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Identification and evaluation of grizzly bear habitat in the Bob Marshall Wilderness Area Montana

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IDENTIFICATION AND EVALUATION OF GRIZZLY BEAR

HABITAT IN THE BOB MARSHALL WILDERNESS AREA

MONTANA

By

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ABSTRACT

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Eight grizzly bear habitat components were identified. They were: floodplain complex, avalanche chute complex, timbered creekbottom, mountain sidehill park, burn shrubfield, subalpine meadow, slabrock, and alpine complex. Within these components, 28 vegetation types were sampled by stratified random sampling. Vegetative information was also obtained for 3 forest habitat types.

Vegetation types were evaluated for 2 forging seasons (herbaceous foraging season, and fruit foraging season). Each vegetation type was seasonally evaluated on the basis of succulent vegetation, modified stems (roots,corms, bulbs), and fruit. During the herbaceous forage season, the tallgrass/Senecio triangularis vegetation type (subalpine meadow) ranked first in succulent vegetation. Several vegetation types of the avalanche chute complex and the floodplain complex ranked relatively high for this season. Vegetation types of the floodplain complex, slabrock, and alpine complex habitat components ranked high for modified stems. The Abies lasiocarpa/Xerophyllum tenax-Vaccinium globulare forest habitat type ranked the highest of all vegetation types for shrub taxa (fruit).

Most habitat components did not correlate well with landtype associations. Those that did correlate well included the floodplain complex, timbered creekbottom, and the alpine complex.

Physiographic descriptions of each habitat component and vegetation type are given and comparisions with pertinent literature are made.

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TABLE OF CONTENTS

Page

LIST OF TABLES

Table | Page

Table		Page

LIST OF FIGURES

LIST OF PHOTOGRAPHS

Photo | Page

INTRODUCTION

In 1975, the U.S. Fish and Wildlife Service listed the grizzly bear (*Ursus arctos horribilis*) as a threatened species in the contiguous 48 states. This designation lead to increased research in Montana and other western states to determine the biology and habitat needs of the bear within its' Occupied Habitat. Research efforts on the grizzly bear to date have emphasized the non-wilderness areas of Montana. Other than the Craighead et al. (1982) LANDSAT mapping in the Scapegoat Wilderness Area (Montana), little is known of grizzly bear population dynamics, distribution, biology, or habitat in the wilderness core of Montana.

A Grizzly Bear Recovery Plan (USDI 1982) was adopted to provide a sequence of management actions necessary for the conservation and recovery of the grizzly bear in selected portions of the contiguous 48 states. This Plan identified six major "Ecosystems" to be used as a basis for management, research, and recovery. The largest of these is the Northern Continental Divide Grizzly Bear Ecosystem. The Bob Marshall Wilderness Area constitutes approximately 17% (385,000 ha) of this Ecosystem. A habitat classification, encompassing temperate to alpine regions is not available for the Bob Marshall Wilderness Area.

The purpose of this research project was to develop a classification of grizzly bear habitat within the Wilderness study area and to compare this classification with other classification systems currently used the Northern Rocky Mountains.

The objectives of this study were to

1) delineate and describe grizzly bear habitat components within the study area using definitions from other areas and studies where possible;
2) develop a seasonal ranking of grizzly bear habitat based on food composition and availability;
3) compare the developed habitat component classification system with landtype associations and grizzly bear constituent elements; and
4) generate a map comparing the various habitat classifications systems.

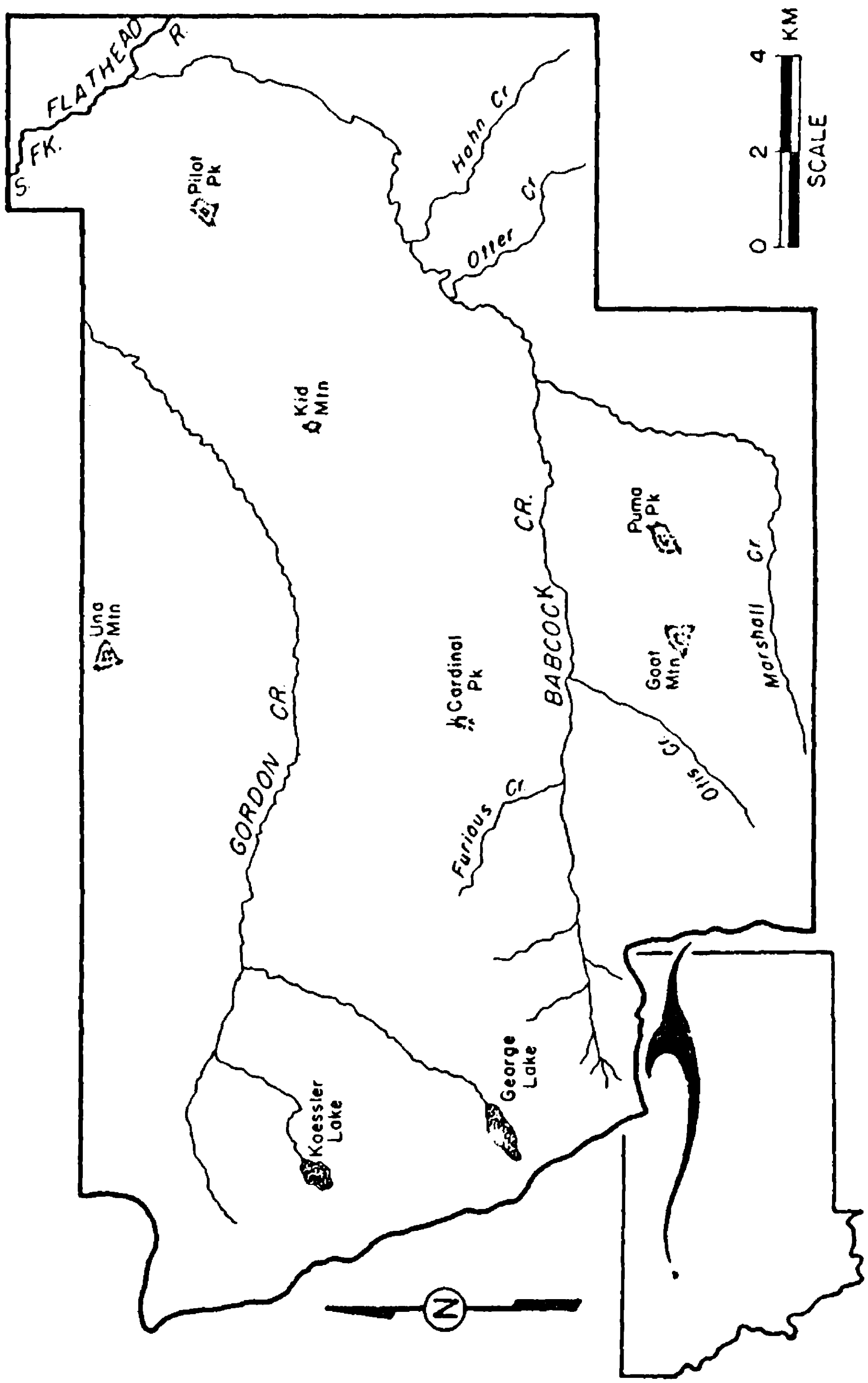
The results of this thesis have been divided into 3 major sections. The first section is a description to grizzly bear habitat components and the vegetation types of each. The second section is a seasonal ranking of vegetation types that occur within the habitat components. Grizzly bear habitat components are compared with other habitat classifications in the third section.

STUDY AREA

The study area was located in the southern Bob Marshall Wilderness Area as shown in Fig. 1. The Swan Mountain Range and the Danaher River formed the western and eastern boundaries respectively. To the North, the study area was bounded by the Gordon Creek drainage while to the south it was bounded by Marshall Creek. Major drainages within the approximately 390 km^2 study area included: Gordon, Babcock, and Youngs creeks and a portion of the South Fork of the Flathead River floodplain.

Geological history of the Bob Marshall was described by Deiss (1958) and by Montagne and McMannis (1961). The study area is of a rugged mountain terrain located in the Rocky Mountain Cordillera. Approximately 600 million years ago (Proterozoic Era), western North America was covered by shallow marine waters. Fine-grained sediments (clays, sands, and silts) were deposited into the oceans to an estimated thickness of 15,000 m. These deposits hardened and compressed into what are now limestones, sandstones, shales, and argillites. Subsequent erosion over millions of years again reduced the area to nearly sea level. Inland seas covered the study area during the Paleozoic Era, and deposited sediments which were to become known as the Cambrian, Devonian, and Mississipian rock formations. Land

Figure 1. The study area.



that was to become the Swan Range was uplifted and tilted between 70-60 million years ago. Mountain glaciers began to carve the mountain ranges 10,000-1 million years ago and formed the U-shaped valleys, cirques, hanging valleys, horns, and aretes in evidence today.

The study area is strongly influenced by maritime air masses moving east from the Pacific Ocean. Daubenmire (1969) noted that this oceanic influence decreases from north to south in western Montana. Air masses must pass the Cascade, Selkirk, Bitterroot, Cabinet, and Mission mountain ranges before reaching the study area. Upon reaching the Continental Divide on the eastern side of the Wilderness, much of the moisture in these oceanic air masses has been depleted.

Most annual precipitation at higher elevations falls as snow (Holdorf et al. 1980), and may persist from October through June on many sites. Detailed precipitation data are lacking for the study area, however Gabriel (1976) provided precipitation measurements for the Danaher River drainage. Johnson (1982) presented 33 years of precipitation data obtained from Hungry Horse Reservoir (north of the Wilderness), and from Ovando, Montana (south of the study area). Johnson's data and those of Habeck (1967) suggested that precipitation decreases from north to south within the

Wilderness.

Rugged mountain topography and complex local climates create an array of vegetation, with relatively dry open slopes occuring in rain shadows, and cool, moist drainages in areas of relatively high precipitation and cloud cover (Arno 1979). The study area contains the *Pseudotsuga menziesii*, *Picea engelmannii*, and *Abies lasiocarpa* climax series of Pfister et al. (1977). Pfister et al. (1977) recorded hybridization between *Picea engelmannii* and *P. glauca* in several counties of the study area. This hybridization decreases from the Canadian border southward. It was assumed that little hybridization occurs in the study area. Grassland communities were described by Johnson (1982). Many plant taxa have adapted to natural fire, and seral vegetation forms complex mosaics throughout the study area. The history and influences of fire in the northern Rocky Mountains are given by Steele (1960), Habeck and Mutch (1973), and Arno (1980).

METHODS

Definitions of Terms

Several terms used throughout the text are defined as follows:

Landtype Associations:

A landtype association is a combination of landtypes that have been grouped according to their association with each other and are the fourth level of precision in the ECOCLASS land classification system (Buttery et al. 1973). Landtypes are the most precise level of the land system and are composed of closely related sites having uniform land configuration. Fourteen landtype associations (Table 1) were delineated and mapped by the U.S. Forest Service for the Bob Marshall Wilderness (USDA 1980).

Constituent Elements:

Biological and physical factors of Critical Habitat that are considered essential for the recovery of a species listed under the Endangered Species Act of 1973 (Code of Federal Regulations: 424.12) are termed Constituent

Table 1. Landtype associations of the Bob Marshall Wilderness study area (from USDA 1980).

Forested flood plains
Wet, grass-sedge meadows
Grass and forested stream terraces
Glacial cirque basins
Forested ground moraine
Forested steep lateral moraine
Slump land
Forested high elevation ridges
Forested smooth residual slopes
Forested moderately dissected residual slopes
Forested and grassland smooth residual slopes
Peaks and alpine ridges - sparsely vegetated rock land
Forested, cool aspect break lands
Forested, warm aspect break lands

Elements. The U.S. Forest Service (USDA 1983) has defined 4 habitat Constituent Elements for the grizzly bear. These Elements are spring, summer, and autumn feeding habitat and denning habitat. Broad categories of grizzly bear foods that occur within landtype associations were used to develop the Constituent Element classification.

