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Survey of the nongame mammals in the upper Rattlesnake Creek drainage of western Montana

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A SURVEY OF THE NONGAME MAMMALS IN THE
UPPER RATTLESNAKE CREEK DRAINAGE
OF WESTERN MONTANA

By

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During 2 field seasons, snaptrap lines were used to determine small mammal diversity within each habitat, niche width for each mammal species, and niche overlap between species in the Upper Rattlesnake Creek Drainage, Montana. The 14 trapping locations represented 18 habitat types with varying diversities. Diversity was strongly related to elevation but was not correlated with either shrub development or tree canopy closure. Masked shrews, northern bog lemmings, long-tailed and meadow voles, and northern flying squirrels had the narrowest niches; red-backed voles, yellow pine chipmunks, vagrant shrews, red-tailed chipmunks, jumping mice, and deer mice had progressively larger niches. Most species pairs did not show much, if any, niche overlap, especially when habitat abundance was considered. Mammal species diversity varied greatly from one habitat to another along a scent station line, ran twice during summer 1977, but was influenced more by the presence of the road than by habitat features. Additional mammals that visited the scent stations included golden-mantled and columbian ground squirrels, red squirrels, porcupines, bushy-tailed woodrats, black bears, weasels, badgers, bobcats, red foxes, and coyotes. Niche overlap was moderate for most prey species pairs; predators did not overlap much although use tended to concentrate in a few areas. Diversity, niche breadth, and overlap varied between months as a result of food availability, population sizes, and hibernation.

Other species present throughout the Drainage, as determined from sign or mammal sightings, include: pocket gophers, hoary and yellow-bellied marmots, muskrats, beavers, snowshoe hares, pikas, short- and long-tailed weasels, mink, striped skunks, wolverine, lynx, cougar, wolf, and grizzly bear.

The implications of logging, burning, recreation, and wilderness as management options are examined. The effects, both favorable and unfavorable, of these options on the different species of wildlife are summarized.

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CHAPTER I

INTRODUCTION

Wildlife species have traditionally fallen into 2 major categories, game and nongame. Throughout much of American history, no differentiation was made between these 2 categories (Crouse 1974). Wildlife were abundant and considered important only as sources of meat, furs, and other products or as threats to crops, livestock, and human safety. Americans viewed wildlife as a resource to be exploited in keeping with the traditional view of man's role on earth "to multiply and subdue" (Shaw 1974).

By the early 1900's, ruthless exploitation had drastically reduced the wildlife supply in this country. Laws were passed in many states restricting the use of wildlife. The utility and nuisance values of wildlife declined in importance while the recreational value of sport hunting grew. Hunting became a national pastime (Shaw 1974).

Growing hunting pressures, loss of wildlife habitat, inadequate funding for game law enforcement or wildlife management and research, and problems of recreational access to public and private lands were all posing critical problems for state wildlife agencies by 1928. To help agencies cope with these problems, an expert committee, chaired by Aldo Leopold, was appointed. The committee members' deliberations produced, in 1930, the American Game Policy, a "national policy of wild life conservation and restoration, as a basis of cooperative work on the part of all interested organizations and individuals" (Wildlife Management Institute 1971).

Although much has been done since 1930 to protect game animals in particular, wildlife habitats and numbers continued to decline, victims of increasing human populations and industrialization. These changes, coupled with the concentration of people in large urban areas where only a few wildlife species can survive, have resulted in a third way of using and valuing wildlife resources. Consumption of wildlife is being replaced by the aesthetics (viewing, studying, photographing, etc.) and existence (satisfactions from knowing that wildlife exists, recognition of ecological importance, etc.) of wildlife. In other words, viewing wildlife is becoming an unusual experience for more and more Americans who are therefore placing increasing importance on the aesthetic and existence values of a scarce resource (Shaw 1974).

Within the last decade or so, people have become very concerned about the environment. The emphasis of wildlife management has gradually shifted because large segments of the public believe more consideration should be given to the management of nongame species as an important part of the entire ecosystem

(Crouse 1974).

One response to the changes of the last 40 years was the formation of a new Committee on North American Wildlife Policy in 1972. Their report re-examined the principles and programs affecting all wildlife resources, supplementing and updating the 1930 American Game Policy (Allen 1972). A second response took the form of federal legislation: the Multiple Use-Sustained Yield Act of 1960; the Wilderness Act of 1964; the National Environmental Policy Act of 1969; the Endangered Species Act of 1973; the Forest and Range Renewable Resources Planning Act of 1974; and the National Forest Management Act of 1976. Some of these laws provided for actual protection of wildlife species, whereas others made full consideration of wildlife mandatory in land-use planning processes.

As required by federal law, the Upper Rattlesnake Drainage is currently the subject of 2 land-use planning processes by employees of the United States Forest Service (USFS). The Roadless Area Review and Evaluation (RARE) process was begun in 1972 "to identify those roadless, undeveloped areas that appeared to be the best candidates for inclusion in the NWPS" (National Wilderness Preservation System; USDA Forest Service 1979). In the final environmental statement of RARE II, the Rattlesnake was recommended for further planning.

The second planning process involves formulating a forest-wide management plan for the Lolo National Forest. One of 31 major considerations in this process concerns the Rattlesnake: specifically, how recreation in the Drainage should be managed (Daniels, Supervisor, Lolo National Forest, pers. comm.).

My survey of the nongame mammals of the Rattlesnake Drainage was begun in response to both current interest in nongame wildlife and the need for comprehensive data on which to base management plans. To fulfill these needs, my objectives were to:

1) determine what species of nongame mammals inhabit the Drainage, their distribution by habitat, and relative abundance within each habitat;
2) determine, in a general way, the nature of the prey base and how it is utilized within each habitat type; and
3) make suggestions regarding the impact(s) various management options could have on the nongame mammals in the Drainage.

CHAPTER II

STUDY AREA

Description

Location and ownership. The Upper Rattlesnake Creek Drainage is located 8.3 km north of Missoula in western Montana (Figure 1). The Drainage is bordered by the Flathead Indian Reservation on the north, the Gold Creek Drainage on the east, and the Grant Creek Drainage on the west. The study area encompasses approximately 21,053 ha; 46% is owned by the USFS and 41% by the Montana Power Company (MPC). Small parcels (227 ha and smaller) are owned by United States Plywood, the State of Montana, the Rattlesnake Valley Irrigation Company, I. E. Peterson, and the Burlington Northern Railroad (Heardon 1975).

Hydrology. Rattlesnake Creek originates on the flanks of McLeod and Triangle peaks, flowing south or southwestward to end in the Clark Fork of the Columbia River at Missoula. Thirty-seven km long, the Creek descends 1613 m from source to mouth. Of the 9 perennial tributaries, 3 (Wrangle, Lake, and High Falls creeks) originate from glacial lakes; the remaining 6 (Porcupine, East Fork Rattlesnake, Beeskove, Pilcher, Fraser, and Spring creeks) originate

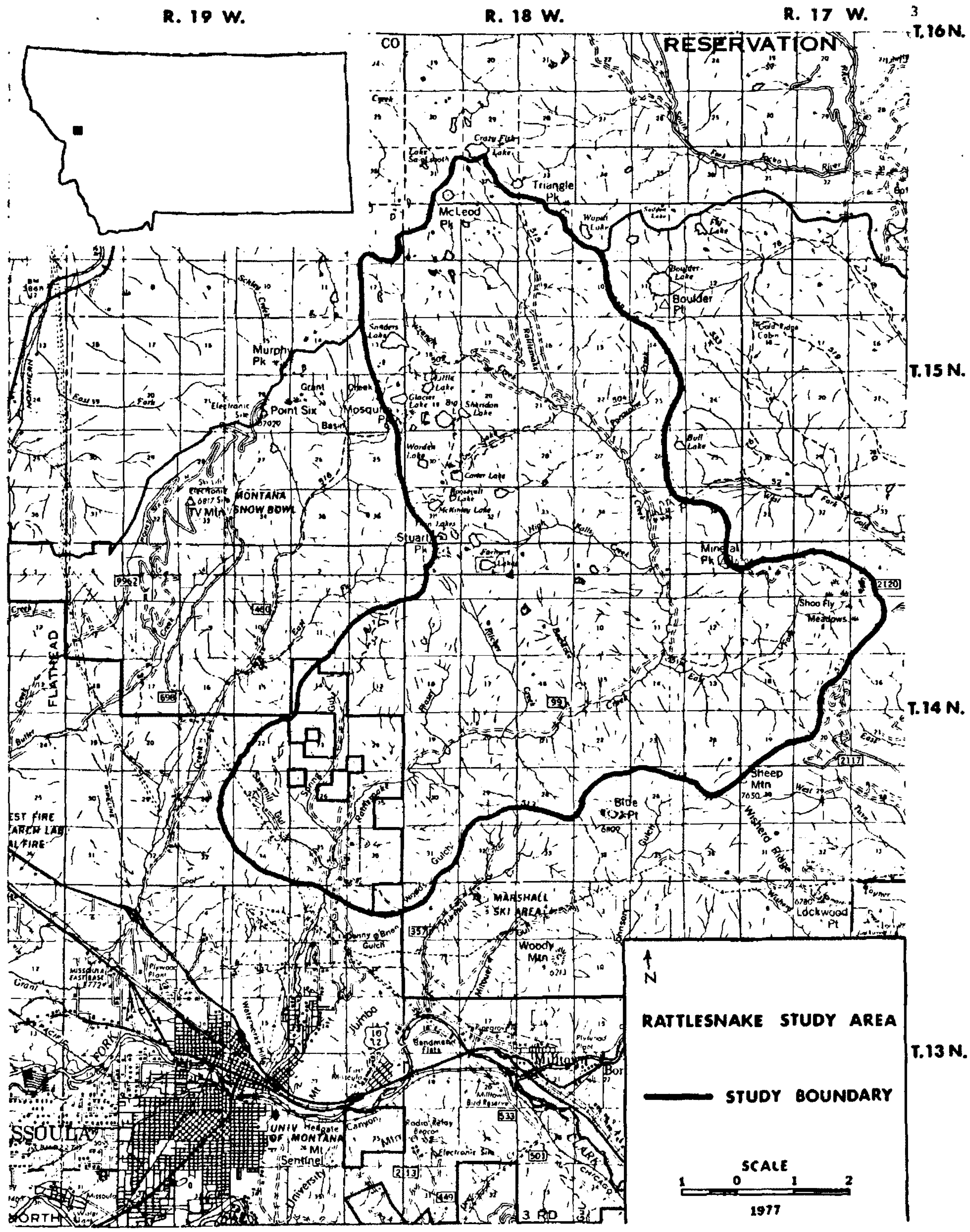

Figure 1. Map of study area.

from springs. Numerous intermittent streams, draining relatively small areas and flowing only during high runoff periods, also feed Rattlesnake Creek. More than 20 lakes are located in the study area, mostly on the west side, between Stuart and McLeod peaks (Reardon 1975). The watershed is characterized by a relatively high peak discharge per unit area, a disproportionately large amount of which comes from the upper elevations (Van der Poel 1979).

Geology. At least 3 advances of mountain glaciation during the Pleistocene carved the Rattlesnake Valley, producing the U-shaped canyon, hanging valleys, and numerous cirques. Morainal and outwash deposits, laid between glacial advances, occupy most of the Valley bottom. The terminal moraine is a transverse ridge in the southwest quarter of section 19, T.14N R.18W (Nelson and Dobell 1961, Van der Poel 1979). Local glacial ice may have extended further south, into the Lower Rattlesnake Drainage, rather than ending at the transverse moraine. Strandlines from Glacial Lake Missoula are evident in the lower canyon up to an elevation of 1341 m (Van der Poel 1979).

Talus formation and creep are active phenomena, and alluvial, landslide, and colluvial deposits are present throughout the Drainage (Van der Poel 1979). Parent materials include argillites, quartzites, and limestones of the Precambrian Belt series, as well as Cambrian shales and limestones (Nelson and Dobell 1961).

Climate. The climate of the Missoula area, including the Rattlesnake Drainage, is semi-arid with an average annual precipitation of 32 cm. The average maximum temperature for the year is 13.3°C and the minimum is -0.8°C; extremes of 40.5°C and -34.4°C have been recorded. The maximum temperature reaches 32°C or higher 22 days in each year, and 0°C or below 51 days. The average annual snowfall is 121 cm (Knoche 1968).

Vegetation. The vegetation in the study area forms a mosaic of types because of varying topography, soils, and moisture availability. These types include alpine tundra; subalpine, spruce-fir, lodgepole pine, and Douglas-fir forests; riparian areas; bog meadows; forested and rock scree; and man-created meadows and clearcuts.

Tree species include aspen, black cottonwood, Douglas-fir, Engelmann spruce, grand fir, lodgepole pine, ponderosa pine, subalpine fir, western larch, and whitebark pine. The most common shrubs are alder, ceanothus, chokecherry, creeping Oregon grape, elderberry, huckleberry, kinnikinnick, menziesia, ninebark, pachistima, red-ozier dogwood, Rocky Mountain maple, rose, serviceberry, snowberry, spirea, willow, and yew. Sedges and grasses such as fescues, wheatgrasses, bluegrasses, pinegrass, and bluejoint are present throughout the area. Numerous forbs are also present, including arnica, balsamroot, beargrass, bedstraw, fireweed, glacier lily, mountain heath, knapweed, lupine, meadowrue, prince's pine, queencup, pyrola, senecio, Solomon's seal, strawberry, and wild onion.

History

Fire. Very little fire history data are available for the Rattlesnake Drainage. A 60 cm Douglas-fir slab cut in 1977 from Woods Gulch shows evidence of 10 fires, the most recent in 1919. A major fire burned much of the Upper Drainage south of Stuart Peak in 1919; another occurred in the Shoo Fly Meadows area (Figure 2). Smaller fires than those of 1919 occurred during 1914, 1917, and 1944 (Brown 1979).

Logging. Prior to 1930, timber harvesting was restricted to Woods, Sawmill, Dry and Spring gulches, and the Rattlesnake Valley south of the East Fork Rattlesnake Creek. Much of this logging was to clear the land for agricultural and developmental purposes, although some commercial harvesting also occurred. Between 1956 and 1964, major logging operations were conducted on MPC lands by the Rother Lumber Company of Missoula. A total of 52,800 m^3 of wood were cut in 2 stages (Figure 3):

1) 7440 m^3 of mature and overmature residual timber selectively cut during 4 months, 1956 and 1957; and
2) 45,360 m^3 clear- and selectively cut between 1958 and 1964.

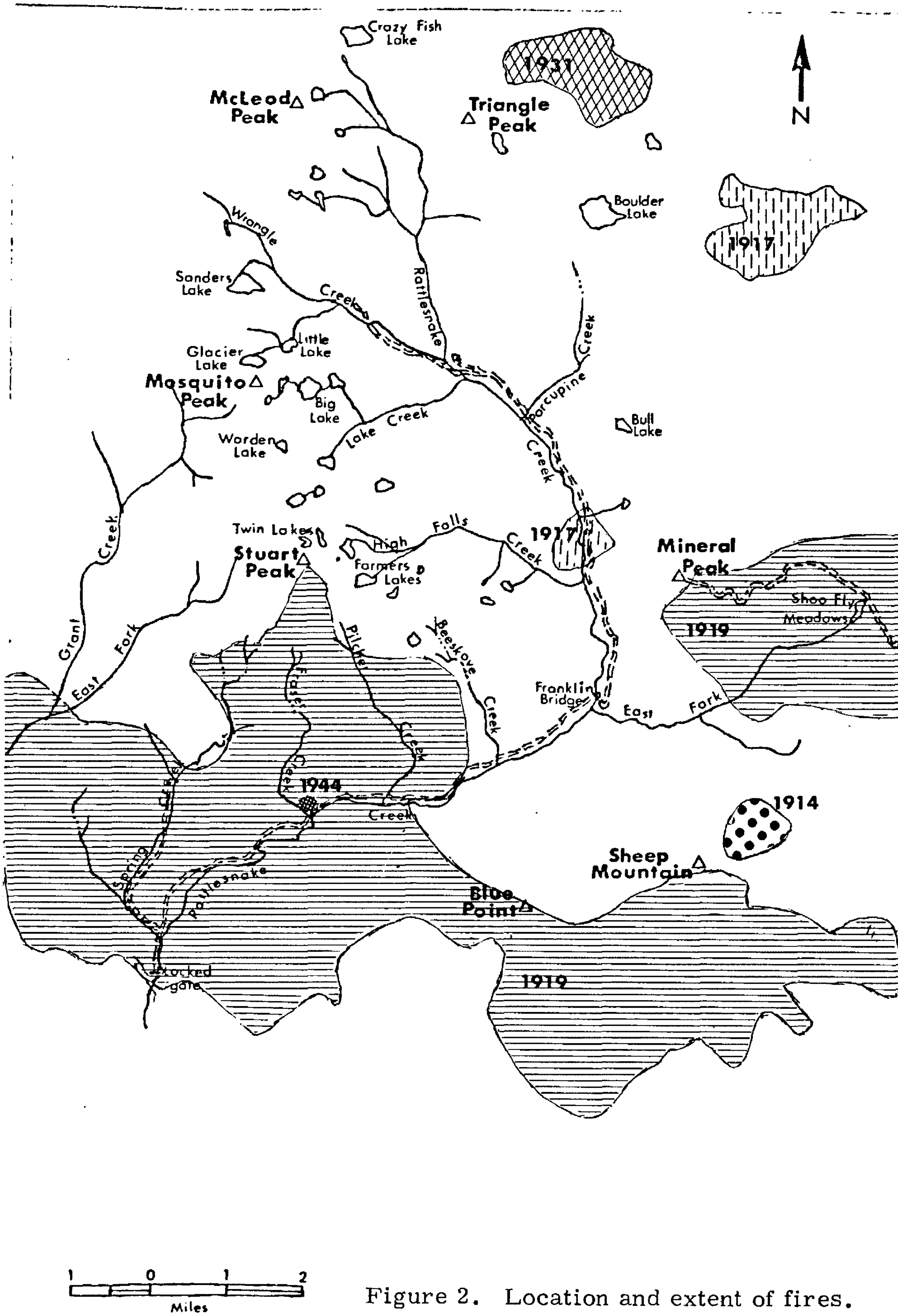

Figure 2. Location and extent of fires.

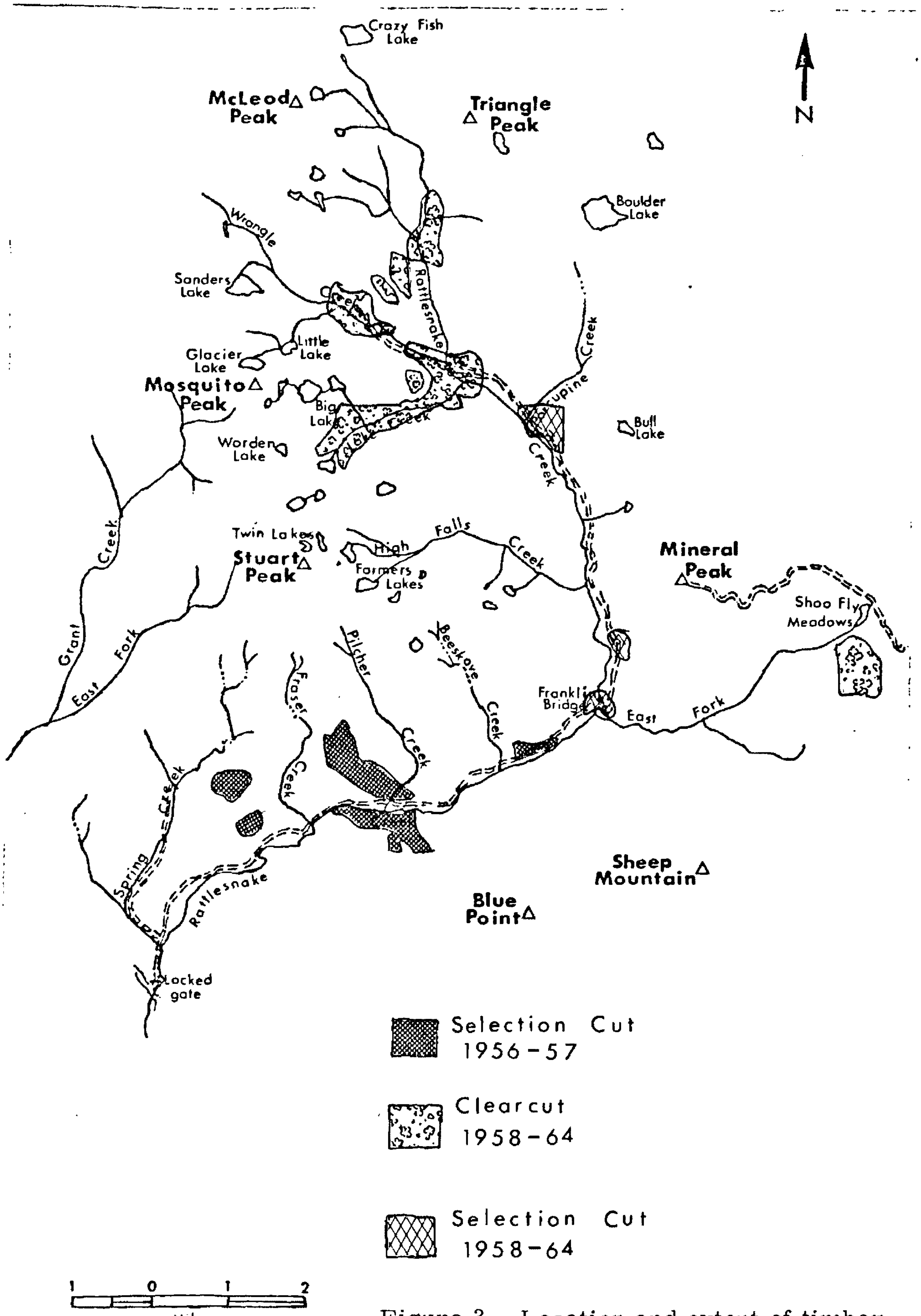

Figure 3. Location and extent of timber harvesting.

USFS lands are uncut for the most part although 2400 m^3 were removed from lands along the road right-of-way and from salvage cutting 2 small tracts along Lake Creek during 1958-1964 (Reardon 1975).

Agriculture. The earliest inhabitants of the Upper Rattlesnake Valley were Indians who hunted in the Valley and later traded with and worked for the white man. During the late 1800's, white men began moving into the area, forcing the Indians out. Some of the early white settlers were woodchoppers, trappers, and miners, claiming their land under the Timber and Stone Act of 1878. Other settlers were farmers taking advantage of the Homestead Act of 1862 (Wendel 1978). By 1900, scattered agricultural use extended into Spring Gulch and up Rattlesnake Canyon to the East Fork. In 1936, the MPC bought out all the landowners in the study area and removed all buildings to prevent pollution of the water system. Commercial agriculture in the area virtually ceased at that time (Reardon 1975).

Cattle grazing has occurred on a very limited basis. Between 1958 and 1968, the MPC leased out about 162 ha along Spring Creek for cattle grazing, a use which has since been discouraged on lands above the water intake dam. No grazing permits have been issued for USFS lands as they are not suitable for grazing by domestic stock (Reardon 1975). For many years, cattle from the Wooten Ranch adjoining

Sawmill Gulch have trespassed into Spring Gulch and the Rattlesnake Valley. An employee of the MPC once counted as many as 40 head of trespassing cattle. The trespass problem ended in early 1976 when Gille Wooten died (Leuschen, Manager Missoula Division, Montana Power Company, pers. comm.).

Watershed. Rattlesnake Creek has been an important source of water for the Missoula Valley since the 1800's. Use of the Creek as a drinking source predated the founding of the city in 1864. The Creek was diverted numerous times for irrigation after 1868. By 1900, the demand for water frequently exceeded availability during periods of high use. Between 1903 and 1950, a commissioner was seasonally employed to apportion the Creek water by decree; a job that declined in importance as irrigation lessened. The MPC purchased the water system in 1929 and had acquired their Rattlesnake lands by 1936 (Reardon 1975). Negotiations for the sale of the water facilities (but not the MPC's Rattlesnake lands) are currently in progress between the MPC and the Park Water Company of Downey, California (Shirley 1979).

The Rattlesnake Drainage has been managed by the MPC primarily as a watershed. About 45% of Missoula's water needs are presently supplied by Rattlesnake Creek, wells supply the remaining 55%. Wells can supply all of the city's water and do so during spring runoff (because of a high sediment load in the Creek). In addition, as Missoula expands, wells are becoming more important because they are providing for this expansion (Leuschen, pers. comm.).

Recreation. Recreational use of the Rattlesnake has grown rapidly, particularly as public awareness about the area has increased. To cope with the increased recreational use and reduce land-use conflicts, a number of management steps have been taken by the USFS and MPC. In 1970, the MPC installed a locked gate at Sawmill Gulch, closing the main road to vehicles wider than 100 cm. Prior to summer 1975, the USFS and MPC drafted a set of interim guidelines to regulate recreational use. Since then, many of the trails in the study area have been closed to motorcycle traffic, a number of signs (including a map at the main gate, distance signs at the Spring Gulch trail junction, and signs prohibiting motorcycle use) have been erected, and a fence was installed across the Spring Gulch road. Beginning in 1976, the USFS and MPC have split the cost of a backcountry patrolman to enforce the regulations on recreational use during the summer (Reardon 1975; Leuschen, pers. comm.).

