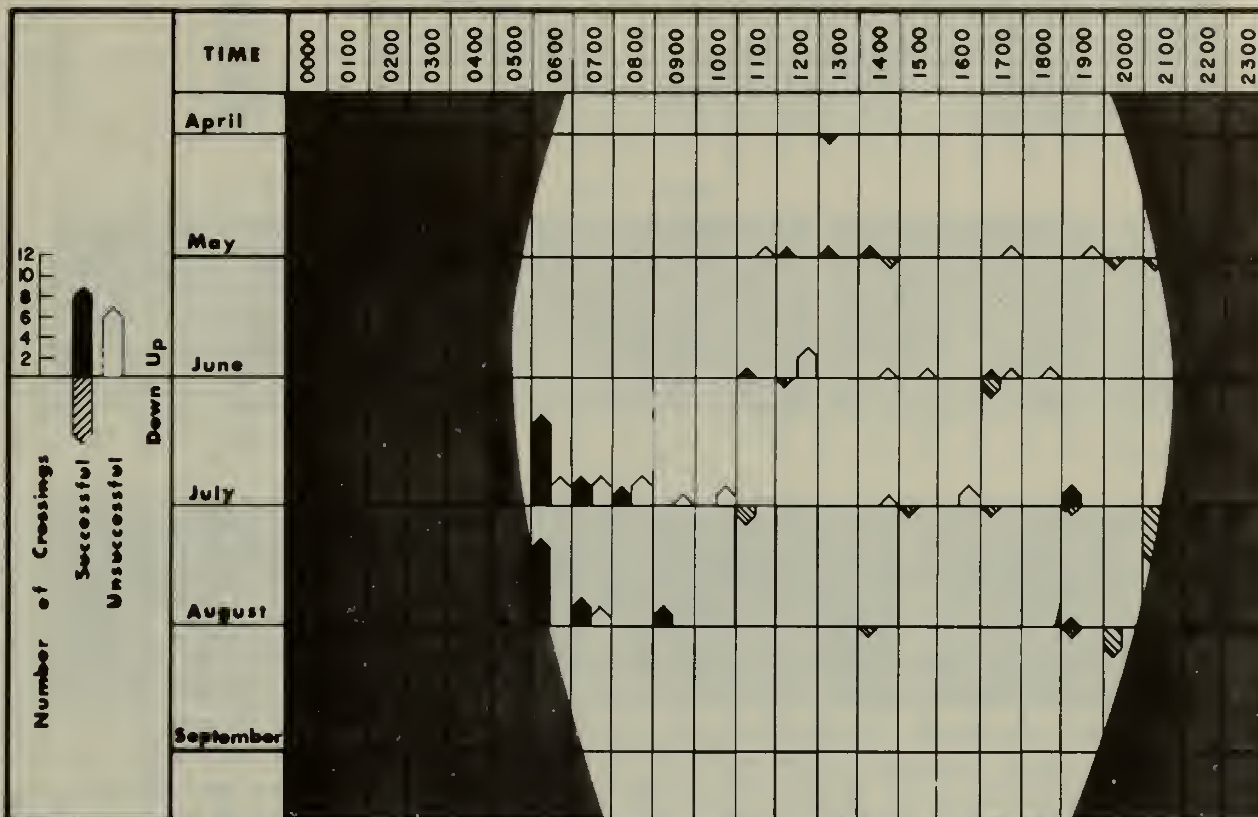
Positive: Arrivals (down) later than 2.5 hours before sunset.
Positive: Departures (up) earlier than 2.5 hours after sunrise.
Negative: Arrivals (down) earlier than 2.5 hours before sunset.
Negative: Departures (up) later than 2.5 hours after sunrise.

Positive was considered to support the crepuscular - oriented pattern, while negative was not.

It was suspected that positive was found in successful highway crossings at the Walton Goat Lick during peak visitor activity after July 1, and that negative was found in, 1) road crossing patterns at the Walton Goat Lick prior to July 1, 2) patterns of unsuccessful highway crossing attempts at the Walton Goat Lick, and 3) patterns of arrivals and departures at the control lick, the little Dog Licks.

Successful highway crossings after July 1 were found to be very highly significantly associated with the crepuscular pattern, but successful crossings prior to July 1 were not ($X^2 = 10.46 > X^2_{.05(1)} = 3.84$, $P < .005$). Unsuccessful crossing attempts after July 1 were not associated with the crepuscular pattern ($X^2 = 9.82 > X^2_{.05(1)} = 3.84$, $P < .005$). Arrivals and departures at the little Dog Licks did not follow the crepuscular pattern ($X^2 = 20.67 > X^2_{.05(1)} = 3.84$, $P < .0005$). In addition, regularity of movements to the Walton Goat Lick was further indicated by an average group size for arrivals and departures of 6.72 goats which was significantly larger than the average size of 4.37 goats for the control group at the Little Dog Licks ($t = 2.4$, $P < .05$).

Figure 13. Time of day of 87 successful and 31 unsuccessful crossing attempts of Highway 2 near the Walton Goat Lick in 1975.



The crepuscular highway crossing pattern was most fully developed in August, which coincided with a high success rate of 94 percent for crossings (Table 16). Development of the crepuscular pattern with the progression of the season may have been related to, 1) a seasonal adaptation to the increasing visitor and traffic activity which peaked in August, 2) greater proportion of the more successful adult nannies with kid at side as leaders in August, or 3) less movements during the daytime heat in summer.

Mountain goats utilized the lick throughout nocturnal hours during a 3 day period when moonlight helped to illuminate the lick (Figure 14). Goats were not observed to move at night when moonlight was available. Data from dark nights including spotlight checks of the lick, track records on the highway and similar goat counts on the lick at dusk and the following dawn, all indicated that goats were not arriving or departing from the lick during the night.

Response to Highway Noise. Mountain goats initially reacted to all highway, railway, and visitor noise when first arriving at the lick

Table 16. Comparison between percent of successful highway crossings for each month in 1975 at the Walton Goat Lick.

Month	Percent Successful	(Sample)
April	100	(1)
May	70	(10)
June	53	(17)
July	68	(57)
August	94	(31)
September	100	(2)

in the season. They soon became habituated and, while on the lick, did not react to the sounds of trains passing across the river or to the sounds of visitors. Mountain goats continued to associate passing vehicles with highway noise and the highway pavement. The shifting and down-shifting of trucks negotiating highway grades near the lick greatly affected crossing goats, often causing goats to run back from the edge of the highway when the truck was 1 km or farther away. Goats were also observed to run along a trail when 400 m from the highway and to run off of the lick in response to sounds of approaching trucks. Goats often hesitated on the highway pavement edge and walked stiff-legged or ran across the highway even when there were no visitors and no vehicles within sight or hearing.

Vehicles and Highway Crossings

The majority of highway crossings by mountain goats were safe. Goats crossed the traffic lane with no oncoming vehicle in sight ($>$400 m) in 70 percent of the crossings, while the nearest vehicle was $>$10,000 m away during 43.8 percent of the crossings (Table 17). The low traffic volumes along this section of Highway 2 particularly during the crepuscular crossing hours are partially responsible for the number of safe crossings. More important, however, were the behavioral responses of goats, especially hesitations, running across the highway and running back from the highway edge in the face of an oncoming vehicle. For example, running back from the highway edge was observed in 38 (56.7%) successful crossings. Hesitations

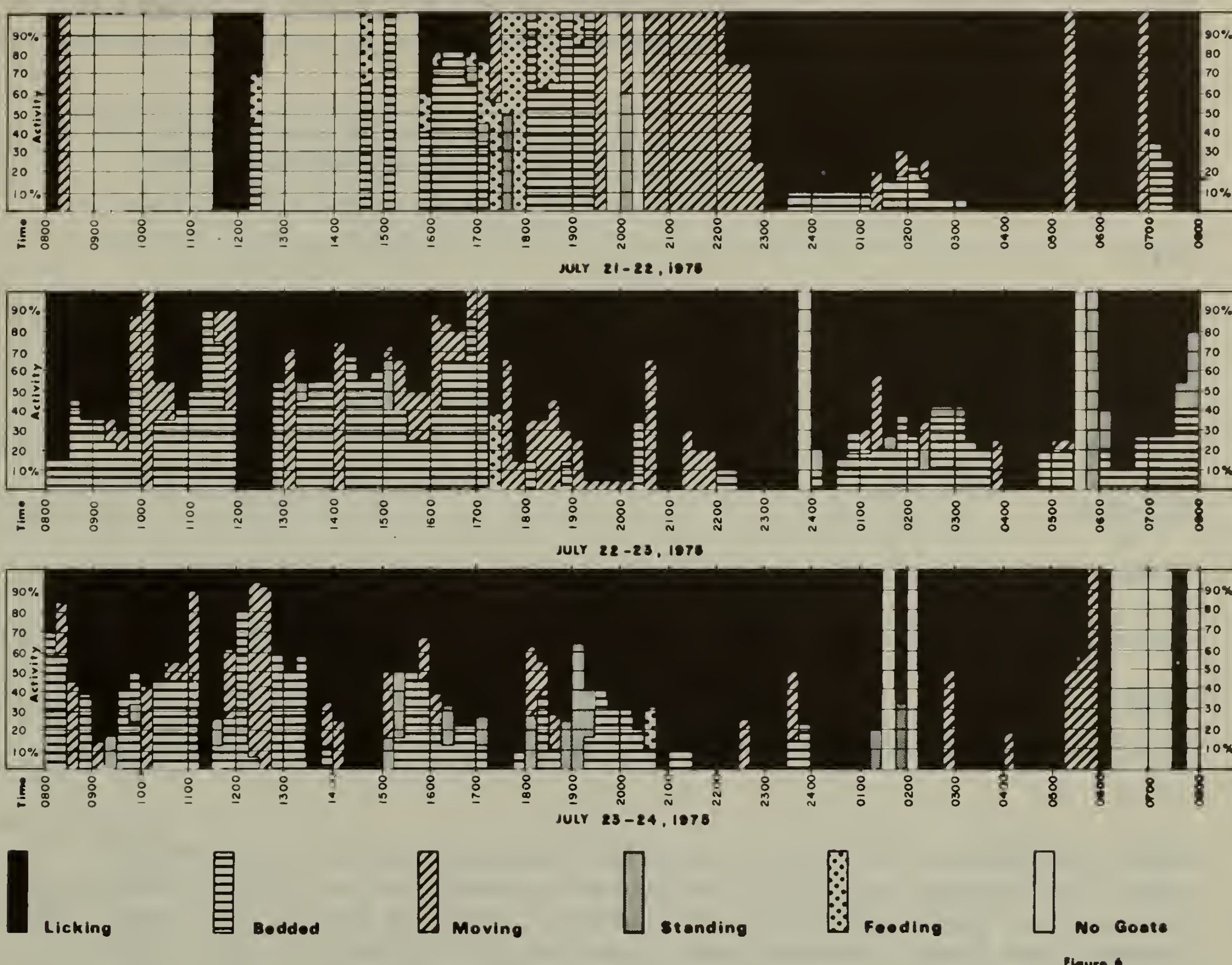


Figure 14. Round-the-clock activity patterns of mountain goats at the Walton Goat Lick on July 21-24, 1975.

by goats in the conifer cover above the highway while they watched the highway were common, and were in large part responsible for safe crossings. Such behavioral responses were often repeated several times during a single crossing.

A total of 13 near hits, with oncoming vehicles 15 m or less from individual crossing goats, was observed. In each case the vehicle slowed or braked to avoid a collision; in six of those cases the vehicle stopped and in one case the vehicle stalled. An estimated 100 near hits occurred in 1975, assuming that rates were the same during those daylight hours when observers were not at the lick.

The behavioral response of running back from the highway edge was absent in the near hits. Short reaction time for drivers, less cautious male goats, and large crossing groups were factors in the

Table 17. Distance to the nearest oncoming vehicle during crossings of Highway 2 by mountain goats in 1975.

Distance (m)	No. of Crossings (%)
0-15	10 (11.5)
16-49	4 (4.6)
50-99	4 (4.6)
100-399	11 (13.7)
400-999	8 (9.2)
1,000-9,999	11 (12.6)
>10,000	38 (43.8)
TOTAL	87 (100.0)

near hits (Table 20). All of the nine classified goats involved were males. In 6 (46%) near hits the crossing group size was 31-48 goats, and crossing goats may have felt a greater drive to follow the larger groups. Six (46%) involved goats crossing the highway on route 5 and traffic that was east bound, which gave drivers a short reaction time. In three (23%) near hits, vehicles were less than 1 m from crossing goats. Reduced vehicle speeds in the crossing area no doubt contributed to the avoidance of a number of collisions.