Physiognomy:

Physiognomy is the general appearance (architecture) of a vegetation type or habitat component. This appearance is characterized by the life-form of the dominant plants (all strata combined). For example, a site dominated by shrubs might be physiognomically termed a shrubfield (Barbour et al. 1980).

Vegetation Types:

Vegetation types are considered subdivisions of the total habitat component flora. They are distinguished by obvious spatial arrangement, physiognomic characteristics, and the existing composition of vegetation.

Grizzly Bear Habitat Component:

Habitat components are particularly important habitats to grizzly bears for foraging, denning, and other requirements. A habitat component classification was developed by the Border Grizzly Project (Zager et al. 1980) for northwestern Montana, and was based on telemetry information obtained from radio-instrumented grizzly bears.

A Habitat component is a combination of vegetation types of a distinctive successional stage exhibiting a unique physiognomy. The structure and vegetal composition of each component are determined by distinctive environmental factors such as elevation, aspect, microclimate, and moisture. Components may be composed of topo-edaphic climaxes, disclimaxes, or seral vegetation types. Although the combination of vegetation types is unique to a particular habitat component, a given vegetation type may be present in more than 1 component. In this thesis, habitat components were evaluated for forage value.

Dominant Taxa:

Dominant taxa are plants that contribute the greatest percent canopy cover and percent occurrence in a given stratum of a specified vegetation type relative to other taxa in that stratum and type.

Forested Habitat Types:

"All land areas potentially capable of producing similar plant communities at climax may be classified as the same habitat type (Daubenmire 1968)." A given habitat type may support several types of disturbed communities, but through plant succession will ultimately produce a climax community (Pfister et al. 1977).

Field Methods

Grizzly bear habitat data were collected in the Bob Marshall Wilderness Area during the summers of 1982 and 1983. During the second field season, several trips were made outside of the study area to judge the the potential for habitat extrapolations to other Wilderness locations. These trips were made into the the Gorge, Cannon, and Trickle creek drainages in the northwestern corner of the Wilderness, and into the Spotted Bear River and White River drainages in the northeastern portion of the Wilderness.

Logistics:

On several occasions, the U.S. Forest Service and commercial outfitters with packstock assisted in the transportation of equipment and supplies to and from the interior portions of the Wilderness. Other travel throughout the study area was accomplished on foot. Foot travel with gear necessitated that vegetation sampling and reconnaissance schedules be pre-established and strictly followed. Sampling trips into the Wilderness varied from 10 days to 6 weeks. Base camps were established at the center of sampling areas, and from these, 5 to 6 day sampling forays were conducted. In some instances, travel to specific sampling sites from a base camp took several days. Therefore, attempts were made to consolidate the sampling of various components into each trip. This minimization of travel time was not without disadvantage; sampling vegetation at less than optimum phenological stages was sometimes necessary.

Inclement weather often hampered research efforts. Spring runoff made river and stream crossings treacherous. When severe weather struck during a sampling session, it was not always possible to continue sampling that site or return to it at another date.

Vegetation Sampling Procedures

Existing habitat component categories served as a foundation for vegetation sampling. Component definitions developed for the lower South Fork of the Flathead River (Zager et al. 1980), the Mission Mountains (Servheen and Lee 1979), the Cabinet Mountains (Madel 1982), and the wilderness portion of the Rocky Mountain East Front (Aune and Stivers 1982) were field-checked through ground reconnaissance and interpretation of aerial photographs to determine feasibility of use. Specific vegetation descriptions were not extrapolated from elsewhere. Rather, vegetation sampling was conducted in each potential habitat component that was identified.

Plots were placed within the major vegetation types of each habitat component (stratified random sampling) with the specific intent of describing that vegetation and ultimately ranking its seasonal forage value to grizzly bears. An important criterion was that each vegetation type be readily discernable from aerial photographs. The final habitat component and vegetation type classification was developed from several criteria; the first discriminating factors considered were location of the vegetation, its characteristic structure, and its site history. The second level of refinement grouped vegetation according to similarities in plant taxa. The third factor considered was similarity in grizzly bear food plants.

Plot centers were determined using a random numbers table for distance and a spinner for direction. Open-timbered and timbered vegetation (30%-60% and >60% canopy cover) were sampled using 375 m^2 circular plots (Pfister et al. 1977). Small vegetation types were sampled using circular plots of 5 m^2 . The number of plots taken per vegetation type was determined in the field by construction of a species-area-curve (Mueller-Dombois and Ellenberg 1974). Sampling was terminated when no new taxa were encountered after 3 consecutive plots were taken. When present in a plot, a representative tree was increment bored for approximate stand age. An effort was made to compile a complete plant taxa list, thus multiple visits to some areas were necessary to gather data on ephemerals. Plants of questionable identity were labeled and pressed for laboratory verification. Genera and species of grasses and sedges were not always distinguishable in the field and were therefore combined. However, dominant grasses and sedges were collected for identification.

Cover values for each plant species, bare ground, rocks, logs, bryophytes, and litter were ocularly estimated using the modified Daubenmire cover classes of Pfister et al. (1977): O=absent, T=trace-1%, A=1-5%, B=5-25%, C=25-50%, D=50-75%, E=75-95%, and F=95-190%.

Tree, shrub, and herbaceous cover per stratum were recorded in each plot. Height categories employed were: A=0-0.9 m, B=0.9-2.0 m, C=2.0-9.0 m, and D=>9.0 m.

All timbered sites were keyed to the forest habitat type following the system of Pfister et al. (1977). Fire history data were obtained for U.S. Forest Service files (Kalispell, Montana) and from USDA (1978a). Botanical nomenclature followed Hitchcock and Cronquist (1973).

Analytical Procedures

Peter Stickney of the Intermountain Forest and Range Experiment Station expediently verified approximately 300 pressed plant specimens. Subsequent to plant identification, vegetation data were assembled into association tables (Mueller-Dombois and Ellenberg 1974). The resulting sample-by-species data matrices were then scrutinized to suggested relationships among plots, and to identify outlying plots (Gauch 1982). Taxa present in several height categories were given a unique code per stratum.

A 34 line fortran program was used to simplify and expedite data entry into the DEC-20 computer. This program (TRANSFORM.PROG, Appendix A) accepted data in standard condensed format and outputted 2 files, 1 full format and the other transposed condensed format. With all data sets in 3 formats, execution of various computer programs was possible.

Average percent cover (% cover) was derived by summing the cover class midpoints of a species and then dividing the summation by the total number of plots in the vegetation type. Percent occurrence values were also determined for each taxa.

The Statistical Package for the Social Sciences (SPSS) (Nie et al. 1975) subprogram FREQUENCIES was used to obtain both cover and occurrence values of all taxa per vegetation type.

Coefficients of percent species similarity (Jaccard 1912) were calculated for those vegetation types sampled in more than 1 location (e.g. 5 shrubfields were sampled in 5 avalanche chutes). In these instances, 2 coefficients were calculated. The first coefficient was calculated using all but ephemeral taxa, because not all areas were sampled at the same time of year or within the same year. A second similarity coefficient was calculated using only grizzly bear food items. Genera and species of a given genera were considered different taxa in these analyses. For example, *Erigeron* spp. and *Erigeron speciosus* were considered 2 taxa. The following formula for percent taxa similarity was used:

$$\frac{\text{number of taxa common to both locations (A and B)}}{\text{number of taxa unique to location A + number of taxa unique to location B + number of taxa common to both locations}} \times 100$$

Seasonal Ranking of Vegetation Types

A list of food items in the study area was collated using recent literature on grizzly bear food habits from the Northern Rocky Mountains of the United States and southern Canada (Russell et al. 1979, Aune and Stivers 1982, Craighead et al. 1982, Sumner 1973, Servheen and Wojciechowski 1978, and Mace and Jonkel In prep.). Food items were placed into 1 of 3 major food categories: succulent vegetation, modified stems (roots, corms, bulbs), or fruit. Each food item was given a seasonal preference rank. A rank of "3" represented an often selected food, a rank of "2" was given to moderately selected food items, and a rank of "1" meant a low use. These preference ranks were used with the percent cover value of each plant food to rank the seasonal importance value of each vegetation type. This ranking was accomplished using the following formula:

Food Item
Importance= % cover x seasonal preference rank

To obtain a total importance value for a vegetation type, the food item importance values for each forage item were summed. Two seasonal categories were used: an "herbaceous foraging season" (den emergence to 31 July), and a "fruit foraging season" (1 August to den entry). Tests of statistical differences among these "vegetation type importance values" in regard to food category were accomplished using nonparametric Mann-Whitney (M-W) procedures (Nie et al. 1975).

Mapping Procedures

Habitat components were mapped in the field using topographic quadrangles, color photos, and orthophotos. A stereoscope was used with color photos to make final map interpretations. Landtype association maps were obtained from the U.S. Forest Service (Region 1, Missoula, Montana).

The relationships between landtype associations and habitat components were evaluated using random dots (Mendenhall 1971). The number of random dots used was determined as follows. 1) The study area was composed of portions of 6 topographic quadrangles. It was first necessary to determine the proportion of the study area contained in each quadrangle, and the proportion of 400 random dots that would be used in that quadrangle. 2) Estimates of the proportion of each habitat component within each quadrangle were made. For example, it was estimated that the slabrock habitat component comprised approximately 35% of the Holland Peak quadrangle. 3) The correct number of random dots to use for each habitat component (out of the total of 400 for the study area) was than determined. 4) A random dot grid was then overlayed the map of components/landtypes and the number of times a dot hit a specific component and a specific landtype was recorded.

HABITAT USE BY GRIZZLY BEARS: A REVIEW OF PERTINENT LITERATURE

This literature review is an overview of the habitats important to grizzly bears in the northern Rocky Mountains. The habitat component system for the Bob Marshall Wilderness was developed from the following general habitat use trends.

The home range of a grizzly bear is a composite of several, sometimes seasonally separated ranges (Pearson 1975, Craighead 1976, Russell et al. 1979). While the grizzly bear may be found at many elevations and in all available habitats throughout the non-denning period (Zager 1980, Servheen 1981, Aune and Stivers 1982), certain sites are seasonally preferred over others. This preference for specific habitats is influenced in part by the distribution and availability of food resources (Pearson 1975, Hamer and Herrero 1983). Nelson et al. (1983) reported that grizzly bears exhibit 4 metabolic states: hibernation, walking hibernation, normal activity, and hyperphagia. These 4 stages correlate well with the phenological cycles of plant foods selected by grizzly bears in various habitats (Stelmock 1981, Craighead et al. 1982).

Valley floodplains are important to grizzly bears during the spring and early summer in several areas. Key (1974), Singer (1978), and Riggs and Armour (no date) each discussed grizzly bear use of the North Fork of the Flathead River, Montana. These authors found that grizzly bears grazed succulent forbs and grasses, and dug the underground parts of Oxytropus spp., Allium spp., Erythronium grandiflorum, and Hedysarum spp. Valley bottoms also served as important wintering areas for ungulates, and were traveled by grizzly bears searching for carrion. Similar spring use of floodplains by grizzlies in Canada was reported by Pearson (1975) in Klune National Park, Russell et al. (1979) in Jasper National Park, and by Hamer and Herrero (1983) in Banff National Park.

Avalanche chutes are an important component of grizzly bear habitat in northwestern Montana. Zager (1980) reported that chutes were selected by grizzlies in significantly greater proportion than suggested by their availability. Similar results were found by Rockwell et al. (1978), Mace et al. (1979), and Mace and Jonkel (1980). In fact, McLellan and Jonkel (1980) reported grizzly bear use of this component throughout the year. Avalanche chutes are particularly important in the spring and early summer for succulent forbs and grasses. The corms of Erythronium grandiflorum and Claytonia lanceolata, if present, were dug in this component as well. Zager (1980) and Mace and Jonkel (1980) reported that grizzly bears in the lower South Fork of the Flathead River drainage used Alnus spp. shrubfields within avalanche chutes as diurnal resting areas.