Almost 27,000 people visited the Upper Rattlesnake between summer 1977 and spring 1978, but their use patterns varied seasonally. Most visitors (60-70%) traveled on foot, except in the winter when most users (71%) were on cross-country skis. Motorized use, both motorcycles and snowmobiles, accounted for 25% of summer use, decreasing to less than 4% in the winter. All motorized use was restricted to the main road, whereas hikers generally preferred Spring Gulch (except in the spring when two-thirds of the hikers used the main road). A large proportion (about 80%) of use occurs within 5 km of the locked gate; motorcycles tend to penetrate further into the Drainage. Overnight use is not great, ranging from 12% in the summer to 1.4% in the winter, and most overnight users prefer to travel by way of Spring Gulch. An estimated 727 visitor-use days were calculated for the highcountry (the High Falls, Lake, and Wrangle creek basins) between 1 July and 15 September 1977; about one-third was by day-use groups, the rest by overnight groups. Hunting is allowed during the fall but only 10-15% of the fall visitors are hunters (McCool and Kelley 1977; McCool and Philley 1978a, b, c).

CHAPTER III

METHODS AND MATERIALS

Traplines

Small mammals were trapped during 2 field seasons in 14 locations representing different habitats, elevations, and aspects. Locations were classified into habitat types based on the presence of specific indicator plants (Pfister et al. 1977). The presence of other key food species was also noted, as were tree diameters at breast height, percent canopy closure, seral stage, and stand history (fire, logging, grazing, etc.). Two plots were usually sampled per location but only 1 plot was sampled in those locations with apparently homogeneous vegetation. Additional types were added for clearcuts, cottonwood bottoms, and old homestead sites.

Traplines consisted of 60 small snaptraps placed in groups of 3, each group about 8 m apart, with a trapping period of 3 days (Calhoun 1948). Traps were baited with a mixture of peanut butter and anise oil. Site limitations (topography, vegetation, etc.) occasionally resulted in fewer than 60 traps being used. Four to eight 8 X 9 X 23-cm, collapsible Sherman livetraps baited with peanut butter and sunflower seeds were set in 7 traplines.

External measurements, reproductive status, and physical condition were recorded for each mammal snaptrapped. Livetrapped mammals were marked by toe-clipping and released after recording external measurements, and when identifiable, sex. Species were identified using keys by Hoffmann and Pattie (1963) and Burt and Grossenheider (1976).

The presence of other mammals was recorded from observations of sign (tracks, scats, middens, etc.) or the animal itself.

Scent Station Lines

Two scent station lines were run along the main road through the Drainage during summer 1977. The vegetation adjacent to each scent station was classified following the same procedure used in trapline locations but with only 1 plot per station.

Each scent station consisted of a 0.97-m diameter circle of level ground evenly covered with finely sifted dirt. A small plastic capsule containing isovaleric acid placed in the center of the circle served to attract animals to the station. Stations were set approximately 0.5 km apart (sometimes more or less, depending on the terrain) on alternate sides of the road, with 50 stations in the first line. The second line only had 40 stations because a bridge over Porcupine Creek was closed, preventing access to the upper scent stations. Each line was checked for 5 consecutive days (Linhart and

Knowlton 1975).

Animal tracks found in the stations were identified from Murie (1974) and recorded. Mammal sign in the habitat type plots were also noted.

Datum Analysis

To facilitate trapline datum analysis, standardized catch rates per 100 trap-nights, CR, were calculated:

$$CR = 100 \frac{n_i}{t_i}$$

where n_i is the number of individuals in habitat i, and t_i is the number of trap-nights in habitat i. Analysis of scent station data was based on the number of visit-days recorded per species in each habitat.

Because all mammals collected in the traplines could be identified and counted, Brillouin's formula gives the most appropriate measure of small mammal diversity, H (Pielou 1966):

$$H = \frac{1}{N} \ln \frac{N!}{n_1! n_2! \ldots n_s!}$$

where N is the total number of individuals, s the number of species, and n_i the number of individuals in the i^{th} species, so that $\sum_i n_i = N$. The maximum possible diversity, H_{max}, occurs when individuals are distributed among the species as evenly as possible and is calculated from the formula:

$$H_{max} = \frac{1}{N} \ln \frac{N!}{\left\{\left[\frac{N}{s}\right]!\right\}^{s-r}\left\{\left(\left[\frac{N}{s}\right]-1\right)!\right\}^{r}}$$

with $\left[\frac{N}{s}\right]$ the integer part of $\frac{N}{S}$, and $r = N - s\left[\frac{N}{s}\right]$. Evenness, J, is the ratio of the observed species diversity to the maximum possible diversity:

$$J = \frac{H}{H_{max}} .$$

Each scent station, however, represented a large community whose characteristics can only be inferred from a sample; thus the Shannon index (Shannon and Weaver 1964) is the appropriate diversity index (Pielou 1977):

$$H' = - \sum_i p_i \ln p_i$$

with p_i the proportion of total visit-days in habitat i. The maximum possible diversity is given by

$$H'_{max} = - \Sigma \frac{1}{s^*} \ln \frac{1}{s^*} ,$$

where s^* is the total number of species in the community, and evenness by

$$V' = \frac{H'}{\ln s^*} .$$

Species richness and McNaughton's (1967) community dominance index provided 2 additional measures of diversity for both traplines and scent stations. The community dominance index equals the percentage of the absolute density contributed by the 2 most abundant species in a community and is inversely related to diversity.

Correlations between trapline diversities and habitat features were calculated with the Kendall rank and partial rank correlation coefficients, τ (tau; Siegel 1956). Pearson's correlation coefficient, r (Wonnacott and Wonnacott 1972), was used with scent station data.

A relative measure of the range of resources exploited by a single species is niche breadth, B:

$$B = \frac{1}{\sum_i p_i^2}$$

where p_i is the proportion of total catch rate or visit-days in habitat i (MacArthur 1972). Niche breadth values were standardized to vary between 0 and 1 by dividing by the total number of habitats, thereby facilitating comparison of values (Pianka 1973).

In this study, each habitat was sampled by a transect of variable length. Two indices were used in determining niche overlap, a measure of joint occupancy of transects. The first, Pianka's (1973) multiplicative measure, reflects the amount of ecological similarity between the 2 species:

$$O_{jk} = O_{kj} = \frac{\sum_i p_{ij}\ p_{ik}}{\sqrt{\sum_i p_{ij}^2 \quad \sum_i p_{ik}^2}}$$

where p_{ij} and p_{ik} are the proportions of the i^{th} resource used by the j^{th} and k^{th} species respectively. This equation is symmetric, giving a single overlap value for each species pair. Values for O_{jk} are never less than 0 (signifying no overlap) or greater than 1 (the niche space of j completely overlaps that of k).

The second index measures the degree to which frequency of interspecific encounter is higher or lower than it would be if each species utilized each resource state in proportion to its abundance (Hurlbert 1978). With my data, transect length represents "habitat abundance" and Hurlbert's formula adjusts for transect variations:

$$L = \frac{A}{XY} \sum_i \left(\frac{x_i y_i}{a_i} \right)$$

where A is the total size or abundance of the resource (the total length of the traplines in my study); X and Y the total numbers of the 2 species; and a_i, x_i, and y_i the proportions of habitat i and the species x and y in habitat i. If all habitats are equally abundant, as in the scent station lines, the above equation reduces to

$$L = n \sum_i \left(p_{xi} \, p_{yi} \right)$$

with n the total number of resource states. L assumes a value of 0 when no habitat is shared by the 2 species and 1.0 when each habitat is used in proportion to its abundance by both species. L is greater than 1.0 when each species utilizes certain habitats more intensively than others and the utilization preferences of the 2 species tend to coincide.

Other Mammal Data

Mammals were trapped at 2 additional locations in the Drainage, an old homestead about 0.4 km southwest of Fraser Creek and a campsite adjacent to Franklin Bridge (Figure 4). In the former location, 40 8X8X28-cm livetraps were placed at 16-m intervals in a grid arrangement. The traps, baited with peanut butter and sunflower seeds, were checked twice a day for 3 days. Captured animals were marked by toe-clipping prior to release.

Eight snaptraps, baited with beef jerky, and livetraps, baited with peanut butter and jerky, were set at the campsite for 1 and 2 nights, respectively. Trapped animals were handled the same as those collected in the traplines.

All observations of mammals and/or sign (scats, tracks, etc.) were recorded during day hikes and extended stays in the study area. I also noted the observations of other individuals conducting studies in the Drainage.

Prey Utilization and Management Impacts

Information about predator food habits and the effects of logging, burning, and other land uses on vegetation or specific animals was obtained from the literature.

CHAPTER IV

RESULTS AND DISCUSSION

Traplines

Habitat types. The 14 trapping locations represented 18 habitat types within the study area (Figure 4). The vegetation of each habitat type is described in Table 1 and Appendix C.

Mammals collected. Snaptraps were set out a total of 2331 trapping-days in the 14 locations. During that time, 148 small mammals were collected: 62 deer mice; 32 western jumping mice; 14 red-backed voles; 14 red-tailed chipmunks; 13 vagrant shrews; 4 masked shrews; 4 yellow pine chipmunks; and 1 each of an unidentified shrew, a northern bog lemming, a long-tailed vole, a meadow vole, and a northern flying squirrel (Table 2). During 135 livetrapping-days, 4 or 5 mammals were caught: 2 or 3 deer mice (1 deer mouse may have been caught twice, having escaped the first time before I could mark it), 1 unidentified shrew, and 1 red-backed vole (Table 3).

Prior to this study, the northern bog lemming had been known in Montana only from specimens collected in a sedge-alder bog in Glacier National Park (Wright 1950). On 8 September 1978, I trapped

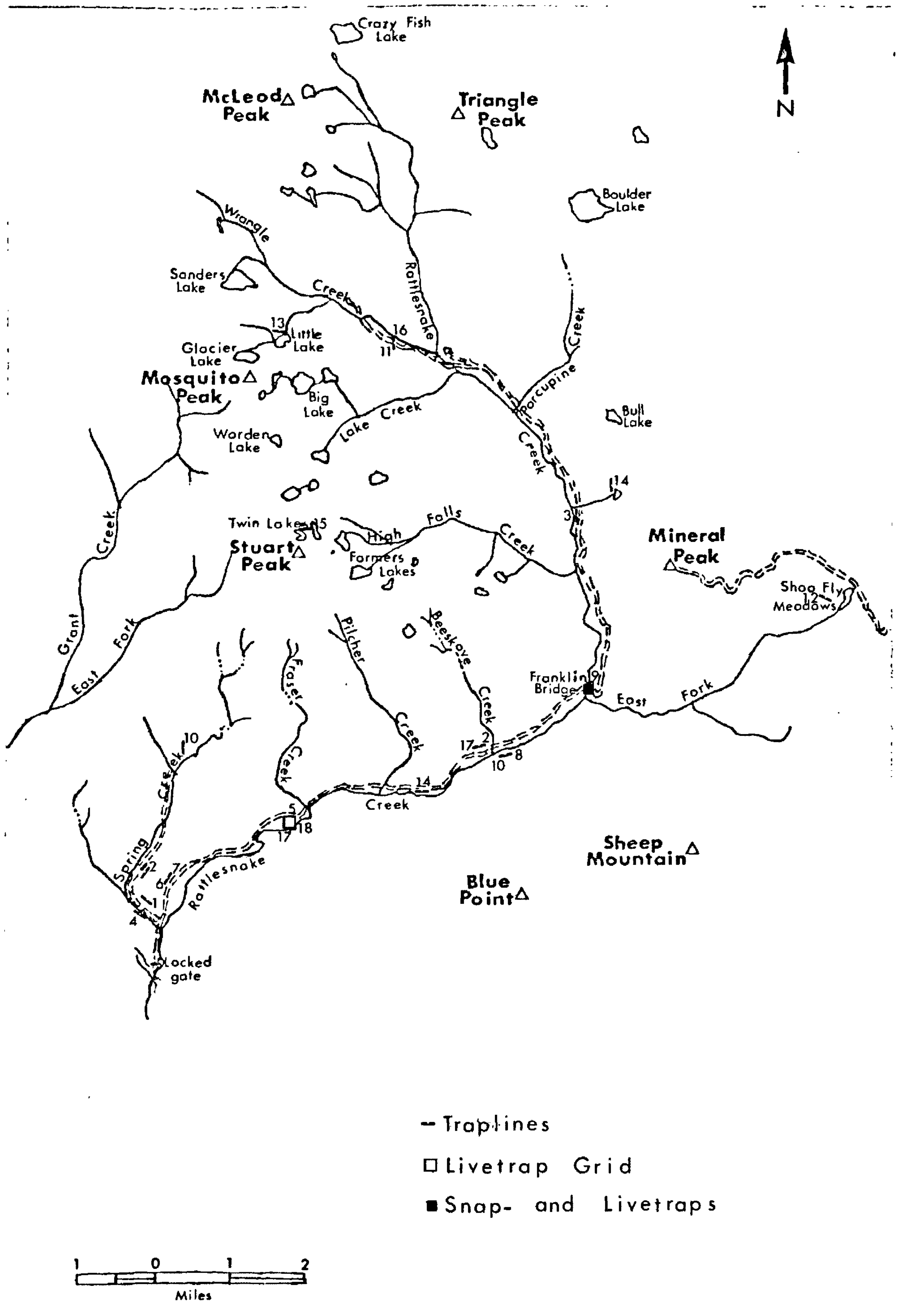
N
Crazy Fish Lake
McLeod Peak
Triangle Peak
Boulder Lake
Wrangle Creek
Rattlesnake
Sanders Lake
Little Lake
Glacier Lake
Mosquito Peak
Big Lake
Lake Creek
Porcupine Creek
Bull Lake
Worden Lake
Twin Lakes
Stuart Peak
High Falls Creek
Farmers Lakes
Mineral Peak
Shoo Fly Meadows
Grant Creek
East Fork
Pilcher Creek
Fraser Creek
Beeskove Creek
Franklin Bridge
East Fork
Creek
Spring Creek
Rattlesnake
Locked gate
Sheep Mountain
Blue Point
Traplines
Livetrap Grid
Snap- and Livetraps
Miles

Table 1. Trapline habitat types.

Habitat type	Location	Elevation (m)	% Canopy closure	Shrub development (rank)	Land use				
					F	L	G	BG	R
Ponderosa pine/Idaho fescue	8	1435	30	2	X		X	X	
Douglas-fir/ninebark-ninebark	10	1290	75	17	X			X	
Douglas-fir/ninebark-ninebark	5	1303	10	11		X		X	
Douglas-fir/blue huckleberry-beargrass	1	1500	50	6				X	
Douglas-fir/twinflower-snowberry	4	1213	70	14					
Douglas-fir/snowberry-pinegrass	3	1210	5	-			X		
Douglas-fir/snowberry-snowberry	3	1210	5	3			X		
Grand fir/unknown	11	1368	80	16				X	
Grand fir/queencup-queencup	11	1368	70	8				X	
Grand fir/queencup-queencup	6	1452	70	15					
Subalpine fir/queencup-menziesia	2	1742	50	10	X	X			
Subalpine fir/bluejoint-bluejoint	12	1897	25	4	X			X	
Subalpine fir/menziesia	13	2071	40	13		X		X	X
Subalpine fir/beargrass-blue huckleberry	7	1829	65	7		X		X	
Subalpine fir/beargrass-grouse whortleberry	9	2326	50	12					X
Clearcut	2	1710	1	5	X	X			
Disturbed meadow[a]	5	1303	2	1		X	X	X	
Cottonwood bottom	14	1323	60	9			X	X	

[a]Southwestern end was boglike, becoming more xeric to the northeast.

F = fire; L = logging; G = domestic stock grazing; BG = big game use; R = recreational use.

Table 2. Mammals collected in traplines, catch rate per 100 days.*

#	Habitat type	Ssp	Sv	Sc	Zp	Pm	Sb	Cg	Ml	Mp	Ea	Er	Gs
1	Douglas-fir/blue huckleberry-beargrass				1.1								
2	Subalpine fir/queencup-menziesia		2.2		24.4	11.1						6.7	
2	Clearcut		0.7		1.5	2.2			0.7				
3	Douglas-fir/snowberry-pinegrass												
3	Douglas-fir/snowberry-snowberry					6.7					0.7		
4	Douglas-fir/twinflower-snowberry					7.2					1.1		
5	Disturbed meadow					6.8							
5	Douglas-fir/ninebark-ninebark					16.7							
6	Grand fir/queencup-queencup		0.6		3.7	1.9							
7	Subalpine fir/beargrass-blue huckleberry					2.2						0.6	
8	Ponderosa pine/Idaho fescue				1.5	3.9					0.5		
9	Subalpine fir/beargrass-grouse whortleberry	0.7			5.2	1.3		3.9				3.3	
10	Douglas-fir/ninebark-ninebark					1.0							
11	Grand fir/queencup-queencup					3.3							
11	Grand fir/unknown		0.7			1.4							
12	Subalpine fir/bluejoint-bluejoint		1.0				0.5	0.5		0.5			
13	Subalpine fir/menziesia	0.9	3.7	6.5		7.4						4.6	
14	Cottonwood bottom												0.5

*Includes both snap- and livetrapped mammals.

Ssp = unidentified shrew; Sv = vagrant shrew; Sc = masked shrew; Zp = western jumping mouse; Pm = deer mouse; Sb = northern bog lemming; Cg = red-backed vole; Ml = long-tailed vole; Mp = meadow vole; Ea = yellow pine chipmunk; Er = red-tailed chipmunk; Gs = northern flying squirrel.

an adult male bog lemming in Shoo Fly Meadows (southwest quarter, section 4, T.14N R.17W). The vegetation of this site, a wet sedge-bluejoint meadow (subalpine fir/bluejoint-bluejoint habitat type), appeared to be typical habitat as described by Hamilton (1943:313) and Wright (1950).

Table 3. Livetrapping results.

Habitat type	Location	Number of livetraps	Mammals collected
Ponderosa pine/Idaho fescue	8	8	none
Subalpine fir/beargrass-grouse whortleberry	9	6	1 shrew (sp. ?) 1 red-backed vole 1-2 deer mice
Douglas-fir/ninebark-ninebark	10	8	none
Grand fir/queencup-queencup	11	2	1 deer mouse
Grand fir/unknown	11	6	none
Subalpine fir/bluejoint-bluejoint	12	8	none
Subalpine fir/menziesia	13	3	none
Cottonwood bottom	14	4	none

The northern flying squirrel, collected in a cottonwood bottom, was not caught in a trap but was found dead beside a trap. A necropsy showed the animal, a female, to be badly malnourished with pneumonic lungs and hemorrhaging on top of the head. Nothing else was found to indicate the cause of death, which may have resulted from shock and concussion when the weakened squirrel collided with a tree.

Relative abundance of mammals. One variation in trapline results was in the numbers of individuals collected per species. Given the assumption that mammals were collected in proportion to their population size, the relative abundance of each species thus varied from 1 habitat type to another. This assumption, however, may not be valid as several other factors (discussed later) can affect the number of individuals trapped in a given habitat type.

Community dominance. The community dominance index (Tables 2 and 4) is not only an inverse measure of diversity but is also a measure of the 2 most abundant species in a community. Jumping mice were the most dominant species wherever they were found except in the clearcut and ponderosa pine/Idaho fescue habitat types where deer mice dominated. The dominance of jumping mice may have been the result of competitive exclusion: because they are only active for 2.5-3 months, jumping mice can not afford to be restricted to sub-optimal areas. As a result, jumping mice exclude other species from the most productive areas of the habitat (Stinson 1976).

If any 1 species could be said to dominate the small mammal fauna of the Rattlesnake, the deer mouse would be that species. Deer mice were 1 of the 2 most abundant mammals (usually the most abundant) in all but 1 of the 13 habitats in which they were trapped. Only in the subalpine fir/beargrass-grouse whortleberry habitat type were

Table 4. Small mammal diversity indices for traplines.

#	Habitat type	Brillouin's formula	Evenness	Community dominance	Species richness
1	Douglas-fir/blue huckleberry-beargrass	0	0	1	1
2	Subalpine fir/queencup-menziesia	0.913	0.787	0.8	4
2	Clearcut	0.863	0.937	0.714	4
3	Douglas-fir/snowberry-pinegrass	-	-	-	0
3	Douglas-fir/snowberry-snowberry	0.230	0.417	1	2
4	Douglas-fir/twinflower-snowberry	0.310	0.531	1	2
5	Disturbed meadow	0	0	1	1
5	Douglas-fir/ninebark-ninebark	0	0	1	1
6	Grand fir/queencup-queencup	0.674	0.807	0.9	3
7	Subalpine fir/beargrass-blue huckleberry	0.322	0.699	1	2
8	Ponderosa pine/Idaho fescue	0.633	0.726	0.917	3
9	Subalpine fir/beargrass-grouse whortleberry	1.174	0.879	0.636	5
10	Douglas-fir/ninebark-ninebark	0	0	1	1
11	Grand fir/queencup-queencup	0	0	1	1
11	Grand fir/unknown	0.366	1	1	2
12	Subalpine fir/bluejoint-bluejoint	0.819	1	0.6	4
13	Subalpine fir/menziesia	1.236	0.907	0.6	5
14	Cottonwood bottom	0	0	1	1

deer mice not abundant. Apparently at high elevations (above 1850 m), red-backed voles replaced deer mice as a dominant species. This replacement occurred, for example, in the subalpine fir/bluejoint-bluejoint, subalpine fir/menziesia, and subalpine fir/beargrass-grouse whortleberry habitat types. Shrews, particularly vagrant shrews, also became dominant in the higher elevation communities.

Although chipmunks were often 1 of the more abundant species in a community, they could be considered dominant only where 1 other species was present (i.e., the Douglas-fir/snowberry-snowberry, Douglas-fir/twinflower-snowberry, and subalpine fir/beargrass-blue huckleberry habitat types). In general, though, red-tailed chipmunks were more abundant than the yellow pine.

Small mammal diversity. Small mammal diversity (as determined by Brillouin's formula) varied greatly from 1 habitat type to another (Table 4), a function of both the number of species (richness) and the number of individuals per species (evenness) present. Generally, as richness and evenness increase, diversity also increases. Furthermore, the fewer species present in a community, the more those species dominated that community, producing a higher community dominance index.

Diversity is apparently directly related to the elevation and shrub development of a particular location, and inversely related to the tree canopy closure (Figures 5, 6, and 7). However, only elevation shows a significant correlation with diversity (τ = 0.62 with a critical confidence value of 0.34); correlations with shrub development and tree canopy closure are not significant (τ = 0.086 and -0.072, respectively). Species richness is also strongly correlated with elevation (τ = 0.593) although less so than is Brillouin's diversity, a difference attributable to the evenness component of the latter index.

A partial correlation between diversity and elevation, holding the shrub development and tree canopy factors constant (τ = 0.624), indicates that the latter 2 habitat features do not influence diversity through their association with elevation. Even though it is not possible to calculate a critical confidence value for partial correlations, 0.624 is sufficiently greater than the critical ($p \leq 0.05$) value obtained for a full correlation (0.34) to be significant. In contrast, partial correlations between diversity and shrub development with elevation and canopy closure held constant, and between diversity and canopy closure with elevation and shrub development held constant, are not significant (τ = 0.226 and -0.173, respectively).