Leadership, Dominance and Cohesion

Leadership. Nannies with kid at side were the most frequent (47.5%) leaders during highway crossings, and the most important leaders since they led larger groups of mixed classes (Table 18). Goats migrated to the lick in small groups ($\bar{x}$ = 1.6 goats, n = 10), but while at the lick joined larger groups ($\bar{x}$ = 6.7 goats, n = 118) which were usually led by nannies with kid at side. Goats moving off the lick often hesitated and waited to join a group led by a nanny with kid at side. When groups were split by a passing vehicle, the remainder, hesitating near the road, often waited until a second nanny with kid at side assumed leadership across the highway. Goats were often observed bedded or standing on the north peak of Running Rabbit Mountain apparently requiring an appropriate leader or stimulus to move to the lick below.

Table 18. Comparison between groups led by the various sex and age groups of mountain goats during 118 crossing attempts of Highway 2.

Sex and Age of Leader	GROUP TYPE Kid	Yearling	Female	Nanny with kid	Male	Mixed	Unidentified Group	Total
Kid	1							1
Yearling		3				1		4
2-yr. female			2					2
2-yr. male					8			8
Adult billy					26		3	29
Adult nanny			7			4		11
Nanny w/kid				15		35	6	56
Unidentified adult							7	7

Nannies with kid at side did not solicit companions, although other classes, particularly juveniles, often did. Goats solicited companions by hesitating and looking back towards the other goats. In five cases yearlings that were unable to solicit companions returned to the lick. Nannies with kid at side were often aggressive leaders and would threaten or chase other goats which attempted to shift position and assume leadership.

Dominance Relations. Dominant classes of goats at the lick were billies, nannies and nannies with kid at side (Table 19). Nannies, two-year-old females and yearlings were involved in more dominance interactions at the lick than expected by chance ($X^2 = 87.20 > X^2_{.05(6)} = 12.60$, $P < .001$). Kids were sheltered from most interactions by their nanny. Active lick area decreased from the entire lick (3600 m^2) to only wet seeps (360 m^2) in the late summer, and competition and dominance interactions increased. In one instance, on August 20 when 57 goats were at the lick, 5 goats , including 1 billy and 5 two-year-olds, were actually excluded from the lick.

"Adult nannies with kid at side were the most frequent (47.5%) leaders during highway crossings, and were the most important leaders since they led larger groups of mixed classes."

Table 19. Comparison of the percent of dominance interactions won and the number of interactions involved in between sex and age classes at the Walton Goat Lick. Expected values are based upon sex and age ratios in the lick population. A "*" indicates a significant difference between the observed and expected values.

Sex and Age Class	Percent Won	No. of Interactions Involved in (expected)
Kid	0.	63 (72)*
Yearling	6.3	48 (31)*
Two-year-old male	16.7	18 (13)
Two-year-old female	18.8	16 (8)*
Adult nanny	57.1	46 (25)*
Adult nanny with kid	84.5	63 (72)
Adult billy	89.8	67 (49)
TOTAL		270 (270)

In comparison between percent of the dominance interaction won at the lick and percent of leadership of highway crossings, nannies with kid at side were dominant less than they were leaders, while nannies and billies were dominant more than they were leaders (38.6% < 47.5%, 17.% > 9.3%, 37.% > 24.6% respectively). In 19 movements of groups where dominance relationships were known, the dominant goat was the leader in 13 movements (68%). I observed two cases where a two-year-old male led billies, and one case where a yearling led a billy. Stewart and Scott (1969) found that while age is a factor which was favorable to dominance in domestic goats (*Capra hircus*) and of somewhat lesser importance in leadership, the two phenomena were largely independent in individual cases.

Marked goats that were reobserved (n = 48 observations) were in different groups 38 (79%) times and in the same group only 10 (21%) times. Marked goats were reobserved in the same group type 35 (73%) times and in a different group type 13 (27%) times. New arrivals at the lick in the season initially avoided other goats but within a few hours integrated into the group(s) present and adopted the regular movements up and down Running Rabbit Mountain. The exception was one adult billy which crossed the river on July 21 from Flathead National Forest and remained for four days in a solitary existence at the lick. In a few cases small groups appeared to be cohesive and remained apart from the larger group(s).

DISCUSSION

Endangered Species

Grizzly bears were readily observed 3 km or farther from Highway 2 in both Glacier National Park and the Flathead National Forest, suggesting that they avoid the highway area. Two males which exploited human food sources along the highway were trapped and removed. Grizzly bears are observed crossing Highway 2 at many points by residents and visitors, particularly along Bear Creek. No data was available on how grizzly bears react to different types of highways, or whether the present highway acts as a partial barrier to movements.

The contiguous mountain ranges from Lincoln to the Canadian border are considered to contain one population of grizzly bears, the Bob Marshall "ecosystem" (U.S. Fish and Wildlife Service 1975: 31374). Highway 2 is the only highway bisecting that population range, and if it acted as a barrier to movements, two distinct populations would be the result. Genetic interchange would be reduced and would be considered gene flow between two populations. The adaptive significance of gene flow depends upon the average environments and the population means of the two populations (Levins 1964).

Timber wolves did not frequent the section of Highway 2 proposed for reconstruction, nor did this section appear to be a natural corridor crossing area, such as the Giefer Creek - Fielding Pass area. Natural crossing areas are more important to timber wolves than to grizzly bears, because of the more extensive movements of wolves and because of the importance of natural passes in winter movements.

Little information is available on the status of timber wolves on the study area. The infrequent observations may indicate that wolves are resident in inaccessible portions of the study area and avoid the Highway 2 corridor. Resident wolves in the northern portions of Glacier National Park travel inaccessible areas (Singer in press). Carbyn (1974a:98-100) reported that highways affected den locations in Jasper National Park, and that more wolf predation occurred along a less-traveled highway in comparison to a well-traveled highway. Another suggestion is that the wolf population is disrupted and characterized by sporadic breeding and excessive travelling. Excessive travelling was described for woodland caribou prior to extirpation in sections of western Montana (Evans 1964). Giant sable (*Hippotragus niger variani*) are normally resident year-round within an area of 13 km^2, but at abnormally low population densities, and/or when seriously disturbed, sable may wander much more widely (Estes and Estes 1974:88). In a tsete-control area where game was being eradicated, one herd of sable circulated within an annual range of 320 km^2 for two consecutive years (Child and Wilson 1964).

In my opinion, Section 7 of the Endangered Species Act of 1973 would not apply to timber wolves and the proposed reconstruction because the area was not used by wolves as a denning area or activity center, nor was the area a recognized corridor crossing. Movements by grizzly bears across Highway 2 were poorly understood, but the section proposed for reconstruction did not appear to be used differently than other sections. Since a highway already exists, a conservative approach to physical and visual design features should have no additional effects upon grizzly bear crossings.

Black bears, mountain lions (*Felis concolor*), and wolves often frequent mountain goat licks in other areas (Cowan and Brink 1949; McCrory 1965). A wolf pack established a rendezvous site right at a natural lick for mountain goats along the Athabasca River in Jasper National Park (Carbyn 1974b). No predators were observed at the Walton Goat Lick in 1975, with the exception of one black bear observed feeding on unidentified carrion across the Middle Fork from the lick.

Habitat

Habitat difference may explain the higher densities of mountain goats in the Glacier National Park sector in comparison to the Flathead National Forest sector of the study area. Goats were observed during winter primarily on or near outcrops at 1219-1767 m (4000-5800 feet) elevation, at slopes of 43°-51°, on south to west exposures, and in situations with 0-6 cm of snow. Those situations were less common west of the thrust zone and in the Flathead National Forest where both the quantity and distribution of outcrops is more restricted. In addition, ledges were less common on the existing outcrops.

The habitat utilized by mountain goats was narrowly and rigidly defined in comparison to the habitats utilized by other artiodactyls on the study area. The steep outcrops utilized by goats tended to support climax or stable plant communities.

Learning and Leadership

Geist (1974:209) theorized that the exploitation of stable, self-regenerating, climax plant communities by ungulates selects for cohesion between individuals, leadership, gradual disassociation of mother and young, and home range traditions. All of these aspects of social behavior were demonstrated by mountain goats.

Visits to the natural licks is traditional in mountain goats. Nannies with kid at side led more of the observed movements than other classes. Nannies with kid at side also led larger groups and led more successful highway crossings than other classes. Juvenile mountain goats solicited companions more than other classes of goats.

Mountain goats may have relied more upon adult nannies with kid at side, and perhaps certain nannies, as leaders of highway crossings than was the case in undisturbed areas. In support, it was observed that in longer migrations to the lick, the group size was smaller and leaders were different than in highway crossings. For example, yearlings led two of the observed longer migrations to the lick.

Old animals lead groups to traditional ranges in bighorn sheep (Geist 1971), and lead groups to specific locations such as water wells in camels (Gauthier-Pilters 1974:547). Elephants move in matriarchial groups, the oldest female dictating the movements (Laws 1974:520).

Development of crepuscular highway crossing pattern at the Walton Goat Lick may have been related to learning and/or leadership by adult nannies with kid at side. Some crepuscular crossings may have been due to movements during cooler periods in the summer months. Goats were observed to arrive at licks in the evening hours by other researchers (DeBock 1970 ; Chadwick 1973). However, the well-defined crepuscular pattern at the Walton Goat Lick was suspected to be at least partially a response to visitor and traffic patterns. The number of unsuccessful crossing attempts during diurnal periods at the Walton Goat Lick and absence of the crepuscular pattern at the control lick supported this hypothesis.

Learning and habituation was also suggested by other data. Mountain goats, from their position on the lick, continued to associate the highway and highway sounds as a threat, but became conditioned to trains passing by across the river and to visitors in the exhibit. During alterations of crossing routes, goats often circled so quickly to shielded routes as to suggest learning and memory. Repeated crossings of a simulated pipeline in Alaska suggested that caribou were beginning, through learning, to recognize crossing facilities as avenues of access to the other side.

Population Dynamics

Elk. Elk have been successfully harvested by legal hunting in North America, the hunting replacing other sources of mortality and/or being compensated for by increased reproduction. A stable elk population in the Middle Fork drainage is suggested by hunter harvest in hunting District 140 and by relatively stable counts in Glacier National Park (Martinka 1975).

Winter poaching along the section of Highway 2 proposed for reconstruction has been reported since the 1950's and in 1975 the known poaching was 32 percent of the local wintering herd. These losses could not be compensated for by reproduction and are apparently sustained by recruitment from the larger Middle Fork population. Poaching losses represent a departure from natural conditions in a National Park and may serve to decrease the legal hunting harvest outside of the park. Poaching rates should remain stable or decline after highway reconstruction since slow "cruising" would be more difficult and poachers might be more visible.

No increase in elk mortality is predicted after reconstruction to a wider, faster highway. Elk would continue to cross mainly during the night, or perhaps would avoid crossing the highway. Ward *et. al* (1973: 335) found that elk would regularly feed as close to 300 yards (274 m) from Interstate 80 in Wyoming, but that the 4-lane highway acted as a barrier to elk movements. Continued movements across this section of Highway 2 may be important in maintaining use of the components of winter range on both sides of the highway and in maintaining possible traditional migrations of elk between seasonal ranges in Glacier National Park and the Flathead National Forest.

Mountain Goats. Mountain goats, on the other hand, would continue crossing Highway 2 to the Walton Goat Lick even if they were subjected to higher mortality. Additional highway losses would probably be cumulative to other sources of mortality and would not be compensated by increased reproduction. A population decline would probably appear first in the mountain goat population from the Flathead National Forest which visits the Walton Goat Lick.

Bighorn sheep have continued to visit traditional licks at Mount Norquay in Banff National Park and at Disaster Point in Jasper National Park in spite of increasing highway mortality. The local herd at Norquay has suffered losses of 26 percent in a single year, and may have seriously declined since construction of the Trans-Canada Highway (Wackerle 1974).

The population growth of mountain goats appears to be very strongly related to winter conditions. Hjeljord (1973:361) found kid:adult ratios of 20:100, the lowest recorded in 12 years, following an unusually severe winter in Alaska. In the Sapphare Mountains of Montana, over-winter losses of kids and yearlings during a severe winter (1971-72) were 73 percent and 59 percent respectively, while in a mild winter (1972-73) losses were only 28 percent and 2 percent respectively (Rideout 1974).