Low gradient creekbottoms provide a source of grizzly bear foods during the spring and early summer. Zager (1980) found that the riparian zone habitat component (creekbottom) was important to grizzly bears in the lower South Fork of the Flathead River. Zager also reported that 1 male grizzly bear extensively used creekbottoms as travel routes. Similar use of such habitat was reported by McLellan (1982). Hamer and Herrero (1983) found that mountain tributaries provided important Equisetum spp. feeding sites to grizzly bears in Banff National Park, Canada.

The literature suggested that sidehill parks are used as foraging habitat by grizzly bears (Zager 1980, McLellan and Jonkel 1980, Servheen 1981, Aune and Stivers 1982). However, in the above studies, use of this component was generally less than 2% of all radio locations.

Root, corm, and bulb digging is the most apparent foraging activity of grizzly bears in slabrock areas of the subalpine zone (Mace and Jonkel 1980, Sizemore 1980). Craighead et al. (1982) and Mace and Jonkel (In prep.)

reported the importance of underground parts of *Lomatium* spp., *Claytonia* spp., *Erythronium grandiflorum*, and *Polygonum* spp. to grizzly bears using such areas.

Zager (1980) stated that grizzly bears used high elevation meadows in greater proportion than available, but not significantly so. Personal observations suggest that subalpine meadows are used by grizzlies for grazing, digging the corms *Erythronium grandiflorum* and *Claytonia* spp., and digging ground squirrels (*Spermophilus columbianus*) from their burrows.

Sumner (1973) and Craighead et al. (1982) discussed in detail the value of the alpine zone to grizzly bears in the Scapegoat Wilderness Area, Montana. These authors provided a summary of plant food items identified in scat samples from the alpine and subalpine zones. Their results for the spring season (1 May to 30 June) showed the underground parts of *Lomatium* spp., *Claytonia* spp., and *Erythronium grandiflorum* were eaten in conjunction with grasses and sedges. The nuts of *Pinus albicaulis* occurred in 38.1% of the spring scat samples (Craighead et al. 1983).

Chapman et al. (1953), Sumner (1973), Servheen (1981), and Craighead et al. (1982) each reported grizzly bears feeding on army cutworm moths (*Chorizagrostus auxilaris*) or other moths of the Noctuidae family from mid-July through August at high elevation sites. Zager (1980) found no evidence of this feeding behavior in the tributaries of the lower South Fork of the Flathead River.

The fruits of several shrub taxa, especially *Vaccinium globulare*, *Shepherdia canadensis*, *Sorbus* spp., and *Amelanchier alnifolia* are very important to grizzly bears during the late summer and autumn months (Martinka 1971, Martin 1979, Zager 1980, Servheen 1981, Craighead et al. 1982, Mace and Jonkel In prep.). Fruit is the single most important food for weight gain prior to autumn den entry (Nelson et al. 1983).

Valley floodplains provide fruit to grizzly bears during the late summer and autumn. Pearson (1975), Russell et al. (1979, and Hamer and Herrero (1983) each discussed grizzly bear use of floodplains in Canada. Key (1974), Singer (1978), and McLellan (1982) reported grizzly bear foraging activity on the North Fork of the Flathead River floodplain during this season. Each of the above authors reported the fruit of *Shepherdia canadensis* and roots of *Hedysarum* spp. were important food items to grizzlies using this low elevation habitat.

Natural fire creates and maintains favorable habitat for the grizzly bear. Grizzly bears rely on the fruit of several shrub species found in such areas (Martinka 1971, Martin 1979, Zager 1980, Mace and Jonkel 1980, Aune and Stivers 1982, Mace and Jonkel In prep.). In fact, Mace and Jonkel (1980) found that individual grizzlies may severly limit movements, and forage in a single, relatively small shrubfield for periods in excess of 5 weeks. *Vaccinium globulare*, *Amelanchier alnifolia*, and *Shepherdia canadensis* increase cover and fruit production for several years following wildfire (Martin 1979, Zager 1980, Fischer and Clayton 1983).

The seeds of *Pinus albicaulis* are an important food item to grizzly bears during the summer and autumn months in the more xeric regions of Montana and Wyoming (Schallenberger and Jonkel 1980, Kendall 1981, Aune and Stivers 1982, Craighead et al. 1982, Mace and Jonkel In prep.). Kendall (1981) felt that where pine nuts were available, grizzly bears would take advantage of them. *P. albicaulis* has been greatly reduced in the Northern Rockies by epidemics of mountain pine beetle (*Dedroctonus ponderosae*) and this reduction correlates well with the regional food habits of the grizzly bear in Montana (Mace and Jonkel In prep.). The seed production cycle of this food item is estimated to be between 6 and 8 years by Forcella and Weaver (1977), and between 3 and 5 years (USDA 1974).

The mountainous habitat of the grizzly bear in Montana include the forested zones. Grizzly bears do not restrict their activities to open types of habitat, but use forested habitat types throughout the non-denning period. The more important habitat types (Pfister et al. 1977) to grizzly bears include the *Abies lasiocarpa*/*Xerophyllum tenax*-*Vaccinium globulare*, the *A. lasiocarpa*/*Menziesia ferruginea*, the *A. lasiocarpa*/*Clintonia uniflora*, and the *Picea* spp. habitat type series (Martin 1979, Singer 1978, Zager 1980). Over 95% of radio locations obtained from 4 grizzly bears in the South Fork of the Flathead River were classified as forested (Border Grizzly Project files, Missoula Montana).

RESULTS

Eight grizzly bear habitat components were designated for the study area. Within these components, 28 vegetation types (VT) were identified (Table 2). Several forested habitat types were also analyzed. This section includes: 1) descriptions of habitat components and associated VT's, 2) seasonal rankings of VT's, 3) the distribution of "key" grizzly bear food items, and 4) a comparison between grizzly bear habitat components and landtype associations. A floral list for the study area (scientific and common names) is given in Appendix B.

Description of Grizzly Bear Foraging Habitat Components

Floodplain Complex Habitat Component

To comply with other classification systems for valley bottomlands, the floodplains of the study area were divided into 2 zones (USDA 1978, Pfister and Batchelor 1984). These zones were used to distinguish the topographic/geographic position of each VT. The riparian zone was adjacent to the river channel and susceptible to annual or periodic flooding. The terrestrial zone was that area of undulating

Table 2. Classification of grizzly bear habitat components and associated vegetation types in the Bob Marshall Wilderness Area, Montana.

I. Floodplain Complex Habitat Component
1. *Salix* spp. flat VT
2. Sandbar and gravel bar VT's
3. *Carex* spp. VT
4. Mesic herbaceous meadow VT
5. Riparian *Picea engelmannii* VT
6. *Populus trichocarpa* VT
7. Terrestrial *Picea engelmannii* VT
8. Xeric graminoid meadow VT

II. Avalanche Chute Complex Habitat Component
1. Streamside VT
2. *Alnus* shrubfield VT
3. *Xerophyllum tenax* VT
4. Xeric, warm-aspect VT
5. Mesic herbaceous fan VT
6. Xeric herbaceous fan VT

III. Timber Creekbottom Habitat Component
1. Closed timber VT
2. Glade (opening) VT

IV. Mountain Sidehill Park Habitat Component
1. Mixed graminoid VT
2. Xeric bunchgrass VT

V. Burn Shrubfield Habitat Component
1. Temperate Zone burn shrubfield VT
2. Subalpine Zone burn shrubfield VT

VI. Subalpine Meadow Habitat Component
1. Shortgrass/*Phyllodoce empetriformis* VT
2. Hydromesic herbaceous VT
3. Tallgrass/*Senecio triangularis* VT

VII. Slabrock Habitat Component

VIII. Alpine Complex Habitat Component
1. Fellfield VT
2. Mesic alpine meadow VT
3. Vegetated rock/talus VT

and terraced valley floor not subject to floodwaters.

The floodplain complex was formed by valley glaciers and exhibited a U-shaped topography. The elevation of these low-gradient river or creek valleys varied from 1415 to 1576 m.

The broad valleys of the Bob Marshall were complexes of riparian and terrestrial plant communities (Photo's 1, 2, and 3). Vegetation composition reflected water table depth, frequency of floods and natural fires, subtle gradients of temperature and elevation, and soil type and depositional pattern.

Nonforested vegetation of the riparian zone included *Salix* spp. flats, gravel bar communities, mesic herbaceous meadows, and hydric sedge-dominated channel borders. Riparian forested vegetation consisted of seral and mature *Picea engelmannii* stands. Blocks of highly-stocked *Pinus contorta* and *Pseudotsuga menziesii* interspersed with xeric graminoid/*Artemisia tridentata* meadows occupied well-drained terraces of the terrestrial zone. Small inclusions of *Populus tremuloides* and *P*. trichocarpa were scattered throughout the floodplain at sites of high soil moisture. Numerous microsites (e.g. frost pockets) and vegetation ecotones added to the complexity of this component.

The South Fork of the Flathead River (approximately 1.6 km wide near Big Prairie) and lower Youngs Creek (approximately 0.8 km wide near the confluence of Hahn Creek) were the 2 major floodplains in the study area.

The following vegetation types of the floodplain complex were identified and sampled: 1) *Salix* spp. flat, 2) sand and gravel bars, 3) *Carex* spp., 4) mesic herbaceous meadow, 5) riparian *Picea engelmannii* 6) *Populus trichocarpa*, 7) terrestrial *Picea engelmannii*, and 8) xeric graminoid meadow. The percent cover and percent occurrence values of dominant taxa in each VT are given in Table 3. Complete taxa lists for each VT are given in Appendix C.

1) *Salix Flat VT*: Shrubfields dominated by *Salix* spp. occupied mesic and hydric river oxbows, narrow margins adjacent to river channels, and to a lesser extent mesic openings in *Picea engelmannii* stands. Riverine *Salix* flats (proximate to river channels) were subjected to annual flooding. Bisecting these flats were 3-m deep channels, formed during spring flood stages and often maintained because of a near-surface water table.

Thirteen shrub taxa were found in this VT. *Salix* spp. showed the greatest percent cover in all strata. *Lonicera involucrata* and *Ribes* spp. were considered codominant with

Photo 1. Panoramic view of Youngs Creek drainage.

Photo 2. Mesic herbaceous meadow vegetation type (A). Riparian *Picea engelmannii* vegetation type (B).

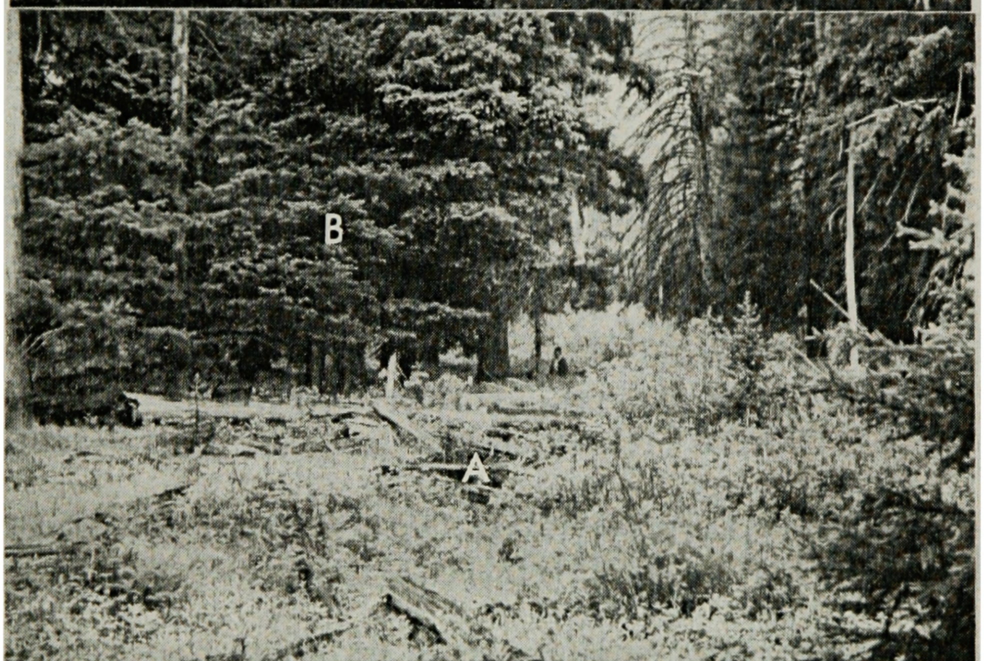
Photo 3. The sand bar vegetation type (A), and the *Salix* spp. flat vegetation type (B).