Part of the reason for the strong correlation of diversity with elevation involves 2 factors entirely coincidental to elevation. The first factor is the time of year a location was trapped, although only 3 locations, the disturbed meadow, Douglas-fir/ninebark-ninebark (at the higher elevation), and cottonwood bottom habitat types, are actually

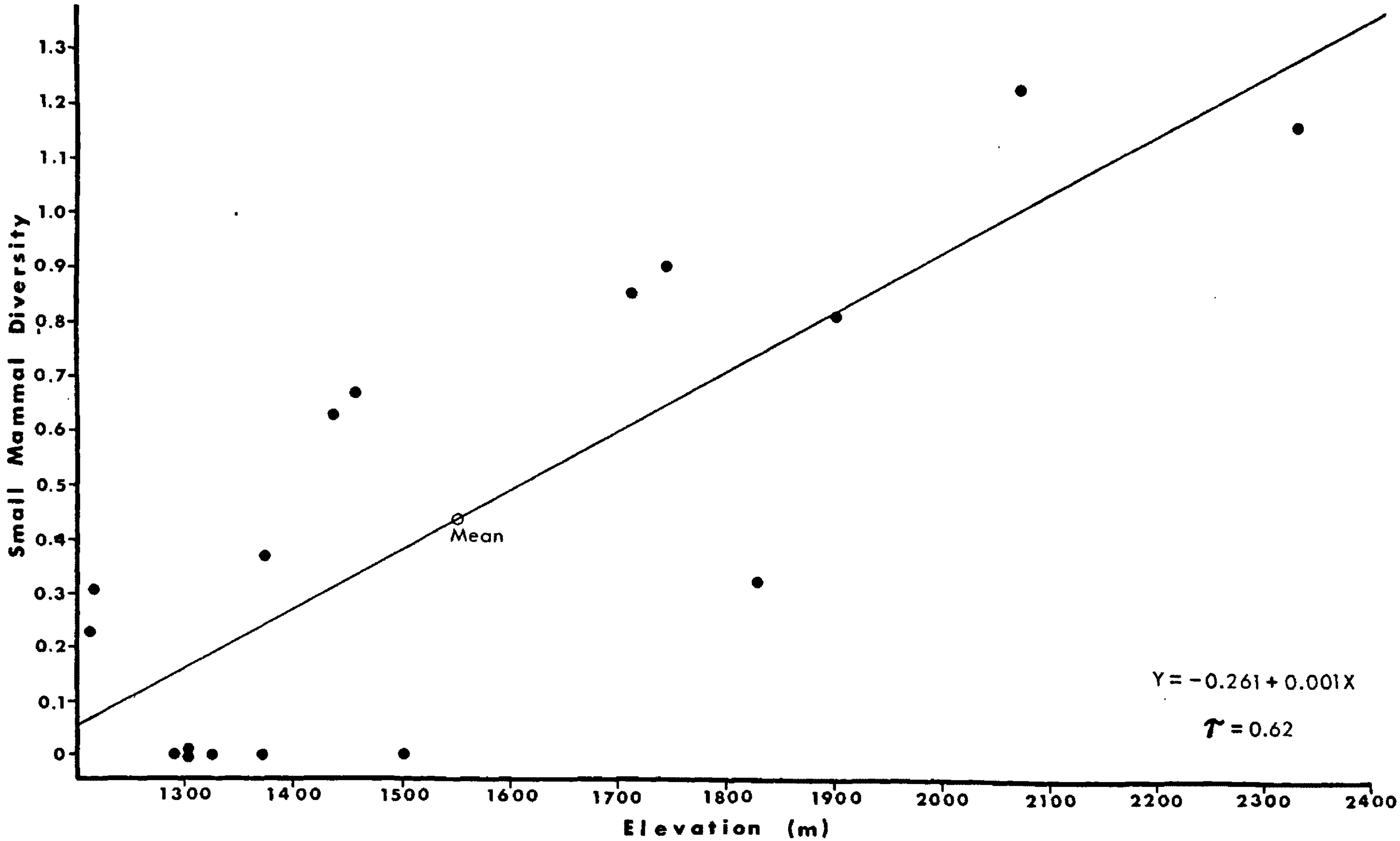

Figure 5. Relationship between small mammal diversity and elevation of traplines.

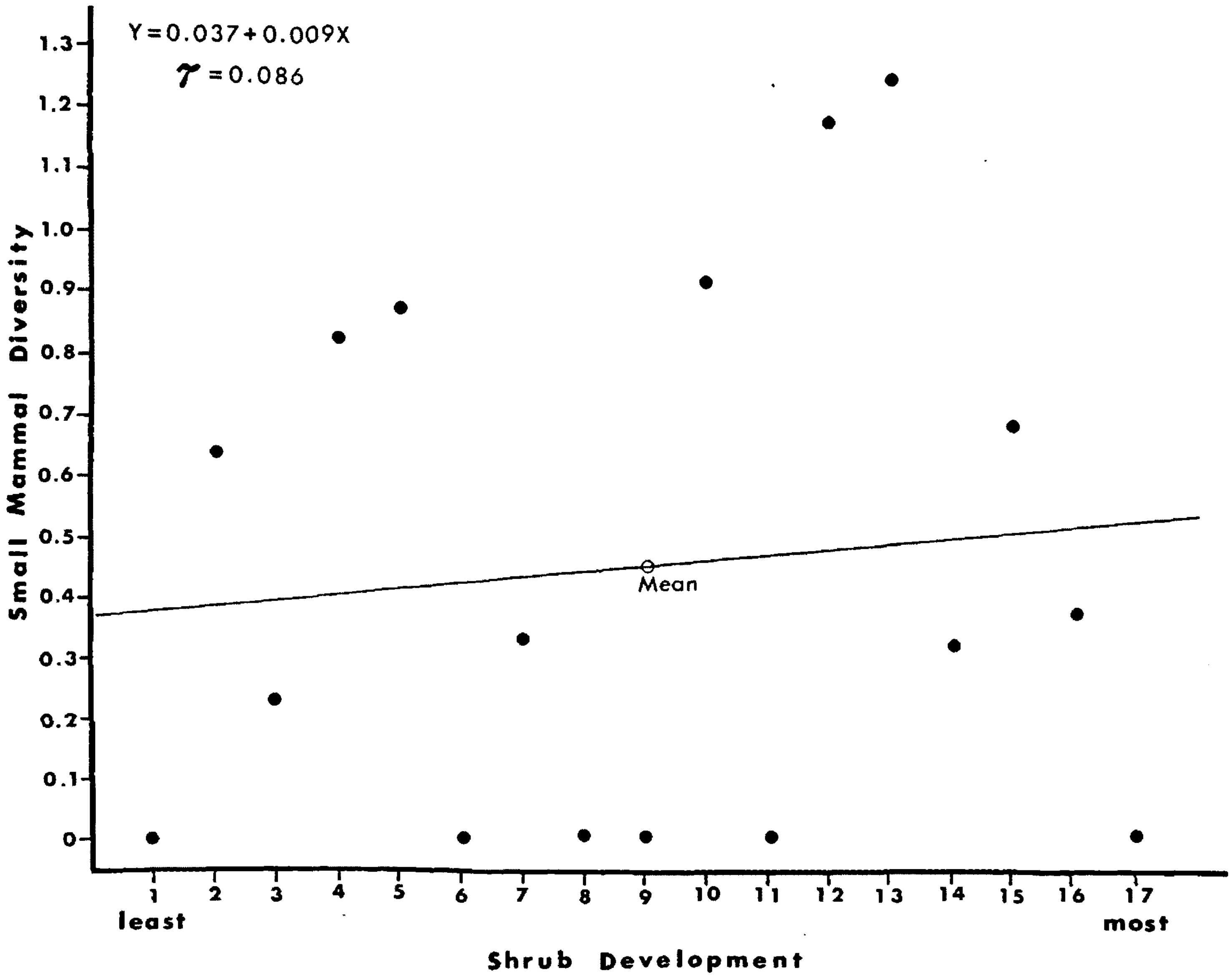

Figure 6. Relationship between small mammal diversity and shrub development.

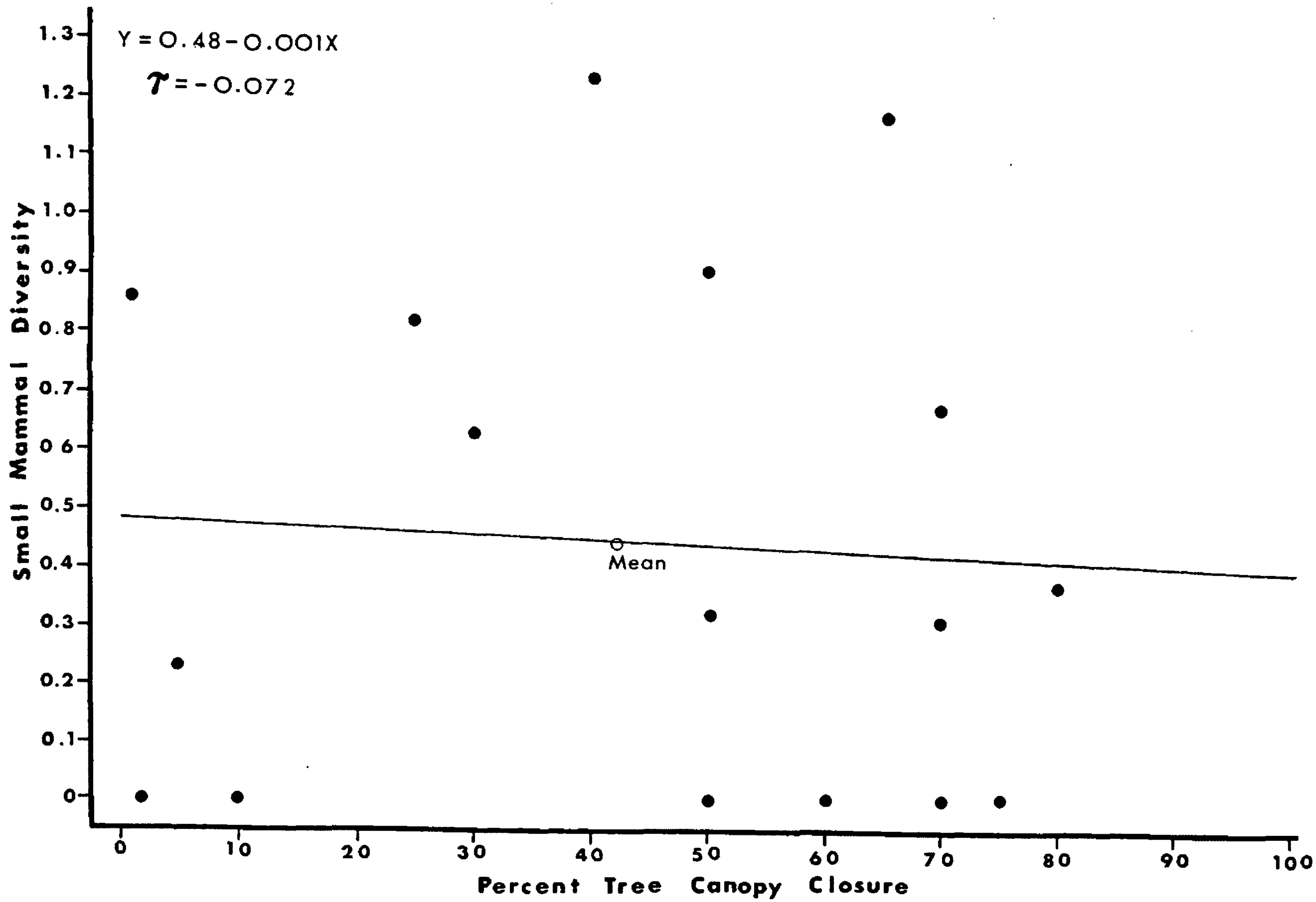

Figure 7. Relationship between small mammal diversity and tree canopy closure.

affected. All 3 sites were trapped in October, by which time at least 1 species, the western jumping mouse (Brown 1967), had begun hibernating. As a result, I could not collect individuals of this species if they were present in those locations and thus obtained lower diversity and richness values than if trapping had occurred earlier.

Secondly, human activities can produce an increase in small mammal populations and in diversity. Clevenger and Workman (1977) found that small mammal populations tended to be larger in campgrounds than in noncampground areas, probably because of the additional food made available by campers. Thus camping activities in the Twin Lakes and Little Lake areas of the Rattlesnake may partially account for the high diversity of small mammals in those subalpine fir/beargrass-grouse whortleberry and subalpine fir/menziesia habitat types, respectively.

Disturbances, such as fire and logging, by increasing population sizes, can also increase mammal species diversity for a time (Ahlgren 1966, Gashwiler 1970), as for example in the clearcut site. Differences in climate and microclimate, competition between species with similar ecological requirements, predators, and parasites are additional causes of diversity (Webb 1973).

Niche breadth. The niche breadths of the 12 species I collected varied depending on both the number of habitats in which each species occurred and how evenly each population was distributed among those habitats (Table 5). The masked shrew, northern bog lemming, long-tailed vole, meadow vole, and northern flying squirrel appeared to have the narrowest niches, as each occurred in a single habitat. Both the masked shrew and the bog lemming tend to be somewhat restricted in their distributions; the former by the presence of vagrant shrews and the latter by its habitat preferences (Hoffmann and Pattie 1968). Vole populations typically undergo cyclical fluctuations such that during low periods both the distribution and abundance of voles decrease, resulting in the narrow niche breadths observed for the long-tailed and meadow voles. The niche of the northern flying squirrel appears narrow largely because squirrels are not usually collected in snaptrap lines. Commonly occurring in subalpine, montane, and riparian cottonwood forests (Hoffmann and Pattie 1968), flying squirrels have been observed in at least 2 other habitats in the Rattlesnake, indicating a broader niche than was calculated.

The remaining species all show successively larger niche breadths, reflecting increasingly wider distributions. That most of the niche breadths are still relatively narrow indicates that those distributions are restricted by the habitat preferences of each species. In order of increasing niche breadth, red-backed voles generally prefer dense subalpine forests; yellow pine chipmunks occur in ponderosa pine and Douglas-fir forests; vagrant shrews in a variety of mesic habitats, red-tailed chipmunks in subalpine fir and spruce forests; and jumping mice in a variety of habitats from dry grasslands to mesic forests (Hoffmann and Pattie 1968). Deer mice have by far the broadest niche, occurring in nearly every habitat, as would be expected of this ubiquitous cricetine.

Table 5. Niche breadth along habitat dimension for mammals collected from traplines.

Species	Niche breadth
Unidentified shrew	0.111
Vagrant shrew	0.169
Masked shrew	0.056
Western jumping mouse	0.242
Deer mouse	0.485
Northern bog lemming	0.056
Red-backed vole	0.125
Long-tailed vole	0.056
Meadow vole	0.056
Yellow pine chipmunk	0.148
Red-tailed chipmunk	0.180
Northern flying squirrel	0.056

Niche overlap. A simple definition of niche overlap is the joint use of a resource, or resources, by 2 or more species (Colwell and Futuyma 1971). In other words, the higher the overlap value, the more 2 species use the same resource(s). Thus, masked and vagrant shrews use the same resource to a very great extent (Table 6, upper right portion); similarly for shrews and red-backed voles, shrews and

Table 6. Niche overlaps between species collected from traplines. Values in upper right of table calculated from Pianka (1973); those in lower left from Hurlbert (1978).

	Ssp.	Sv	Sc	Zp	Pm	Sb	Cg	Ml	Mp	Ea	Er	Gs
Ssp	1.0	.7	.7	.4	.1	0	1.0	0	0	0	.8	0
Sv	.3	1.0	.9	.2	.5	.3	.8	.1	.3	0	.6	0
Sc	7.2	1.2	1.0	0	0	0	.8	0	0	0	.7	0
Zp	0	0	0	1.0	.4	0	.3	.1	0	.1	.6	0
Pm	0	0	0	0	1.0	0	.1	.2	0	.8	.2	0
Sb	0	.2	0	0	0	1.0	.1	0	1.0	0	0	0
Cg	.4	0	1.0	0	0	.1	1.0	0	.1	0	.5	0
Ml	0	0	0	0	0	0	0	1.0	0	0	0	0
Mp	0	.2	0	0	0	15.6	.1	0	1.0	0	0	0
Ea	0	0	0	0	0	0	0	0	0	1.0	0	0
Er	.3	0	.7	0	0	0	0	0	0	0	1.0	0
Gs	0	0	0	0	0	0	0	0	0	0	0	1.0

Ssp. = unidentified shrew; Sv = vagrant shrew; Sc = masked shrew; Zp = western jumping mouse; Pm = deer mouse; Sb = northern bog lemming; Cg = red-backed vole; Ml = long-tailed vole; Mp = meadow vole; Ea = yellowpine chipmunk; Er = red-tailed chipmunk; Gs = northern flying squirrel.

red-tailed chipmunks, deer mice and yellow pine chipmunks, and meadow voles and bog lemmings.

However, Pianka's (1973) overlap measure assumes that overlap is partly a function of the species' niche width outside the overlap zone. A different (and perhaps more biologically appropriate) definition is the degree to which species occur together more or less than they would if each utilized each habitat in proportion to its abundance (Hurlbert 1978 and lower left portion of Table 6). On this basis, masked shrews and red-backed voles can be said to both utilize each habitat in proportion to its abundance. For bog lemmings and meadow voles, the probability of an interspecific encounter is almost 16 times higher than it would be if the 2 species were uniformly distributed among the habitats. For most species in the Rattlesnake, essentially no habitats are shared.

But overlap by itself does not imply the existence of competition between 2 species (Colwell and Futuyma 1971, Pianka 1974, Sale 1974, Hurlbert 1978). Pianka (1974) hypothesizes an inverse relationship: if resources are not in short supply, extensive niche overlap is then correlated with reduced competition. Similarly, disjunct niches may indicate an avoidance of competition in situations where it could potentially be severe (i.e., jumping mice and deer mice; cf. Stinson 1976). Sale (1974) further points out that an absence of niche overlap is only a possible, and probable, result of competitive interactions over time. The absence of overlap very likely can not be correlated with the intensity of competition, nor can it be used as evidence for the present existence of competitive interactions.

Trapping susceptibility. Several factors, through their effect on trapping susceptibility, may well have influenced my trapline results. Susceptibility to trapping differs from 1 species to another (Getz 1961). Some species are readily caught in traps whereas other species seem to avoid traps.

Daily weather conditions can affect susceptibility (Getz 1961) in that many animals are less active on cold and/or rainy days, and are therefore less likely to get caught, than on warm clear days. My data indicate that yearly weather conditions also affect trapping success. More animals (both in number of individuals and number of species) were collected in 1978, a relatively wet year, than during 1977, a relatively dry year.

Seasonal differences in trapping success not only occur but vary between species (Fitch 1954). Fitch observed that baits were least attractive when natural foods were abundant (in the spring and early summer). The best catches were most likely to be made when the preferred foods were in short supply, even though the population was at its annual low point. Furthermore, seasonal differences were small for some species of mammals (i.e., deer mice) and very large for other species (such as jumping mice whose above ground activities and trapping susceptibility are limited to the summer months).

Livetrapping success. The livetraps used with snaptraps in 7 locations were not very successful, although the information thus gained was important in diversity and niche measurements. Mammals were caught in livetraps in just 2 locations, represented by the subalpine fir/beargrass-grouse whortleberry and grand fir/queencup-queencup habitat types (Table 3). Additionally, except for a shrew in the subalpine fir/beargrass-grouse whortleberry type, the livetrapped species were also collected in snaptraps. As a result, the only information gained from livetrapping was the presence of an unidentified shrew in 1 location and larger population sizes for deer mice and red-backed voles.

The major reason for my lack of success with livetraps is probably that small mammals reacted negatively to the livetraps and avoided them. That I often collected specimens in snaptraps immediately adjacent to an unsuccessful livetrap seems to support this conclusion.

Other mammals. Seven other species of mammals were noted as present in the trapline locations (Table 7), based largely on sign (tracks, scats, diggings, and middens). Red squirrels were common in forested areas, and columbian ground squirrels and northern pocket

Table 7. Additional mammals noted as present along traplines.

#	Habitat type	Red squirrel	Columbian ground squirrel	Northern pocket gopher	Porcupine	Leporid	Black bear	Coyote
1	Douglas-fir/blue huckleberry-beargrass			X	X	X		
2	Subalpine fir/queencup-menziesia							
2	Clearcut							
3	Douglas-fir/snowberry-pinegrass		X					
3	Douglas-fir/snowberry-snowberry		X					
4	Douglas-fir/twinflower-snowberry							
5	Disturbed meadow		X	X				
5	Douglas-fir/ninebark-ninebark	X						
6	Grand fir/queencup-queencup	X				X		
7	Subalpine fir/beargrass-blue huckleberry					X		X
8	Ponderosa pine/Idaho fescue		X				X	
9	Subalpine fir/beargrass-grouse whortleberry					X		
10	Douglas-fir/ninebark-ninebark	X				X	X	
11	Grand fir/queencup-queencup	X				X	X	
11	Grand fir/unknown							
12	Subalpine fir/bluejoint-bluejoint							
13	Subalpine fir/menziesia	X						
14	Cottonwood bottom	X					X	

gophers in locations with an open tree canopy, as is typical for these species (Hoffmann and Pattie 1968). Leporids could not be identified to species from their pellets but were most likely snowshoe hares. Occupying montane and subalpine forest habitats (Hoffmann and Pattie 1968), snowshoe hares were the only leporids I observed in those habitats. Black bear scats were found in lower elevation sites and apparently were left in early summer.

Scent Station Lines

Habitat types. The scent station lines passed through a wide variety of vegetational types, with 15 habitat types and 6 additional cover types represented (Table 8; Appendix E).

Operative stations. All scent stations containing tracks on a particular day were considered operative for that day, along with those stations dry enough to retain track impressions had they been visited by mammals. Only 3 stations were thus deemed inoperative for 1 day each (the result of rain or moisture seeps); other stations in a similar condition were operative only because some tracks (usually deer) were present.

Mammal tracks. The 2 scent station lines were operative a total of 447 station-nights, 248 nights for the first line (29 July-2 August) and 199 nights for the second (9-13 September). I noted 583

Table 8. Vegetational types adjacent to scent stations.

Vegetational type	Number of stations
Douglas-fir/ninebark	1
Douglas-fir/ninebark-ninebark	7
Douglas-fir/ninebark-pinegrass	2
Douglas-fir/blue huckleberry-blue huckleberry	1
Douglas-fir/snowberry-snowberry	2
Douglas-fir/pinegrass-bluebunch wheatgrass	1
Douglas-fir/white spirea	3
Grand fir/beargrass	1
Grand fir/queencup-queencup	1
Subalpine fir/queencup-queencup	2
Subalpine fir/queencup-beargrass	8
Subalpine fir/queencup-menziesia	1
Subalpine fir/beargrass-blue huckleberry	5
Subalpine fir/beargrass-grouse whortleberry	1
Subalpine fir/elk sedge-Douglas-fir	1
Clearcut	5
Creek bottom	1
Disturbed meadow	2
Rock scree	3
Forested scree	4
Disturbed shrub	1

wild animal visits by such species as the western jumping mouse, deer mouse, red squirrel, columbian and golden-mantled ground squirrels, bushy-tailed woodrat, porcupine, black bear, marten, badger, bobcat, red fox, coyote, and elk. Also noted but not identified by species were mice, chipmunks, ground squirrels, leporids, weasels, skunks, and deer (Appendix F). Sixty-eight visits by domestic dogs were recorded, as were 19 by humans (either footprints or motorcycle tracks) and 1 by a domestic cat.

Mammal species diversity. The relationship between the 4 diversity indices used with scent station data (the Shannon formula, evenness, species richness, and community dominance) is the same as for those used with trapline data (Table 9). As species richness and evenness, the 2 components of mammalian species diversity, increase, so does diversity. The community dominance index, on the other hand, is highest when the other 3 indices are lowest.

Unlike trapline diversities, however, scent station diversities showed no correlation at all with elevation (Figure 8) or with successional factors (correlation coefficient equals 0.0003). Diversity was probably influenced more by the road itself than by habitat type. Some mammal species may have avoided the road, even though present in an adjacent habitat type, as a result of human use of the road. For other mammals, especially porcupines, coyotes, and deer, the road served

Table 9. Mammalian diversity indices for scent station lines.