Mountain goats, in contrast to North America cervids often do not respond to hunting harvest. In southeastern Alaska, overharvests frequently occur along travel corridors, causing wildlife managers to close the season or to cut back on the season and bag limits (Wayne Ballard pers. corres.). The goat population in southern Alberta has greatly declined as the result of improved access resulting in overharvest by hunters (Mark Quaedvlieg pers. corres. in Chadwick 1973). Lonn Kuck (pers. corres.) has found that mountain goats were unable to compensate for hunting losses in the Pahsimerai herd in Idaho. Chamois (*Rupicapra rupicpra*), under intensive hunting control in New Zealand, took refuge in marginal habitat which suppressed their compensatory response mechanisms (Batcheler 1968).

Harvests of mountain goats in hunting District 140 declined from 74 in 1958 to 0-10 from 1970 through 1975. Hunting permits were reduced from unlimited to 5 and male:female ratios in the harvest shifted from 2:1 to 1:2 during the same period (Chadwick 1973). The mountain goat population from the Flathead National Forest which visits the Walton Goat Lick would consequently be extremely sensitive to any highway losses.

Effects of Construction

Highway construction should affect only mountain goats since the construction season for the most part would not include the season when elk and mule deer are on the winter range. Construction along the Snowslide Gulch and highway crossing area might be expected to have some effect upon mountain goats using the Walton Goat Lick.

Mountain goats do exhibit some degree of habituation to noise and disturbances, however, very loud or sudden nearby disturbances would probably cause mountain goats to avoid or to greatly restrict their use of an area. Chadwick (1973) and Ballard (1975) observed a very high reaction by mountain goats to helicopters. Chadwick (1973) also reported a strong response to sonic booms and thunder, and short reactions to distant dynamite blasting. Mountain goats remained on traditional range during distant road building and logging operations in the Bunker Creek drainage of the Swan Mountains (Chadwick 1973). All mountain goats left the area and moved to habitat 3 miles (4.8 km) distant when activities progressed to a point directly across from the goat ledges. No goats were observed for one month, but after that period goats were seen during the day on the highest cliffs. At the same time, goats returned to use the lower cliffs and a natural lick on weekends and to some extent at night, moving down towards the lower area about dusk as the construction began to terminate.

Mountain goats visited the Walton Goat Lick from mid-April to mid-September. Diurnal use of the lick was nearly continuous only from mid-May to August 1. From mid-May to August 1,mountain goats were absent from the lick during the working hours of 0700-1900 only 9 (14.0%) of 64 days of observation. During August, mountain goats were absent from the lick 13 (50%) of 26 days of observation. Goats were less likely to be on the lick during rainy days.

The data suggests that construction involving blasting and heavy equipment could be conducted on an intermittent basis prior to May 15 and after August 1-5. Isolated blasting might occur during other periods on an occasional basis if a check of the lick and slopes of Running Rabbit Mountain revealed no goats. Termination of construction in Glacier National Park due to winter weather is variable, but in many years it occurs about mid-October (Bud Clark pers. corres.). In view of such a restricted schedule, alternatives to heavy equipment, such as man power and draft horses, and alternatives to dynamite blasting might be considered for the lick area.

Mountain goats are attracted to salt sources from humans in other areas and the construction zone should be policed so that no salt attractants bring goats onto the highway or highway edge. In the back-country of Glacier and Olympic National Parks, mountain goats are strongly attracted to human urine, salts on packs and nitrates from dynamite blasting (Bansner 1974; Moorehead 1973).

Highway Design

Elk and Grizzly Bears. Ward *et. al* (1973) found that Interstate 80 in Wyoming was a barrier to elk movements, but that telemetered elk did cross nearby secondary roads. The appearance of a road with respect to the horizon and surrounding terrain is important with regards to any visual barrier for caribou (Raymond Cameron pers. corres.). Caribou selected areas for crossing where the berm height of the highway was less.

The Walton-Nimrod section of Highway 2 is much like a secondary road with little road edge or berm. Coniferous trees and various shrubs grow to the very edge of the road. This was the only section of Highway 2 in the study area where crossings by elk were frequent during the winter. Minimum burm, minimum or no road edge, and revegetation of the road edge and construction zones with young conifers should result in a minimum of additional barriers to elk movements. These considerations would apply particularly to the forest stands at both ends of the section proposed for reconstruction.

Similar conservation design should be applied with regard to physical and visual features with respect to grizzly bear movements until information is available on movements of grizzly bears in this area and on the response by grizzlies to different highway designs.

Mountain Goats and Cover. Conifer cover was important to goats approaching the highway, particularly when visitors or passing vehicles were present. When goats altered their crossing route in response to vehicle and/or visitor disturbances, 16 (67%) of the 24 alterations were to routes with greater cover or shielding. Goats that were disturbed, but remained on the same crossing route, often drifted into the trees that were closest to the highway prior to crossing. The lodgepole pine grove above the highway cut was frequently used by goats hesitating prior to crossing downhill to the lick.

The available data indicates that the relative amount of use for any highway crossing structure or crossing route will be proportional to the amount of approach cover or shielding and the proximity of cover to both sides of the highway.

Crossing Locations and Trails. Visual cues were very important to goats in their final stages of orientation to the lick. Goats arrived at the highway crossing routes and across the Middle Fork of the Flathead River with their eyes focused on the lick, and most goats swam the river and crossed the highway to the lick (53.5%) with the lick in their vision. Any crossing structures or routes should be located to take advantage of this visual orientation. Mountain goats were very trail-oriented and might be encouraged to use crossing structures and to deviate slightly from the present crossing routes through construction of trail(s) and corresponding eradication of existing trails.

Traffic and Visitors. Highway crossings by mountain goats were affected by the pattern, amount and location of traffic and visitor activity. Goats were particularly affected when traffic volume was greater than 10 passing vehicles during a crossing and when visitors were in the west parking lot. Greater use and success of a crossing structure is predicted if visitors were restricted from the area, and if goats were shielded from heavy traffic during crossings.

Physical and Visual Obstacle. The drive to visit the lick is very strong in mountain goats and it is unlikely that the highway would ever act as a barrier to movements. The primary causes for behavioral responses of goats during crossings and for unsuccessful crossings were disturbances by visitors and traffic. Goat appeared to associate the highway pavement and vehicle sounds with the danger presented to them by moving vehicles. The obstacles of passing traffic and visitors apparently was greater to goats attempting to cross the highway uphill from the lick and/or there was a difference in drives.

A higher, wider highway cut in the crossing area would not present a physical barrier to goats. Goats frequently ascend and descend the present cut even though level routes are available. When traffic was present during crossings, goats were observed to hesitate in the lodgepole pine cover at the top of the lick. When a vehicle passed while goats were partially down the cut they typically ran back up to the top of the cut. When goats were disturbed they often moved west along the cut and moved where tree cover was available down the cut to the highway edge.

Half bridging or cribbing of the highway in the steep crossing hillside would present a physical barrier to goats attempting to cross the highway either uphill or downhill, and the goats would probably seek a route around the barrier. Some goats might move along the highway seeking a break in the structure and be in continued jeopardy of a collision with a vehicle. Bridging or cribbing would remain a design alternative if at the same time a successful crossing structure or route was available and fencing prohibited goats from access to the bridging or cribbing.

Overpass. Mountain goats are adapted to handle an overpass structure and might use such a device depending upon the surrounding terrain and the dimensions of the overpass. The situation in the highway crossing area near the Walton Goat Lick would require goats departing from the lick to cross up and over the highway. I am not aware of any studies or information on the use of overpasses that would predict the response of goats to such a structure. Child (1973) observed greater use of ramps than other structures by caribou crossing a simulated pipeline. The ramps involved, however, were only about 1.5 m above the surrounding terrain, while a minimum of 3.6 m would be required to overpass Highway 2.

Location of an overpass structure in relation to present crossing routes could be critical to its use by mountain goats. Klein (1971:396) reported that reindeer are reluctant to use bridges over streams unless they are built where the caribou traditionally cross. Lead-in fences have not compensated for poor choice of location.

An overpass of the highway near the Walton Goat Lick could create a safety hazard for traffic in the winter. Snowsheds in Glacier National Park, B.C., are very similar to the type of highway overpass that would be needed at the Walton Goat Lick. Numerous accidents occur in these snowsheds due to frequent development of black ice inside the sheds and to limited visibility. Reaction time is greatly reduced for drivers in the sheds. Five mountain goats have been killed in sheds or shed exits since 1965 (Table 24).

Underpass and Bridging. The location and dimensions of an underpass may be important in its success. Mule deer made poor use of a confining underpass (10 feet x 10 feet, 100 feet long), the entrance:exit activity was 18:1 (Reed 1971a). Mule deer were wary of an underpass, probably because of its confining structures and characteristics (Gilbert *et. al* 1971). Pojar *et. al* (1972) noted a 23 percent increase per year in crossings of an underpass by mule deer.

Goat passages under the Snowslide Gulch bridge suggested several possibilities for a more successful underpass. Mountain goats were unaffected by highway traffic when approaching the bridge 4-5 m or more below the highway and in two cases when goats crossed low in the streambed, 10 m under the bridge. The frequently used passage, however, was confined (2 m high x 3 m wide) and located immediately beneath the highway. In addition, the downhill approach to the bridge is completely open which makes it unattractive for goats. Bridging should be constructed: 1) on present crossing routes, 2) a minimum of 5 m high, 3) with existing or planted conifer cover on both approaches and under the bridging, and 4) 100 m or more in length.

Mountain goats would not pass under the Snowslide Gulch bridge while visitors were on the bridge. Access by people to any bridging should be restricted since goats not only would not pass under with people there, but might begin to associate the bridging with human disturbance and avoid it. Visitors would vigorously seek access to the bridge, especially if it was obvious that the bridge was designed for goat crossings. I have observed visitors including parents with children, to use poor judgment and go out on Snowslide Gulch bridge to view descending mountain goats. Greater height of bridging and continuous conifer cover under the bridge might help to eliminate disturbances of goats.

Fencing. Fencing achieves poor results in directing the movements of artiodactyls unless the location is acceptable or unless the fencing is completely restrictive. Caribou were observed to crawl under, jump over, break through or to turn and not enter a drift fence (Miller *et. al* 1972). Nine (47%) of 19 mule deer which entered fencing turned and went back (Reed 1973b). Only 16 (33.3%) of 120 mule deer which entered ¼ mile (.4 km) fencing wings actually moved through an underpass tunnel (Papez 1963). Bighorn sheep were trapped between right-of-way fences and became entangled in the barbed wire fences (Endress 1967). Fences to lead reindeer into corrals are successful only if they are built with a clear understanding of the relation between features of the terrain and reindeer movements and behavior (Klein 1971:397).

Restrictive fencing, 8 feet (2.4 m) high, erected for 1.1 mile (1.8 km) along a 4-lane highway reduced the number of mule deer crossings by 87 percent in one season. The drift fence in conjunction with an underpass was the site of 1,325 deer passages in a three-year period (Pojar *et. al* 1972). Red deer (*Cervus elaphus*) successfully used a tunnel underpass of a highway between two completely fenced preserves in Sweden (Hallé Flygare pers. corres.).

Restrictive fencing might be employed at the Walton Goat Lick to keep goats from cribbing or bridging or to restrict goats from crossing the highway in conjunction with availability of a crossing structure. Any fencing would need to be completely restrictive in order to keep goats from becoming trapped on the highway. The advantages to human and mountain goat safety would have to outweigh the aesthetic intrusion of a fence in a National Park.

Human Safety. Many safety hazards are present at the Walton Goat Lick exhibit, however, accidents are rare. Slow vehicle speeds and long reaction time are the primary reasons for avoidance of many collisions. Vehicle collisions are more frequent on faster highways in Canadian Parks due to : 1) vehicles pulling in and out of viewing areas, 2) vehicles stopped in traffic lanes to view wildlife, and 3) people walking on the highway and preoccupied with scenery or wildlife. Fast commercial and through-traffic is often incompatable with the slower National Park visitor who is preoccupied with scenery or wildlife. Off-the-road parking, a third lane near the exhibit, warning signs, and locations of exhibits away from curves or hills has helped the problems in many Canadian Parks.