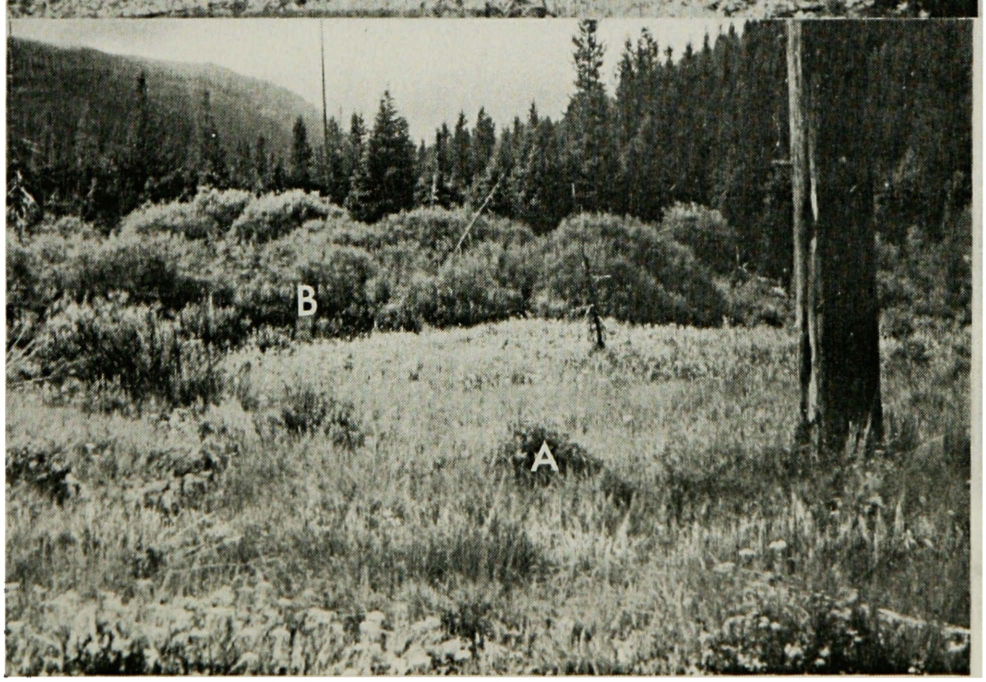
Salix spp. in stratum A.

Dominant taxa in stratum A included *Equisetum* spp., *Heracleum lanatum*, *Senecio pseudaureus*, *Salix* spp., *Ribes* spp., and *Lonicera involucrata*. Collectively, grasses and sedges had a cover value of 32% and appeared in all plots.

2) Sand Bar and Gravel Bar VT's: The gravel bar VT occupied that portion of the channel adjacent to the stream bank and was inundated by water during annual floods. Fluvial deposited pebbles, gravels (approximately 8 cm), and silts supported 30 taxa. Gravels and soils constituted 77% of the cover. Dominant taxa included *Salix* spp., *Epilobium glandulosum*, *Trifolium* spp., and *Astragalus alpinus*. *Hedysarum sulpherenscens* was not present in plots, nor observed on the sand or gravel bars of Youngs Creek or the South Fork of the Flathead River. Vegetation structure was simple; all taxa occupied stratum A.

The sand bar VT occured on fine-grained fluvial sand and silt deposits on oxbows adjacent to but above the water level. This type was more stable than gravel bars, and would only be disrupted or destroyed by catastrophic flood. Nonvascular ground cover was 36%. Dominant herbaceous taxa included *Oxytropis campestris*, *Sedum stenopetalum*, *Lupinus* spp., and *Eriogonum flavum*. The cover of


B
A


B
A

Gramineae/Cyperaceae was 8%. Hedysarum sulpherenscens although not present in plots, was observed once as an individual plant.

3) Carex spp. VT: Several hydric river and creek borders of the riparian zone supported high cover of Carex spp. This VT also occurred as narrow bands adjacent to beaver (Castor canadensis) marshes.

4) Mesic Herbaceous Meadow VT: Mesic herbaceous meadows of the riparian zone were a complex mosaic of edges and openings occurring in and between Picea engelmannii, Salix spp., and Pinus contorta vegetation. On certain sites, these meadows formed abrupt edges between 2 or more types of vegetation, while on other sites they formed a gradual continuum from the adjacent vegetation. The areal extent of these meadows varied from approximately 0.04 to 0.4 ha.

Apparently favorable combinations of light, moisture, and temperature led to a high diversity of plant taxa. Gramineae/Cyperaceae had a combined cover of 39%. Thalictrum occidentale was the dominant herbaceous species in stratum A. Other herbaceous taxa with relatively high cover values included Fragaria virginiana, Heracleum lanatum, Epilobium angustifolium, and Arnica latifolia.

Eighteen shrub taxa were found in stratum A, with *Rosa* spp. and *Cornus stolonifera* exhibiting the greatest cover. Invasion and subsequent growth of *Picea engelmannii* was apparent.

5) *Riparian Picea engelmannii VT*: Pockets of mature *P. engelmannii* all of which survived the natural wildfire of 1926 and some of which survived the wildfire of 1895 (stand ages 85-179 years), occupied poorly drained soils of the riparian zone. Seral "doghair" *Pinus contorta* stands, burned in 1926, were also present. Habitat types of this VT included *Picea/Galium triflorum*, and *Picea/Clintonia uniflora* (*Clintonia uniflora* absent, *Cornus canadensis* present).

Seventy plant taxa were encountered in plots. Dominant taxa of stratum A, while variable by habitat type, included *Thalictrum occidentale*, *Senecio pseudaureus*, *Aster conspicuous* ,*Fragaria virginiana*, *Cornus canadensis*, *Pyrola* spp., *Linnaea borealis*, and *Cornus stolonifera*. *Calamagrostis canadensis* was the predominant grass on moist sites. *Alnus* spp., *Lonicera involucrata*, and *Cornus stolonifera* were shrubs present in stratum B.

6) Populus trichocarpa VT: Small (<1.6 ha) stands of Populus trichocarpa colonized fluvial sand and gravel deposits of the riparian zone. The stands sampled were located approximately 1.6 km south of Big Prairie, along the South Fork of the Flathead River at an elevation of 1415 m. The relatively high cover values of Trifolium spp. and Taraxacum spp. and evidence of vegetation trampling suggested that livestock (horses) heavily grazed these areas. Other dominant herbs in stratum A included Fragaria virginiana, Senecio pseudaureus, Erigeron spp., and Solidago missouriensis. Shrub species with high cover values were Cornus stolonifera, Arctostaphylos uva-ursi, and Shepherdia canadensis. Grasses and sedges (principally Calamagrostis canadensis), had a cover of 17%.

7) Terrestrial Picea engelmannii VT: Seral, well-drained phases of the P. engelmannii climax series (Pfister et al. 1977) existed as large relatively homogeneous stands on flat benches above the riparian zone. All stands sampled were renewed following the the wildfire of 1926. Pinus contorta was the dominant tree in all strata. Picea engelmannii and Pseudotsuga menziesii stems were present as regeneration in the lower strata.

Thirty-six taxa were present in 23 sample plots. Dominant shrubs were Vaccinium caespitosum, Arctostaphylos uva-ursi, and Shepherdia canadensis. All herbaceous taxa occurred in trace amounts. However, those with the greatest percent occurrence were Epilobium angustifolium, Pedicularis spp., Erigeron spp., and Lupinus spp.

8) Xeric Graminoid meadow VT: Dry meadows of the terrestrial zone were located on large alluvial fans or existed as small openings in the Picea/Vaccinium caespitosum habitat type. This VT exhibited a pronounced seasonal change from a late spring/early summer flush to severe dessication by August.

The xeric meadow VT corresponded to the Festuca scabrella-Stipa richardsonii community type of Johnson (1982) and the Festuca scabrella-Festuca idahoensis grassland habitat type of Mueggler and Stewart (1980). The Artemisia tridentata phase of the aforementioned community type was observed on the Hahn Creek alluvial fan.

Gramineae and Cyperaceae showed a combined cover of 27% and occurrence of 100%. Dominant herbaceous species included Eriogonum umbellatum, Geum triflorum, Trifolium spp., and Lupinus spp. Nonvascular ground cover was 43%.

Table 3. Dominant taxa in the floodplain complex habitat component (% cover/% occurrence).

Taxa	Salix flat n=26	Sand bar n=13	Gravel bar n=27	Carex spp. n=6	Mesic herbaceous meadow n=13	Riparian Picea spp. n=27	Populus trichocarpa n=4	Terrestrial Picea spp. n=23	Xeric graminoid meadow n=20
FORBS:									
Equisetum spp.	4/46				1/77	2/59			
Heracleum lanatum	4/73				2/62	1/63			
Senecio pseudaureus	2/62	1/85							
Fragaria virginiana	1/65				3/85	6/82	2/75		
Trifolium spp.		1/15	t/44[1]			4/41			
Achillea millefolium		t/100					1/100		
Lupinus spp.		2/54						t/44	
Oxytropis campestris		2/46							
Epilobium latifolium			4/70						
Thalictrum occidentale					16/85	12/63			
Smilacina stellata					1/92				
Angelica arguta					1/92				
Galium triflorum						3/74			
Epilobium spp.							4/75		
Taraxacum spp.							2/25		
Astragalus miser							1/75		
Epilobium angustifolium								t/65	
Erigeron spp.								t/65	
Eriogonum umbellatum									2/50
Geum triflorum									1/55
Penstemon spp.									3/85
Potentilla spp.									2/35
Adenocaulon bicolor				1/83					
SHRUBS:									
Salix spp.									
0-0.9 m	4/81		2/37	7/50	t/23				
0.9-2.0 m	42/85								
Ribes spp.	5/81								
Lonicera involucrata									
0-0.9 m	3/85				2/77	2/74			
Rosa spp.		2/62			7/85	3/70			
Arctostaphylos uva-ursi		1/31					17/50	16/91	
Linnaea borealis								t/13	
Cornus stolonifera									
0-0.9 m							24/75		
Vaccinium ceaspitosum								22/91	
Artemisia tridentata									2/20
GRAMINEAE/CYPERACEAE:	32/100	8/69	3/74	81/100	39/100	16/100	17/75	4/100	27/100
NONVASCULAR COVER:	1/74	36/100	77/100	8/83	5/54	15/100	15/100	1/13	43/100

[1] t= < 0.5% cover.

<u>Avalanche Chute Complex Habitat Component</u>

Avalanche chutes were a combination of vegetation types subjected to annual or periodic cascading snow. Avalanche chutes typically formed in the linear and concave irregularities of steep mountain slopes. However, they also existed as extensive open and undulating parks dominated by *Xerophyllum tenax* beneath steep mountain headwalls or palisades. The composition and pattern of vegetation was determined by the average interval between successive snowslides (Schaerer 1973), radicals in environmental gradients (Stauffer 1976), the predominant aspect, and presence or absence of a stream course.

The major vegetation types of avalanche chutes were extremely variable in size and species composition. They included supple-stemmed shrubfields on cool and moist aspects, mesic and hydric streamside vegetation, xeric-site vegetation, herbaceous/graminoid lower fans, and *Xerophyllum tenax* dominated vegetation on lower elevation fans or in higher elevation bowls.

The criteria used to differentiate avalanche chutes from other grizzly bear habitat components were evidence of avalanche activity, topographic concavity, presence of a narrow and linear avalanche tract, and juxtaposition and abruptness of vegetation boundaries. Large *Xerophyllum tenax* parks, if subjected to avalanche, were considered an avalanche chute.