#	Habitat type	Shannon formula			Evenness			Community dominance			Species richness		
		JA	S	C	JA	S	C	JA	S	C	JA	S	C
1	Clearcut	1.39	-	1.39	0.86	-	0.86	0.55	-	0.55	5	0	5
2	Clearcut	1.51	-	1.51	0.94	-	0.94	0.63	-	0.63	5	0	5
3	Clearcut	1.52	-	1.52	0.94	-	0.94	0.56	-	0.56	5	0	5
4	Subalpine fir/queencup-beargrass	0.50	-	0.50	0.72	-	0.72	1.0	-	1.0	2	0	2
5	Subalpine fir/queencup-beargrass	1.06	-	1.06	0.96	-	0.96	0.80	-	0.80	3	0	3
6	Subalpine fir/queencup-menziesia	2.06	-	2.06	0.94	-	0.94	0.50	-	0.50	9	0	9
7	Clearcut	1.75	-	1.75	0.97	-	0.97	0.40	-	0.40	6	0	6
8	Forested scree	0.56	-	0.56	0.81	-	0.81	1.0	-	1.0	2	0	2
9	Subalpine fir/queencup-beargrass	0.63	-	0.63	0.92	-	0.92	1.0	-	1.0	2	0	2
10	Subalpine fir/queencup-beargrass	1.51	-	1.51	0.94	-	0.94	0.60	-	0.60	5	0	5
11	Subalpine fir/queencup-beargrass	0.0	-	0.0	-	-	-	1.0	-	1.0	1	0	1
12	Subalpine fir/queencup-beargrass	1.01	-	1.01	0.92	-	0.92	0.83	-	0.83	3	0	3
13	Clearcut	1.82	-	1.82	0.95	-	0.95	0.40	-	0.40	8	0	8
14	Subalpine fir/queencup-queencup	1.08	1.56	1.69	0.99	0.97	0.93	0.71	0.50	0.53	3	5	6
15	Subalpine fir/beargrass-blue huckleberry	1.33	1.09	1.48	0.96	0.99	0.92	0.60	0.73	0.63	4	3	5
16	Subalpine fir/queencup-beargrass	1.04	1.34	1.84	0.95	0.97	0.96	0.75	0.64	0.47	3	4	7
17	Subalpine fir/beargrass-blue huckleberry	1.54	1.25	1.85	0.96	0.90	0.96	0.57	0.80	0.50	5	4	7
18	Subalpine fir/beargrass-blue huckleberry	1.06	0.69	1.24	0.96	1.0	0.89	0.80	1.0	0.73	3	2	4
19	Douglas-fir/blue huckleberry-blue huckleberry	1.27	0.69	1.21	0.92	1.0	0.87	0.71	1.0	0.77	4	2	4
20	Subalpine fir/queencup-beargrass	1.81	1.47	1.89	1.0	0.91	0.87	0.33	0.75	0.50	6	5	9
21	Subalpine fir/beargrass-blue huckleberry	1.39	1.46	1.90	1.0	0.91	0.90	0.50	0.64	0.53	4	5	8
22	Subalpine fir/beargrass-grouse whortleberry	1.25	1.52	1.99	0.90	0.94	0.94	0.67	0.58	0.39	4	5	8
23	Subalpine fir/beargrass-blue huckleberry	0.69	1.52	1.77	1.0	0.94	0.98	1.0	0.53	0.42	2	5	6
24	Subalpine fir/queencup-queencup	1.01	1.19	1.72	0.92	0.86	0.89	0.83	0.80	0.50	3	4	7
25	Forested scree	0.67	1.47	1.50	0.97	0.91	0.93	1.0	0.62	0.56	2	5	5
26	Forested scree	0.63	1.15	1.47	0.92	0.83	0.91	1.0	0.71	0.62	2	4	5
27	Forested scree	1.27	1.50	1.48	0.92	0.93	0.92	0.71	0.62	0.55	4	5	5
28	Rock scree	0.56	0.0	1.0	0.81	-	0.91	1.0	1.0	0.86	2	1	3
29	Grand fir/beargrass	1.10	0.0	1.15	1.0	-	0.83	0.67	1.0	0.71	3	1	4
30	Disturbed shrub	0.0	0.0	0.50	-	-	0.72	1.0	1.0	1.0	1	1	2
31	Subalpine fir/elk sedge-Douglas-fir	1.36	1.51	1.63	0.84	0.94	0.90	0.70	0.57	0.54	5	5	6
32	Douglas-fir/ninebark-ninebark	1.74	1.24	2.16	0.96	0.89	0.94	0.43	0.73	0.44	6	4	10
33	Douglas-fir/ninebark-ninebark	1.61	1.51	1.98	1.0	0.94	0.93	0.50	0.63	0.50	5	5	8
34	Douglas-fir/ninebark-ninebark	1.73	1.06	1.81	0.96	0.97	0.94	0.44	0.78	0.50	6	3	7
35	Grand fir/queencup-queencup	0.69	1.54	1.89	1.0	0.96	0.98	1.0	0.57	0.44	1	6	7
36	Disturbed meadow	-	0.96	0.96	-	0.87	0.87	-	0.86	0.86	0	3	3
37	Douglas-fir/ninebark-ninebark	1.27	1.80	2.09	0.92	0.93	0.96	0.71	0.54	0.40	4	7	9
38	Rock scree	1.52	1.24	1.81	0.94	0.89	0.94	0.56	0.73	0.45	5	4	7
39	Douglas-fir/ninebark	1.33	1.29	1.41	0.96	0.93	0.88	0.60	0.64	0.63	4	4	5
40	Douglas-fir/ninebark-pinegrass	-	0.87	0.87	-	0.79	0.79	-	0.83	0.83	0	3	3
41	Douglas-fir/ninebark-pinegrass	0.0	0.66	0.94	0.0	0.95	0.85	1.0	1.0	0.89	1	2	3
42	Disturbed meadow	1.06	1.24	1.55	0.96	0.89	0.86	0.80	0.73	0.63	3	4	6
43	Creek bottom	0.63	0.46	1.15	0.92	0.66	0.83	1.0	1.0	0.78	2	2	4
44	Douglas-fir/ninebark-ninebark	1.57	0.90	1.17	0.98	0.82	0.89	0.50	0.88	0.57	5	3	7
45	Douglas-fir/ninebark-ninebark	0.69	1.61	1.67	1.0	1.0	0.92	1.0	0.40	0.56	2	5	6
46	Douglas-fir/ninebark-ninebark	1.33	1.54	1.88	0.96	0.96	0.98	0.67	0.57	0.39	4	5	7
47	Forested scree	0.0	1.04	1.33	0.0	0.95	0.96	1.0	0.75	0.60	1	3	4
48	Douglas-fir/white spirea	0.0	-	0.0	0.0	-	0.0	1.0	-	1.0	1	0	1
49	Douglas-fir/white spirea	0.69	0.69	1.39	1.0	1.0	1.0	1.0	1.0	0.50	2	2	4
50	Douglas-fir/snowberry-snowberry	0.69	0.0	1.20	1.0	0.0	1.0	1.0	1.0	0.67	2	1	3
51	Douglas-fir/white spirea	-	-	-	-	-	-	-	-	-	0	0	0
52	Douglas-fir/snowberry-snowberry	-	0.0	0.0	-	0.0	0.0	-	1.0	1.0	0	1	1
53	Douglas-fir/pinegrass-bluebunch wheatgrass	-	0.0	0.0	-	0.0	0.0	-	1.0	1.0	0	1	1

JA = July-August line; S = September line; C = combined July-August and September lines.

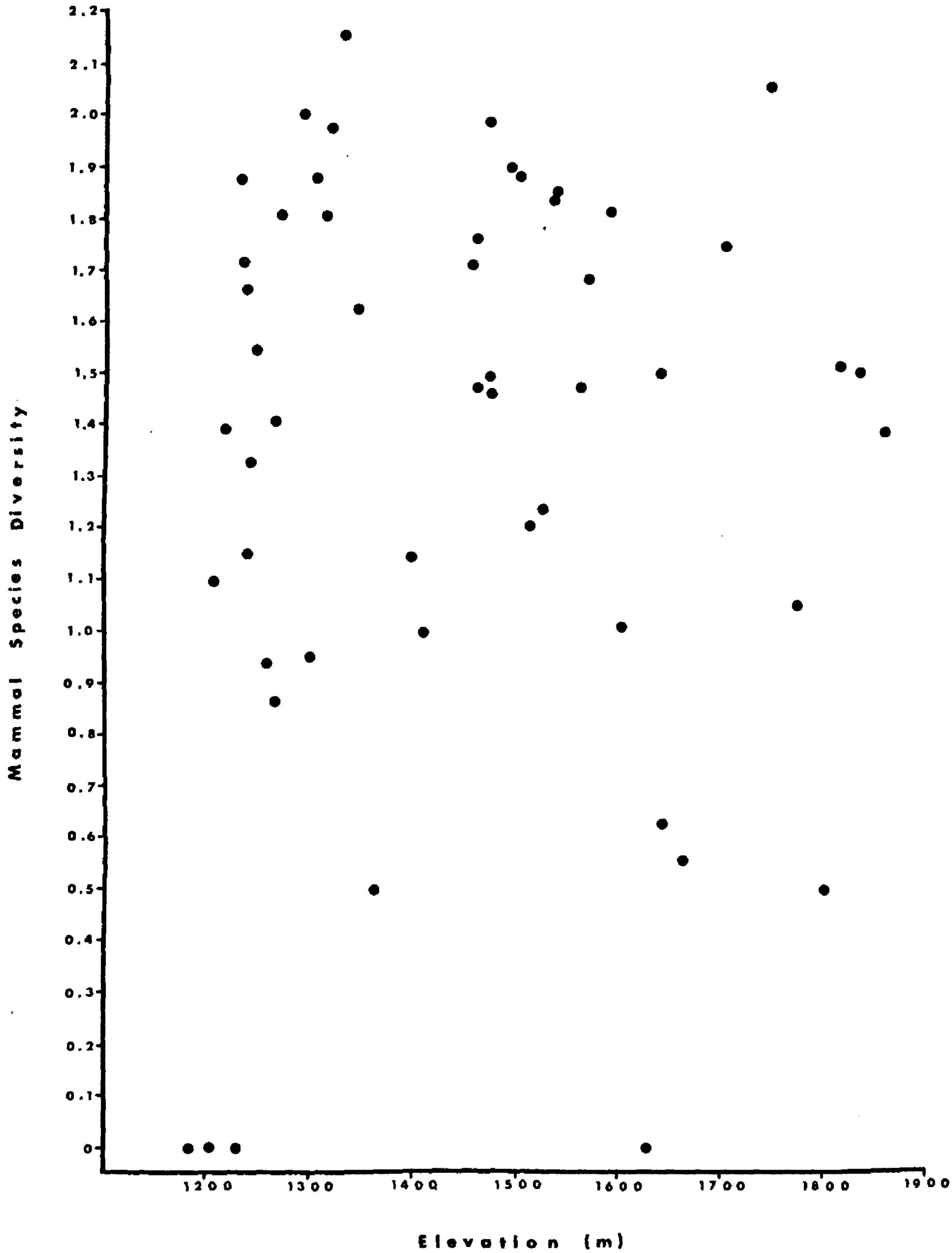

Figure 8. Relationship between mammalian species diversity and elevation (combined July-August and September scent station lines).

as a travel corridor. These mammals were not only more likely to visit the scent stations, but probably did so irrespective of habitat type. The Rattlesnake Road was most likely not a barrier to movements by small forest mammals because of its narrow width and relative low traffic density (Oxley et al. 1974). The large number of visits to the scent stations by small mammals would confirm that the road, in this case at least, was not a barrier.

Habitat did exert a little influence on the community dominance index in terms of what species were dominant in a particular scent station. Mice, primarily deer mice, and/or chipmunks (both species) were the most abundant species in almost every station, regardless of habitat. Ground squirrels, usually golden-mantled, were dominant in a number of different habitats although less often than mice or chipmunks and only in the July-August line. Red squirrels and porcupines, however, were dominant only in those stations adjacent to forested areas, and bushy-tailed woodrats in stations near rock slides or rocky slopes.

Diversity values did differ somewhat from the July-August line to the September line. For the 34 stations that were visited by mammals during both months, the average diversity was higher in September ($\overline{X} = 1.1$) than in July-August ($\overline{X} = 1.05$; average difference between the 2 means is -0.05 ± 0.19). This difference is probably related to food availability. Because less food is available in

September than earlier in the summer, animals must wander further afield in search of food, and are therefore more likely to visit the scent stations. The September values also seemed directly related to those of July-August (Figure 9) although the correlation coefficient ($r = 0.053$) was not significant.

Niche breadth. Except for the coyote, carnivores all appeared to have very narrow niches (Table 10). Two species, the badger and bobcat, were noted only once and may have been transient rather than resident in the Drainage. Based on observations of sign and of the animals, black bears, weasels, marten, and coyotes all utilize a wider range of habitats than was indicated by scent station visits. Apparently carnivores either avoided the road altogether or, if using the road, simply were not attracted by the isovaleric acid in the scent capsules.

Western jumping mice also appeared to have a very narrow niche, in sharp contrast to the much broader niche determined from trapline data. As with carnivores, jumping mice were not attracted to the scent stations. No visits were recorded at all during September, because jumping mice had already begun hibernating (Brown 1967).

The unidentified leporids were most likely snowshoe hares as they were the only leporids seen in the study area. However, sightings, pellets, and tracks were noted in a great many habitats for a much

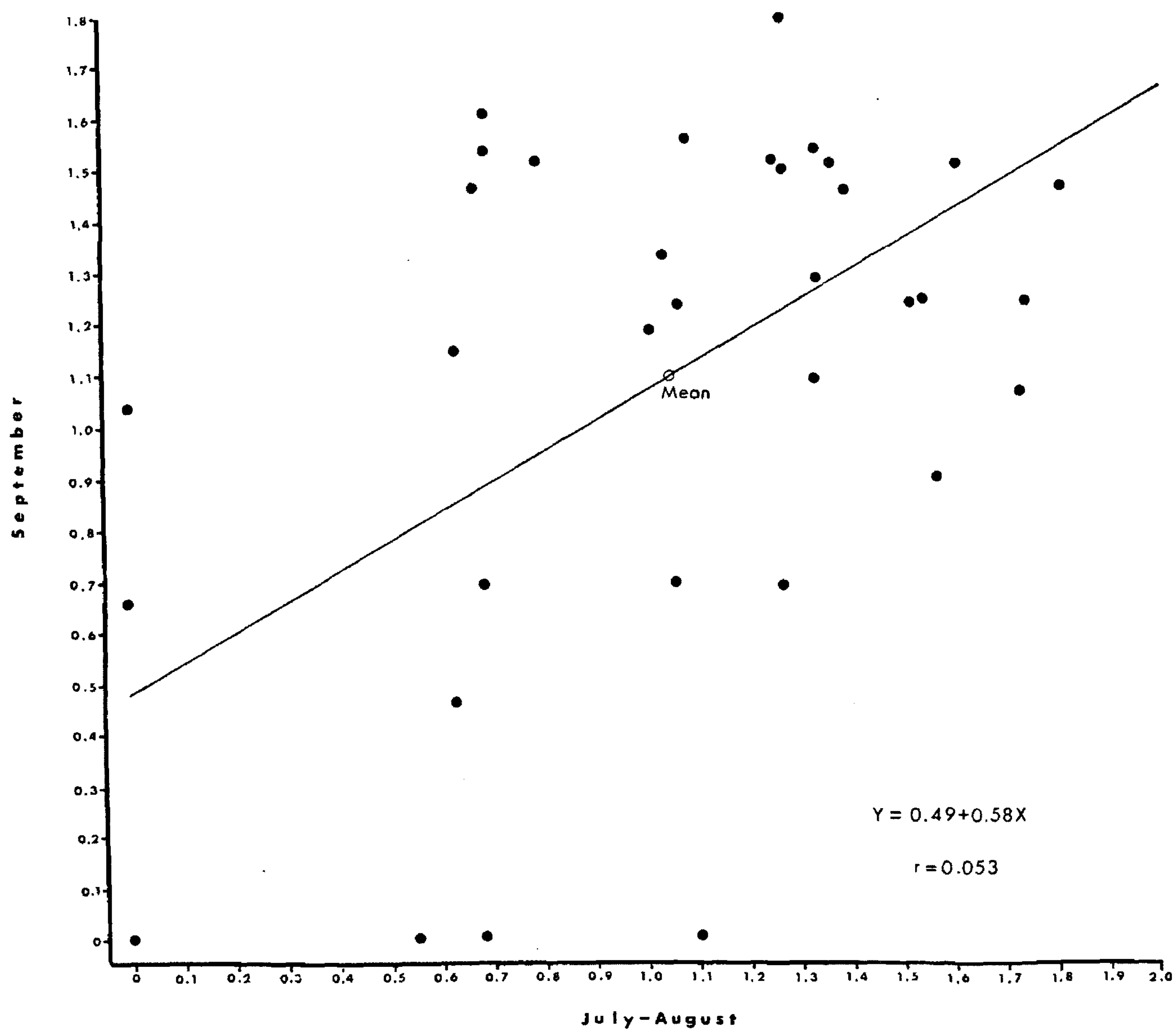

Figure 9. Relationship between mammalian species diversities from July-August and September scent station lines.

Table 10. Niche breadths along habitat dimension for mammals that visited scent stations.

Species	Niche breadth		
	July-August	September	Combined
Unidentified cricetid	0.286	0.019	0.279
Western jumping mouse	0.068	-	0.068
Deer mouse	0.279	0.520	0.524
Chipmunk	0.456	0.455	0.629
Red squirrel	0.155	0.185	0.289
Unidentified ground squirrel	0.094	-	0.094
Columbian ground squirrel	0.209	0.019	0.285
Golden-mantled ground squirrel	0.487	0.135	0.509
Bushy-tailed woodrat	0.057	0.078	0.148
Porcupine	0.038	0.165	0.172
Unidentified leporid	0.075	0.019	0.094
Black bear	0.034	-	0.034
Weasel	0.057	-	0.057
Marten	0.034	0.019	0.030
Skunk	0.057	0.049	0.086
Badger	-	0.019	0.019
Bobcat	-	0.019	0.019
Red fox	0.038	-	0.038
Coyote	0.038	0.139	0.189

wider niche than was obtained from scent station visits.

The niches of the bushy-tailed woodrat and the porcupine were very narrow in July-August but widened in September, possibly because both species were traveling more in search of food. Neither species would be expected to have very wide niches as woodrats generally prefer rocky areas and porcupines forested areas (Hoffmann and Pattie 1968). That expectation was apparently borne out by my data although both species may actually have a somewhat wider niche than I found.

Red squirrels had a relatively broad niche, reflecting a wider distribution and greater abundance than the aforementioned species. Like porcupines, red squirrels prefer forested habitats (Hoffmann and Pattie 1968) and were found only in those stations adjacent to such habitats.

Of the 2 ground squirrel species, the columbian ground squirrel had a narrower niche than did the golden-mantled, a reflection of their habitat preferences. The latter species usually occurs in a wide variety of habitats whereas the former prefers habitats with relatively open canopies. The 2 species further had considerably broader niches in July-August than in September as a result of their hibernating. Adult columbians generally begin hibernating in August and only the young of the year are still active in September (Manville 1959). Golden-mantled ground squirrels usually begin hibernating somewhat later in the fall (late September at the earliest) although the actual date varies from place to place (Gordon 1943).

Both unidentified cricetids and deer mice had fairly broad niches in July-August with the former's becoming narrower in September and the latter's much wider. The variation in niche width is probably more the result of inaccurate track identification than anything else. Some "unidentified mouse" tracks may have been made by deer mice and some "deer mice" in September may have been voles. However, because deer mice can occur in such a wide number of habitats, their niche should be quite wide, as it is in the Rattlesnake.

Chipmunks had the broadest niche of the mammals visiting scent stations, and it did not vary between the 2 months. Although the tracks could not be identified down to species, both species observed in the traplines undoubtedly occurred in the scent stations. My calculated niche width is thus a combination of 2 niches, those of the yellow pine (lower elevation, Douglas-fir and ponderosa pine forests) and the red-tailed chipmunk (upper elevation, spruce and subalpine fir forests).

Niche overlap. Niche overlap varied somewhat not only between prey species pairs but also from 1 month to the next (Table 11). Joint use of the habitat was moderate for most species pairs, just as the probability of interspecific encounter for most pairs tended to be somewhat greater than it would be if both species were uniformly

Table 11. Niche overlaps between prey species that visited scent stations. Values in upper right of tables calculated from Pianka (1973); those in lower left from Hurlbert (1978).

	Cri.	Zp	Pm	Esp.	Th	Ssp.	Sc	Sl	Nc	Ed	Lep.
July-August											
Cri.	1.0	.5	.6	.6	.2	.1	.2	.4	0	.1	.2
Zp	3.4	1.0	.7	.2	.1	0	.1	.1	0	0	.2
Pm	2.2	4.7	1.0	.7	.3	0	.1	.5	.1	0	.3
Esp.	1.6	1.3	1.8	1.0	.4	.3	.7	.7	.2	.2	.2
Th	.8	.8	1.2	1.3	1.0	0	.2	.2	0	0	0
Ssp.	.9	0	0	1.5	0	1.0	.3	0	.3	.3	.2
Sc	.9	.9	.3	2.2	1.3	2.2	1.0	.4	.2	.1	.2
Sl	1.0	1.2	1.4	1.4	.8	.9	1.1	1.0	.4	.1	.3
Nc	0	0	.7	1.4	0	3.5	1.8	2.1	1.0	.4	0
Ed	1.1	0	0	1.4	0	5.3	1.3	1.1	8.8	1.0	.3
Lep.	1.1	.7	2.1	1.1	0	2.7	1.5	1.3	0	0	1.0
September											
Cri.	1.0	0	.1	.2	0	0	0	0	0	.2	0
Zp	0	1.0	0	0	0	0	0	0	0	0	0
Pm	1.6	0	1.0	.8	.4	0	.2	.3	.4	.2	.1
Esp.	1.6	0	1.7	1.0	.5	0	.2	.3	.5	.3	.1
Th	0	0	1.4	1.7	1.0	0	0	.4	.2	.1	0
Ssp.	0	0	0	0	0	1.0	0	0	0	0	0
Sc	0	0	2.1	1.6	0	0	1.0	0	.1	.2	0
Sl	0	0	1.3	1.4	2.4	0	0	1.0	.3	.2	.3
Nc	0	0	1.9	2.6	1.5	0	2.1	3.3	1.0	.4	0
Ed	3.7	0	.8	1.5	.7	0	3.7	1.1	3.6	1.0	0
Lep.	0	0	.5	.5	0	0	0	5.3	0	0	1.0
Combined											
Cri.	1.0	.5	.5	.7	.3	.1	.4	.4	.2	.1	.1
Zp	3.4	1.0	.4	.2	.1	0	.1	.2	0	.1	.2
Pm	1.3	1.8	1.0	.8	.2	.1	.5	.7	.4	.3	.3
Esp.	1.6	1.0	1.4	1.0	.6	.3	.5	.9	.4	.4	.3
Th	.9	.8	1.5	1.5	1.0	.3	.4	.4	.2	.2	.1
Ssp.	.9	0	.6	1.4	.6	1.0	.3	.1	.1	0	.2
Sc	1.2	.9	1.2	1.2	1.3	2.0	1.0	.5	.5	.4	.3
Sl	1.0	1.0	1.3	1.5	1.0	.4	1.3	1.0	.7	.4	.2
Nc	.8	0	1.3	1.5	.8	.6	2.4	2.4	1.0	.3	0
Ed	.6	1.2	.9	1.1	.9	.3	2.0	1.3	1.6	1.0	0
Lep.	.1	1.8	1.2	1.2	.6	2.1	1.9	1.0	.3	0	1.0

Cri. = unidentified cricetid; Zp = western jumping mouse; Pm = deer mouse; Esp. = chipmunk; Th = red squirrel; Ssp. = unidentified ground squirrel; Sc = columbian ground squirrel; Sl = golden-mantled ground squirrel; Nc = bushy-tailed woodrat; Ed = porcupine; Lep. = unidentified leporid.

distributed among the habitats. A few species overlapped considerably, such as deer mice and chipmunks, chipmunks and golden-mantled ground squirrels (both in terms of habitat use), and porcupines and bushy-tailed woodrats (frequency of interspecific encounter). Other species showed no overlap at all.

Overlap increased in September for some pairs because those species traveled more in search of food. For other pairs, overlap decreased as a result of 1 or both members of a pair having begun hibernation.

Little niche overlap was apparent between predator species (Table 12). Use of the same habitats (O_{jk} value) was not great for any of the 4 pairs that did overlap. However, the frequency of interspecific encounters (L value) tended to be 3-6 times greater than would be expected if both species were uniformly distributed amongst the resource states. Evidently, most predators tend to avoid the road,

Table 12. Niche overlaps between predator species that visited scent stations.

	O_{jk} (Pianka 1973)	L (Hurlbert 1978)
Marten-skunk		
July-August line	.3	5.8
Combined lines	.3	5.8
Skunk-red fox		
Combined lines	.2	2.7
Skunk-coyote		
Combined lines	.1	.5
Red fox-coyote		
Combined lines	.2	2.7

hence the low overlap values. But, when they do use the road, they tend to use only certain portions, resulting in a relatively high probability of interspecific encounter.

Factors affecting scent station results. The time of year a scent station line is used can greatly affect the results. Population sizes are higher during late summer than at any other time, increasing the likelihood that a particular species will visit a scent station. Food also becomes scarcer as summer progresses so animals must cover more territory to find food, and are thus more likely to visit a station. The number of visits made by some species will decline markedly, perhaps ceasing altogether, in lines used during September or later as those species begin hibernation.

The obliteration of tracks by wind, rain, and other animals (deer, for instance) undoubtedly occurred frequently in both lines. As a result, both the number of species visiting stations and the frequency of visits may be inaccurate.

Rodents may have responded to the dirt covering each station rather than to the isovaleric acid in the scent capsules. On 2 occasions, golden-mantled ground squirrels were observed eating this dirt, which had been brought into the Rattlesnake Drainage from the National Bison Range. Minerals lacking in Rattlesnake soils but present in Bison Range soil may well have served to attract rodents.

Wild carnivores were not strongly attracted to the scent stations. Avoidance of the road may partially explain the low frequency of carnivore visits, but not entirely. Two individuals during July-August and 1 during September were observed in the vicinity of operative stations; yet, for some unknown reason, none of the 3 (a coyote, cougar, and black bear, respectively) visited those stations.

The only carnivorous species strongly attracted was the domestic dog with 68 recorded visits. That dogs were very common in the Drainage below Franklin Bridge, either with or without human companions, was confirmed by observation. However, some "dog" tracks may actually have been coyote (and vice versa) as it can be difficult to distinguish between the 2.

The road itself, used as a travel corridor by some species and avoided by others, had some effect on animal visits to the scent stations. Inaccurate track identification may also have influenced results to some extent, particularly for cricetids and canids.

Other Mammal Data

Trapping. The old homestead below Fraser Creek included 3 types of vegetation:

1) Douglas-fir/snowberry habitat type with Douglas-fir the dominant tree (Engelmann spruce, lodgepole and ponderosa pine, and western larch were also present) and serviceberry,

ninebark, white spirea, Rocky Mountain maple, and snowberry in the undergrowth;

2) a small wet meadow of sedges and rushes with some alder and water birch; and

3) a large disturbed meadow comprised mostly of knapweed, bluebunch wheatgrass, and other exotic grasses.

Eight deer mice were caught during the trapping period, all at least once in the dry meadow. Three of them were also caught in the Douglas-fir/snowberry habitat type, and 1 a third time in the wet meadow. A yellow pine chipmunk (found dead in the trap) and a bushy-tailed woodrat were also trapped in the Douglas-fir/snowberry habitat type.

The vegetation adjoining the campsite next to Franklin Bridge was classified into the grand fir/queencup habitat type. Grand fir and Engelmann spruce were the only trees present and the undergrowth was predominantly yew. Some bedstraw and queencup were also present. Four deer mice were snaptrapped and a bushy-tailed woodrat was live-trapped at this site.