Traffic Volume. Pojar (1971) reported that more mule deer were killed along one of two highways with greater traffic volume. Reindeer milled close to the tracks, were repeatedly frightened away, and eventually stopped crossing a railroad in Norway after the frequency of passing trains increased (Klein 1971:393). Mountain goats would be faced with increasing difficulty in crossing Highway 2 and probably increased mortality and nanny/kid separations should the traffic volume increase greatly. The present traffic volume is very low on this section of Highway 2, with the exception of the July and August visitor activity peak. Any projected traffic volume estimate would be speculative in view of unpredictable economic and fuel situations in the United States.

Seeded Roadsides. Wide roadsides seeded to palatable grasses can be a major source of mortality in National Parks where artiodactyls become habituated to traffic and regularly feed along the highway. This kind of a situation has developed along the Trans-Canada Highway in Banff and Kootenay National Parks and along the Yellowhead Highway in Jasper National Park (Table 24).

Drainage Patterns. Availability of water seeping onto the lick was identified as a key factor in late summer use. This should be considered during construction along the Roosevelt Fault and disruption of drainage patterns should be avoided.

New Licks. Several new licks were exposed near the pre-existing Kerkeslin mountain goat lick by highway cuts in Jasper National Park. Herbert and Cowan (1971:607) described new licks exposed by logging road construction. Any new lick exposed by a highway cut should be covered immediately, because of the danger posed by goats using a lick on the edge of the highway.

Warning Signs. Motorists reduced their speed approximately 3 mph when a lighted animated deer sign was installed (Pojar *et. al* 1972). In addition, there was a 44 percent increase in safe highway crossings per deer kill in comparison to safe crossings per deer kill without a sign. There has been some reduction in bighorn sheep vehicle accidents along the Yellowhead Highway in Jasper National Park after erection of signs reading "Sheep On Road".

SUMMARY

1. U. S. Highway 2 enters Glacier National Park for 5.2 km (3.2 miles) and traverses elk and mule deer winter range and a movement route for mountain goats visiting a natural mineral lick on the banks of the Middle Fork of the Flathead River. A study was conducted February 20 - September 15, 1975 to obtain data on the mountain goats, elk and the surrounding environment to form a basis for options in a proposed highway reconstruction.

2. Grizzly bears, a threatened species, were frequently observed in nearby, unroaded drainages, but appeared to avoid the Highway 2 corridor. Sightings of Northern Rocky Mountain Timber Wolves were reported in the study area, but did not indicate the proposed reconstruction zone as a breeding area or as a natural travel route.

3. A gradient analysis of winter observations demonstrated that goat winter range was in early stages of primary succession, at higher elevations (1219-1767 m), steeper slopes (43°-51°), and in lesser snow depths (0-60 cm) than either elk, moose, or mule deer. Moose and mountain goats habitat was rigidly defined in comparison to elk and mule deer; elk habitat patterns show graphically as a bimode. The Walton-Nimrod section of Highway 2, in view of the gradient analysis, traverses optimal elk winter range, marginal mule deer winter range and is not mountain goat winter range. Ledge structure and outcrop distribution and abundance appeared to explain higher goat densities of 4.1:1 in Glacier National Park in comparison to the Flathead National Forest.

4. Elk frequently cross Highway 2, primarily during nocturnal and crepuscular periods, to gain access to range components below the highway and possibly for seasonal migrations. Elk crossings of Highway 2 are frequent only in the section proposed for reconstruction.

5. Flight reaction of wintering elk is significantly associated with presence of the highway. Habituation to Highway 2 made elk susceptible to poaching; 9 elk of a local wintering herd of 28 were poached in 1975. In all situations, flight distances for mountain goats were less than for elk. However, mountain goat range was at higher elevations and inaccessible to most poaching.

6. A minimum of 89 different mountain goats and an estimated 200 different goats visited the Walton Goat Lick in 1975. Reobservations of 27 recognizable goats and population estimates for the study area strengthened the 200 estimate. At least 16 and very likely more different goats came to the lick from the Flathead National Forest. Visits to the lick occurred from April 15 - September 15, with peak use occurring in late June and early July.

7. Traffic volume was 932 vehicles per day during July - August and much lower during other months. From 0-40 percent of the passing traffic stopped at the Walton Goat Lick exhibit, depending upon the time of day. An estimated 24,000 vehicles and 66,000 visitors stopped at the exhibit in 1975; as many as 39,000 people may have seen goats on the lick.

8. Vehicle speeds were less on the Walton-Nimrod section of Highway 2 than on the adjacent sections reconstructed in the 1960's. Mean speeds were only 25.3-29.3 mph past the exhibit and 20 mph at the Nimrod Railroad Underpass. Slow speeds contributed to avoidance of vehicle-vehicle and vehicle-goat collisions.

9. A total of 87 successful crossings of Highway 2 involving 692 crossing mountain goats were observed and an estimated 812 crossings involving 2460 crossing goats occurred in 1975. Crossings occurred on six routes in a 400 m stretch of Highway 2; the majority of crossings occurred on two routes.

10. A high rate of disturbances by passing traffic and visitors occurred during goat crossings. Crossing goats responded to disturbances by hesitating, running back from the edge of the highway, running across the highway, and/or altering their crossing route. Stimulus for goat responses was traffic and visitors in 41 (34.7%) crossing attempts, traffic alone in 38 (32.2%) attempts, visitors alone in 23 (19.5%) attempts, while in 16 (13.6%) attempts there were no traffic or visitors. Thirty-one (42%) of the crossing attempts by goats departing from the lick were unsuccessful. Successful crossings are highly significantly associated with no human presence, or light traffic only. Unsuccessful crossing attempts are associated with visitors in the west parking lot, visitors in both parking lots, or heavy traffic.

11. Successful highway crossings after July 1 are very highly significantly associated with a crepuscular pattern of highway crossings. Unsuccessful attempts after July 1, successful attempts prior to July 1, and arrivals and departures at a undisturbed control lick were not associated with crepuscular times.

12. Crossing success was highly significantly associated with the size of groups, all groups (2-25 goats) being more successful than individual goats. Crossing success was highly significantly associated with sex and age of the group leader. Nannies with kid at side were the most successful leaders, billies were less successful, and other classes including nannies, two-year old males, two-year old females, yearlings and kids were the least successful leaders.

13. Mountain goats on the lick became habituated to sounds of visitors on the exhibit and passing trains across the river, but continued to perceive the sounds and presence of passing vehicles as a hazard. Goats and humans were brought into proximity and interacted when visitors left the exhibit or when goats moved through the exhibit area during highway crossings. All goat reactions were avoidance of and/or flight from humans.

14. The nearest vehicle was more than 1,000 m away in 43.8 percent of the goat crossings and no vehicle was in sight ($>$ 400 m) in 70 percent of the crossings. High proportion of safe crossings was primarily due to, 1) low traffic volumes along Highway 2 during the times of goat crossings, and 2) behavioral responses of goats during crossings especially running back and hesitations. One goat was hit in 1973, two in 1974 and none in 1975. Thirteen near hits ($<$ 15m) of goats by vehicles were observed in 1975 and an estimated 100 occurred. Nannies were separated from kids by passing vehicles in three cases; one separation may have been permanent. Slow vehicle speeds contributed to avoidance of collisions.

15. Nannies with kid at side were the most frequent (47.5%) leaders and the most important leaders since they led larger groups of mixed classes. Leaders and size of groups arriving at and departing from the control lick and groups migrating to the Walton Goat Lick suggested that goats crossing the highway were more likely to do so in a larger group and in a group led by adult nanny with kid at side.

16. Nannies with kid at side were dominant at the lick less than they were leaders, while billies and nannies were dominant more than they were leaders. Nannies, two-year old females and yearlings were involved in more dominance interactions at the lick than expected.

17. Recognizable goats that were reobserved (n = 48 observations) were in different groups 38 (79%) times and in the same group only 10 (21%) times, although goats were in the same group type 35 (78%) times.

18. Highway design considerations are discussed. Major conclusions are: 1) in view of exhibit hazards and goat crossings of the highway, highway safety would appear to be a goal and highway speed of less concern, i.e., reconstruction and realignment to a straighter highway, but one with a maximum design speed of 45 mph, 2) minimal berm height and minimum between tree/road width were essential to elk movements; "super" highway design would act as a barrier to movements, 3) highway design speed greater than 35 mph in the goat crossing area would increase goat mortality and nanny-kid separations; the losses, particularly for the goat population from the Flathead National Forest, would probably not be compensated, 4) bridging is the most promising crossing structure, 5) success of a crossing structure would be increased by conifer cover in the approaches, on, or in the structure, 6) mountain goats are trail-oriented and trail construction could increase the success of a crossing structure; locations of trails and planted trees could be purposeful and strategic, 7) any visitor exhibit should be located away from goat crossing structures or routes, 8) fencing, if used, should be completely restrictive and used only in conjunction with successful crossing structures, and 9) exhibit design should consider off-the-road parking, a third lane, location, and warning signs.

19. Highway construction considerations were discussed. Major conclusions are: 1) heavy equipment and blasting near the lick should be done after September 15, or intermittently prior to May 15 and after August 5; man power and draft horses might be considered as alternatives in the lick vicinity, and 2) construction zone should be regularly policed for salt attractants for goats, 3) disruption of drainage patterns which might affect water seepage onto the lick should be avoided, and 4) any new lick uncovered by construction should be covered immediately.

MANAGEMENT ALTERNATIVES

No Change

Advantages:

1. Slow highway speeds, which contribute to a reduction in vehicle and goat collisions, would continue.

2. No additional effects on elk crossings of the highway.

3. No additional effects on lick visits or highway crossings by mountain goats.

4. No additional disturbances and intrusions in a natural area and World Biosphere Reserve.

5. Least expensive alternative.

Disadvantages:

1. Safety hazards would continue including, a) sharp, blind turn at Nimrod Underpass, b) three curved and banked grades west of the lick, where vehicles slide under icy conditions, c) vehicle lines to chain-up for this stretch in winter, d) snow removal problems, e) curved bridge over the Middle Fork at Walton, f) a very narrow bridge over Snowslide Gulch, where often one lane stops to let the other pass.

2. Continuation of goat disturbances by humans and traffic while on the lick and crossing the highway. Highway disturbances could be detrimental to goat crossings should traffic volume greatly increase.

No Exhibit

Advantages:

1. Elimination of at least 19 percent of the disturbed crossings and 54 percent of crossing route alterations.

2. Elimination of at least 19.3 percent of the unsuccessful crossing attempts.

3. Elimination of safety hazards in the exhibit area.

Disadvantages:

1. Knowledge of the lick is widespread as demonstrated by the number of observed vehicles and people stopping in the absence of any exhibit identification. Stopping on the highway and increased hazards is predicted, in the absence of a pull out.

2. Loss of a major mountain goat viewing and interpretive site. An estimated 66,000 people stop at the exhibit and as many as 39,000 see goats.

Reconstruct Highway 50 M.P.H.

Advantages:

1. Elimination of those safety hazards associated with sharp curves, banked curves and a narrow road.

2. Least expensive alternative.

3. Elimination of snow removal and travel time concerns.

Disadvantages:

1. Creation of new unsafe conditions at the exhibit and goat crossing area.

2. Greater hesitation by goats in crossing highway due to increase in noise and preception of hazard.

3. Probable greater goat mortality and nanny-kid separations at the crossing area.

Construct Highway On West Side Of River

Advantages:

1. Elimination of problems associated with an estimated 812 highway crossings of goats in a season.

2. Elimination of exhibit, highway safety problems, and snow removal problems on the existing highway.

3. Elimination of a highway intrusion from a natural area and World Biosphere Reserve.

4. Elimination of a highway that traverses optimal elk winter range and marginal mule deer range.

5. Elimination of travel time concerns.

6. Elimination of one short-span bridge.

Disadvantages:

1. Creation of problems associated with an estimated 32 highway crossings by goats in a season.

2. Creation of some new safety problems associated with bridges during the winter.

3. Creation of a highway intrusion into the proposed Great Bear Wilderness and a candidate for the Wild and Scenic Rivers Act.