Seven avalanche chutes were sampled and the dominant aspect of each were as follows:

Babcock Creek ....south
Marshall Creek............south
Otter Creek ....west
Bigslide..................east
Marshall Creek............north
Jumbo Creek...............north
Otis Creek................southeast

The characteristic vegetation of avalanche chutes were determined from these 7 avalanche chutes. The final stratification of vegetation types was 1) streamside, 2) *Alnus* spp. shrubfields, 3) *Xerophyllum tenax*, 4) Xeric, warm-aspect, 5) Mesic herbaceous fan, and 6) Xeric herbaceous fan. The physical data collected in each vegetation type are given in Table 4. The percent cover and occurrence of dominant taxa in each VT are given in Table 5. Complete taxa lists for each VT are given in Appendix D. Several vegetation types of the Jumbo Creek chute are shown in Photo 4.

1) Streamside VT: Vegetation plots were established adjacent to the intermittent and continuously flowing steams of 5 avalanche chutes. Marshall Creek (north facing) and Otis Creek (southeast facing) did not have streams.

Comparisons of similarity coefficients for the streamsides are given in Table 6. Coefficients varied from 29 to 49% when all but ephemeral taxa were included, and the average similarity was 37%. The greatest percent similarity was between the Bigslide and the Otter Creek avalanche chutes. When only grizzly bear foods were considered, the average was 53% (range 28% to 75%). Chutes showing the greatest similarity in food items were Bigslide (east facing) and Babcock Creek (south facing). Three of 113 taxa (6%) were common to all streamsides (*Thalictrum occidentale*, *Heracleum lanatum*, and *Senecio triangularis*).

Herbaceous species with the highest cover included *Senecio triangularis*, *Heracleum lanatum*, *Senecio pseudaureus*, and *Galium triflorum*. *Mimulus lewisii* and *Saxafraga arguta* occupied hydric sites. The dominant shrub species in stratum A were *Rhamnus alnifolia* ,*Rubus parviflorus*, and *Salix* spp. *Alnus* spp. and *Rhamnus alnifolia* were dominant shrubs in strata B and C.

2) Alnus spp. VT: Alnus spp. dominated shrubfields were found on cool and moist sites in all but the avalanche chute of Marshall Creek. The most extensive shrubfields were on northern aspects of linear tracts and on east-facing cirque headwalls of the Swan Range (Photo 5). In southfacing chutes, shrubfields were less expansive, and occupied southeastern exposures.

The average of 10 similarity coefficients, using all taxa was 37%. When only bear foods were evaluated, the coefficient increased to 39%. The greatest similarity in grizzly bear foods was 50%.

Eleven shrub taxa were present in sample plots. Alnus spp. was the dominant shrub in strata B and C. Menziesia ferruginea, Lonicera involucrata, and Rhamnus alnifolia were other shrubs in the upper strata. Veratrum viride, Senecio triangularis, and Thalictrum occidentale were the herbaceous species exhibiting the greatest cover beneath the shrub canopy. The cover of Heracleum lanatum was greatest along Alnus spp. ecotones and under canopies of low-growing shrubs. Athyrium filix-femina and Polystichum lonchitis were 2 ferns present. No trees were observed in this type.

3) *Xeric, Warm-Aspect VT*: A xeric VT dominated by grasses and forbs was sampled on steep, thin, and well-drained soils in all but the north-facing chutes of Marshall and Jumbo creeks. In linear chute tracts, it occupied continuous vertical bands on dry aspects. This VT was also found within the *Xerophyllum tenax* VT on upper elevation sites.

Similarity coefficients derived from 5 avalanche chutes averaged 35% when all but ephemeral taxa were used (Table 6). When only grizzly bear foods were considered, the similarly increased to 39%.

Vegetation in the xeric, warm-aspect VT was confined to stratum A. *Balsamorhiza sagittata*, *Antennaria microphylla*, *Erigeron* spp., *Fragaria virginiana*, *Achillea millefolium*, and *Sedum stenopetalum* were considered dominant herbaceous taxa. *Amelanchier alnifolia*, showed the greatest cover of 9 shrub taxa. Gramineae (principally *Festuca idahoensis*, *Agropyron spicatum*, *Melica spectabilis*) and Cyperaceae had a combined cover of 25%. Nonvascular ground constituted 38% cover.

4) _Xerophyllum_ _tenax_ _VT_: Vegetation dominated by _Xerophyllum_ _tenax_ varied greatly in areal extent among avalanche chutes. It occupied small pockets on particularly unstable surfaces, or relatively extensive undulating matts on mid to upper-elevation sites adjacent to the _Abies_ _lasiocarpa_/_Xerophyllum_ _tenax_ and _A_. _lasiocarpa_/_Luzula_ _hitchcockii_ habitat types (Photo 6). This VT was observed in all but the north-facing Marshall Creek and the west-facing Otter Creek chutes.

Avalanche chute bowls exhibited a _X_. _tenax_ dominated ground cover on all but the driest and thinnest soils. In these dry microsites, the _Xerophyllum_ _tenax_ VT was replaced by the xeric, warm-aspect VT described previously.

Whereas the concave portion of an avalanche chute tract often acted as a natural fire barrier, certain upper elevation bowls were subjected to ground fire within the last 50 years. The most obvious influence of fire on these sites was an increase in shrub presence and cover values. Because of fire history differences among avalanche chutes, similarity coefficients were low (Table 6). For example, the upper elevation _Xerophyllum_ _tenax_ VT of the Babcock Creek chute, which burned in 1934, showed twice the number of shrub taxa compared to otherwise quite similar sites.

Xerophyllum tenax showed the greatest herbaceous cover value. *Fragaria virginiana*, *Erigeron* spp., *Osmorhiza occidentalis*, and *Thalictrum occidentale* were other forbs of relatively high cover in stratum A. *Vaccinium scoparium* was the dominant shrub in stratum A. Cover of *V. globulare* was greatest in areas that burned. Nonvascular ground had a cover value of 20%. Combined, grasses and sedges showed 8% cover.

5) *Mesic Herbaceous Fan VT*: The lower fans of cool and moist aspect chutes supported herbaceous and graminoid vegetation. Because of the northerly to northwesterly aspect and/or upper elevational position, these mesic fans held snow longer than other chutes and exhibited delayed phenological development.

Senecio triangularis ,*Xerophyllum tenax*, *Thalictrum occidentale*, and *Heracleum lanatum* were dominant herbs in stratum A. *Ribes lacustre* exhibited the greatest cover of 15 shrubs in stratum A. Gramineae and Cyperaceae showed a combined cover of 19% and appeared in all sample plots (primarily *Carex geyeri* and *Calamagrostis rubescens*). Nonvascular ground comprised 9% cover. Occasional stems of *Abies lasiocarpa*, *Pseudotsuga menziesii*, and *Picea engelmannii* were present.

Table 4. Physical data collected from 6 vegetation types of the avalanche chute complex.

Vegetation type	Average plot elevation (m)	Elevation range (m)	Average plot aspect (degrees)	Aspect range (degrees)
Streamside	2017	1606-2165	182	60-355
Alnus spp. shrubfield	1838	1700-2151	48	351-81
Xerophyllum tenax	1932	1679-2120	174	90-210
Xeric, warm-aspect	2022	1590-2236	210	41-261
Mesic herbaceous fan	1971	1967-2028	278	275-330
Xeric herbaceous fan	1626	1590-1776	102	71-141

Table 5. Dominant taxa of the avalanche chute complex habitat component (% cover/% occurrence).

	Vegetation type					
	Xeric, warm-aspect n=114	Xeric herbaceous fan n=26	Xerophyllum Tenax n=93	Streamside n=129	Alnus Shrubfield n=52	Mesic herbaceous fan n=45
FORBS:						
Balsamorhiza sagittata	2/25					
Achillea millefolium	t/82[1]	1/91	t/73			2/38
Sedum stenopetalum	t/60					
Antennaria microphylla	1/49					
Galium boreale		3/25				
Fragaria virginiana		4/78	5/63			
Osmorhiza occidentalis		3/38	2/20			1/36
Aster spp.		6 /75				
Solidago canadensis		3 / 38				
Xerophyllum tenax			45/82			7/36
Erigeron spp.			5/60			
Senecio triangularis				15/70	9/75	11/73
Heracleum lanatum				6/47	6/52	3/40
Senecio pseudaureus				5/59		
Galium triflorum				1/24	2/52	
Taraxacum spp.				2/30		
Veratrum viride					9/54	
Thalictrum occidentale			1/35		5/50	5/78
Streptopus amplexifolius					1/42	
SHRUBS:						
Amelanchier alnifolia	4/51		1/26			
Rhamnus alnifolia		11/28				
Symphoricarpos albus		3/16				
Vaccinium scoparium			4/21			
Vaccinium globulare			1/11			
Alnus spp. (0.9-2.0 m)					40/89	
Alnus spp. (> 2.0 m)				4/15	38/71	
Sorbus spp. (0.9-2.0 m)					3/17	
Salix spp. (0.9-2.0 m)				3/15		
Ribes lacustre						4/22
GRAMINEAE/CYPERACEAE:	25/100	14/100	8/60	6/100	2/72	19/100
NONVASCULAR COVER:	38/100	t/100	20/100	6/100	20/100	9/100

[1]t= <0.5% cover

Table 6. Jaccard percent similarity coefficients for vegetation types of the avalanche chute habitat component (all but ephemeral taxa/grizzly bear foods only).

STREAMSIDE VT (n=129)

	Marshall Cr. S. Facing n=31	Bigslide E. Facing n=26	Otter Cr. W. Facing n=23	Babcock Cr. S. Facing n=29	Jumbo Cr. N. Facing n=20	Otis Cr. SW. Facing	Marshall Cr. N. Facing
Marshall Cr.		38/38	34/61	44/70	33/55	ABSENT	ABSENT
Bigslide			49/47	38/75	29/28		
Otter Cr.				31/63	37/54		
Babcock Cr.					34/41		

<u>ALNUS</u> SHRUBFIELD VT (n=52)

	Jumbo Cr. N. Facing n=8	Bigslide E. Facing n=12	Otter Cr. W. Facing n=10	Babcock Cr. S. Facing n=12	Marshall Cr. N. Facing n=10	Otis Cr. SW. Facing	Marshall Cr. S. Facing
Jumbo Cr.		40/21	35/50	36/27	27/33	ABSENT	ABSENT
Bigslide			30/36	41/32	33/19		
Otter Cr.				27/22	48/50		
Babcock Cr.					48/27		

<u>XEROPHYLLUM</u> <u>TENAX</u> VT (n=93)

	Babcock Cr. S. Facing n=55	Bigslide E. Facing n=12	Marshall Cr. S. Facing n=20	Otis Cr. SW. Facing n=6	Otter Cr. W. Facing	Jumbo Cr. N. Facing	Marshall Cr. N. Facing
Babcock Cr.		28/38	25/33	25/39	ABSENT	ABSENT	ABSENT
Bigslide			27/18	50/45			
Marshall Cr.				38/40			

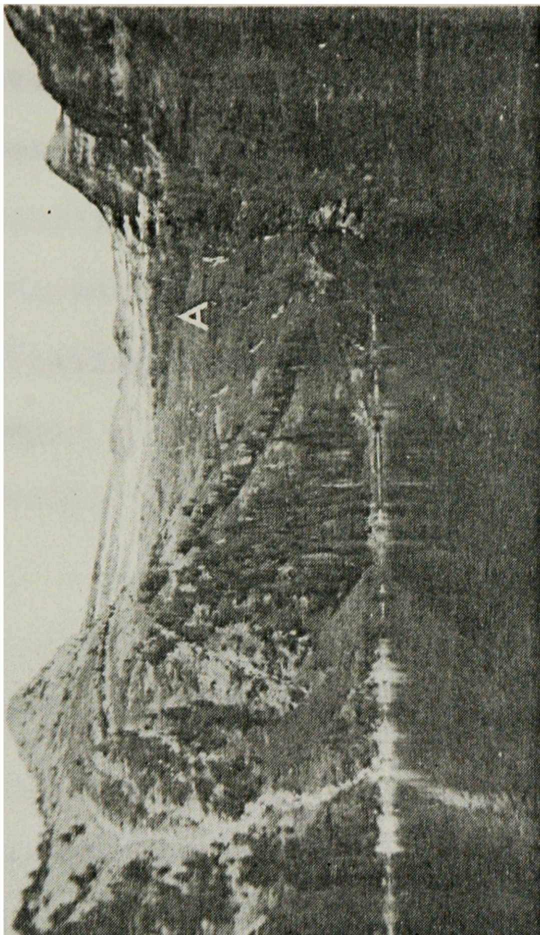
XERIC, WARM ASPECT VT (n=114)

	Marshall Cr. S. Facing n=34	Bigslide E. Facing n=18	Otter Cr. W. Facing n=36	Babcock Cr. S. Facing n=20	Otis Cr. SW. Facing n=6	Marshall Cr. N. Facing	Jumbo Cr. N. Facing
Marshall Cr.		45/60	37/43	38/36	33/45	ABSENT	ABSENT
Bigslide			32/21	31/50	28/20		
Otter Cr.				29/29	35/40		
Babcock Cr.					32/45		

Photo 4. Jumbo Creek Avalanche chute.
A. Mesic herbaceous fan vegetation type.
B. Xeric, warm-aspect vegetation type.
C. *Alnus* spp. vegetation type.