No additional information was gained by trapping either of these sites except for the presence of woodrats. Given my trapline data, the results were generally what I would expect for the vegetational types. The large number of deer mice collected near Franklin Bridge would also be expected because this particular site was heavily used by campers (Clevenger and Workman 1977).

Mammalian sign. I observed the tracks of the following mammals in snow: mice (probably deer mice), red squirrels, and snowshoe hares frequently, and coyotes occasionally, throughout the lower part of the study area; red-tailed chipmunk and black bear on a snow patch near Mosquito Peak in September; black bear on the Sheep Mountain trail in January; yellow pine chipmunk, also on a snow patch, in April; porcupine and marten along the main road above Pilcher Creek; and weasel just off the main road about 1.5 km above the locked gate. Black bear tracks were also seen on muddy ground along trails.

Scats indicated the presence of leporids, black bear, and coyotes, although coyote scats for the most part occurred only along trails and roads. I also observed diggings of columbian ground squirrels and pocket gophers, and red squirrel middens. Beaver cuttings and 2 attempted dams (both in the same location but in 2 consecutive years) were found near or on Rattlesnake Creek north of Fraser Creek.

Observations of mammalian sign were used primarily to indicate the presence of a particular species in the study area. The only conclusions made regarding habitat use or population size are as follows:

1) pocket gophers were common in low-elevation meadows and along the road edges;
2) columbian ground squirrels occurred frequently in open areas, particularly meadows;
3) very common throughout the study area under forest canopies were red squirrels;
4) snowshoe hares seemed to be abundant everywhere as more tracks (at least in snow) and scats were noted for this species than for any other (with the exception of deer);
5) coyotes either were abundant or traveled widely as their scats were also common everywhere, especially on roads; and,
6) extensive grizzly bear diggings, including a den, were noted in subalpine areas around McLeod Peak, apparently dug by grizzlies permanently inhabiting that area although the population density seems to be low (Servheen 1977).

Mammal sightings. Actual sightings were made of an unidentified shrew and cricetid, yellow pine and red-tailed chipmunks, red squirrels, a northern flying squirrel, columbian and golden-mantled ground squirrels, snowshoe hares, pikas, black bears, a marten, a cougar, and coyotes.

Mammal sightings were also made by a number of people other than myself (Table 13). Some species have been observed, whether by others or by me, only once or twice and so may be transient individuals. Other species, observed numerous times throughout the study area, are resident, apparently in relatively large numbers. Amongst the latter are included yellow pine and red-tailed chipmunks, red squirrels, columbian and golden-mantled ground squirrels, snowshoe hares, black bears, and coyotes. More restricted in habitat than the aforementioned species, pikas were commonly noted in rock piles and talus slopes above about 1450 m in elevation.

Table 13. Mammal sightings made by other people.

Mammals	Source
Hoary marmot, beaver, wolverine, lynx, cougar, and wolf	Chinske, Executive Director, Friends of the Rattlesnake, pers. comm.
Hoary marmot, beaver, muskrat, short-tailed weasel, mink, wolverine, and bobcat	Kerling and Chinske 1977
Hoary marmot, yellow-bellied marmot, short-tailed weasel, long-tailed weasel, striped skunk, and wolverine	University of Montana Zoological Museum

Colonies of hoary marmots were seen in 2 locations: the McLeod Peak area and around Sanders Lake. Specimens in the University of Montana Zoological Museum (UMZM) were collected from

3 other locations: Stuart Peak, along the Lake Creek Road, and on the main road below Porcupine Creek (the last was taken from an adult female wolverine that had apparently killed the marmot; Wright, Professor of Zoology, University of Montana, pers. comm.). Two yellow-bellied marmots, collected near the MPC intake dam in 1958 and above Franklin Ranger Station in 1940, are also in the UMZM but there are no recent records for this species in the Upper Drainage.

Both muskrat and beaver have been observed near the mouth of Fraser Creek and probably occur wherever there is suitable habitat. Beaver have long been known to inhabit the study area, having been in fact protected from trapping until the late 1920's when the population had grown large enough to cause some damage (Poe, former resident, Upper Rattlesnake Valley, pers. comm.). No known trapping activity has occurred in recent years, partly because it had been thought that beaver no longer inhabited the Drainage (Leuschen, Manager Missoula Division, Montana Power Company, pers. comm.). Beaver may well have been present all along although in low numbers, as at the present time.

Specimens of both weasel species and the striped skunk have been collected from the Valley. A short-tailed weasel was seen near McLeod Peak; 2 mink were also seen in different areas along Rattlesnake Creek. Striped skunks which may have come from the Upper Rattlesnake have not infrequently created problems in the residential portion of the Drainage.

Two mustelids considered wilderness-dependent, the marten and the wolverine (Schoenfeld and Hendee 1978), have resident populations in the study area. They have both been seen at different times near McLeod Peak and in the High Falls Creek Drainage. A juvenile female wolverine, accompanied by a second cub and an adult female carrying a dead hoary marmot, was collected in 1967 (Wright, pers. comm.; both the female cub and the marmot, mentioned earlier, are in the UMZM).

Field observations include bobcat (1 sighting near Mosquito Peak), lynx (1 sighting in mid-High Falls Creek Drainage), and cougar (several sightings, including winter locations of radiocollared cats). Whether lynx and bobcat are transient is not known, although bobcat may possibly be summer residents. The area between Wisherd and Johnson creeks is important winter range so bobcats may well cross into the Rattlesnake high country during the summer. A resident cougar population uses the Drainage below Franklin Bridge, including Spring Gulch, during winter and the high country as summer range (following seasonal migrations of deer and elk). Transient cougar probably also occur in the study area (Murphy, senior, wildlife biology, University of Montana, pers. comm.).

Prey Utilization

Potential prey in the form of shrews, rodents, lagomorphs, ungulates, birds, reptiles, fish, and invertebrates (insects, spiders, worms, etc.) are abundant throughout the study area. All are undoubtedly consumed to a lesser or greater degree by 1 or more of the predators also occurring in the area (Table 14). Because the abundance of individual prey species varies from 1 habitat type to another, predator use of each type also tends to vary somewhat. However, most predators feed on several prey species and may thus use a number of habitat types. In general, a predator is most common in those habitats in which its primary prey species is most abundant.

The following authors listed the prey of the mammalian predators occurring in the Rattlesnake Drainage: black bear (Tisch 1961); grizzly bear (Jonkel 1978); short- and long-tailed weasels (Hamilton 1933, Polderboer et al. 1941, Llewellyn and Uhler 1952, Martin et al. 1961); mink (Llewellyn and Uhler 1952); marten (Weckworth and Hawley 1962); striped skunk (Llewellyn and Uhler 1952, Verts 1967); badger (Snead and Hendrickson 1942); wolverine (Rausch 1959, Rausch and Pearson 1972; Hornocker, Leader, Idaho Cooperative Wildlife Research Unit, pers. comm.); bobcat (Gashwiler et al. 1960); lynx (Saunders 1963); cougar (Robinette et al. 1959); red fox (Hamilton 1935, MacGregor 1942); and coyote (Sperry 1941, Reichel 1976, Henderson 1977).

Other, non-mammalian, predators also inhabit the Drainage, feeding mostly on small mammals, birds, fish, and carrion. Raptors

Table 14. Utilization of prey by mammalian predators.

	Predators[a]												
Prey	Black bear	Grizzly bear	Weasels	Mink	Marten	Striped skunk	I	Wolverine	Bobcat	Lynx	Cougar	Red fox	Coyote
Shrews			2-3		6	X						X	
Undet. mice	X			1		2-W, Sp	X						
Jumping mice			X										
Deer mice			X		X		2		4			X	X
Undet. microtines			X					5					
Bog lemmings					X								
Red-backed voles					2			X				X	
Voles			1	2	1		5		X	3		1	2-W
Muskrat										X		X	X
Chipmunks					X				X				
Undet. squirrels			X			X						X	
Red squirrels					X								X
Flying squirrels					X								
Ground squirrels	Sp, A				X		1	4	X		X		X
Marmots								2			X	X	X
Pocket gophers			X		X		X						X
Woodrats					X				3		X		
Beaver								X		X	X		
Porcupine			X					X	X		2	X[b]	X
Undet. lagomorphs											3		
Pikas			X										
Leporids			2-3	X	X	X	4	3	1	1		2	3-W
Carnivores					X	X		X			X	X	X
Ungulates	2	2[b]			X	X		1[b]	2[b]	2[b]	1		1-Sp, W
Birds	X		X	X	5		X	X	X	X		X	Sp, S
Reptiles			X			X	X		X			X	
Fish	X	X	X							X			
Invertebrates	X		X	X	3	1-A	3			X		X	S, A
Vegetation	1	1			4	3	X	X	X	X	X	X	3-A, W

Season of primary use:

W = Winter
Sp = Spring
S = Summer
A = Autumn

Importance in diet (where determined):

1 = Primary food
2 = Secondary food
etc.

X = Importance or time of use not known.

[a]References listed by predator species in text.

[b]Consumed largely as carrion.

include the Turkey Vulture; Goshawk; Sharp-shinned, Marsh, Rough-legged, Red-tailed, and Swainson's hawks; Bald and Golden eagles; Kestrels; and Screech, Great Horned, and Barred owls (Beaudette and Kerling 1977). Several varieties of garter snakes are also present.

CHAPTER V

MANAGEMENT IMPACTS

Every management option affects some species of wildlife beneficially and others detrimentally, and can thus only be judged as favorable or unfavorable for particular species, not for wildlife as a whole. Furthermore, any such judgment must be based on both the habitat requirements of the species involved and the characteristics of the management operation (Webb 1973).

This chapter summarizes the impacts various options could have on the wildlife species of the Rattlesnake Drainage. Gaps in the summary result from either a lack of information in or the unavailability of the literature. Finally, any decision concerning the "best" option for the Rattlesnake depends on the specific objectives established by managing agencies and are thus beyond the scope of my thesis.

Logging

General impacts. Logging impacts vary with the type of cut (selection, shelterwood, seed-tree, or clearcut); the number, size, and shape of trees removed; size and shape of an individual cut and its location with respect to other harvested areas; elevation, latitude, aspect, and slope; the underlying soil composition, chemical and physical; and annual precipitation in the area (Rexler 1972). The immediate effect of logging is on the vegetation; succession is reversed and a closed-canopy forest becomes an open forest or shrubfield, each with a different fauna. The more trees removed from an area and the larger the area cut, the greater the impact on vegetation and animals. Elevation, slope, soil, precipitation, etc., all influence the rate of recovery from logging.

Subsidiary activities such as road construction, regeneration techniques, and slash treatments also alter both flora and fauna. Road building not only destroys animal habitats, but use of those roads can inhibit movements of mammals as well (Oxley et al. 1974). If improperly located, roads can be a major source of erosion, further destroying vegetation. Planting trees and fertilizing cut-over lands generally advances succession, speeding up recovery (Thomas et al. in press). Leaving slash alone can improve habitat for some animals because slash provides escape cover, nesting habitat, and direct or indirect forage sources (Dimock 1974). Dimock notes, too, that slash treatments for the most part have transitory effects; however, the more radical the changes effected by treatment, the more pronounced and lasting will be their effects. Burning slash, for example, generally reduces some types of wildlife uses (Maser et al. in press) by eliminating an important source of cover. At the same time, by stimulating sprouting and seed germination, particularly in herbaceous plants (Gashwiler 1970), slash burning is beneficial in providing forage.

Response of mammals. Uneven-aged timber management (single tree selection harvesting) tends toward a loss of animal species diversity over time. Because a continuous forest dominated by relatively mature trees is produced, only those species adapted to mature forest conditions (i.e., marten and fisher) are favored. In contrast, even-aged management (group selection, including clear-cutting) can increase diversity by creating a mosaic of openings and forest stands of varying ages (Thomas in press). Under both forms of management, specific species are affected to the extent that sufficient food and cover to meet their needs are present.

Deer mouse populations are much larger on logged than on unlogged areas with the increase in numbers beginning almost immediately after logging occurs (Tevis 1956, Gashwiler 1970). However, Tevis noted that, as the variety of vegetation increases with time, deer mice become less abundant. He concluded young and middle-aged cutovers provide much more favorable habitat than do old ones.

Voles, chipmunks, and leporids also increase in numbers, although at different times after cutting, depending mostly on the amount of cover (shrubs and slash) present. Ground squirrels will migrate into cutovers, establishing modest populations (Tevis 1956, Gashwiler 1970).

Although apparently not inhabitants of cutovers, jumping mice, bushy-tailed woodrats, and pikas are visitors. Short-tailed weasels occur in relatively low numbers on both cut and uncut lands (Gashwiler 1970). Pocket gophers, porcupines (Rexler 1972), and potentially grizzly bears (Jonkel 1978) can also benefit from timber harvesting that increases food and cover.

Shrews can be found in clearcut areas but in relatively low numbers, being more common in uncut stands (Gashwiler 1970). Because they are inhabitants of virgin forests, both red-backed voles and flying squirrels rarely occur on cutovers (Tevis 1956). Population densities of red squirrels also decrease (Wolff and Zasada 1975). A decrease in numbers coupled with an increase in home range size occurs following shelterwood cutting. Territories in clearcuts are completely vacated for a time.

Early post-clearcut successional stages may receive little marten use even during summers, whereas later stages may become productive habitat providing ample food and good cover (Koehler et al. 1975). A critical factor is the size of the disturbance; smaller clearings are less restrictive to movements as marten seldom cross openings greater than 97 m in width. Selective logging of mesic sites on which canopy closure is maintained at 30% or more may not adversely affect marten.

Wolverine seem to prefer undisturbed forest, pretty much avoiding clearcuts (Hornocker, Leader, Idaho Cooperative Wildlife Research Unit, pers. comm.). Despite a wide habitat tolerance, cougar apparently use openings only occasionally, and then as travel corridors (Seidensticker et al. 1973).

Fire

Wildfire. Whether caused by lightning or by man, wildfire has played a major role in forest ecology, in the Rocky Mountains and elsewhere (Cooper 1974). Douglas-fir is dependent on fire for its establishment; by creating openings in the forest, fire allows the seeds of this relatively shade-intolerant species to germinate. Also requiring fire is lodgepole pine; its serotinous cones will not open unless exposed to heat. For ponderosa pine and western larch, periodic fire is a normal part of the environment, retarding succession and reducing fuel accumulation on the forest floor.

Wildfires can occur at any time of the year but are most common during the dry months. Most prehistoric fires were the result of lightning although many were deliberately started by Indians to clear land and drive game toward hunters. After about 1930, the number of wildfires decreased as a result of intensive fire suppression and prevention efforts. Those fires that did occur were often caused by man's carelessness (lit matches and cigarettes tossed aside, campfires left burning, etc.).

Prescribed burning. A prescribed or controlled burn is intentionally set under specific conditions to meet specific objectives. These fires are usually set in the spring or fall (when soil and vegetation have the highest moisture content) on cool, somewhat humid days with little or no wind. Allowed only to burn a limited area, prescribed fires are also extinguished if conditions (especially wind) should change. The reasons for using controlled burns include: preparing seedbeds for forest regeneration; reducing the amount of dry fuel on the ground and thus the risk of an uncontrolled wildfire; stimulating sprouting and seed germination to improve forage; removing slash after logging; and imitating the effects of periodic wildfire on succession and tree regeneration.

Overall effects. Two main factors determine just what the effects of fire will be in an area, the intensity of the fire (a function of fuel accumulation) and the size of the area burned. The more intense the fire and the larger the area burned, the more severe are the effects. At the ground surface, fire destroys organic litter, increases soil fertility, and increases either soil moisture or runoff, depending on the porosity of the soil (Daubenmire 1974). A fire will kill some plants (including trees) and only the above ground parts of others (shrubs, forbs, and grasses) which soon resprout. Fire resistant tree species (i.e., ponderosa pine, lodgepole pine, western larch) generally survive all but the most severe fire, suffering only scorched bark and burnt needles. The overall effect on vegetation is to retard succession and maintain a more open forest (Cole 1977), creating a mosaic of plant communities. Thus, fire also increases animal diversity although individual species are affected differently, just as is true for logging. Furthermore, animals can in turn alter vegetational patterns; seed consumption by deer mice (Krefting and Ahlgren 1974) and selective browsing by hares (Hooven 1969) are 2 ways by which this can occur.

Response of mammals. Fire most often influences mammalian populations indirectly rather than directly. Few mammals are actually killed by fire unless trapped or the fire is a major conflagration. Instead, the destruction and eventual recovery of habitat influences mammalian populations.

Deer mouse numbers may be reduced immediately after a fire (Horn 1938, Hooven 1969) but soon increase greatly as more and more insects and seeds become available (Ahlgren 1966, Hooven 1969). For several years, deer mice remain the most abundant species, eventually decreasing in numbers as succession proceeds (Krefting and Ahlgren 1974).

Populations of other rodents and leporids decrease after fire, remaining low for some time. Chipmunks again become abundant during the first postburn growing season (Hooven 1969); red-backed voles re-establish themselves between 3 (Ahlgren 1966) and 7 (Krefting and Ahlgren 1974) years later, once enough succulent vegetation for food and cover is present; and snowshoe hares begin re-occupying burned sites during the second summer as brushy cover is re-established (Keith and Surrendi 1971). Numbers of masked shrews, meadow voles, and jumping mice may remain low for as many as 12 years after burning (Krefting and Ahlgren 1974), becoming more abundant as the tree canopy is again established. Red squirrels, woodrats and porcupines also increase in numbers as burned areas become reforested (Hooven 1969).

Predators seem to respond to fire much as they do to logging. Weasel numbers may increase somewhat on burns but are generally low (Hooven 1969). Prescribed burning has potentially positive effects for grizzly bears (Jonkel 1978) by stimulating new vegetative growth and thus increasing food and cover. Seidensticker et al. (1973) observed that cougars often utilized the edges of burned areas to a considerable degree but only occasionally frequented open burns.

Open burns are avoided by marten in winter but may be used in summer and fall if they provide adequate food (insects, fruit, voles, and ground squirrels) and cover (Koehler and Hornocker 1977). Fire is important for marten in creating a mosaic of forest communities supporting discontinuous fuel types which, being subject to smaller and generally cooler fires, results in less marten habitat being replaced over time and space.

Recreation

Of all the various options, management for recreational use has the greatest potential for an adverse ecological impact because the damage can occur before anyone is aware of it. The magnitude of the impact is determined by 2 factors, the kind of use (mechanized, nonmechanized, or both) and how heavy it is. To some extent, the latter factor is the more important as heavy nonmechanized use can do more harm than light mechanized use.

Vegetation. The major cause of damage to vegetation is trampling, whether by feet or motorized vehicles. Occasional non-motorized use spread over 1 or more seasons produces only minor damage. The more concentrated the use, as on trails or in campgrounds, the greater the damage will be. An initial loss of ground cover follows the onset of use, with a gradual replacement of the original species by other drought-resistant species as use, and soil compaction, continues (LaPage 1967). In addition, the extent of damage varies directly with the moisture conditions of the soil; the wetter the soil, the greater the damage. Also, some habitat types are more susceptible to trampling (alpine tundra) than others, just as some plant forms within a type are (sedges of wet alpine sites; Willard and Marr 1970). Finally, damaged areas such as alpine tundra can require between several hundred and a thousand years for ecological processes to rebuild a natural climax ecosystem, even under total protection (Willard and Marr 1971).

Use of off-road vehicles, or ORV's (trail bikes, dune buggies, snowmobiles, etc.), has increased tremendously since 1970. Along with this has come considerable destruction of vegetation, also the result of trampling and soil compaction (Fialka 1975). More damage comes from erosion (gully formation, landslides, loss of topsoil) starting with the loss of ground cover. Again, a very long time can elapse before overused areas recover.

Mammals. As plant cover is destroyed, so is mammalian habitat. When trampling removes cover, leaving only bare ground, the vole populations formerly occupying such an area will withdraw into remaining grassy areas. Degradation of vegetative cover will presumably lead to decreasing deer mouse populations as well (Garton et al. 1977).

Some animal populations (deer mouse, chipmunk, and woodrat) increase in campground areas, a response to supplemental foods in the form of garbage and litter. The increase will continue with increasing human use up to a point at which escape cover becomes limiting (Clevenger and Workman 1977, Garton et al. 1977). Other species, particularly bears, can become habitual scroungers at campgrounds and garbage dumps, creating serious problems for both visitors and wildlife managers. Hand feeding animals habituates them to human presence and, especially in the case of grizzlies, can result in a bear-man encounter ending in human injury or death (Craighead and Craighead 1971).

A more serious impact relates to the actual disturbance of animals. Human activities occurring in critical locations at critical times during an animal's life cycle can exact a high price. Snowmobilers and dogs who chase any species during the winter and early spring force animals to draw on energy reserves they can ill afford to deplete, especially with the relative scarcity of food at those times (Fialka 1975). Photographers, researchers, campers, and hikers using breeding and birthing areas can lead to animals abandoning young, decreasing reproductive success. Sudden encounters between humans and wildlife can elicit a flight response from the animal, also a drain on energy reserves. Repeated encounters can cause animals to stop using traditional migration routes or feeding and birthing areas (Schoenfeld and Hendee 1978). Access roads can affect dispersal of small mammals and are an additional source of mortality (Oxley et al. 1974), particularly as traffic density increases.

Wilderness

By managing an area as a wilderness, that area can be preserved in a more or less natural condition. Any alterations of the flora and/or fauna are supposedly the result of natural processes (succession or wildfire) only, and not of man's efforts (logging, prescribed fire, mechanized recreation, etc.). Wilderness is largely beneficial to wildlife, especially those species most vulnerable to human influences; i.e., marten, wolverine, and lynx (Schoenfeld and Hendee 1978). Threatened and endangered species such as the northern Rocky Mountain timber wolf, grizzly bear (USDA Fish and Wildlife Service 1973), and Bald Eagle (Anonymous 1978) also benefit because wilderness protects critical habitat.

Two important considerations are involved, both of which greatly affect wildlife. The first deals with fire; should fires be allowed to burn in wilderness areas? Sixty years of protection have predisposed many forests to fires such as the 1961 Sleeping Child and 1967 Sundance fires (Beaufait 1972). Not only would considerable destruction within the wilderness occur, but such a conflagration could easily spread into adjacent developed lands. On the other hand, fire is a natural phenomenon very important in creating and maintaining the natural mosaic of plant communities in a forest. Without fire, succession proceeds towards climax vegetation, the mosaic is lost, and animal diversity decreases as seral species disappear.

The second consideration involves recreational use. Although ORV's are not a problem (they are prohibited on wilderness lands), nonmechanized recreational use can be a big problem (as discussed above). It may thus be necessary to regulate human use (through issuance of backcountry permits, closure of certain areas at specific times, etc.) to preserve "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain" (The Wilderness Act of 1964, 16 United States Code §§ 1131-1136).

Impact on the Rattlesnake Creek Drainage

Both clearcutting and prescribed burning, if restricted to small areas and occurring at different time intervals, will create a mosaic of forests, edges, and openings. Such a mosaic would provide a continuing range of habitats optimal for a wide variety of animal species (prey and predator; mammalian, avian, reptilian, and invertebrate). Overall species diversity would thus be very high in the area. Management of the area as a wilderness with fires permitted to burn periodically will produce a similar effect on vegetation and animal species diversity. The result of the above options would be to preserve total species diversity much as it is at the present time.

Within clearcut or burned areas, animal diversity can either increase or decrease. If fires are severe or all logging slash is removed, the resultant loss of vegetation and cover will reduce small mammal diversity. And, as the small mammals in an area decline, the predators, both mammalian and non-mammalian, will also decline. As such areas become revegetated over time, small mammals and predators will return and diversity will increase.

Moderate fires and logging can stimulate growth of vegetation such that, if sufficient cover is present in the form of downed logs and shrubs, animal diversity will increase. Leaving snags alone provides nesting sites for both birds and mammals, as well as perching or roosting sites for birds (particularly raptors). Even mammals that tend to avoid disturbed areas (i.e., marten, wolverine, cougar, and grizzly bear) will use them as long as those areas are small and contain ample cover.

The effect of wilderness management without fire is to allow plant communities to achieve a climax condition. The same thing will occur over time following logging or burning if later logging or burning does not occur. The end result is a decrease in both plant and animal species diversity although certain species may be favored ("wilderness-dependent" species such as marten, fisher, and wolverine).

Recreational use of the Drainage, if unregulated or heavy, is likely to destroy vegetation and thus reduce animal diversity. An animal's behavior and physical well-being can also be directly affected by recreationists, especially during late winter and early spring. Yet light or regulated recreational use (such as camping when not concentrated) provides an additional food source for small animals and can thus increase animal diversity.

CHAPTER VI

SUMMARY

Between June 1977 and March 1979, I conducted a survey of the nongame mammals in the Upper Rattlesnake Creek Drainage of western Montana. Trapping, scent stations, and observations of sign or the animals indicated what species inhabited the Drainage and their distribution by habitat. Mammal diversity within each habitat and niche breadth and overlap were determined from the trapping and scent station results.