4. Much higher costs.

5. Engineering problems on one unstable slope and from paralleling a railway on a steep slope.

6. Construction of three long-span bridges.

<u>Construct Bridge Goat Crossing Structure</u>

Advantages:

1. Elimination of goat mortality and nanny-kid separations.

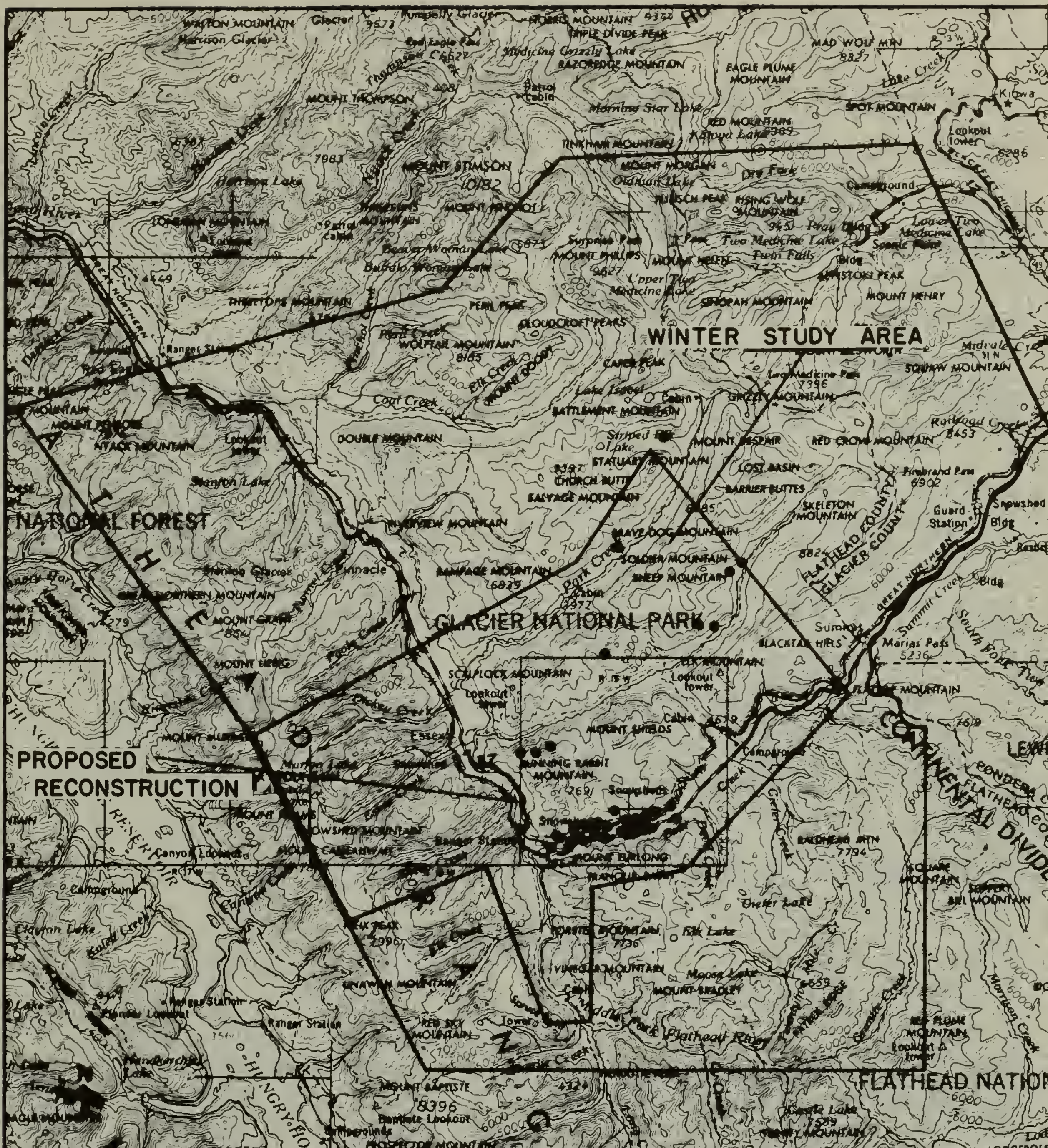
2. Elimination of disturbances to crossing mountain goats; return to more natural conditions for the goats to visit the lick.

3. Elimination of safety, travel time, and snow removal problems.

4. Use of a futuristic design alternative for wildlife and highway problems - bridging.

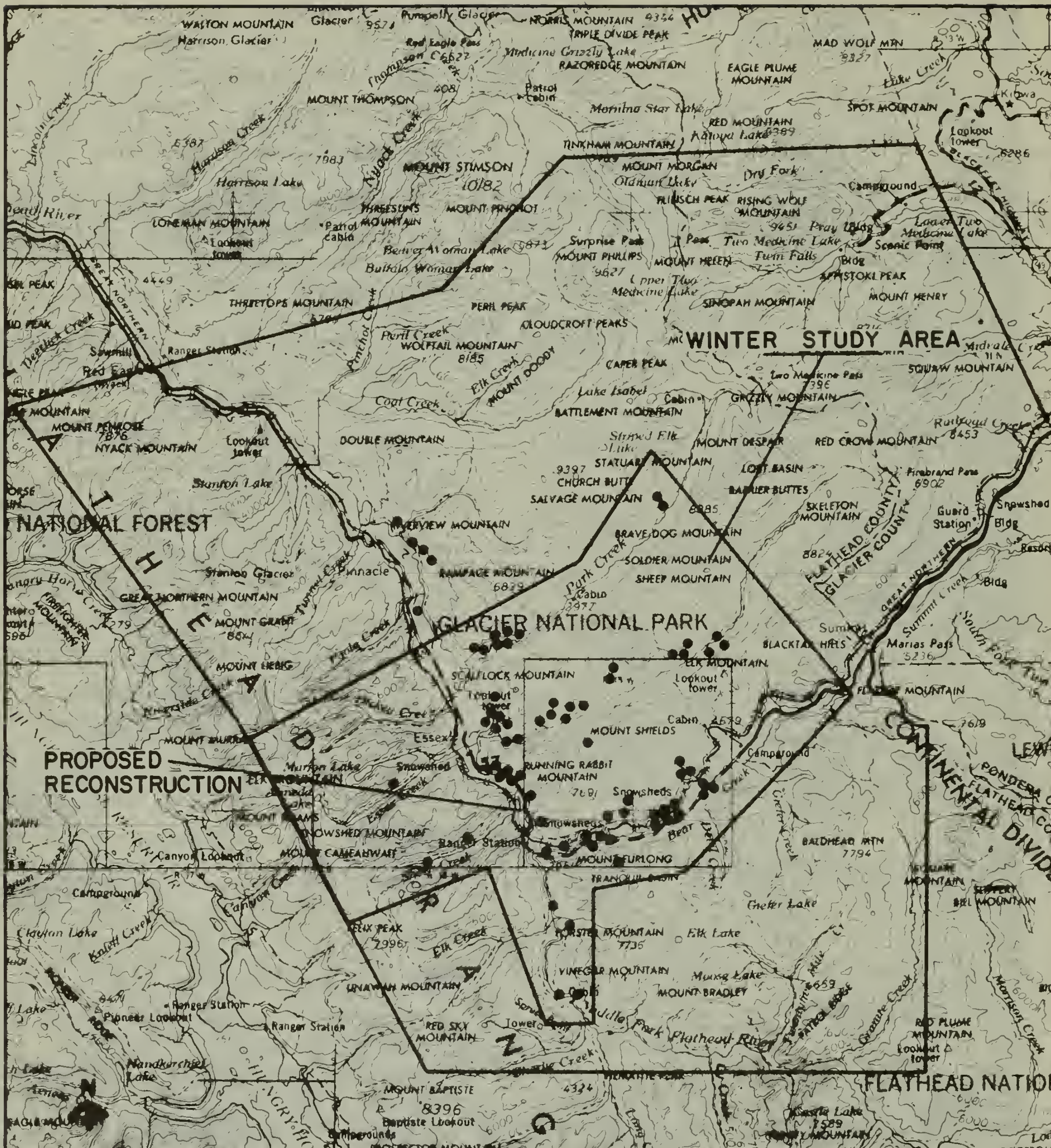
Disadvantages:

1. Best location for bridging is an unstable hillside.



Mountian Goat •

Figure 15. Map showing the location of winter observations of mountain goats during census of the winter study area in 1975.



Elk •

Figure 16. Map showing the location of elk observations during winter 1975.

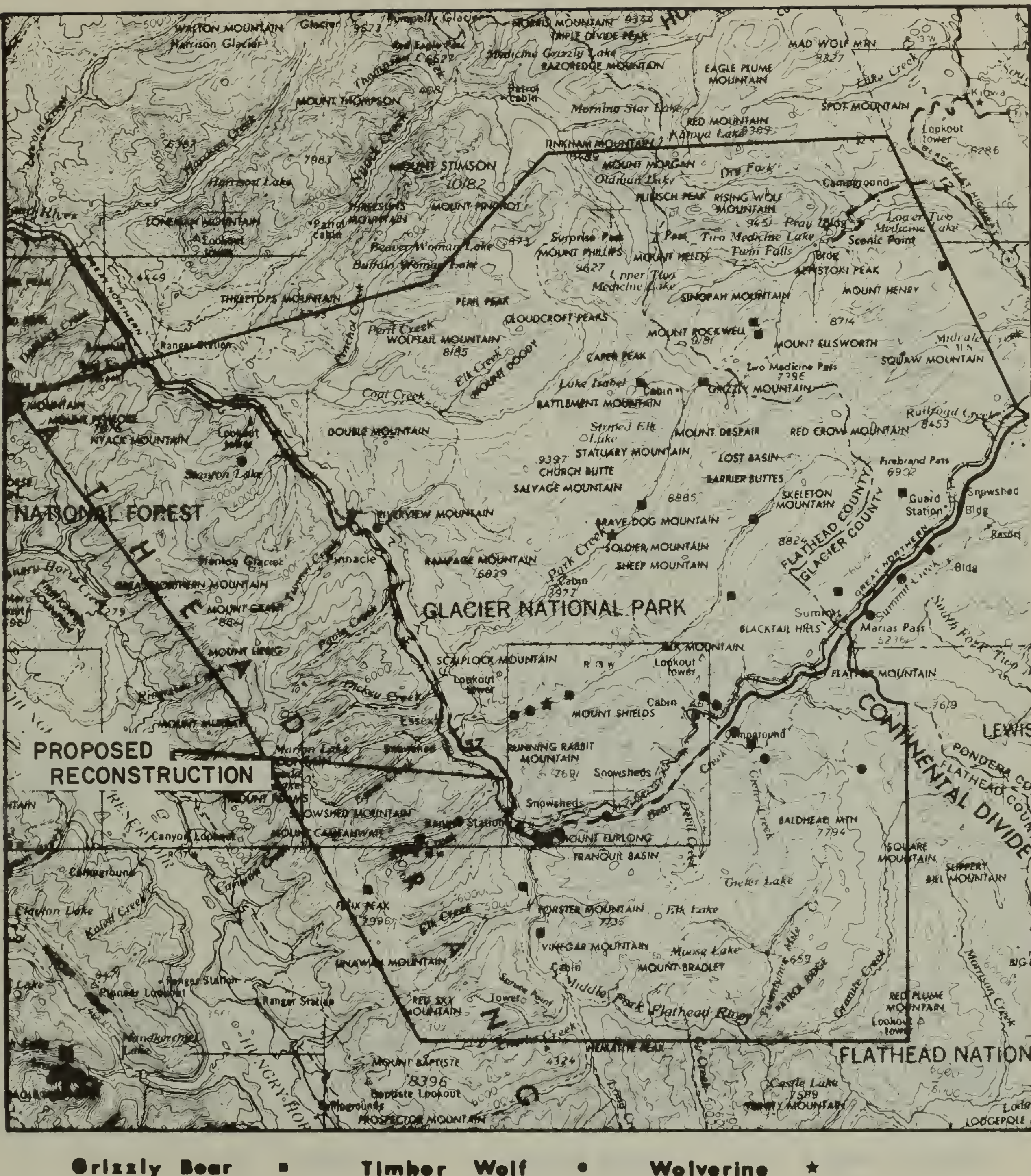


Figure 17. Map showing location of observations of grizzly bears and tracks of wolverines during 1975, and reliable reports of timber wolf observations from 1971 through 1975.