Photo 5. The *Alnus* spp. vegetation type (A) near Koessler Lake.

Photo 6. The *Xerophyllum tenax* vegetation type (A) in Otis Creek.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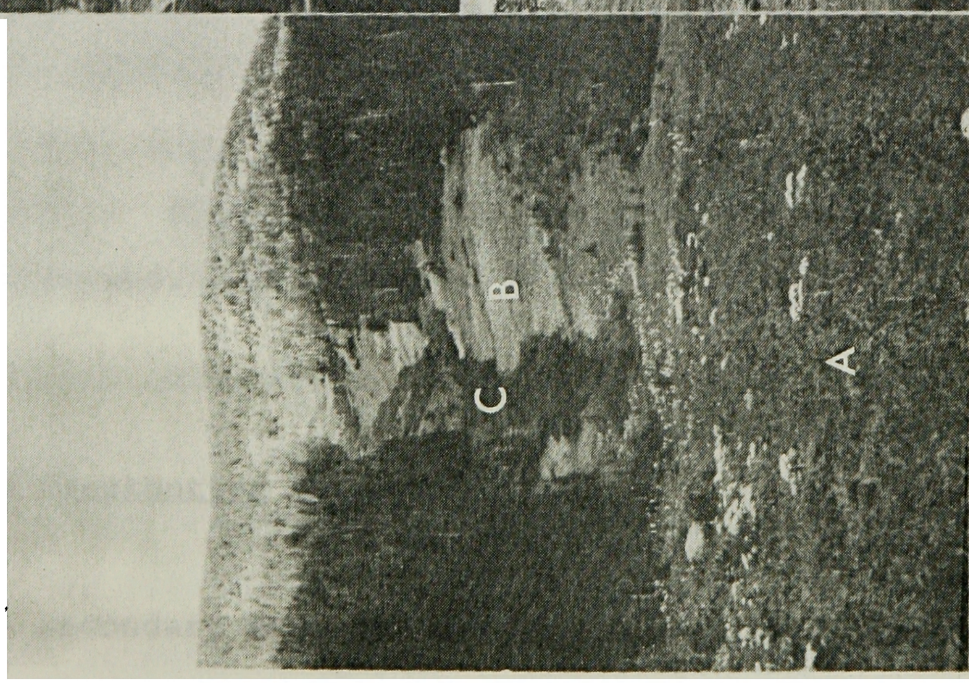
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6) *Xeric Herbaceous Fan VT*: The vegetation of several chutes fans was greatly influences by surface and subsurface ephemeral stream runoff. On exceedingly convex and generally warm-aspect fans, combinations of taxa slowly gradated from mesic conditions near the fan center to increasingly drier conditions towards the edges. One example of this VT was sampled in the Bigslide chute, although it was observed in several locations.

Rhamnus alnifolia was the dominant taxa at sites of high soil moisture with *Heracleum lanatum*, *Thalictrum occidentale*, *Angelica arguta*, *Osmorhiza occidentalis*, and *Hackelia jessicae* present beneath a shrub canopy. *Fragaria virginiana*, *Galium boreale* *Aster* spp., *Erigeron* spp., *Eriogonum umbellatum*, and *Geranium viscosissimum* occupied drier sites. Gramineae/Cyperaceae constituted 14% of the ground cover. *Symphoricarpos albus* and *Ribes lacustre* were dry site shrubs. All taxa occupied stratum A.

Timbered Creekbottom Habitat Component

The secondary drainage bottoms of the study area such as those of Babcock, Marshall, and Gordon creeks exhibited an overstory canopy cover greater than 60%. The overstory vegetation in these timbered creekbottoms was a mixture of conifer species, with occasional small stands of _Populus trichocarpa_ or _P. tremuloides_. Small openings (glades) in the canopy were common. The topographic position of this component created favorable conditions for cold air inversions. The elevation of this habitat component varied from 1439 to 1740 m.

Two timbered creekbottom VT's were identified. The cover and occurrence values of dominant taxa are given in Table 7. Complete taxa lists for this habitat component are given in Appendix E.

1) _Closed timber VT_: Timbered portions of creekbottoms had a mixture of conifer species. Mature _Picea engelmannii_, _Pseudotsuga menziesii_, _Pinus contorta_, and _Abies lasiocarpa_ were present in stratum D. Regeneration of these species was evident in all lower strata. Individual _Populus tremuloides_ trees also occured in this type.

Lonicera involucrata, _Salix_ spp., _Alnus_ spp., and _Cornus stolonifera_ were dominant shrubs in strata A, B, and C. _Thalictrum occidentale_ was the dominant herbaceous species, and occurred in 93% of the plots. Other dominant herbs were _Fragaria virginiana_, _Galium triflorum_, and _Arnica_ spp. Gramineae and Cyperaceae showed a combined cover value of 24%.

Table 7. Dominant taxa in the timbered creekbottom habitat component (% cover/% occurrence).

Taxa	Vegetation type: Closed timber n=40	Vegetation type: Glade n=28
FORBS:		
Angelica arguta	2/40	
Thalictrum occidentale	3/93	3/79
Heracleum Lanatum	1/48	
Arnica spp.	2/65	
Fragaria Virginiana	1/68	4/61
Equisetum spp.		6/82
Senecio triangularis		3/50
SHRUBS:		
Cornus stolonifera (0.9-2.0 m)	12/37	6/21
Lonicera involucrata (0-0.9 m)	7/ 72	
Alnus spp. (0.9-2.0 m)	3/40	
Rosa woodsii (0-0.9 m)	1/53	
Salix spp. (0.9-2.0 m)		22/57
Ribes lacrustre (0-0.9 m)		1/57
GRAMINAE/CYPERACEAE:	24/100	21/100
NONVASCULAR COVER:	21/100	14/100

2) <u>Glade VT</u> : Openings in the forest canopy occured along stream channels, near log-jams, in "blow-down" areas, and on sites where avalanche chutes crossed the drainage bottoms. Such sites were mesic to hydric. The cover values of several shrub taxa were greater than in the closed timber type. <u>Salix</u> spp., <u>Rubus parviflora</u>, and <u>Ribes lacustre</u> were all apparently favored by openings in the forest canopy.

The greatest cover values of conifers were in stratum C, and regeneration of <u>Picea engelmannii</u>, <u>Pseudotsuga menziesii</u>, <u>Abies lasiocarpa</u> and <u>Populus trichocarpa</u> was evident in lower strata. <u>Pinus contorta</u> did not appear in sample plots.

<u>Equisetum</u> spp., <u>Fragaria virginiana</u>, <u>Thalictrum occidentale</u>, and <u>Senecio triangularis</u> were dominant herbs. <u>Heracleum lanatum</u>, <u>Angelica arguta</u>, and <u>Ligusticum canbyi</u> each appeared in 46% of sample plots. Gramineae/Cyperaceae cover was 21%.

Burn Shrubfields Habitat Component

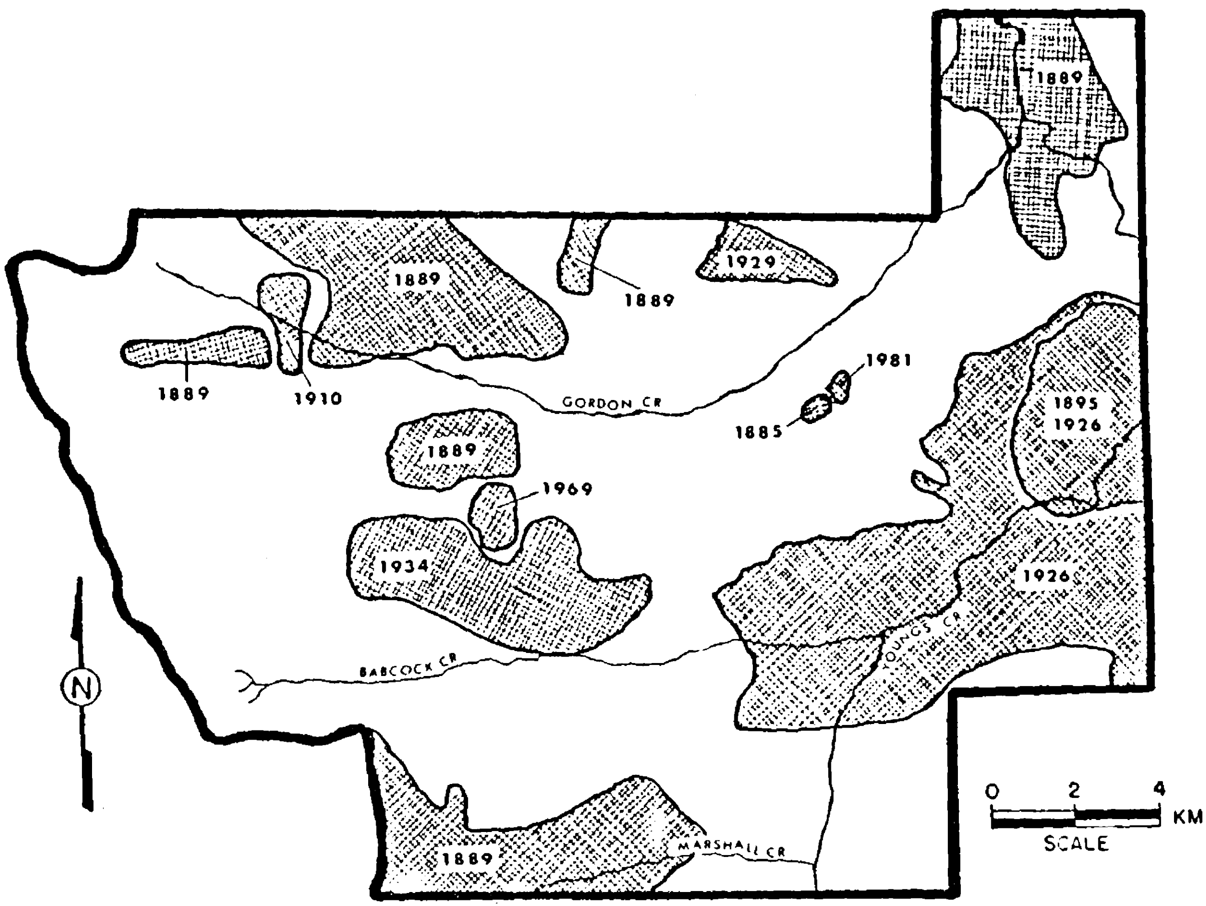
The four relatively recent periods of natural fire in the study area have shaped the composition and juxtaposition of vegetation. The oldest recorded burn ignited in 1895, and the most recent in 1981 (Fig. 2). Many of these burned areas failed to fully regenerate conifers since burning and existed as open shrubfields.