Snaptrap lines were used in 14 locations, representing 18 habitat types as follows: ponderosa pine/Idaho fescue, Douglas-fir/ninebark-ninebark (at 2 elevations), Douglas-fir/blue huckleberry-beargrass, Douglas-fir/twinflower-snowberry, Douglas-fir/snowberry-pinegrass, Douglas-fir/snowberry-snowberry, grand fir/unknown, grand fir/queencup-queencup (2 elevations), subalpine fir/queencup-menziesia, subalpine fir/bluejoint-bluejoint, subalpine fir/menziesia, subalpine fir/beargrass-blue huckleberry, subalpine fir/beargrass-grouse whortleberry, clearcut, disturbed meadow, and cottonwood bottom.

Small mammal diversity varied greatly from 1 habitat to another, related directly with the species richness and evenness of the habitats, and indirectly with community dominance. Elevation was the habitat feature with the strongest relationship to diversity; shrub development and tree canopy closure were not significantly correlated with diversity. The time of year trapping occurred and camping activities in 2 sites probably influenced measures of diversity also.

Deer mice and jumping mice had the broadest niches with the former occurring in most of the habitat types and the latter in a variety of mesic types. Red-tailed chipmunks, vagrant shrews, yellow pine chipmunks, and red-backed voles had progressively smaller niches, reflecting each species' habitat preferences. Apparently having the narrowest niches were the masked shrew, northern bog lemming, long-tailed vole, meadow vole, and northern flying squirrel, each of which occurred in a single habitat type.

Most species pairs did not overlap much, if at all, in habitat use, especially when resource abundance was considered. Shrews and red-backed voles overlapped although their utilization of each habitat was in proportion to its abundance. Masked and vagrant shrews, shrews and red-tailed chipmunks, deer mice and yellow pine chipmunks, and meadow voles and bog lemmings largely used the same habitats. However, only for the latter pair was the probability of interspecific encounter considerably higher than it would be if the 2 species were uniformly distributed with respect to habitat.

A scent station line, passing through a variety of vegetational types, was used twice during summer 1977. Mammal species diversity also varied greatly but showed no relationship to habitat. The road, used as a travel corridor by some species and avoided by others, undoubtedly influenced diversity. The average diversity, however, was somewhat higher in September than in July-August, probably because less food was available for some species and populations were largest in September.

Chipmunks, deer mice, and golden-mantled ground squirrels, occurring in a variety of habitats, had the widest niches. Red squirrels, columbian ground squirrels, unidentified cricetids, coyotes, porcupines, and bushy-tailed woodrats had smaller niches; leporids, skunks, jumping mice, weasels, red foxes, marten, black bears, badgers, and bobcats had the narrowest niches. Niche width also varied between the 2 months as some species had smaller niches in September (the hibernators mostly), whereas others had larger niches (decreased food availability so animals wandered more in search of food).

Niche overlap was moderate for most pairs, a few did not overlap at all (particularly in September), and some showed a relatively large amount of overlap (deer mice and chipmunks, chipmunks and golden-mantled ground squirrels, and porcupines and bushy-tailed woodrats). Predators generally did not use the same habitats very much although use tended to be concentrated in a few areas.

Observation of sign (tracks, scats, middens, diggings, or cuttings) and of the mammals were used primarily to indicate the presence of a species in the Drainage. Habitats were determined for a few mammals, however. Red squirrels occurred under forest canopies and snowshoe hares under brushy cover throughout the area; pocket gophers and columbian ground squirrels in lower elevation, open areas; muskrats and beavers along the creeks; pikas in rock piles and talus slopes above 1450 m; grizzly bears in subalpine areas around McLeod Peak; marten in mature subalpine fir and spruce forests; and black bears, coyotes, and cougars used a number of habitats throughout the Drainage. Other mammals present were hoary and yellow-bellied marmots, short- and long-tailed weasels, mink, striped skunks, wolverines, lynx, and wolves.

Prey species were abundant throughout the study area and were used by a number of mammalian and non-mammalian predators.

The impact of any management operation varies, not only with the size and intensity of the operation, but also from 1 species to another. To some extent, logging and fire tend to have similar effects: plant succession is reversed; a mosaic of vegetational types is created (and in the case of periodic fire, maintained); mammalian diversity increases, as do populations of deer mice, chipmunks, and other small rodents; and habitat is destroyed for species dependent on climax or mature forests (i.e., marten and wolverine). Recreation probably can have the most adverse impact, destroying habitat, creating problem animals (those accustomed to food handouts), and disturbing wildlife (chasing them or being in the wrong place at the wrong time). Wilderness can be particularly beneficial to mammals intolerant of human influences (i.e., grizzlies, marten, and wolverine) because areas are preserved in essentially a natural condition. However, 2 previously mentioned factors are also involved with wilderness management, fire and recreation, both of which have an impact on the quality of the wilderness.

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APPENDIX A

NAMES OF ANIMAL SPECIES

Mammals

Masked shrew	*Sorex cinereus*
Vagrant shrew	*Sorex vagrans*
Western jumping mouse	*Zapus princeps*
Deer mouse	*Peromyscus maniculatus*
Bushy-tailed woodrat	*Neotoma cinerea*
Northern bog lemming	*Synaptomys borealis*
Red-backed vole	*Clethrionomys gapperi*
Long-tailed vole	*Microtus longicaudus*
Meadow vole	*Microtus pennsylvanicus*
Muskrat	*Ondatra zibethicus*
Red-tailed chipmunk	*Eutamias ruficaudus*
Yellow pine chipmunk	*Eutamias amoenus*
Red squirrel	*Tamiascuirus hudsonicus*
Northern flying squirrel	*Glaucomys sabrinus*
Columbian ground squirrel	*Spermophilus columbianus*
Golden-mantled ground squirrel	*Spermophilus lateralis*
Hoary marmot	*Marmota caligata*
Yellow-bellied marmot	*Marmota flaviventris*
Northern pocket gopher	*Thomomys talpoides*
Beaver	*Castor canadensis*
Porcupine	*Erethizon dorsatum*
Snowshoe hare	*Lepus americanus*
Pika	*Ochotona princeps*
Black bear	*Ursus americanus*

Grizzly bear	Ursus arctos
Short-tailed weasel	Mustela erminea
Long-tailed weasel	Mustela frenata
Mink	Mustela vison
Marten	Martes americana
Striped skunk	Mephitis mephitis
Badger	Taxidea taxus
Wolverine	Gulo gulo
Bobcat	Lynx rufus
Lynx	Lynx canadensis
Cougar	Felis concolor
Domestic cat	Felis cattus
Red fox	Vulpes vulpes
Coyote	Canis latrans
Wolf	Canis lupus
Domestic dog	Canis familiaris
Mule deer	Odocoileus hemionus
White-tailed deer	Odocoileus virginianus
Elk	Cervus elaphus

Birds

Turkey Vulture	Cathartes aura
Goshawk	Accipiter gentilis
Sharp-shinned Hawk	Accipiter striatus
Marsh Hawk	Circus cyaneus
Rough-legged Hawk	Buteo lagopus
Red-tailed Hawk	Buteo jamaicensis
Swainson's Hawk	Buteo swainsoni
Bald Eagle	Haliaeetus leucocephalus
Golden Eagle	Aquila chrysaëtos
Kestrel	Falco sparverius

Screech Owl	*Otus asio*
Great Horned Owl	*Bubo virginianus*
Barred Owl	*Strix varia*

Reptiles

Garter snake	*Thamnophis sirtalis*

APPENDIX B

NAMES OF PLANT SPECIES

Trees	
Rocky Mountain juniper	*Juniperus scopulorum*
Western red cedar	*Thuja plicata*
Subalpine fir	*Abies lasiocarpa*
Grand fir	*Abies grandis*
Western larch	*Larix occidentalis*
Engelmann spruce	*Picea engelmannii*
Lodgepole pine	*Pinus contorta*
Ponderosa pine	*Pinus ponderosa*
Whitebark pine	*Pinus albicaulis*
Douglas-fir	*Pseudotsuga menziesii*
Quaking aspen	*Populus tremuloides*
Black cottonwood	*Populus trichocarpa*
Water birch	*Betula occidentalis*
Paper birch	*Betula papyrifera*
Apple	*Pyrus malus*
Shrubs and Subshrubs	
Yew	*Taxus brevifolia*
Juniper	*Juniperus* spp.
Willow	*Salix* spp.
Alder	*Alnus sinuata*
Creeping Oregon grape	*Berberis repens*
Gooseberry	*Ribes* spp.
Mock-orange	*Philadelphus lewisii*
Serviceberry	*Amelanchier alnifolia*

Douglas hawthorn	Crataegus douglasii
Oceanspray	Holodiscus discolor
Ninebark	Physocarpus malvaceus
Chokecherry	Prunus virginiana
Raspberry	Rubus spp.
Rose	Rosa spp.
Mountain ash	Sorbus spp.
White spirea	Spirea betulifolia
Pachistima	Pachistima myrsinites
Rocky Mountain maple	Acer glabrum
Ceanothus	Ceanothus spp.
Bunchberry dogwood	Cornus canadensis
Red-ozier dogwood	Cornus stolonifera
Kinnikinnick	Arctostaphylos uva-ursi
Prince's pine	Chimaphila umbellata
Menziesia	Menziesia ferruginea
Mountain heath	Phyllodoce empetriformis
Blue huckleberry	Vaccinium globulare
Grouse whortleberry	Vaccinium scoparium
Twinflower	Linnea borealis
Elderberry	Sambucus spp.
Snowberry	Symphoricarpos albus

Perennial Graminoids

Wood-rush	Luzula hitchcockii
Sedges	Carex spp.
Elk sedge	Carex geyeri
Bluebunch wheatgrass	Agropyron spicatum
Bluejoint	Calamagrostis canadensis
Pinegrass	Calamagrostis rubescens
Idaho fescue	Festuca idahoensis
Rough fescue	Festuca scabrella

Perennial Forbs and Ferns

Scouring rush	Equisetum spp.
Common horsetail	Equisetum arvense
Lady fern	Athrium felix-femina
Oak fern	Gymnocarpium dryopterus
Baneberry	Actea rubra
Western meadowrue	Thalictrum occidentale
Strawberry	Fragaria virginiana
Lupine	Lupinus spp.
Round-leaved violet	Viola orbiculata
Fireweed	Epilobium angustifolium
Pyrola	Pyrola spp.
Mullein	Verbscum thapsus
Bedstraw	Galium triflorium
Yarrow	Achillea millefolium
Woods pussytoes	Antennaria racemosa
Heartleaf arnica	Arnica cordifolia
Mountain arnica	Arnica latifolia
Arrowleaf balsamroot	Balsamorhiza sagittata
Knapweed	Centaurea spp.
Arrowleaf groundsel	Senecio triangularis
Wild onion	Allium spp.
Queencup	Clintonia uniflora
False Solomon's seal	Smilacina racemosa
Starry Solomon's seal	Smilacina stellata
Twisted stalk	Streptopus amplexifolius
Beargrass	Xerophyllum tenax

APPENDIX C

VEGETATION OF TRAPPING LOCATIONS

Canopy coverage classes:

+ = Outside plot	3 = 25- 50%
T = Rare to 1%	4 = 50- 75%
1 = 1-5%	5 = 75- 95%
2 = 5-25%	6 = 95-100%

Diameter (cm) at breast height (dbh) for overstory tree species given in parentheses.

Overstory trees $>$ 10 cm dbh
Understory trees $<$ 10 cm dbh

Location	Habitat type	Elevation (m)	Seral condition	% canopy closure	Tree species Overstory/Understory: Western red cedar	Grand fir	Subalpine fir	Western larch	Engelmann spruce	Lodgepole pine	Ponderosa pine	Whitebark pine	Douglas-fir	Black cottonwood	Water birch	Apple
1	Douglas-fir/blue huckleberry-beargrass	1500	Late	50				2/- (15, 20)	-/1	3/1 (10, 15, 20, 25)			3/1 (13, 22, 27, 30)			
2	Subalpine fir/queencup-menziesia	1742	Late	50			3/2 (25, 30)	1/- (35)	-/2							
2	Clearcut	1710	Early	<5			1/1		-/1	-/1						
3	Douglas-fir/snowberry-pinegrass	1210	Mid	15							1/- (10, 13, 35)		-/T			
3	Douglas-fir/snowberry-snowberry	1210	Mid	5							1/T (10, 13)		+/+			
4	Douglas-fir/twinflower-snowberry	1213	Late	70				2/T (30, 35)	-/T		1/- (22, 35)		3/T (30, 35, 35)			
5	Douglas-fir/ninebark-ninebark	1303	Mid	10				+/-			+/-		2/2 (30)			
5	Disturbed meadow	1303	Early	< 5							-/T					1/- (18, 25, 33)
6	Grand fir/queencup-queencup	1452	Mid	70	1/+ (15)	2/2 (10, 13, 18)		+/-	3/2 (15, 25, 33, 38)				2/- (25, 33)			
7	Subalpine fir/beargrass-blue huckleberry	1829	Mid	65			T/1 (13)	2/- (18, 25, 43, 45)	-/+	4/1 (10, 15, 18, 22)			1/1 (10, 10, 25)			
8	Ponderosa pine/Idaho fescue	1435	Late	30							3/+ (48, 50)		+/+			
9	Subalpine fir/beargrass-grouse whortleberry	2326	Late	50			3/3 (10, 15, 20)					2/1 (20, 22, 25)				
10	Douglas-fir/ninebark-ninebark	1290	Late	75				3/- (15, 18, 18, 20)			+/T		4/1 (13, 20, 22, 27)			
11	Grand fir/queencup-queencup	1368	Mid	70		2/2 (13, 22)		1/- (48)	3/1 (22, 38)				2/1 (25)	3/- (22, 40, 53)		
11	Grand fir/unknown	1368	Mid	80		2/2 (10, 10, 38)		2/- (18, 20, 22)	1/2 (15)	2/- (22, 30)			2/3 (18, 20, 38)			
12	Subalpine-fir/bluejoint-bluejoint	1897	Early-mid	25			1/1 (10)		2/2 (15, 15)	2/2 (10, 13, 25)		-/T				
13	Subalpine fir/menziesia	2071	Late	40			2/3 (20, 30, 33)		2/1 (20, 30)			1/- (10, 18)				
14	Cottonwood bottom	1323	Late	60		1/- (27)		1/- (50)	2/- (50, 55)					3/- (50, 50+, 50+)		
Livetrap grid	Douglas-fir/snowberry	1226	Late	60				3/- (22, 27)	-/+	2/+ (25, 33)	+/-		3/2 (27)		1	
Livetrap grid	Wet meadow	1226	Early	10				+/-	+/1	T/1	+/-		+/1		3	
Livetrap grid	Disturbed meadow	1226	Early	< 5						-/1						
Franklin Campsite	Grand fir/queencup	1355	Mid-late	60		3/3 (15, 22, 30)		1/T	2/1 (30, 43)					+/T		

Shrubs and Subshrubs

Location	Habitat type	Yew	Juniper	Willow	Alder	Oregon grape	Gooseberry	Serviceberry	Douglas hawthorn	Oceanspray	Ninebark	Chokecherry	Rose	Mountain ash	White spirea	Pachistima	Rocky Mtn. maple	Ceanothus	Bunchberry dogwood	Red-ozier dogwood	Kinnikinnick	Prince's pine	Menziesia	Mountain heath	Blue huckleberry	Grouse whortleberry	Twinflower	Elderberry	Snowberry
1	Douglas-fir/blue huckleberry-beargrass			T		1		1		1					T	3									1				2
2	Subalpine fir/queencup-menziesia			√	1																		4		3			2	
	Clearcut			√	2		2																2		2				
3	Douglas-fir/snowberry-pinegrass					1	T	T			T	T	1		1						1								3
	Douglas-fir/snowberry-snowberry										T				2						2								2
4	Douglas-fir/twinflower-snowberry					T		1			+				+		2			3							3		5
5	Douglas-fir/ninebark-ninebark					2		2			3				2			T											3
	Disturbed meadow							T																					
6	Grand fir/queencup-queencup	3			3	T	1	1		T	T		2			1	3			2					2		3		2
7	Subalpine fir/beargrass-blue huckleberry		+												T										4	4			
8	Ponderosa pine/Idaho fescue										3																		T
9	Subalpine fir/beargrass-grouse whortleberry																							3		3			
10	Douglas-fir/ninebark-ninebark					1		3			3		2		3		4	+	T	1	T								4
11	Grand fir/queencup-queencup				1	2	T	1					T			T	3		T								T		3
	Grand fir/unknown			T		4	T	T			1				3	T	3		T	T	4	2							2
12	Subalpine fir/bluejoint-bluejoint																								2	T			
13	Subalpine fir/menziesia													1									4	T	3	3			
14	Cottonwood bottom				3	T	T		T								1		+	1									4
Livetrap grid	Douglas-fir/snowberry					1	1	1			1		1		3		2												3
	Wet meadow				3																								1
	Disturbed meadow					1							T																
Franklin Campsite	Grand fir/queencup	4		T		T	T	T								1	T											+	

Perennial Graminoids

Location	Habitat type	Wood-rush	Sedges	Elk sedge	Bluebunch wheatgrass	Bluejoint	Pinegrass	Idaho fescue	Rough fescue
1	Douglas-fir/blue huckleberry-beargrass			1			1	T	
2	Subalpine fir/queencup-menziesia								
	Clearcut			T					
3	Douglas-fir/snowberry-pinegrass			T			3		
	Douglas-fir/snowberry-snowberry			T			T		T
4	Douglas-fir/twinflower-snowberry						3		
5	Douglas-fir/ninebark-ninebark			2				2	
	Disturbed meadow		2						
6	Grand fir/queencup-queencup						T		
7	Subalpine fir/beargrass-blue huckleberry			T			T		
8	Ponderosa pine/Idaho fescue				1			2	1
9	Subalpine fir/beargrass-grouse whortleberry	2		T					
10	Douglas-fir/ninebark-ninebark						2		
11	Grand fir/queencup-queencup			1					
	Grand fir/unknown			T					
12	Subalpine fir/bluejoint-bluejoint		4			2			
13	Subalpine fir/menziesia	2		T					
14	Cottonwood bottom			T					
Livetrap grid	Douglas-fir/snowberry			3					
	Wet meadow		3						
	Disturbed meadow				2				
Franklin Campsite	Grand fir/queencup								

Perennial Forbs and Ferns

Location	Habitat type	Scouring rush	Common horsetail	Lady fern	Baneberry	Western meadowrue	Strawberry	Lupine	Round-leaved violet	Pyrola	Mullein	Bedstraw	Yarrow	Woods pussytoes	Heartleaf arnica	Mountain arnica	Arrowleaf balsamroot	Knapweed	Arrowleaf groundsel	Wild onion	Queencup	False Solomon's seal	Starry Solomon's seal	Twisted stalk	Beargrass
1	Douglas-fir/blue huckleberry-beargrass					2	1			T					2				T				1		3
2	Subalpine fir/queencup-menziesia											T			3						T		1		2
	Clearcut											T			2						T		1		
3	Douglas-fir/snowberry-pinegrass						1								T										
	Douglas-fir/snowberry-snowberry						T																		
4	Douglas-fir/twinflower-snowberry	+	T			2	T					2			2	2			T		2	T	2		
5	Douglas-fir/ninebark-ninebark						2							T	1				T	1					
	Disturbed meadow						1				T							3					T		
6	Grand fir/queencup-queencup		T		1	1	T			2		1			1	4			1		2		2	T	T
7	Subalpine fir/beargrass-blue huckleberry																								4
8	Ponderosa pine/Idaho fescue							3									3								
9	Subalpine fir/beargrass-grouse whortleberry															2									4
10	Douglas-fir/ninebark-ninebark					+	3					T		T	T		T		1				T		
11	Grand fir/queencup-queencup					2				4		3							T		1		T		
	Grand fir/unknown			T			1							1					T				T		
12	Subalpine fir/bluejoint-bluejoint		T		2				T															T	
13	Subalpine fir/menziesia				T	T			T																4
14	Cottonwood bottom		T				T			1		1							1						
Livetrap grid	Douglas-fir/snowberry		T				T						T			3	1			T					
	Wet meadow	1	1				T		1			T				1			1				T		
	Disturbed meadow																	5							
Franklin Campsite	Grand fir/queencup								T			T									T				

APPENDIX D

MAMMALS COLLECTED IN TRAPS

Snaptrapped Animals:

Species	Date collected	Specimen number	External Measurements (mm) Total length	Tail	Hind foot	Ear	Sex and reproductive status
Trapline No. 1 -- Douglas-fir/blue huckleberry-beargrass							
Western jumping mouse	7/20/77	EA 101	180	115	28	10	♂ testes 5 x 2 mm
Western jumping mouse	7/21/77	EA 102	241	117	34	7	♀ non-pregnant
Trapline No. 2 -- Subalpine fir/queencup-menziesia							
Vagrant shrew	7/30/77	EA 211	95	42	12	5	?
Western jumping mouse	7/30/77	EA 212	203	125	29	11	♂ testes 4 x 2 mm
Western jumping mouse	7/31/77	EA 220	190	120	26	11	♀ juvenile
Deer mouse	7/30/77	EA 208	170	75	21	18	♀ embryos 3R 3L 4 x 2 mm
Deer mouse	7/30/77	EA 209	159	71	20	15	♂ testes 12 x 6 mm
Deer mouse	7/31/77	EA 219	125	55	18	15	♀ juvenile
Deer mouse	8/ 1/77	EA 226	123	50	18	17	♂ juvenile
Deer mouse	8/ 1/77	EA 227	120	53	18	15	♂ juvenile
Red-tailed chipmunk	7/30/77	EA 210	237	98	33	14	♀ non-pregnant
Red-tailed chipmunk	7/31/77	EA 218	230	90	30	17	♂ testes 9 x 3 mm
Trapline No. 2 -- Clearcut							
Vagrant shrew	7/30/77	EA 202	104	44	12	6	?
Western jumping mouse	7/30/77	EA 201	217	127	29	15	♀ non-pregnant
Western jumping mouse	7/30/77	EA 203	246	144	32	15	♀ non-pregnant
Western jumping mouse	7/30/77	EA 204	214	134	32	14	♂ testes 5 x 3 mm
Western jumping mouse	7/30/77	EA 206	235	140	31	16	♀ non-pregnant
Western jumping mouse	7/31/77	EA 213	190	120	27	12	♂ juvenile

Snaptrapped Animals (continued):

Species	Date collected	Specimen number	External Measurements (mm) Total length	Tail	Hind foot	Ear	Sex and reproductive status
Western jumping mouse	7/31/77	EA 214	230	140	30	15	♂ testes 6 x 3 mm
Western jumping mouse	7/31/77	EA 215	225	135	30	12	♀ non-pregnant
Western jumping mouse	7/31/77	EA 216	235	145	28	15	♀ non-pregnant
Western jumping mouse	7/31/77	EA 217	200	130	29	10	♂ testes 6 x 3 mm
Western jumping mouse	8/ 1/77	EA 223	221	133	28	13	♂ testes 6 x 3 mm
Western jumping mouse	8/ 1/77	EA 224	221	135	29	13	♀ non-pregnant
Deer mouse	7/30/77	EA 205	165	70	20	19	♂ testes 11 x 6 mm
Deer mouse	7/30/77	EA 207	165	65	19	17	♀ embryos 3R 2L 3 x 2 mm
Deer mouse	8/ 1/77	EA 225	130	57	18	17	♀ juvenile
Long-tailed vole	8/ 1/77	EA 222	130	46	17	7	♀ embryos 1R 2L 7 x 6 mm
Red-tailed chipmunk	8/ 1/77	EA 221	Only tail caught in trap.				

<u>Trapline No. 3</u> -- Douglas-fir/snowberry-snowberry

Species	Date collected	Specimen number	Total length	Tail	Hind foot	Ear	Sex and reproductive status
Deer mouse	8/ 8/77	EA 301	130	63	18	19	♂ testes 3 x 2 mm
Deer mouse	8/ 8/77	EA 302	168	75	19	20	♀ embryos 0R 2L 1 x 1 mm
Deer mouse	8/ 8/77	EA 303	164	70	19	20	♂ testes 6 x 3 mm
Deer mouse	8/ 8/77	EA 304	144	60	17	18	♀ non-pregnant
Deer mouse	8/ 8/77	EA 305	152	65	19	20	♂ testes 3 x 2 mm
Deer mouse	8/ 8/77	EA 306	142	65	18	18	♂ testes 3 x 2 mm
Deer mouse	8/ 8/77	EA 307	145	65	18	17	♀ non-pregnant
Deer mouse	8/ 9/77	EA 308	135	59	18	16	♀ juvenile
Deer mouse	8/10/77	EA 310	144	65	19	17	♂ testes 4 x 2 mm
Yellow pine chipmunk	8/10/77	EA 309	214	88	32	16	♀ non-pregnant

Snaptrapped Animals (continued):

Species	Date collected	Specimen number	External Measurements (mm) Total length	Tail	Hind foot	Ear	Sex and reproductive status
Trapline No. 4 -- Douglas-fir/twinflower-snowberry							
Deer mouse	8/ 8/77	EA 401	150	65	19	18	♂ testes 3 x 2 mm
Deer mouse	8/ 8/77	EA 402	160	64	19	19	♀ non-pregnant
Deer mouse	8/ 8/77	EA 403	128	58	18	17	♀ juvenile
Deer mouse	8/ 8/77	EA 404	132	54	17	17	♂ testes 4 x 3 mm
Deer mouse	8/ 8/77	EA 405	144	61	20	18	♀ non-pregnant
Deer mouse	8/ 8/77	EA 407	120	65	19	17	♂ testes 4 x 2 mm
Deer mouse	8/ 8/77	EA 408	148	65	18	20	♀ non-pregnant
Deer mouse	8/ 8/77	EA 409	133	60	19	18	♀ non-pregnant
Deer mouse	8/ 8/77	EA 410	143	64	19	17	♂ testes 3 x 2 mm
Deer mouse	8/ 9/77	EA 412	174	75	20	19	♀ non-pregnant
Deer mouse	8/10/77	EA 413	131	56	18	14	♂ testes 3 x 2 mm
Deer mouse	8/10/77	EA 414	140	64	19	18	♂ testes 4 x 2 mm
Deer mouse	8/10/77	EA 415	142	62	18	19	♂ testes 3 x 2 mm
Yellow pine chipmunk	8/ 8/77	EA 406	211	90	26	17	♂ testes 5 x 3 mm
Yellow pine chipmunk	8/ 8/77	EA 411	210	92	28	16	♂ testes 4 x 3 mm
Trapline No. 5 -- Douglas-fir/ninebark-ninebark							
Deer mouse	10/ 9/77	EA 508	148	67	20	17	♂ testes 3 x 2 mm
Deer mouse	10/ 9/77	EA 509	140	64	19	18	♂ testes 3 x 2 mm
Deer mouse	10/ 9/77	EA 510	151	68	20	18	♂ testes 3 x 2 mm
Trapline No. 5 -- Disturbed meadow							
Deer mouse	10/ 8/77	EA 501	138	67	19	17	♀ non-pregnant
Deer mouse	10/ 8/77	EA 502	Only part of hindfoot caught in trap.				