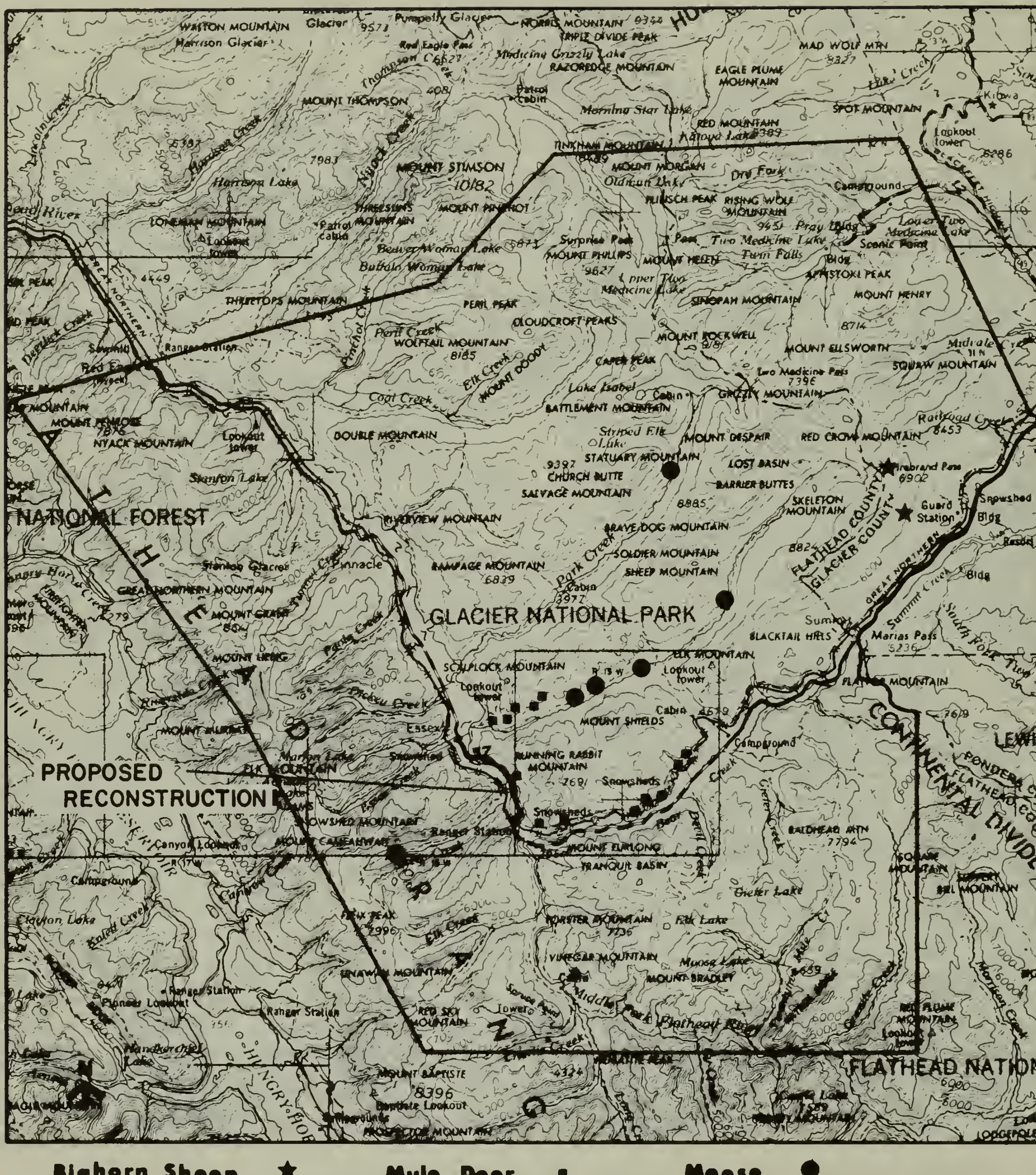


Figure 18. Map showing location of mule deer, moose, and bighorn sheep observations in the study area in 1975.

Table 20. Behavioral notes during hits and near hits of mountain goats by vehicles at the Walton Goat Lick.

Date	Time	Observations
August 20, 1975		I talked to several people at the exhibit on the 21st who had seen a goat hit by a sedan on the evening of the 20th. The goat was in a group of 44 crossing downhill to the lick; 20 visitors were present. the goat flipped twice after it was hit and then ran downhill into the forest.
May 5, 1975	1455	Two billies crossing the highway on route 4 headed uphill. The first billy crossed the highway. The second hesitated on the road's edge, to stare at a truck and then ran across. The truck braked and slowed. Goat crossed 6 m from vehicle.
May 28, 1975	2150	Three billies crossing the highway on route 4 headed downhill. The lead billy started down the highway cut never changing its speed as a sedan approached west bound. The sedan slowed from approximately 30 mph to 10 mph as the goat crossed 5 m in front of it.
June 28, 1975	2222	One billy crossing highway on route 4 headed downhill. The billy stopped on the highway to stare at a west bound vehicle. The vehicle slowed and goat crossed 10 m in front of it.
June 30, 1975	1725	A two-year old male altered its crossing route due to the approach of a photographer. The goat walked into the west lot and a car approached east bound. The goat then ran across the highway 10 m in front of the vehicle.
July 1, 1975	2155	Group of 4 goats being led by two-year old male downhill on route 4. Two-year old male led down and onto road, then ran back along with rest of group as a west bound sedan passed (12 m).

July 7, 1975	2100	Two goats hesitating on highway cut preparing to cross downhill on route 4. People were present in the west lot below. Richard Munro was driving by and one goat ran across in front of him, the second goat bolted across less than 1 m in front of the vehicle.
August 14, 1974	0628	A group of 17 goats crossing uphill from the lick on route 5. A two-year old male ran across in front of a east bound compact car coming around the turn. The driver braked and stopped the car stalling the engine as the goat crossed less than 1 m in front of the vehicle.
August 20, 1975	2029	A group of 48 crossing downhill to the lick. Two billies ran on across on route 3, 2 m in front of a west bound sedan which stopped. Two other goats quickly ran in front of the stopped vehicle as it began honking
August 20, 1975 (same day)	2035	Two billies crossed on route 4, 20 m in front of a vehicle which also braked and stopped.
August 20, 1975 (same day)	2037	A billy ran across the road 2 m in front of a east bound sedan. The sedan braked and stopped as three more goats ran across in front of it.
August 21	0634	A total of 31 goats crossing uphill from the lick. One unclassified adult ran across the highway while an east bound Volkswagon bus crossed the Snowslide bridge. A second unclassified goat on the road edge then ran across 5 m in front of the bus causing it to brake and stop.
August 21 (same day)	0638	Two goats crossed 5 m in front of a west bound car which was pulling a camping trailer. The car braked and stopped and remained stopped as three more goats ran across in front of it. A second west bound sedan approached, stopped behind the first and began vigorously honking his horn.
September 3, 1975	2000	Total of 54 goats moving downhill to the lick. An east bound semi-truck was forced to stop as three goats ran across 3 m in front of it on route 5. The truck waited as three more goats ran across. The truck started to move and a seventh goat whisked 1 m in front of it.

Table 21. Behavioral notes during kid-nanny seperations at the Walton Goat Lick, 1975.

Date	Time	Observations
July 15	0606	Smooth crossing of nanny and kid, no vehicles or visitors present. The kid hesitated on the highway edge as the nanny crossed and climbed the cut bank. The nanny called to her kid "aaah" and after 65 seconds the kid ran across the highway to the nanny's side.
July 21	2310	An adult nanny leading a group of 16 goats crossed the highway headed down towards the lick. The lead nanny's kid remained on the cut bank bleating. The nanny returned across the highway walking slowly to the kid, and then recrossed the highway followed by two unidentified adults and then the kid, all in single file and on the run.
July 22	0659	A group of 8 goats departing from the lick uphill across the highway. A kid remained on the pavement edge, hesitating to cross the highway while the nanny waited on the highway cut bank. After 40 seconds the kid ran across the highway to the nanny's side.
July 22	0920	Adult nanny with kid at side were observed directly across the Middle Fork from the lick. The nanny repeatedly walked up and down the gravel bars staring at the lick with the kid following. The goats were observed across river throughout the day, bedded, dusting or walking on the gravel bars. At 1600 a yearling which had not been previously noted, swam from across the Middle Fork about 100m upstream of the lick and then walked down the river bank to the lick. At 1730 the nanny made repeated efforts to encourage her kid into the river by walking in herself. Between 1820 - 1904 the nanny entered the river 20 times, sometimes up to her belly in the water encouraging the kid to enter. The kid alternately waited on the

July 22	0920 cont'd	river edge bleating; twice the kid entered the water. At 1915 the nanny entered the river and swam across, the current carried her down stream to the lick and she climbed out. The kid swam half-way across but lost headway and was swept downstream and then into a back current to the side from which it started. The kid remained across the river but at 1008 the following day managed to cross the river to the lick. For the next 36 hours it was seen in the lick area bleating and moving about investigating nannies but being rejected by each of them.
August 14	0638	Group of 17 crossing the highway from the lick to the hillside above were split by a passing truck; a nanny and kid were separated during the split. The nanny returned to the highway cut and called to her kid in a low "aaah", the kid responded with a higher "eeeh" from below the pavement edge where the remaining goats had run-back. The nanny came back across the highway stiff-legged and aggressive, sniffed her kid and then threatened and hornswiped at a nearby yearling and two-year-old male. The nanny then led her kid and the rest of the group across the highway and up the highway cut bank.
August 21	0649	A group of 31 goats crossing up the hillside across the highway; two almost hits and four run-backs during the crossing. A passing vehicle split the group and seperated a nanny from two kids, apparently twins. The nanny returned to the two bleating kids. The group of 7 started to cross the highway but ran-back from a passing vehicle, and then the nanny with the twins at her side led the group across the highway.
August 21	0650	During the same time that the nanny was separated from her twins, another separated kid was observed returning bleating from the highway edge by itself towards the lick. The kid was seen bleating and inspecting nannies with kids on the lick throughout the morning. At 1400 it was observed associated with a two-year-old goat.

Table 22. Ungulate poaching along U.S. Highway 2 from Walton to Summit, 1974-75.

Date	Observation
December 1974	Tim Darr and Don Lucke (Montana Dept. of Highways, Summit) saw two different blood skid marks in the snow close to where Autumn Creek crosses U.S. 2.
December 14, 1974	Tim Darr (Montana Dept. of Highways, Summit) found where one elk had been dragged through the snow to the road edge (GNP records).
January 1975	Tim Darr (Montana Dept. of Highways, Summit) saw where an elk had been dragged to U.S. 2 near the Nimrod underpass.
January 18, 1975	Lloyd Kortge (National Park Service Ranger, St. Mary) found a bull elk that had been shot in the head 1 mile west of Java (GNP records).
February 1975	Dwight Liinberg (Montana Dept. of Highways, Nyack) found where an elk had been dragged to U.S. 2 and found the entrails right above the Walton Goat Lick.
February 17, 1975	Jerry Bell (NPS Ranger, West Glacier) found where an ungulate, probably an elk, had been shot and dragged to U.S. 2 road edge about 1.5 miles east of Java underpass.
March 4, 1975	Art Sedlack (NPS Ranger, West Glacier) found where one elk had been killed, dressed and the entrails left on the gas line swath about 50 yards uphill from the Slide Creek bridge along U.S. Highway 2.
March 12, 1975	Lloyd Kortge was notified by a butcher in East Glacier that he had just turned down a request to cut up 3 elk poached along the U.S. 2.
March 25, 1975	Douglas Erskine (NPS Ranger, West Glacier) found where a cow elk had been shot and the entrails left by the roadside, 1 mile west of the Walton Goat Lick.

April 23, 1975	Jack Fewlass (NPS West Lakes Manager) investigated a report of a poached elk called in on April 21, 1975. Fewlass found the blood trail and dressed entrails about 150 yards west of Slide Creek bridge, or right above the Goat Lick.
April 23, 1975	Fewlass found a pile of entrails , the head of an adult cow elk and a blood drag mark about .3 miles west of the Goat Lick.
Fall 1975	Lloyd Kortge (NPS Ranger, St. Mary) saw a pile of elk entrails about 1 mile east of the Walton Goat Lick.

Poaching reports occur in other years. National Park Service Rangers assigned to Walton reported poaching of as high as 22 elk even in early 1950's along this section of U.S. 2. Cliff Martinka (NPS Biologist, West Glacier) saw a quartered elk lying along the railway near the snow-sheds in the winter of 1968. Bill Devial (Burlington Northern R.R., Summit) saw an elk shot and left on the hillside above U.S. 2 about 1 mile east of the Walton Goat Lick, during the winter of 1971. Bill Devial and George Walker on the railway came across two poachers, gutting out two cow elk along the Bear Creek line, winter of 1972-73. In late December, 1973, Devial was driving along U. S. 2 when two cow elk which had been shot, slid down from above into the road at the Walton Goat Lick. The elk held up traffic and several other people, including NPS Rangers, saw the elk.