Seven burn shrubfields were sampled. These were divided into temperate zone burn shrubfields and subalpine zone burn shrubfields. The physical data are given in Table 8, and the dominant taxa of each type are given in Table 9. Complete taxa lists for this habitat component are given in Appendix F.

1) Temperate Zone Burn Shrubfield VT: Burn shrubfields of the temperate zone were located on low to mid-mountain slopes below 2121 m. These shrubfields occurred on all aspects, yet were most prevalent on southern exposures.

The seral composition of these shrubfields was a consequence of natural fire (Photo 7). Approximately 1 m tall shrubs of mixed species dominated most sites. However, on particularly exposed and severely burned soils, only herbaceous taxa survived or invaded. The most recent period of burning for all temperate shrubfields sampled was 1926. Large stumps and snags suggested that these shrubfields were

Figure 2. Fire history of the study area.



previously an open timbered *Pseudotsuga menziesii* forest, and limited data from unburned timbered islands suggested a *Pseudotsuga menziesii*/*Calamagrostis rubescens* habitat type. The natural fire of 1926 was extensive, and few paired unburned sites were available for comparison.

Similarity coefficients for the 5 burns of the temperate zone are summarized in Table 10. The average similarity for all taxa was 28%. When only bear food items were analyzed, the average similarity among the shrubfields increased to 39%.

Herbaceous plants exhibiting the greatest cover and occurrence included *Balsamorhiza sagittata*, *Aster conspicuus*, *Hedysarum occidentale*, and *Epilobium angustifolium*. *Ceanothus velutinus* showed the greatest cover value of shrubs followed by *Amelanchier alnifolia*, and *Spiraea betulifolia*. Nonvascular ground cover was 32%. Gramineae/Cyperaceae showed a combined cover value of 14%. Principal graminoids were *Festuca idahoensis*, *Agropyron spicatum*, *Carex geyeri*, and *Calamagrostis rubescens*.

Observations on shrub productivity during 2 field seasons suggested *Amelanchier alnifolia*, *Rubus* spp., *Ribes* spp., and *Prunus virgiana* did not consistently produce fruit on these 58-year-old burns. Most shrubs appeared to have been heavily browsed by ungulates during winter. Excellent *Shepherdia canadensis* fruit production was seen both in 1982 and 1983 on sites with at least 30% mature tree cover. Where this species grew in the open, little fruit production was observed.

2) *Subalpine Zone Burn Shrubfield VT*: Burn shrubfields of the subalpine zone occurred at elevations exceeding 2121 m and on southeasterly exposures (Photo 8). Bulletnose Mountain last burned in 1929 (55 years ago), and the Furious Creek burn last ignited in 1934 (50 years ago). The average plot elevation of the Bulletnose Mountain burn was 62 m higher than that of Furious Creek. Both burns occurred within the *Abies lasiocarpa*/*Xerophyllum tenax*-*Vaccinium scoparium* and the *A. lasiocarpa*/*X. tenax*-*V. globulare* habitat types.

Xerophyllum tenax was the dominant herbaceous species, having a cover value of 51%. Percent cover of this species was greater in the Bulletnose Mountain site than in the Furious Creek burn. *Hedysarum occidentale*, *Senecio triangularis*, *Gentiana calycosa*, and *Epilobium angustifolium* were other herbaceous taxa with relatively high cover values. *Balsamorhiza sagittata*, *Erigeron* spp., and *Aster integrifolius* dominated particularly severe (xeric, shallow soils) sites.

Table 8. Physical data for 2 vegetation types of the burn shrubfield habitat component.

Burn Name	Sample Size	Average Elevation (m)	Elevation Range	Average Aspect (degrees)	Aspect Range
		TEMPERATE ZONE			
Hahn Creek	21	1880	1742-2030	230	169-280
Jumbo Creek	19	1692	1600-1772	209	180-240
Otter Creek	3	1729	1721-1736	270	269-271
Babcock Creek	5	1628	1612-1636	162	150-170
Pilot Peak	30	2045	1820-2120	201	80-280
		SUBALPINE ZONE			
Furious Creek	11	2238	2150-2370	177	15-141
Bulletnose Mtn.	20	2303	2270-2409	148	10-255

Table 9. Dominant taxa of the burn shrubfield vegetation types (% cover/% occurrence).

Taxa	vegetation type: Temperate zone burn shrubfield n=78	vegetation type: Subalpine zone burn shrubfield n=31
FORBS:		
Balsamorhiza sagittata	2/51	
Achillea millefolium	t/90[1]	
Aster conspicuus	1/30	
Hedysarum occidentale	1/23	1/52
Hieracium cynoglossoides	t/51	
Epilobium angustifolium	t/47	t/45
Xerophyllum tenax		51/100
Senecio triangularis		1/58
Gentiana calycosa		t/61
SHRUBS:		
Ceanothus velutinus	12/54	
Amelanchier alnifolia	9/86	
Spiraea betulifolia	6/76	
Berberis repens	2/77	
Shepherdia canadensis	2/24	
Vaccinium scoparium		16/100
Vaccinium globulare		3/13
GRANINEAE/CYPERACEAE:	14/100	6/90
NONVASCULAR COVER:	32/100	14/100

[1]t= <0.5% cover

Table 10. Jaccard similarity coefficients for the temperate zone burn shrubfields (all but ephemeral taxa/grizzly bear foods only).

	Jumbo Cr. n=19	Pilot Mtn. n=30	Otter Cr. n=3	Babcock Cr. n=5	Hahn Cr. n=21
Jumbo Cr.		33/39	21/40	24/40	41/53
Pilot Mtn.			19/27	23/32	33/46
Otter Cr.				21/36	28/25
Babcock Cr.					37/47

Photo 7. The temperate zone burn shrubfield of Jumbo Creek.

Photo 8. The subalpine zone burn shrubfield of Bulletnose Mountain.

Six shrub taxa appeared in the sample plots in this VT. *Valeriana sitchensis* had the highest cover of herbs and was closely associated with continuous *Xerophyllum tenax* matts. *Vaccinium globulare* (3% cover) was found only in the *Abies lasiocarpa*/*Xerophyllum tenax*-*Vaccinium globulare* habitat type in the Furious Creek burn. This species was noticeably absent in the in the *A. lasiocarpa*/*X. tenax*-*Vaccinium scoparium* habitat type of the Bulletnose Mountain burn.

Forest Habitat Types

Three forest habitat types were sampled for cover and occurrence of shrub taxa and are summarized below. The percent cover and percent occurrence of shrub taxa are given in Table 11. For complete descriptions of these forest habitat types see Pfister et al. (1977).

1) *Abies lasiocarpa*/*Xerophyllum tenax*-*Vaccinium globulare* Habitat Type: The *Abies lasiocarpa*/*Xerophyllum tenax*-*Vaccinium globulare* habitat type occurred on southern exposures in the temperate zone and lower subalpine zone. This forested type was sampled on benches above the timbered creekbottom component and in open-timbered to timbered stringers in the *Xerophyllum tenax* VT of avalanche chutes. The elevation and aspect measurements of this type are

Table 11. Percent cover and occurrence of shrub taxa in forest habitat types (% cover/% occurrence).

Shrub taxa	Habitat Type: *Abies lasiocarpa/Xerophyllum tenax-Vaccinium globulare* n=34	Habitat Type: *Abies lasiocarpa/Menziesia ferruginea* n=12	Habitat Type: *Abies lasiocarpa/Luzula hitchcockii-Vaccinium scoparium* n=12
Menziesia ferruginea	t/9[1]	55/100	t/17
Vaccinium globulare	22/97	t/92	3/33
Pachistima myrsinites	t/32	t/8	
Rubus parviflorus	t/12		
Sorbus spp.	t/35		
Shepherdia canadensis	1/15		1/17
Amelanchier alnifolia	t/32		
Arctostaphylos uva-ursi	t/3		
Vaccinium scoparium			15/100

[1]t=cover < 0.5%.

displayed in Fig. 3.

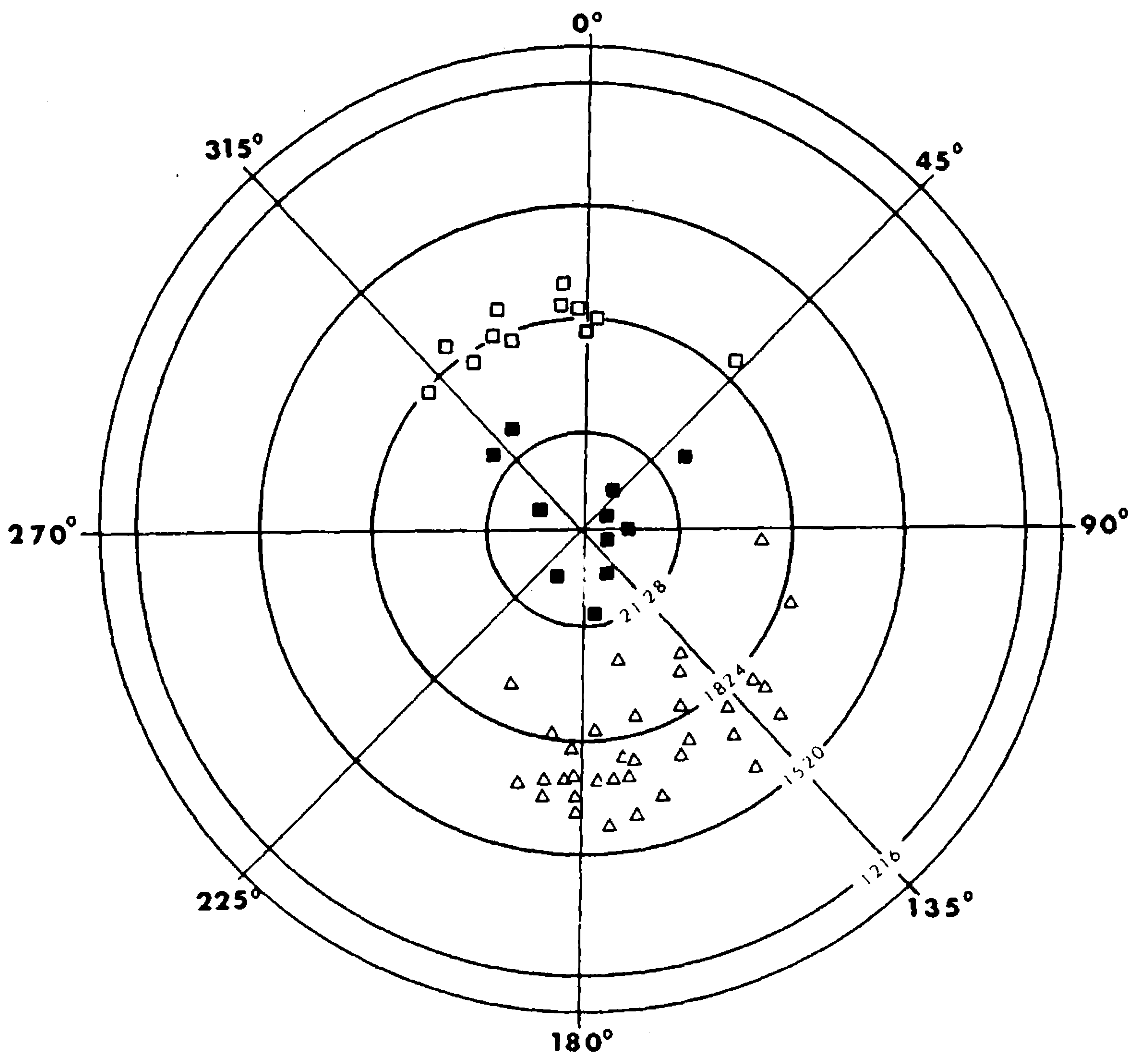
2) _Abies lasiocarpa/Luzula hitchcockii-Vaccinium scoparium Habitat Type_: This habitat occupied sites above 2121 m on all exposures (Fig. 3). Understory vegetation was dominated by _Vaccinium scoparium_ and scattered stems of _Vaccinium globulare_.