Snaptrapped Animals (continued):

Species	Date collected	Specimen number	External Measurements (mm) Total length	Tail	Hind foot	Ear	Sex and reproductive status
Deer mouse	10/ 8/77	EA 503	135	64	18	17	♀ non-pregnant
Deer mouse	10/ 8/77	EA 504	151	69	19	19	♂ testes 3 x 2 mm
Deer mouse	10/ 8/77	EA 505	162	69	20	19	♀ non-pregnant
Deer mouse	10/ 8/77	EA 506	140	61	19	16	♂ testes 3 x 2 mm
Deer mouse	10/ 9/77	EA 507	151	75	20	17	♂ testes 3 x 2 mm
Deer mouse	10/10/77	EA 511	169	78	19	17	♂ testes 3 x 2 mm
Trapline No. 6 -- Grand fir/queencup-queencup							
Vagrant shrew	6/ 7/78	EA 609	100	39	11	4	♀ non-pregnant
Western jumping mouse	6/ 5/78	EA 601	225	130	28	14	♂ testes 7 x 4 mm
Western jumping mouse	6/ 5/78	EA 604	225	140	29	11	♂ testes 8 x 4 mm
Western jumping mouse	6/ 5/78	EA 605	245	150	30	15	♂ testes 8 x 4 mm
Western jumping mouse	6/ 5/78	EA 606	207	129	29	14	♂ testes 7 x 4 mm
Western jumping mouse	6/ 5/78	EA 607	210	130	29	14	♂ testes 7 x 4 mm
Western jumping mouse	6/ 7/78	EA 610	225	135	29	14	♀ non-pregnant
Deer mouse	6/ 5/78	EA 602	168	73	20	18	♂ testes 12 x 6 mm
Deer mouse	6/ 5/78	EA 603	164	70	19	19	♂ testes 11 x 6 mm
Deer mouse	6/ 7/78	EA 608	151	60	19	17	♂ testes 12 x 6 mm
Trapline No. 7 -- Subalpine fir/beargrass-blue huckleberry							
Deer mouse	6/14/78	EA 701	152	66	20	18	♂ testes 11 x 8 mm
Deer mouse	6/15/78	EA 702	159	62	18	18	♂ testes 10 x 6 mm
Deer mouse	6/16/78	EA 704	141	60	19	19	♂ testes 10 x 6 mm
Deer mouse	6/16/78	EA 705	152	62	19	19	♀ embryos 3R 3L 2 x 2 mm

Snaptrapped Animals (continued):

Species	Date collected	Specimen number	External Measurements (mm)				Sex and reproductive status
			Total length	Tail	Hind foot	Ear	
Red-tailed chipmunk	6/15/78	EA 703	205	90	29	16	♂ testes 6 x 3 mm
<u>Trapline No. 8</u> -- Ponderosa pine/Idaho fescue							
Western jumping mouse	7/29/78	EA 804	238	141	29	14	♀ lactating
Western jumping mouse	7/29/78	EA 805	232	137	29	16	♀ non-pregnant
Western jumping mouse	7/29/78	EA 807	234	137	30	14	♀ non-pregnant
Deer mouse	7/29/78	EA 801	158	68	18	19	♀ lactating
Deer mouse	7/29/78	EA 802	148	63	19	19	♀ embryos 3R 2L 1 x 1 mm
Deer mouse	7/29/78	EA 803	151	67	19	18	♂ testes 12 x 7 mm
Deer mouse	7/29/78	EA 806	151	64	21	19	♂ testes 8 x 5 mm
Deer mouse	7/30/78	EA 809	110?	chewed off	19	16	? Reproductive organs had been eaten
Deer mouse	7/30/78	EA 810	159	68	19	17	♂ testes 11 x 7 mm
Deer mouse	7/31/78	EA 811	146	61	18	19	♂ testes 12 x 7 mm
Deer mouse	7/31/78	EA 812	147	65	19	19	♂ testes 7 x 5 mm
Yellow pine chipmunk	7/30/78	EA 808	195	88	28	16	? Reproductive organs gone
<u>Trapline No. 9</u> -- Subalpine fir/beargrass-grouse whortleberry							
Western jumping mouse	8/ 7/78	EA 904	232	128	29	15	♀ non-pregnant
Western jumping mouse	8/ 8/78	EA 910	234	138	29	17	♂ testes 7 x 3 mm
Western jumping mouse	8/ 8/78	EA 911	216	130	27	14	♂ testes 7 x 3 mm
Western jumping mouse	8/ 8/78	EA 912	235	140	29	15	♀ non-pregnant

Snaptrapped Animals (continued):

Species	Date collected	Specimen number	External Measurements (mm) Total length	Tail	Hind foot	Ear	Sex and reproductive status
Western jumping mouse	8/ 9/78	EA 915	227	138	29	15	♀ non-pregnant
Western jumping mouse	8/ 9/78	EA 916	230	145	29	15	♀ non-pregnant
Western jumping mouse	8/ 9/78	EA 917	221	127	28	14	♂ testes 6 x 3 mm
Western jumping mouse	8/ 9/78	EA 919	223	137	29	15	♂ testes 6 x 3 mm
Deer mouse	8/ 9/79	EA 918	154	68	19	18	♂ testes 11 x 6 mm
Red-backed vole	8/ 7/79	EA 902	141	41	15	14	♂ testes 10 x 7 mm
Red-backed vole	8/ 7/79	EA 903	121	34	17	12	♂ testes 9 x 6 mm
Red-backed vole	8/ 7/79	EA 907	140	35	16	14	♂ testes 9 x 7 mm
Red-backed vole	8/ 8/79	EA 909	108	30	16	14	♀ non-pregnant
Red-backed vole	8/ 9/79	EA 914	110	31	16	12	♀ non-pregnant
Red-tailed chipmunk	8/ 7/79	EA 901	200	80	30	17	♀ lactating
Red-tailed chipmunk	8/ 7/79	EA 905	202	74	29	18	♀ non-pregnant
Red-tailed chipmunk	8/ 7/79	EA 906	210	80	29	18	♂ testes 7 x 4 mm
Red-tailed chipmunk	8/ 8/79	EA 908	217	90	30	19	♀ non-pregnant
Red-tailed chipmunk	8/ 9/79	EA 913	210	90	29	19	♂ testes 5 x 3 mm
Trapline No. 10 -- Douglas-fir/ninebark-ninebark							
Deer mouse	8/21/79	EA 1001	157	65	19	19	♀ embryos 3R 3L 8 x 8 mm
Deer mouse	8/23/79	EA 1002	156	68	19	18	♀ embryos 4R 1L 21 x 13 mm
Trapline No. 11 -- Grand fir/queencup-queencup							
Vagrant shrew	8/27/78	EA 1103	92	43	12	9	♂ subadult
Deer mouse	8/28/78	EA 1104	152	71	19	18	♀ embryos 3R 2L 1 x 1 mm

Snaptrapped Animals (continued):

Species	Date collected	Specimen number	External Measurements (mm) Total length	Tail	Hind foot	Ear	Sex and reproductive status
Trapline No. 11 -- Grand fir/unknown							
Deer mouse	8/27/78	EA 1101	141	61	18	17	♂ testes 10 x 6 mm
Deer mouse	8/27/78	EA 1102	163	72	20	19	♂ testes 12 x 8 mm
Trapline No. 12 -- Subalpine fir/bluejoint-bluejoint							
Vagrant shrew	9/ 6/78	EA 1201	95	41	11	7	?
Vagrant shrew	9/ 6/78	EA 1202	94	42	11	8	?
Northern bog lemming	9/ 8/78	EA 1203[a]	101	18	15	13	♂ testes 5 x 3 mm
Red-backed vole	9/ 8/78	EA 1205	119	36	16	13	♂ testes 9 x 6 mm
Meadow vole	9/ 7/78	EA 1203	120	35	18	12	♂ testes 5 x 3 mm
Trapline No. 13 -- Subalpine fir/menziesia							
Shrew spp.	9/26/78	EA 1323	95	37	11	9	?
Masked shrew	9/24/78	EA 1302	87	40	11	8	♂
Masked shrew	9/24/78	EA 1304	88	42	11	6	?
Masked shrew	9/25/78	EA 1312	92	37	11	8	?
Masked shrew	9/26/78	EA 1322	94	38	10	9	?
Vagrant shrew	9/24/78	EA 1306	94	40	10	8	?
Vagrant shrew	9/24/78	EA 1307	101	48	12	8	?
Vagrant shrew	9/25/78	EA 1314	91	39	11	8	?
Vagrant shrew	9/25/78	EA 1315	94	40	11	8	?
Vagrant shrew	9/26/78	EA 1319	104	42	11	8	?
Vagrant shrew	9/26/78	EA 1321	106	47	11	9	?
Vagrant shrew	9/26/78	EA 1324	100	42	11	9	?
Red-backed vole	9/24/78	EA 1301	107	32	15	14	♀ non-pregnant

Snaptrapped Animals (continued):

Species	Date collected	Specimen number	External Measurements (mm) Total length	Tail	Hind foot	Ear	Sex and reproductive status
Red-backed vole	9/24/78	EA 1303	120	33	17	13	♀ non-pregnant
Red-backed vole	9/24/78	EA 1309	129	38	16	13	♂ testes 6 x 3 mm
Red-backed vole	9/25/78	EA 1310	123	36	18	16	? Reproductive tract eaten
Red-backed vole	9/25/78	EA 1316	122	35	16	13	♂ testes 3 x 2 mm
Red-backed vole	9/25/78	EA 1317	120	32	17	13	♀ non-pregnant
Red-backed vole	9/26/78	EA 1318	112	28	16	13	♂ testes 2 x 2 mm
Red-backed vole	9/26/78	EA 1325	122	35	17	12	♂ testes 3 x 2 mm
Red-tailed chipmunk	9/24/78	EA 1305	182	45	30	18	♀ non-pregnant
Red-tailed chipmunk	9/24/78	EA 1308	215	87	31	20	♂ testes 10 x 4 mm
Red-tailed chipmunk	9/25/78	EA 1311	Carried away by predator or scavenger.				
Red-tailed chipmunk	9/25/78	EA 1313	215	84	30	18	♂ testes 5 x 3 mm
Red-tailed chipmunk	9/26/78	EA 1320	223	88	32	16	♂ testes 6 x 3 mm
Trapline No. 14 -- Cottonwood bottom							
Northern flying squirrel	10/ 9/78	EA 1401[b]	295	116	39	22	♀ non-pregnant
Franklin Campsite							
Deer mouse	6/17/78	EA 002	165	73	19	19	♀ lactating
Deer mouse	6/17/78	EA 003	159	66	18	19	♀ lactating; 3R 2L embryos 14 x 9 mm
Deer mouse	6/17/78	EA 004	165	67	20	18	♀ lactating
Deer mouse	6/17/78	EA 005	168	76	20	19	♂ testes 12 x 7 mm

Snaptrapped Animals (continued):

Species	Date collected	Specimen number	External Measurements (mm)				Sex and reproductive status
			Total length	Tail	Hind foot	Ear	
Found dead in live trap -- Livetrap Grid -- Douglas-fir/snowberry							
Yellow pine chipmunk	8/18/77	EA 001	199	90	30	18	♂ testes 6 x 3 mm

[a]University of Montana Zoological Museum number 16328 for skull.

[b]University of Montana Zoological Museum number 16332 for skin and skull.

Livetrapped Animals:

Species	Date caught	Toe clipped[a]	External measurements (mm)		Sex and reproductive status
			Total length	Tail	
Trapline No. 9 -- Subalpine fir/beargrass-grouse whortleberry					
Shrew spp.	8/ 7/78	Left 1, front	85	43	?
Deer mouse	8/ 7/78	Escaped			
Deer mouse	8/ 8/78	Left 2, front	168	75	♀ (?)
Red-backed vole	8/ 9/78	Left 3, front	132	32	♀ lactating
Trapline No. 11 -- Grand fir/queencup-queencup					
Deer mouse	8/29/78	Left 5, rear	175	83	♂
Livetrap Grid -- Douglas-fir/snowberry					
Deer mouse	8/17/77	Left 1, front	--	--	♀ juvenile
Deer mouse	8/18/77	Escaped			
Deer mouse	8/19/77	Left 2, front	recapture		
Deer mouse	8/19/77	Right 5, front	--	--	♀
Bushy-tailed woodrat	8/17/77	Escaped			
Livetrap Grid -- Wet meadow					
Deer mouse	8/17/77	Left 1, front	recapture		

Livetrapped Animals (continued):

Species	Date caught	Toe clipped[a]	External measurements (mm)		Sex and reproductive status
			Total length	Tail	
Livetrap Grid -- Dry meadow					
Deer mouse	8/19/77	Left 1, front	recapture		
Deer mouse	8/17/77	Left 3, front	--	--	♀ juvenile
Deer mouse	8/17/77	Left 4, front	--	--	♀ juvenile
Deer mouse	8/19/77	Left 4, front	recapture		
Deer mouse	8/18/77	Right 5, front	recapture		
Deer mouse	8/18/77	Right 6, front	--	--	♂
Deer mouse	8/18/77	Right 6, front	recapture		
Deer mouse	8/19/77	Right 7, front	--	--	♂
Deer mouse	8/19/77	Right 8, front	--	--	♂
Franklin Campsite -- Grand fir/queencup					
Bushy-tailed woodrat	8/28/78	Left 5, rear	387	145	?

[a]Toes numbered from left to right.

APPENDIX E

VEGETATION ADJACENT TO SCENT STATIONS

Canopy coverage classes:

+ = Outside plot	3 = 25-50%
T = Rare to 1%	4 = 50-75%
1 = 1-5%	5 = 75-95%
2 = 5-25%	6 = 95-100%

Overstory trees >10 cm dbh
Understory trees <10 cm dbh

Shrubs and Subshrubs

Station number	Habitat type	Yew	Juniper	Willow	Alder	Creeping Oregon grape	Gooseberry	Mock-orange	Serviceberry	Oceanspray	Ninebark	Chokecherry	Rose	White spirea	Pachistima	Rocky Mountain maple	Ceanothus	Bunchberry dogwood	Red-ozier dogwood	Kinnikinnick	Menziesia	Blue huckleberry	Grouse whortleberry	Twinflower	Elderberry	Snowberry
29	Grand fir/beargrass		T	T		T			1					T	3	T				1		3				T
30	Disturbed shrub			1		T	2	2		2				1								T				4
31	Subalpine fir/elk sedge-Douglas-fir	x				x	x	x	x		x		x			x			x						x	x
32	Douglas-fir/ninebark-ninebark					x		x	x			x	x		x	x									x	x
33	Douglas-fir/ninebark-ninebark			T		1		T	2	2	3	2		T		3				T					3	3
34	Douglas-fir/ninebark-ninebark					3			2		3			T	+					4						
35	Grand fir/queencup-queencup			1		3		T	1		2	1	T	2	3	2		T		1					T	3
36	Disturbed meadow																									x
37	Douglas-fir/ninebark-ninebark			x		x			x	x		x	x	x	x	x				x		x				x
38	Rock scree				x											x			x						x	
39	Douglas-fir/ninebark					T		3	2		3	3	T													2
40	Douglas-fir/ninebark-pinegrass					2			1		2			2			T		3							2
41	Douglas-fir/ninebark-pinegrass	T				T			T	T	3	T		2						T						2
42	Disturbed meadow							3	x																	x
43	Creek bottom					x		x	x				x	x		x		x								x
44	Douglas-fir/ninebark-ninebark					3		2	3		3		1	1		T		T		3						2
45	Douglas-fir/ninebark-ninebark					1			1		4	T	T	1		1		T	T					T		T
46	Douglas-fir/ninebark-ninebark			1		2			4	T	3			2		1				3				2		1
47	Forested scree					x					x	x	x													
48	Douglas-fir/white spirea								T		T			3						T						
49	Douglas-fir/white spirea					T			T			2		3						T						
50	Douglas-fir/snowberry-snowberry								+				1	+						T						2
51	Douglas-fir/white spirea					T							T	2						T						T
52	Douglas-fir/snowberry-snowberry					2	T		1		1		T	1						2						4
53	Douglas-fir/pinegrass-bluebunch wheatgrass					T			1											1						T

Perennial Graminoids

Station number	Habitat type	Elk sedge	Bluebunch wheatgrass	Pinegrass	Idaho fescue	Rough fescue
29	Grand fir/beargrass	T		1		
30	Disturbed shrub	4		T		
31	Subalpine fir/elk sedge-Douglas-fir	x		x		
32	Douglas-fir/ninebark-ninebark					
33	Douglas-fir/ninebark-ninebark	4		T		
34	Douglas-fir/ninebark-ninebark	4			T	
35	Grand fir/queencup-queencup	4		T		
36	Disturbed meadow					
37	Douglas-fir/ninebark-ninebark	x		x		
38	Rock scree					
39	Douglas-fir/ninebark	T				
40	Douglas-fir/ninebark-pinegrass	3		T		
41	Douglas-fir/ninebark-pinegrass	2	T	T	T	T
42	Disturbed meadow					
43	Creek bottom	x		x		
44	Douglas-fir/ninebark-ninebark	3		T		
45	Douglas-fir/ninebark-ninebark	1		2		
46	Douglas-fir/ninebark-ninebark	T		3		
47	Forested scree					
48	Douglas-fir/white spirea	1		1	1	1
49	Douglas-fir/white spirea		3		1	1
50	Douglas-fir/snowberry-snowberry	T		T	T	1
51	Douglas-fir/white spirea		T	T	T	T
52	Douglas-fir/snowberry-snowberry	T		1	T	T
53	Douglas-fir/pinegrass-bluebunch wheatgrass		T	2	1	1

Perennial Forbs and Ferns

Station number	Habitat type	Common horsetail	Lady fern	Oak fern	Baneberry	Western meadowrue	Strawberry	Fireweed	Pyrola	Mullein	Bedstraw	Yarrow	Woods pussytoes	Heartleaf arnica	Mountain arnica	Arrowleaf balsamroot	Arrowleaf groundsel	Wild onion	Queencup	False Solomon's seal	Starry Solomon's seal	Twisted stalk	Beargrass
29	Grand fir/beargrass												1		T								3
30	Disturbed shrub					2	1						3								T		
31	Subalpine fir/elk sedge-Douglas-fir		x			x			x		x										x		
32	Douglas-fir/ninebark-ninebark			x		x	x		x		x										x		
33	Douglas-fir/ninebark-ninebark		T			1	T		2		T			T			T	T			1		
34	Douglas-fir/ninebark-ninebark					T	T							T									
35	Grand fir/queencup-queencup					1	3		1					T				T	1		1		
36	Disturbed meadow									x		x											
37	Douglas-fir/ninebark-ninebark	x		x		x	x		x		x			x							x		
38	Rock scree																						
39	Douglas-fir/ninebark						1										T				T		
40	Douglas-fir/ninebark-pinegrass						1						T	T				T					
41	Douglas-fir/ninebark-pinegrass						T							T									
42	Disturbed meadow									x		x											
43	Creek bottom					x									x						x		
44	Douglas-fir/ninebark-ninebark		T				1								T								
45	Douglas-fir/ninebark-ninebark	T[a]				T[a]	T				T[a]				3			+	T[a]		T[a]		
46	Douglas-fir/ninebark-ninebark						2						T					3	1				
47	Forested scree																	x					
48	Douglas-fir/white spirea						+							T	3			T					
49	Douglas-fir/white spirea						T							T		T							
50	Douglas-fir/snowberry-snowberry						T											T					
51	Douglas-fir/white spirea						T																
52	Douglas-fir/snowberry-snowberry						1																
53	Douglas-fir/pinegrass-bluebunch wheatgrass						+											+					

[a] Microsite within the plot.

		Shrubs and Subshrubs																								
Station number	Habitat type	Yew	Juniper	Willow	Alder	Creeping Oregon grape	Gooseberry	Mock-orange	Serviceberry	Oceanspray	Ninebark	Chokecherry	Rose	White spirea	Pachistima	Rocky Mountain maple	Ceanothus	Bunchberry dogwood	Red-ozier dogwood	Kinnikinnick	Menziesia	Blue huckleberry	Grouse whortleberry	Twinflower	Elderberry	Snowberry
1	Clearcut																				x	x				
2	Clearcut																				x	x				
3	Clearcut																				x	x				
4	Subalpine fir/queencup-beargrass				x		x	x													x	x				
5	Subalpine fir/queencup-beargrass						x	x													x	x				
6	Subalpine fir/queencup-beargrass			x	1																4	3			2	
7	Clearcut				x		x	x													x	x				
8	Clearcut scree						x	x						x								x				
9	Subalpine fir/queencup-beargrass				2		1		1												3	4		1	1	
10	Subalpine fir/queencup-beargrass					T			2								T					4				
11	Subalpine fir/queencup-beargrass					T			2													3			T	T
12	Subalpine fir/queencup-beargrass	1			2	T			1					+	1		+				1	3			T	T
13	Clearcut						x		x					x	x		x									x
14	Subalpine fir/queencup-queencup			+			T							+		3			+		1	3				T
15	Subalpine fir/beargrass-blue huckleberry					T	1		1						1	2						2	1		T	T
16	Subalpine fir/queencup-beargrass						1		T					T	1	1			1			1				2
17	Subalpine fir/beargrass-blue huckleberry					T	T							3	4	1						2				2
18	Subalpine fir/beargrass-blue huckleberry					T	+		1	T				T	4	1						4				
19	Douglas-fir/blue huckleberry-blue huckleberry		+			1	+		4	+				T	4	1	1					3				T
20	Subalpine fir/queencup-beargrass								2	3				1	3	T						4	T	T		
21	Subalpine fir/beargrass-blue huckleberry	x				T	x		x					T	x	x						1				T
22	Subalpine fir/beargrass-grouse whortleberry		3						1					T	3					1		1	4			T
23	Subalpine fir/beargrass-blue huckleberry	T		+			+		1						3		T					1	2			
24	Subalpine fir/queencup-queencup	2		T			2		2						3	1	T		1			3			T	
25	Forested scree	x		+		x			x	+				x	x	x	+					x				x
26	Forested scree								x							x										
27	Forested scree	x					x		x	x				x	x	x				x		x			x	x
28	Rock scree																									

		Perennial Graminoids					Perennial Forbs and Ferns																					
Station number	Habitat type	Elk sedge	Bluebunch wheatgrass	Pinegrass	Idaho fescue	Rough fescue	Common horsetail	Lady fern	Oak fern	Baneberry	Western meadow rue	Strawberry	Fireweed	Pyrola	Mullein	Bedstraw	Yarrow	Woods pussytoes	Heartleaf arnica	Mountain arnica	Arrowleaf balsamroot	Arrowleaf groundsel	Wild onion	Queencup	False Solomon's seal	Starry Solomon's seal	Twisted stalk	Beargrass
1	Clearcut	x																				x						x
2	Clearcut	x																				x						x
3	Clearcut	x																				x						x
4	Subalpine fir/queencup-beargrass													x		x			x			x		x			x	x
5	Subalpine fir/queencup-beargrass													x		x			x			x		x				x
6	Subalpine fir/queencup-beargrass															T			3					T		1		2
7	Clearcut															x			x			x						x
8	Clearcut scree	x											x															x
9	Subalpine fir/queencup-beargrass										1								2					T				3
10	Subalpine fir/queencup-beargrass	T									1	1							1					T		T		4
11	Subalpine fir/queencup-beargrass	1									2			T					2					T				4
12	Subalpine fir/queencup-beargrass								1		2	T		T		1			2			1		2		T	T	3
13	Clearcut	x									x	x	x			x												x
14	Subalpine fir/queencup-queencup	T									2	T				T			1					2		T		1
15	Subalpine fir/beargrass-blue huckleberry	T									2	1							1									4
16	Subalpine fir/queencup-beargrass			T				1		T	3	T		2		T				2		1		2				2
17	Subalpine fir/beargrass-blue huckleberry	T		T							T	T						T		3								3
18	Subalpine fir/beargrass-blue huckleberry										1	T						T		4								4
19	Douglas-fir/blue huckleberry-blue huckleberry	3										1						T	T	1								
20	Subalpine fir/queencup-beargrass	T		T					T		T							+		3				T		T		4
21	Subalpine fir/beargrass-blue huckleberry	1		T							2	x							1									2
22	Subalpine fir/beargrass-grouse whortleberry	T		T								T												T[a]				4
23	Subalpine fir/beargrass-blue huckleberry	T										T																1
24	Subalpine fir/queencup-queencup	T						2			T	2		1					T			1		3			T	T
25	Forested scree	x		x							x	x							x							x		
26	Forested scree											x								x								
27	Forested scree										x	x																x
28	Rock scree																											