Table 23. Wolf observations from the Middle Fork area, 1970-75. 1/

Date	Observation
Fall 1965	Wolf tracks (4 in. x 4½ in.) were seen in the Cut Bank Valley near Atlantic Falls Junction by Bill Hutchinson and Park Service trail crew.
1967-75	On three occasions in the 8 years of his residence near Summit Don Lucke has seen single wolves cross U.S. Highway 2 in the Summit area. Lucke works for the Montana Department of Highways out of Summit, is a resident, and has worked as an outfitter in the area.

Fall 1970	John Bartlett shot two large canids which he felt were wolves along Giefer Creek and 2 km south of U.S. Highway 2 during late hunting season. The male weighed an estimated 100 pounds, the female 75 pounds. An agent for the U. S. Fish and Wildlife Service will check the pelts soon, which are now in Kansas.
1970-72	Tom Baldwin (Montana Highway crew out of Summit) reported seeing a black wolf in the area of Nimrod on several occasions during the winters of 1970 and 1971. Baldwin is an experienced observer. John Bartlett, a truck driver traveling the U.S. Highway 2 route three to five times weekly for 15 years, reported seeing a pair of black wolves between Nimrod and the snowsheds in the mornings, winters of 1971 and 1972, on several occasions. He always saw them just before or at dawn. Often they were moving down the plowed highway and would run into deeper snow on the side as the truck came. Both men felt the wolves were in the area to feed on the elk which are often hit by the railroad near Nimrod.
Summer 1972	Bob Fagan has a place in Pinnacle and saw a cream-colored wolf near the Middle Fork about 1 km north of Pinnacle. They were glassing for elk across the river when they spotted the wolf which was hunting.
January 1973	Dick Walsh saw one large gray wolf run right across U.S. Highway 2 near Fielding. It was right behind two coyotes which Walsh also saw cross. The wolf was thin and mangy looking. Walsh was born and raised near Polebridge, is experienced, an excellent observer, and very reliable individual.
March 1973	Loren Kaufman saw two black wolves travelling together in the Belton Hills from U.S. Highway 2. Kaufman lives in Kalispell and has hunted and hiked in the mountains. Since Kaufman had binoculars, the steep gorge here presents an excellent view of wildlife on the Belton Hills and both animals were near black, this appears to be an excellent observation.

December 23, 1973 & February, 1975	Chuck Mendenhall, a resident near Fielding, saw a single gray wolf December 23, 1973, on the lower slopes of Elk Mountain near Fielding. Mendenhall's residence is below Elk Mountain and he often looks over the slopes with his binoculars. In February, 1975 Mendenhall saw fresh elk tracks after a snowfall, and got out his binoculars to glass the slopes. He saw two large animals moving through the brush which he initially felt were elk. However, they came to an open area where they stopped and Mendenhall saw that they were wolves, a black animal leading followed by a dark gray animal. The wolves were following fresh elk tracks by smell and three more times they passed through open areas. Then Mendenhall saw first one elk, followed in a few seconds by a second elk running straight downhill in a deep draw, floundering in deep snow which Mendenhall estimated was three to four feet deep. Next came the wolves running on top of the snow down the same draw at top speed and with their large tails up. At this point they went into the forest and Mendenhall took a break. They did not appear.
Winter 1974-75	Dean Biggins saw wolf tracks near Spotted Bear (South Fork). They were probably made by more than one animal. Biggins is a wildlife graduate student, University of Montana.
Fall 1974	Schallenberger reported on three observations of wolves from the nearby Lewis and Clark National Forest. The observations included one set of wolf tracks near Elbow Creek, three gray wolves near Dog Gun Lake, and a wolf shot in the fall of 1974 on the North Fork of the Sun River.
October 25, 1974	A single gray wolf was observed crossing Dean Creek (tributary of Spotted Bear River) by Jerry Ross, packer for Glacier National Park, while he was hunting.
November 1974	Dwight Daber, a very experienced employee of the U. S. Forest Service in Spotted Bear, saw a single gray wolf in a clearcut along Skyland Creek (Sect. 17), south of Summit. Daber and his two campanions shot at the wolf. It was a big heavy animal and they measured the tracks in the snow which were about 5 inches across.

February 1975	Dr. Carl Jacobson and his wife were driving U.S. Highway 2 about sunrise, headed towards Whitefish to ski for the day. Near the Pinnacle Creek underpass, the Jacobsons looked down at the river where Tunnel Creek enters and saw a single dark gray streaked or silver wolf trot across the ice of the river. It was plainly in open view for almost 100 m. Dr. Jacobson is a large animal veterinarian in Cut Bank, an experienced hiker and hunter, and was raised in northern Minnesota where he often saw wolves on the frozen lakes during flight training.
February 1975	Jacobson saw another single wolf during the same month. It was during the sunrise hours while driving along U.S. Highway 2. This animal was in a small clearing along Bear Creek near Silver Stairs and quickly ran into forest cover. This wolf was dark gray, streaked with black, similar in color to the Tunnel Creek observation. Jacobson saw a third wolf while hunting with his son west of Choteau and the Teton road near the Cow Track Inn in December 1973. They peered over the edge of a hill and watched the wolf bound through deep snows into nearby forest cover.
March 1, 1975 & July 24, 1975	I saw fresh wolf tracks on Lower Ole Creek March 1, 1975 in the snow. On July 24, 1975 I saw a second set of fresh wolf tracks in the mud along Sheep Creek.
Spring 1975	Arlie Burk saw wolf tracks on Addition Creek (South Fork) spring of 1975. Burk is a very experienced hunter, trapper and fisherman and trapped a wolf in the winter of 1973-74 north of Eureka.
July 2, 1975	John Baglien, Wildlife Biologist - U. S. Forest Service, and Danny On, Silviculturist - U. S. Forest Service heard several wolves from two groups howling near Spotted Bear Lake (South Fork). Baglien has heard wolves howl in Alaska, while On, a famous local wildlife photographer, has heard wolves howl in Jasper National Park (pers. comm. from J. W. Baglien to Rolland Saylor, August 14, 1975).

September 1975	A gray wolf was observed running across a subalpine meadow on ridgeline of Nyack Mountain above Stanton Lake by Marty and Steve Kelley.

1/ The following list of 23 wolf observations were selected from more than 60 reported observations. Reliability and experience of the observer, length of observations, and identifying features that would distinguish the animal from a coyote or domestic dog were important in considering an observation reliable.

Table 24. Highways in Rocky Mountain National Parks of Canada

National Park	Highways
Banff	Wildlife Mortality. The Trans Canada Highway No. 1 runs through Banff Park from east to west and is paralleled by the railroad and the old Highway 1A for most of its route. Very few wildlife losses occur along the old Highway 1A (scenic route) but losses are considerable along the new highway and railroad. For example, in 1974, 77 ungulates were killed in the Park, 65 were killed along the highway and 12 on the railroad. Most losses were of elk, followed by mule deer, moose and bighorn sheep. Major problems are that habituated elk feed along the road in the seeded roadsides, bighorn sheep are on the road being fed by visitors and elk and moose are caught on the railroad during winter by deep snow or in railroad cuts during other seasons. Present speed limit is 55 mph through the Park, and Highway No. 1 is now proposed for four lane construction, or twinning. Most serious losses are in the Mount Norquay area where a mean of 11 sheep (range 5-14) have been killed per year out of a population estimated at 42-60 sheep, or 18-26% of the estimated population per year (Wackerle 1974). Proximity of the highway to migration routes and winter ranges for bighorn sheep, elk and deer is a major reason for the high losses. (Parks Canada 1975). Safety Features. Information was not yet available on the safety features in the Park, but Ed Carleton (pers. comm.) related that there are vehicle accidents in the Park during the summer when excessive build-ups of traffic occur on No. 1, and some collisions occur

near the Mount Norquay turnoff, due to people stopping and pulling in and out of the parking turnoff. A total of 21.4 percent of all highway accidents in Banff involved vehicle-animal collisions, 1958-1970 (Parks Canada 1975).

Natural Licks and Mountain Goats. The only natural lick near the highway is the old Norquay bighorn sheep licks just west of Banff townsite. These licks were for the most part covered during construction of Highway No. 1 in 1962. According to Ed Carleton (pers. comm.) the sheep still travel the traditional routes towards the licks, but instead now lick salt off the highway (from winter salting) and accept handouts from people, in particular the Mount Norquay turnoff. Road killed losses of sheep are excessive in this area.

Jasper

Wildlife Mortality. The section of Trans Alberta Highway No. 16 (Yellowhead Highway) traverses Jasper Park east-west, while the south Highway No. 93 connects Jasper townsite and Lake Louise in Banff Park. Highway No. 93 is visitor traffic primarily and is closed to truck traffic. Wildlife losses in Jasper along the highways were excessive. For example, 416 ungulates were killed on the highway and 242 on the railroad during the period 1966-1975. These included 207 elk, 163 mule deer, 148 sheep, 89 moose and only 3 mountain goats. A total of 100 animals were killed during one month, January 1974, and 5 bighorn sheep were killed by 1 semi-truck in the fall of 1974. Jasper Park personnel estimate that Highway No. 93 which is primarily traveled by visitors, accounted for only 1.5-2% of the total ungulate losses. Major problems are, 1) the highways and railroad travel through ungulate winter ranges, 2) habituated deer and elk feed extensively on grasses on seeded roadsides, 3) animals are trapped along railroad cuts and tunnels and when attempting to outrun the railroad in winter and 4) many bighorn sheep are killed on Highway No. 16 where they seek road salt and handouts.

Highway Safety. The speed limit on Highway No. 16 in Jasper is 60 mph and some people do 70-80 mph. In 1974, 3,114 traffic violations were issued, 248 accidents occurred each with damages over $200.00 and 5 people were killed (RCMP records, Jasper station). January 1, 1975 to June 12, 1975 there were 74 accidents in the Park. Most accidents are caused by speeding, carelessness and to two incompatable types of traffic; visitors slowing to view wildlife or scenery and faster commercial or through-traffic. In 1973 there were 5 rear-end collisions near Disaster Point (Highway 16) caused by people stopping in the lane of traffic to feed sheep. There are 3-4 accidents each year around the Kerkeslin Lick parking lot and several accidents on Highway 93 south of town caused by people stopping in the road to watch elk on the roadsides. Signs reading "Sheep on Road" near Disaster Point have helped the situation.

Natural Licks and Mountain Goats. Two natural licks are located along the highways in Jasper Park, the Kerkeslin Lick along Highway 93 south and the Disaster Point Lick along Highway 16. The Disaster Point Lick is used primarily by bighorn sheep and to a lesser extent by mountain goats (about 6). Ungulates do not need to cross the highway to use the lick, however, bighorn sheep get out on the road to receive handouts from visitors. The area is dangerous, 1) because the turnout is in the wrong spot for sheep and people stop in the road at the curve to better view the sheep, 2) the lick area is on a curve in the highway which cuts reaction time to respond to sheep on the road or cars parked on the road. Constable Doug Bates (pers. comm.) felt that the blind situation (i.e. on curves or hills) of exhibits like Disaster Point or Kerkeslin create safety hazards.

The Kerkeslin Lick is located on Highway 93 about 32 km south of Jasper townsite. Approximately 100 goats use the lick from the nearby Kerkeslin Mountain range and originally crossed the road. When the highway was improved in 1968, four new clay licks were exposed on the east side of the highway and a visitor viewing area and looping pull-off parking lot were built above the lick. According to Bob Haney (pers. comm.) who was assigned to the area as warden for four years, the goats now use primarily the road cut licks on the west side because, 1) the visitor viewing area puts people only 6-24 m from the goats at the old lick, 2) the new licks do not require the goats to cross the road and are located next to forest escape cover. Goats feed on the seeded grasses along the roadside while at the licks and also cross the road to feed on both roadsides. Only one goat, a kid, was killed when the lick was closely observed in 1966.

Kootenay

Natural Licks/Mountain Goats. An unnatural, man-made lick is located near Mount Wardle along Highway No. 93 in Kootenay Park. The mountain goats from the nearby Mount Wardle range utilize the lick, which is a gravel pit exposed during highway construction. Salt attractants are either nitrates from blasting there and/or salt remaining from years of operating a mountain goat trap (Max Winkler, pers. comm.). Goats do not cross the road to get to the lick, but do walk out to the roadside from the lick to feed upon the seeded grasses.

Yoho

Wildlife Mortality. Kills along Highway No. 1 totaled 30 animals (22 elk) during the one year period April 1, 1974 - March 31, 1975; 16 elk were killed by the highway and 5 elk by the railroad. The Park population estimate is 125 - 140 elk so that in one year as much as 16% of the population may have been lost to the highway and railway. Elk attractions to the highway are the seeded grasses along the roadside and salt on the road. Yoho reports some use of an underpass (Underpass Creek) as a crossing of the highway by elk. Twinning of Highway No. 1 is planned for Yoho Park.

Glacier

Wildlife Mortality. Reported wildlife losses total 53 animals including 4 mountain goats since the construction of Trans Canada Highway No. 1 through Glacier National Park (B.C.) in 1963.

Highway Safety. Highway accidents are numerous in Glacier National Park (B.C.). During two three month periods in 1970 and 1974 there were 20 and 24 accidents, respectively, and 2 people were killed during each period. In 1967, 5 people were killed and there were 16 serious injuries. Most accidents result from dangerous situations along the highway including the snowsheds, a 90 degree turn, the Loop Creek curve and Conwaught Corner.

Natural Licks/Mountain Goats. Mountain goats from a nearby small herd of about 18 animals seek highway salt each spring in the vicinity of the snowsheds. The snowsheds limit driver reaction time. Five reported goat losses occurred here, 1965-1974.

Table 25. Percent cover near the ground (<.5 m) at six conifer forests and two shrub stands along Highway 2.

Plant Species	Sampling Station Number									
	Conifer Forest							Shrub		
Shrubs	1	2	3	6	7	8	Mean	4	5	Mean
Menziesia ferruginea glabella						4.3	.72			
Pachistima myrsinites	9.4	4.2	1.9	6.8	12.3	11.02	7.6			
Prunus virginiana melanocarpa									9.0	4.5
Rubus parviflora									.6	.3
Spirea betulifolia		.9	.6			.25				
Sheperdia canadensis			1.2				.2			
Vaccinium membranaceum		6.5	5.1		6.0	5.7	3.88	8.0		4.0
Vaccinium scoparium	.6				tr	3.8	1.0			
Symphoricarpos albus laevigatus			9.1	10.95		2.5	3.76	2.0	10.3	6.0
Rubus idaeus gracilipes				1.25			.21		.6	.3
Rosa spp.									2.2	1.1
Salix scouleriana								4.1		2.1
Herbs										
Lonicera utahensis		3.2			1.6	.1	8.2			
Osmorhiza chilensis		.7	1.8	.2			.45	tr		tr
Pteridium aquilinum		3.5				.5	.58			
Thalictrum occidentale		8.6		.6			1.53			
Tiarella trifoliata unifoliata	10.6			.6			1.87			
Viola orbiculata	1.3	8.2	4.7	18.6	8.3	2.3	7.23		.7	.3
Xerophyllum tenax			3.5		24.2	8.7	6.65			
Streptopus amplexifolius chalazatus	tr	.1	2.6				.48	4.8		2.4
Listera caurina				tr			tr			
Pyrola spp.			tr				tr			
Grasses and Sedges										
Carex geyeri				1.7	.8		.22			
#56				1.7				46.35	5.7	26.0
Graminia spp.		.1	1.3		6.1				.6	.3
Total Percent Cover	21.9	36.0	30.8	42.3	59.3	39.1	44.0	57.25	29.7	47.3

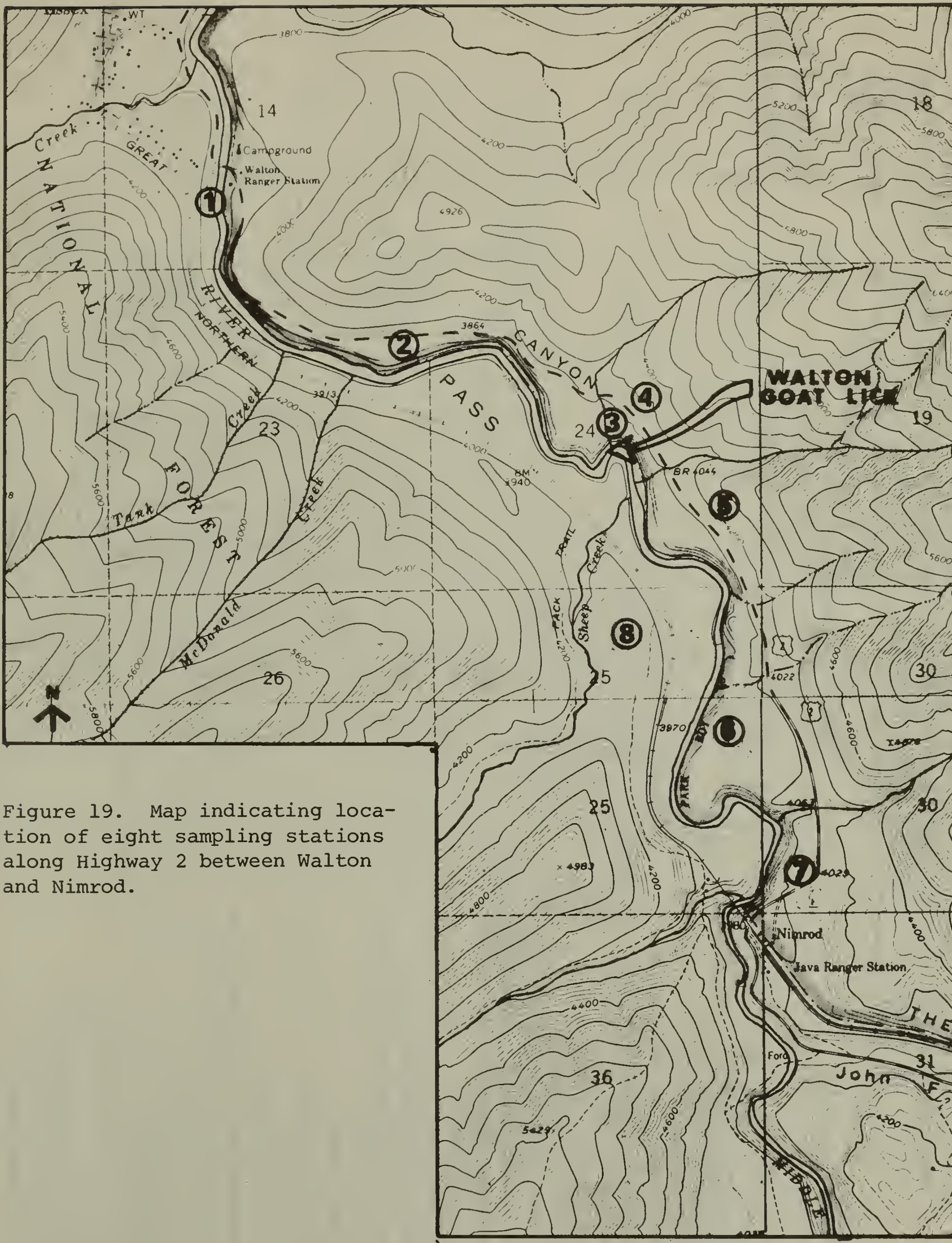


Figure 19. Map indicating location of eight sampling stations along Highway 2 between Walton and Nimrod.

Table 26. Percent coverage of plant species along 100 m lines (line-intercept) in six conifer forests and two shrub stands along Highway 2, stratum at 1 m height.

Plant Species	Sampling Station Number: Conifer Forest							Shrub		
	1	2	3	6	7	8	Mean	4	5	Mean
Trees and Shrubs										
Acer glabrum douglasii	6.00	12.25	12.50	3.50	tr	1.25	5.96	13.25	12.75	13.50
Rubus parviflorus	.25	19.00	40.00	8.50			11.29	.75		.37
Taxus brevifolia	31.00					.75	5.29			
Oplopanax horridum	19.00						3.17			
Alnus sinuata	.75	3.75	.75	7.75			2.17			
Pseudotsuga menziesii		1.50	1.75	.75	1.		1.37	tr		.12
Abies lasiocarpa		1.25	1.50		tr	.75	1.08			
Pteridium aquilinium		2.00	3.75				.96			
Cornus stolonifera			.75	4.50			.88			
Amelanchier alnifolia		1.00					.17	9.50	4.00	6.75
Ceanothus velutina velutina								16.75	10.75	13.75
Pachistima spp.						.25	.04			
Picea engelmanii			.25	.25	.25	.25	.16			
Pinus monticola								1.25		.62
Sheperdia canadensis		.50	.50				.17	3.00		1.50
Prunus virginiana melanocarpa									6.00	3.00
Rosa spp. #19			.25				.04			
Rosa spp. #67									.50	.25
Salix scouleriana								2.75		1.38
Salix bebbiana								1.75		.87
Spirea betulifolia		.50	.75				.12			
Symphoricarpos albus laevigatus		.25		.50			.12	1.00	1.00	1.00
Vaccinium membranaceum		.50	.25			.25	.17			
Lonicera utahensis	.75			.25			.17	3.00		1.50
Grasses and Herbs										
Dryopteris austriaca				2.00			.3	5.5		2.75
Epilobium angustifolium			.25				.04	1.00	.25	.62
Grass #59									tr	tr
Streptopus amplexifolius			.25				.04			
Thalictrum occidentale		.75		.50			.21			
Xerophyllum tenax		.25			.50	.25	.17			
Total Percent Coverage	57.75	32.60	43.20	28.50	1.75	3.75	29.0	49.3	25.1	37.0

Table 27. Relative percent of trees by species in six conifer forests and two shrub stands along Highway 2.

Plant Species	Sampling Station Number: Conifer Forest							Shrub		
	1	2	3	6	7	8	Mean	4	5	Mean
Abies lasiocarpa	20	19	13	9	14	22	16			
Picea engelmanii	42	4	8	6	43	46	25			
Pinus monticola		1			2	1	1	2		1
Pinus contorta		2	4	77	27	9	20	35		17.5
Larix occidentalis	4	60	2		10	9	14			
Betula papyrifera	4	1	58			1	11			
Populus tremuloides	19		5			3	5	30		15
Pseudotsuga menziesii	11	13	10	8	4	9	9	33	100	66.5

Table 28. Use of outcrops of various heights by mountain goats on the study area during summer census, 1975 (n = 117 observations).

	2-10	11-20	21-40	41-100	101-200	201-300	301+	Total
Number of Observations		14	13	14	18	10	4	86
Percent		120	11.1	12.0	15.4	8.5	3.4	73.5

Table 29. Analysis of natural mountain goat and elk licks in Glacier National Park, and of soil samples adjacent to the licks.

	Mineral Composition							
	Percent		Parts per Million					
Lick Samples	Ca	Mg	K	Mn	Zn	Cu	Fe	Na
Little Dog Licks								
#1-A	.20	.032	1400	250	21	6	3300	300
#1-B	.36	.072	230	130	20	6	1900	50
#2	.48	.140	330	120	14	24	3200	80
#3	.22	.036	310	200	17	12	3000	470
#4	.36	.078	230	470	31	6	1700	30
#5	.20	.042	180	90	53	18	2100	40
#6-A	9.20	.840	240	340	21	31	2600	40
#6-B	.22	.041	220	90	17	12	2100	100
Walton Goat Lick	1.00	.068	200	160	85	12	2600	70
North Fork Elk Licks								
Bowman #1	1.60	.200	1600	460	31	6	1700	310
Bowman #2	1.00	.120	1400	530	21	18	2100	360
Kintla Well	4.80	.160	3800	290	24	6	2400	630
Soil Samples								
Little Dog Licks								
#1	.06	.013	170	350	14	6	1600	30
#2								
#3	.30	.041	1100	440	31	10	1600	30
#4	.32	.078	220	220	28	12	2600	50
#5	.44	.064	4000	150	11	6	1400	40
#6-A	.24	.028	190	90	14	6	1400	20
#6-B	.18	.034	160	100	24	6	1400	20
Walton	.24	.044	120	340	0#	6	460	30
North Fork Elk Licks								
Bowman #1	1.00	.150	4100	230	0#	6	1400	50
Bowman #2	1.00	.120	1400	530	21	18	2100	360
Kintla Well	4.80	.840	130	220	17	6	1600	40

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GPO 833-340