Station No.	Habitat type	Elevation (m)	Aspect (degrees)	Land use				Seral condition	% canopy closure	Tree species (overstory/understory)										
				Logging	Fire	Grazing	Big game			Rocky Mtn. juniper	Grand fir	Subalpine fir	Western larch	Engelmann spruce	Lodgepole pine	Ponderosa pine	Douglas-fir	Quaking aspen	Black cottonwood	Paper birch
25	Forested scree	1471	220						50		x/-			x/-			x/-			
26	Forested scree	1471	255						60								x/-			
27	Forested scree	1458	255						10			-/x					x/-			
28	Rock scree	1406	220																	
29	Grand fir/beargrass	1394	240	x	x			Mid	15		1/1		+/-		1/-	2/-	2/2			
30	Disturbed shrub	1360	120					Early			+/+		+/+		+/-	+/-	T/+			
31	Subalpine fir/elk sedge-Douglas-fir	1342					x	Mid	20			x/-	+/-		+/-	x/-	x/-			
32	Douglas-fir/ninebark-ninebark	1329	110					Late	80				x/-			T/-	x/-			
33	Douglas-fir/ninebark-ninebark	1316						Mid	50	T						3/-	2/1			
34	Douglas-fir/ninebark-ninebark	1313				x	x	Early	10	1					+/T	+/+	2/1			
35	Grand fir/queencup-queencup	1303					x	Early	10	T	-/1		+/-	1/1	T/-	+/-	+/1			
36	Disturbed meadow	1294		x		x		Early								x/-	x/-			
37	Douglas-fir/ninebark-ninebark	1290	130					Late	60			-/x	x/x	x/-	x/x		x/x	x		
38	Rock scree	1268	200											x/-					x/-	x/-
39	Douglas-fir/ninebark	1261						Early	10					+/-			2/-			
40	Douglas-fir/ninebark-pinegrass	1261	190				x	Mid	40	T						2/-	3/1			
41	Douglas-fir/ninebark-pinegrass	1252	160				x	Mid	30	T						2/T	2/+			
42	Disturbed meadow	1242						Early								x/x	-/x			
43	Creek bottom	1232															x/-		x/-	
44	Douglas-fir/ninebark-ninebark	1232	130			x		Mid	30	T						1/-	3/2			
45	Douglas-fir/ninebark-ninebark	1235	125					Late	80				3/+			2/-	3/1			
46	Douglas-fir/ninebark-ninebark	1229						Mid	30				3/+			+/1	+/2			
47	Forested scree	1239	100													x/x	x/x	x		
48	Douglas-fir/white spirea	1229						Late	60							3/T	3/T			
49	Douglas-fir/white spirea	1213	150			x		Mid	20							2/2	1/1			
50	Douglas-fir/snowberry-snowberry	1203						Mid	20							2/3	1/1			
51	Douglas-fir/white spirea	1200						Early	10							2/2	T/2			
52	Douglas-fir/snowberry-snowberry	1200						Mid	30							2/2	2/1			
53	Douglas-fir/pinegrass-bluebunch wheatgrass	1181						Early	10							1/T	1/T			

Station No.	Habitat type	Elevation (m)	Aspect (degrees)	Land use: Logging	Land use: Fire	Land use: Grazing	Land use: Big game	Seral condition	% canopy closure	Tree species (overstory/understory): Rocky Mtn. juniper	Grand fir	Subalpine fir	Western larch	Engelmann spruce	Lodgepole pine	Ponderosa pine	Douglas-fir	Quaking aspen	Black cottonwood	Paper birch
1	Clearcut	1858		x				Early	<5					-/x						
2	Clearcut	1832		x				Early	<5					-/x						
3	learcut	1816	350	x				Early	<5			x/x		-/x						
4	Subalpine fir/queencup-beargrass	1800	30	x				Early	10			2/2		-/T						
5	Subalpine fir/queencup-beargrass	1771	20	x				Mid	20			2/1								
6	Subalpine fir/queencup-menziesia	1742	220	x	x			Early	50			3/2	1/-	-/2						
7	Clearcut	1703	10	x				Early				-/x	-/+	-/x	-/x					
8	Clearcut scree	1661	25	x				Early				-/x								
9	Subalpine fir/queencup-beargrass	1639	210	x				Mid	30			3/3		-/x	T/3					
10	Subalpine fir/queencup-beargrass	1639	205					Late	70			3/2	+/T		2/T	1/-				
11	Subalpine fir/queencup-beargrass	1626	225					Mid	70			2/2	3/-	3/1	2/-		1/-			
12	Subalpine fir/queencup-beargrass	1600	220	x				Late	70			3/2	+/+	3/2	3/+					
13	Clearcut	1587	220	x				Early	5					-/x	-/x		x/-			
14	Subalpine fir/queencup-queencup	1565	110					Late	70		T/-	3/2	-/+		-/+		3/1			
15	Subalpine fir/beargrass-blue huckleberry	1561	205					Late	30			3/2					+/1			
16	Subalpine fir/queencup-beargrass	1535						Mid	40		-/T	T/T	2/-	2/2			2/T			
17	Subalpine fir/beargrass-blue huckleberry	1535	240				x	Mid	50		-/T	1/1	2/-	1/1	2/-		2/T			
18	Subalpine fir/beargrass-blue huckleberry	1523	240					Mid	60			+/1	2/-		2/+		3/1			
19	Douglas-fir/blue huckleberry-blue huckleberry	1510	250		x		x	Late	50								3/3			
20	Subalpine fir/queencup-beargrass	1497	260					Mid	70			2/2	3/+	1/1	2/T		2/T			
21	Subalpine fir/beargrass-blue huckleberry	1494	260		x			Mid	30			-/x	+/-	-/1			3/2			
22	Subalpine fir/beargrass-grouse whortleberry	1471	240				x	Mid	50			-/2	2/1	T/2	3/2		2/2			
23	Subalpine fir/beargrass-blue huckleberry	1455	220					Mid	80			3/2	3/1	2/-			1/2			
24	Subalpine fir/queencup-queencup	1452	235					Mid	70		-/T	3/1	2/+	3/T			1/2			

APPENDIX F

DISTRIBUTION OF MAMMALIAN VISITS

ALONG SCENT STATION LINES

Station number	Habitat type	Number operative days	Mammals: Undetermined cricetid	Western jumping mouse	Deer mouse	Chipmunk	Red squirrel	Unidentified ground squirrel	Columbian ground squirrel	Golden-mantled ground squirrel	Bushy-tailed woodrat	Porcupine	Undetermined leporid	Black bear	Weasel	Marten	Skunk	Badger	Bobcat	Red fox	Coyote	Deer	Elk	Domestic dog	Domestic cat	Human
			Number of days a species visited a station 29 July - 2 Aug. / 9-13 Sept. 1977																							
28	Rock scree	5/5			0/3	1/0				3/0																1/0
29	Grand fir/beargrass	5/5				1/0						0/4			1/0							1/0				
30	Disturbed shrub	5/5			0/4					1/0														1/0		
31	Subalpine fir/elk sedge-Douglas-fir	5/5			1/2	5/4	1/3			2/1							0/4					1/0		0/1		0/1
32	Douglas-fir/ninebark-ninebark	5/5			0/5	0/3	0/2	1/0	2/0	1/0	0/1		1/0				1/0					1/0				
33	Douglas-fir/ninebark-ninebark	5/5	1/0		0/3	1/2	0/1			1/1		1/0					0/1						1/0	1/0		
34	Douglas-fir/ninebark-ninebark	5/5	1/0		0/3	2/2	2/0		2/0												1/0	1/4				
35	Grand fir/queencup-queencup	5/5			0/2	0/1	0/1		1/0								0/1			1/0		0/2		0/2		
36	Disturbed meadow	5/5			0/4													0/1				0/2		0/2		
37	Douglas-fir/ninebark-ninebark	5/5	1/0		0/4	2/2			0/3	3/0	0/1	0/2									0/1	1/1		0/2		
38	Rock scree	5/5	2/0		1/3	2/2	0/1		1/0	3/0	0/5													0/1		
39	Douglas-fir/ninebark	5/5	1/0		1/4	2/3	1/3															0/1		1/0		
40	Douglas-fir/ninebark-pinegrass	5/5			0/1	0/4											0/1							2/1		
41	Douglas-fir/ninebark-pinegrass	5/5	1/0		0/5	0/3																		1/4		
42	Disturbed meadow	5/5	1/0	2/0	2/5	0/3	0/1															0/2				
43	Creek bottom	5/5			0/5	0/1	2/0															1/0		2/3		
44	Douglas-fir/ninebark-ninebark	5/5	2/0		0/5	1/2		1/0		1/0											0/1	1/0		0/4		0/1
45	Douglas-fir/ninebark-ninebark	5/5			0/1	2/1			2/0	0/1			0/1								0/1			2/4		0/2
46	Douglas-fir/ninebark-ninebark	5/5	1/0		0/1	1/1	0/2		2/0	0/2						2/1								3/2		1/0
47	Forested scree	5/5			0/1	0/1	0/2															1/0		1/5		3/1
48	Douglas-fir/white spirea	5/5											1/0											0/1		2/2
49	Douglas-fir/white spirea	5/5			0/1	1/0	0/1								1/0									4/3	1/0	1/1
50	Douglas-fir/snowberry-snowberry	5/5	1/0														1/0				0/1			2/4		0/1
51	Douglas-fir/white spirea	0/4																						0/3		0/1
52	Douglas-fir/snowberry-snowberry	0/5				0/1																		0/4		
53	Douglas-fir/pinegrass-bluebunch wheatgrass	0/5			0/1																			0/1		
	Total visit days	248/199	25/1	6/0	19/99	67/75	11/20	5/0	19/3	62/10	3/26	2/30	4/1	3/0	3/0	3/1	3/7	0/1	0/1	2/0	2/8	37/22	1/0	21/47	1/0	9/10
	Percentage of stations visited		34	8	77	81	38	9	26	60	21	21	9	4	6	4	13	2	2	4	19	57	2	42	2	21

Station number	Habitat type	Number operative days	Mammals: Undetermined cricetid	Western jumping mouse	Deer mouse	Chipmunk	Red squirrel	Unidentified ground squirrel	Columbian ground squirrel	Golden-mantled ground squirrel	Bushy-tailed woodrat	Porcupine	Undetermined leporid	Black bear	Weasel	Marten	Skunk	Badger	Bobcat	Red fox	Coyote	Deer	Elk	Domestic dog	Domestic cat	Human
			Number of days a species visited a station 29 July - 2 Aug. / 9-13 Sept. 1977																							
1	Clearcut	5/0	2/0		1/0	4/0				2/0												2/0				
2	Clearcut	5/0				3/0		1/0	1/0	1/0												2/0				
3	Clearcut	5/0	1/0		1/0	3/0				2/0												2/0				
4	Subalpine fir/queencup-beargrass	4/0								1/0												4/0				
5	Subalpine fir/queencup-beargrass	5/0				2/0		1/0														2/0				
6	Subalpine fir/queencup-menziesia	5/0	2/0	1/0	3/0	4/0				3/0			1/0			1/0	1/0					1/0				
7	Clearcut	5/0	2/0	2/0	1/0	2/0			1/0	2/0																
8	Forested scree	5/0	1/0																			3/0				
9	Subalpine fir/queencup-beargrass	5/0	2/0																			1/0				
10	Subalpine fir/queencup-beargrass	5/0	2/0		1/0	3/0								1/0								3/0				
11	Subalpine fir/queencup-beargrass	5/0												2/0												
12	Subalpine fir/queencup-beargrass	4/0			1/0	3/0				2/0																
13	Clearcut	5/0				3/0		1/0	1/0	1/0	1/0	1/0										1/0				1/0
14	Subalpine fir/queencup-queencup	5/5	0/1		0/3	2/2				2/0		0/2										3/2				
15	Subalpine fir/beargrass-blue huckleberry	5/5			0/3	1/4				2/0			1/0									1/4				
16	Subalpine fir/queencup-beargrass	5/5			0/2	0/3	1/0		1/0	2/0		0/4										0/2				
17	Subalpine fir/beargrass-blue huckleberry	5/5			1/1	2/0	1/0			2/1		0/3									1/0	0/1				
18	Subalpine fir/beargrass-blue huckleberry	5/5			0/3	2/3	1/0															2/0				
19	Douglas-fir/blue huckleberry-blue huckleberry	5/5			1/5	2/5	1/0			3/0																
20	Subalpine fir/queencup-beargrass	5/5	1/0	1/0	1/2	1/2	1/0			1/0		0/4							0/1			0/1				
21	Subalpine fir/beargrass-blue huckleberry	5/5			0/2	1/3				1/0	0/1	0/4								1/0	0/1	1/0				
22	Subalpine fir/beargrass-grouse whortleberry	5/5			0/1	0/3	0/2		1/0	3/0	1/2	0/4			1/0											
23	Subalpine fir/beargrass-blue huckleberry	5/5			0/5	0/3			2/0	2/1	0/3	0/3														
24	Subalpine fir/queencup-queencup	5/5			0/1	0/4			2/0	3/0	0/4										0/1	1/0		1/0		
25	Forested scree	5/5			0/4	2/4	0/1			3/1	0/3															
26	Forested scree	5/5			0/4	2/1				4/0	0/1										0/1					
27	Forested scree	5/5			1/3	2/2				3/2	1/5										0/1					
	Subtotals	133/70	73/1	4/0	12/36	46/39	5/3	3/0	9/0	47/5	3/19	1/24	2/0	3/0	1/0	1/0	1/0	0/0	0/1	1/0	1/4	29/10	0/0	1/0	0/0	1/0

APPENDIX G

DATUM SHEETS

Montana habitat type field form (for 3 plots)

NAME			DATE			
TOPOGRAPHY: 1-Ridge 2-Upper slope 3-Mid slope 4-Lower slope 5-Bench or flat 6-Stream bottom	(CODE DESCRIPTION) HORIZONTAL CONFIGURATION: 1-Convex (dry) 2-Straight 3-Concave (wet) 4-Undulating	CANOPY COVERAGE CLASS: 0=Absent 3=25 to 50% T=Rare to 1% 4=50 to 75% 1=1 to 5% 5=75 to 95% 2=5 to 25% 6=95 to 100% NOTE: Rate trees (>4" dbh) and regen (0-4" dbh) separately (e.g., 4/2)	Plot No.			
			Location			
			T, R, S			
			Elevation			
			Aspect			
			Slope	%	%	%
			Topography			
			Configuration			

TREES Scientific Name	Abbrev	Common Name	Canopy Coverage Class		
1. Abies grandis	ABGR	grand fir	/	/	/
2. Abies lasiocarpa	ABLA	subalpine fir	/	/	/
3. Larix lyallii	LALY	alpine larch	/	/	/
4. Larix occidentalis	LAOC	western larch	/	/	/
5. Picea engelmannii	PIEN	Engelmann spruce	/	/	/
6. Picea glauca	PIGL	white spruce	/	/	/
7. Pinus albicaulis	PIAL	whitebark pine	/	/	/
8. Pinus contorta	PICO	lodgepole pine	/	/	/
9. Pinus flexilis	PIFL	limber pine	/	/	/
10. Pinus monticola	PIMO	western white pine	/	/	/
11. Pinus ponderosa	PIPO	ponderosa pine	/	/	/
12. Pseudotsuga menziesii	PSME	Douglas-fir	/	/	/
13. Thuja plicata	THPL	western redcedar	/	/	/
14. Tsuga heterophylla	TSHE	western hemlock	/	/	/
15. Tsuga mertensiana	TSME	mountain hemlock	/	/	/
SHRUBS AND SUBSHRUBS					
1. Alnus sinuata	ALSI	Sitka alder			
2. Arctostaphylos uva-ursi	ARUV	kinnikinnick			
3. Berberis repens	BERE	creeping Oregon grape			
4. Cornus canadensis	COCA	bunchberry dogwood			
5. Holodiscus discolor	HODI	ocean spray			
6. Juniperus communis (+ horizontalis)	JUCO	common (+ creeping) juniper			
7. Ledum glandulosum	LEGL	Labrador tea			
8. Linnaea borealis	LIBO	twinflower			
9. Menziesia ferruginea	MEFE	menziesia			
10. Oplopanax horridum	OPHO	devil's club			
11. Physocarpus malvaceus	PHMA	ninebark			
12. Prunus virginiana	PRVI	chokecherry			
13. Purshia tridentata	PUTR	bitterbrush			
14. Ribes montigenum	RIMO	mountain gooseberry			
15. Shepherdia canadensis	SHCA	buffaloberry			
16. Spiraea betulifolia	SPBE	white spiraea			
17. Symphoricarpos albus	SYAL	common snowberry			
18. Symphoricarpos oreophilus	SYOR	mountain snowberry			
19. Vaccinium caespitosum	VACA	dwarf huckleberry			
20. Vaccinium globulare (+ membranaceum)	VAGL	blue huckleberry			
21. Vaccinium scoparium (+ myrtillus)	VASC	grouse whortleberry			
PERENNIAL GRAMINOIDS					
1. Agropyron spicatum	AGSP	bluebunch wheatgrass			
2. Andropogon spp.	AND	bluestem			
3. Calamagrostis canadensis	CACA	bluejoint			
4. Calamagrostis rubescens	CARU	pinegrass			
5. Carex geyeri	CAGE	elk sedge			
6. Festuca idahoensis	FEID	Idaho fescue			
7. Festuca scabrella	FESC	rough fescue			
8. Luzula hitchcockii (= glabrata)	LUHI	wood-rush			
PERENNIAL FORBS AND FERNS					
1. Actaea rubra	ACRU	baneberry			
2. Antennaria racemosa	ANRA	woods pussytoes			
3. Aralia nudicaulis	ARNU	wild sarsaparilla			
4. Arnica cordifolia	ARCO	heartleaf arnica			
5. Athyrium filix-femina	ATFI	lady fern			
6. Balsamorhiza sagittata	BASA	arrowleaf balsamroot			
7. Clematis pseudoalpina (+ tenuiloba)	CLPS	virgin's bower			
8. Clintonia uniflora	CLUN	queencup beadlily			
9. Equisetum arvense	EQAR	common horsetail			
10. Equisetum spp.	EQU	horsetails & scouring rush			
11. Galium triflorum	GATR	sweetscented bedstraw			
12. Gymnocarpium dryopteris	GYDR	oak fern			
13. Senecio streptanthifolius	SEST	cleft-leaf groundsel			
14. Senecio triangularis	SETR	arrowleaf groundsel			
15. Smilacina stellata	SMST	starry Solomon's seal			
16. Streptopus amplexifolius	STAM	twisted stalk			
17. Thalictrum occidentale	THOC	western meadowrue			
18. Valeriana sitchensis	VASI	sitka valerian			
19. Viola orbiculata	VIOR	round-leaved violet			
20. Xerophyllum tenax	XETE	beargrass			
		SERIES			
		HABITAT TYPE			
		PHASE			

TRAPLINE DATA

Line #: ______ Location: T___ R___ S___

Dates run: ______

Animals collected: ______

Other animal sign: ______

Stand history: Fire ______
Logging ______
Grazing ______
Big game ______

Remarks: ______

	PLOT 1	PLOT 2
Canopy coverage:		
Paper birch		
Cottonwood		
Elderberry		
Mock-orange		
Pachistima		
Red-ozier dogwood		
Ribes spp.		
R. Mtn. maple		
Serviceberry		
Strawberry		
Willow		
Yew		
Overstory:		
① dbh ② ht. if 4" dbh		
Plot information:		
Location		
Date typed		
Habitat type		
Seral condition		
Elevation		
Aspect		
Topography		
% canopy closure		

Remarks:

Datum Sheet for Scent Station Lines

State__________ Line No.__________ Date_____ Observer__________

Weather (circle one):
(1) Clear (2) Cloudy (no rain) (5) Snow
(3) Showers (4) Rain (6) Freezing

Wind (circle one):
(1) No wind (3) Moderate
(2) Gusty (4) Strong

Nighttime temperature (circle one):
Hot (80°F or above) Moderate (33°F to 70°F) Freezing or below (32°F or lower)

Scent station number	Station condition	Coyote visit	Other animals visiting station	Scent station number	Station condition	Coyote visit	Other animals visiting station
1 (L)				26 (R)			
2 (R)				27 (L)			
3 (L)				28 (R)			
4 (R)				29 (L)			
5 (L)				30 (R)			
6 (R)				31 (L)			
7 (L)				32 (R)			
8 (R)				33 (L)			
9 (L)				34 (R)			
10 (R)				35 (L)			
11 (L)				36 (R)			
12 (R)				37 (L)			
13 (L)				38 (R)			
14 (R)				39 (L)			
15 (L)				40 (R)			
16 (R)				41 (L)			
17 (L)				42 (R)			
18 (R)				43 (L)			
19 (L)				44 (R)			
20 (R)				45 (L)			
21 (L)				46 (R)			
22 (R)				47 (L)			
23 (L)				48 (R)			
24 (R)				49 (L)			
25 (L)				50 (R)			

STATION CONDITION (Column two)

Enter appropriate number (below) in column 2

- \- = Station in operating condition
- 1 = <u>Station inoperable</u> (destroyed), no possible way to read tracks (due to poor weather conditions, trampled by cows, etc.)

Capsule carried away from station site by:

- 2 = Predator (record species)
- 3 = Animal other than predator (record species)
- 4 = Unidentified animal

Capsule destroyed at station site by:

- 5 = Predator (record species)
- 6 = Animal other than predator (record species)
- 7 = Unidentified animal

- 8 = Missing capsule not replaced on previous day (example: Ran out of replacement capsules)

COYOTE VISIT (Column three)

Enter appropriate number (below) in column 3

- \- = No coyote tracks at station
- 1 = Coyote tracks at station
- 2 = Questionable coyote tracks at station (poor tracking conditions, not sure if coyote or not)

Specimen Card for Mammals Collected in Trapping

Coll. No. ____________________ UMZ ______________________

Species ________________________________ Date Caught: Mo. ____ Day ____ Year _____

General Locality: County _____________________________ State _____________________

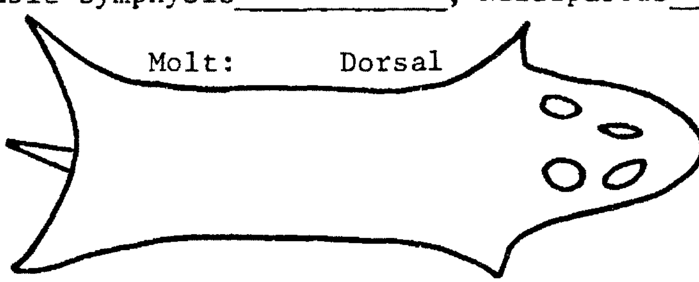
Exact Locality ____

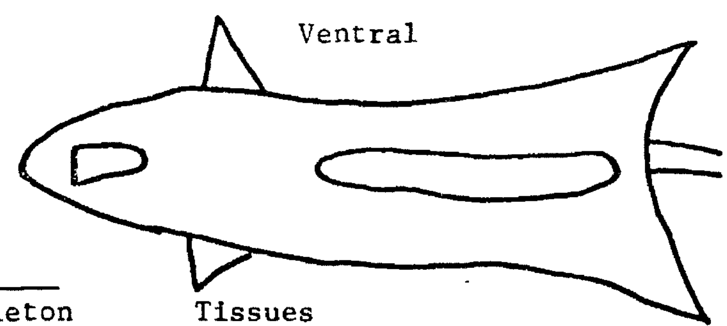
Habitat: ____

Body Weight _____ gms. Lengths: Total _____ Tail _____ Hindfoot _____ Ear _________

Male: Testes _____ x _____ mm.; Seminal Vesicles ________ Epididymus ______________

Females: Embryos: __R, __L; Size in utero: __x__mm.; Tract weight __________ gms.
Placental Scars: __R, __L; plus _______; Uterus diam. ___mm., cond. __________
Corpora Lutea: __R, __L; __mm. Diam., plus __________; Ovary size ____ Cond. ____
Mammary Development ____________; No. Prominent Nipples ______; Vagina __________ .
Pubic Symphysis ___________, Nulliparous _____ Primiparous ________ Multiparous _______





Pelage: Juvenile _____ Subadult _____ Adult _____
Material Saved: Skin _____ Skull _______ Skeleton _____ Tissues ___________