3) _Abies lasiocarpa/Menziesia ferruginea Habitat Type_: Forested zones of the _A. lasiocarpa_ habitat series on northern exposures had an understory dominated by _Menziesia ferruginea_. This habitat type occurred on northern aspects.

Mountain Sidehill Park Habitat Component

Openings in the forest canopy at mid-elevations occurred on mountain slopes of the study area. Although they were present on all aspects, such openings, termed sidehill parks, typically occupied residual soils on southern exposures. These parks were often dominated by grasses and maintained by periodic light ground fires (Johnson 1982, USDA 1980).

Figure 3. Elevation and aspect measurements from 3 forest habitat types.



Habitat Type

△: Abies lasiocarpa/Xerophyllum tenax-Vaccinium globulare

■: Abies lasiocarpa/Luzula hitchcockii-Vaccinium scoparium

□: Abies lasiocarpa/Menziesia ferruginea

Two types of mountain sidehill parks were identified: 1) mixed graminoid VT, and 2) xeric bunchgrass VT. The dominant taxa in these 2 types's are given in Table 12. Complete taxa lists are given in Appendix G.

1) Mixed Graminoid VT: Sidehill parks of mixed grass species occurred within the *Pseudotsuga menziesii* series and lower *Abies lasiocarpa* habitat type series (Photo 9). The elevation of sample plots varied from 1495 to 2097 m, and all aspect measurements were of a southern azimuth (Table 13).

Gramineae/Cyperaceae showed a cover of 44%. Common grass species were *Agropyron spicatum*, *Poa pratensis*, *Phleum pratense*, *Stipa occidentalis*, and *Bromus ciliatus*. Dominant herbaceous taxa included *Balsamorhiza sagittata*, *Lupinus* spp., *Arabis* spp. (possibly *A. divaricarpa*), and *Sedum stenopetalum*.

Thirteen shrub taxa occurred in plots. *Amelanchier alnifolia* and *Berberis repens* were considered dominant, and both were present in 71% of the plots. Nonvascular ground cover was 16%.

2) *Xeric Bunchgrass VT*: Numerous sidehill parks supported a dry bunchgrass vegetation (Plate 10). These xeric parks were located at mid-elevations and on all exposures. These sites exhibited low cover of plant taxa, and high cover of bare ground and rock (56%). Gramineae (Principally *Festuca idahoensis*), and Cyperaceae had a combined cover of 16%. Dominant herbs included *Heuchera cylindrica*, *Achillea millefolium*, and *Castilleja* spp.

Table 12. Dominant taxa in vegetation types of the mountain sidehill park component (% cover/% occurrence).

Taxa	Vegetation Type Mixed graminoid n=17	 Xeric bunchgrass n=50
FORBS:		
Balsamorhiza sagittata	8/77	
Lupinus spp.	2/94	
Achillea millefolium	1/94	t/70
Arabis spp.	1/94	
Castilleja spp.	t/53[1]	
Sedum stenopetalum	t/71	t/68
Hieracium cynoglossoides	t/53	
Heuchera cylindrica		2/60
Erythronium grandiflorum		t/32
Calochortus apiculatus		t/38
SHRUBS:(0-0.9 m)		
Amelanchier alnifolia	2/71	1/20
Berberis repens	1/71	
Prunus virginiana	1/41	
Spiraea betulifolia	t/41	t/12
GRAMINEAE/CYPERACEAE:	44/100	10/90
NONVASCULAR COVER:	16/100	55/100

[1] t= <0.5% cover

Table 13. Physical data collected in 2 vegetation types of the mountain sidehill park habitat component.

Vegetation type	Average plot elevation	Elevation range	Average plot aspect (degrees)	Aspect range (degrees)
Mixed graminoid	1581	1495-2097	156	112-191
Xeric bunchgrass	1720	1690-1939	*	*

*Aspect data were highly variable. This vegetation type was sampled on north, south, east, and west facing slopes.

Photo 9. The mixed graminoid (sidehill park) vegetation type.

Photo 10. The xeric bunchgrass (sidehill park) vegetation type.

Slabrock Habitat Component

The uplifting and tilting of parent material during the mountain building Mesozoic and Pleistocene Eras resulted in exposed and often terraced slabs of glacially-formed rock. Subsequent erosion of parent material allowed soil and vegetation development to progress between these slabs of rock (Photo 11). This component termed "slabrock" was located at the head of cirque basins. A complete taxa list is provided in Appendix H. Physical data from sample plots are in Table 14 and the dominant taxa of this habitat component are given in Table 15.

The composition of vegetation in the slabrock component was variable, and reflected the degree of soil development, local drainage pattern, aspect, and fire history. Tree canopy cover (*Larix lyallii*, *Abies lasiocarpa*, and *Pinus albicaulis*) was variable; areas that burned within the last 55 years showed an increased tree cover and greater soil development than sites that escaped recent fire. In those burned slabrock areas, continuous matts of *Xerophyllum tenax* were present nearly to the exclusion of other plant taxa. A greater variety of taxa were encountered in sites that did not burn recently. The dominant taxa on drier sites included *Antennaria luzuloides*, *Xerophyllum tenax*, *Eriogonum* spp., and *Juncus* spp. (possibly *J. parryi*). *Lomatium*

Table 14. Physical data collected from the slabrock habitat component.

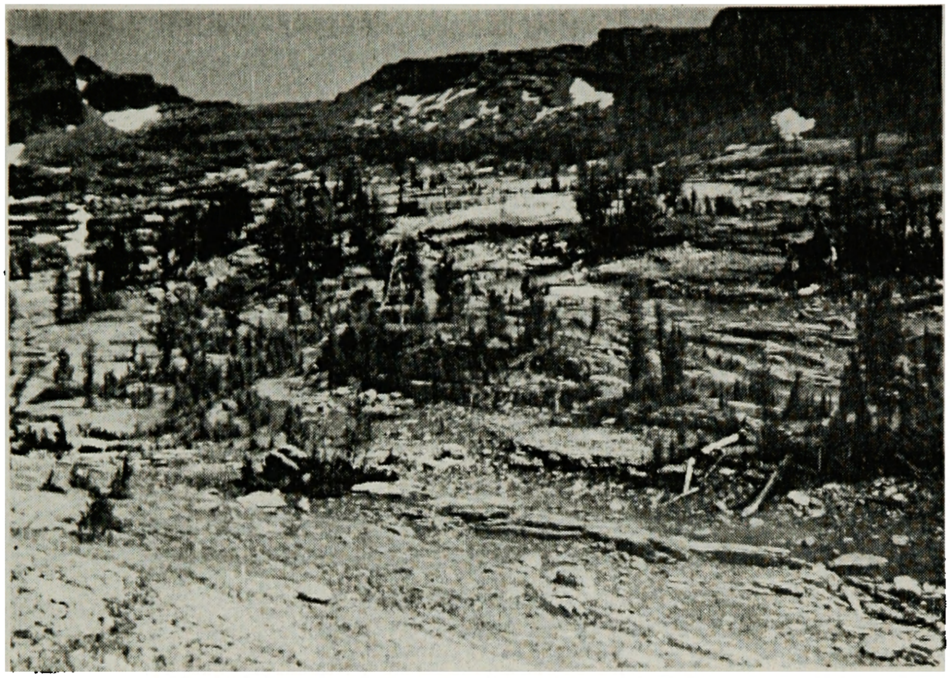
Average plot elevation (m)	Elevation range (m)	Average plot aspect (degrees)	Aspect range (degrees)
2309	2200-2339	143	21-356

Table 15. Dominant taxa in the slabrock habitat component (n=82).

Taxa	% Cover	% Occurrence
FORBS:		
Antennaria luzuloides	8	87
Xerophyllum tenax	6	33
Arnica latifolia	4	63
Ranunculus eschscholtzii	1	38
Polygonum bistortoides	1	39
Erythronium grandiflorum	1	40
SHRUBS: (0-0.9 m)		
Phyllodoce empetriformis	3	29
Vaccinium scoparium	2	19
GRAMINEAE/CYPERACEAE:	16	100
NONVASCULAR COVER:	32	100

Photo 11. Panoramic view of the slabrock habitat component.

Photo 12. Grizzly bear digs for *Lomatium sandbergii* in the slabrock habitat component.



sandbergii was restricted to the most xeric habitats, either in slabrock crevices or on gravelly surfaces abutting the rock slabs. *Phyllodoce empetriformis* and *Vaccinium scoparium* were the only 2 shrubs encountered in sample plots. Sixty-seven randomly placed 375 m^2 plots were sampled to document the cover values of rock slabs, total ground vegetation, and conifers. Results showed 36, 48, and 16% cover values of these 3 general categories. Other taxa in this component found to have relatively high cover and occurrence values are given in Table 15.

Subalpine Meadow Habitat Component

Open meadows of variable size and species composition were present beneath the headwalls of cirque basins in the subalpine zone. Meadows were also present along the terminus of snowfields, near perennial and ephemeral streams, and at other sites where moisture-holding capacity of the soil was high. All meadows were generally flat. Elevations of meadows varied from 2061 to 2291 m (Table 16).

Three distinct meadow types were sampled. Although several plant taxa were common to all types, species diversity and physiognomy were unique to each. The 3 VT's sampled were: 1) shortgrass/*Phyllodoce empetriformis*, 2) hydromesic herbaceous, and 3) tallgrass/*Senecio triangularis*. These 3 types are described below. Dominant taxa in each type are given given in Table 17. A complete taxa list for this component is given in Appendix I.

1) *Shortgrass/Phyllodoce empetriformis VT*: A distinctive characteristic of this type was the dense, turf-like pattern of vegetation (Photo 13). This appearance was due to the low-growing (< 5 cm high) and close-growth habits of *Carex* spp., *Danthonia intermedia*, *Phyllodoce empetriformis*, *Pheum alpinum*, and mosses. Gramineae/Cyperaceae showed a combined cover value of 49% and was present in all plots. Small inclusions of *Juncus parryii* were present on relatively dry sites. *Senecio* spp. (*S. pseudaureus* or *S. resedifolius*) was the herb with the greatest cover and occurrence. *Caltha leptosepala* and *Erigeron* spp. were other herbs with relatively high cover and occurrence values. *Phyllodoce empetriformis* and *Salix* spp. were dominant shrubs. *Menziesia ferruginea* and *Vaccinium scoparium* were other shrubs in this type.

2) *Hydromesic Herbaceous Meadow VT*: Mesic to hydric meadows were located on gentle slopes below cirque headwalls. Ephemeral streams, seeps, and sub-surface water runoff served to saturate soils and supply a constant source of water to the vegetation growing in this environment

Table 16 . Physical data collected in 3 vegetation types of the subalpine meadow habitat component.

Vegetation type	Average plot Elevation (m)	Elevation range (m)	Average plot aspect (degrees)	Aspect range (degrees)
Hydromesic herbaceous	2291	none	151	46-261
Shortgrass/ *Phyllodoce emptriformis*	2152	2061-2242	flat	flat
Tallgrass/ *Senecio tri-angularis*	2212	none	flat	flat

Table 17. Dominant taxa of the subalpine meadow habitat component (% cover/% occurrence).

	Vegetation type		
	Tallgrass/ *Senecio triangularis* n=32	Shortgrass/ *Phyllodoce empetriformis* n=24	Hydromesic herbaceous n=24
FORBS:			
Senecio triangularis	28/100		
Erigeron spp.	12/91	t/46	8/67
Heracleum lanatum	4/31		
Osmorhiza occidentale	7/50		
Veratrum viride	5/53		
Senecio spp.		6/88	
Caltha leptosepala		t/38	4/71
Antennaria luzuloides		t/29	
Hypericum formosum			t/71
Viola adunca			1/79
SHRUBS:			
Phyllodoce empetriformis		5/75	t/42
Salix spp.		2/46	3/12
GRAMINEAE/CYPERACEAE:	26/100	49/100	20/100
NONVASCULAR COVER:	5/65	16/100	19/100

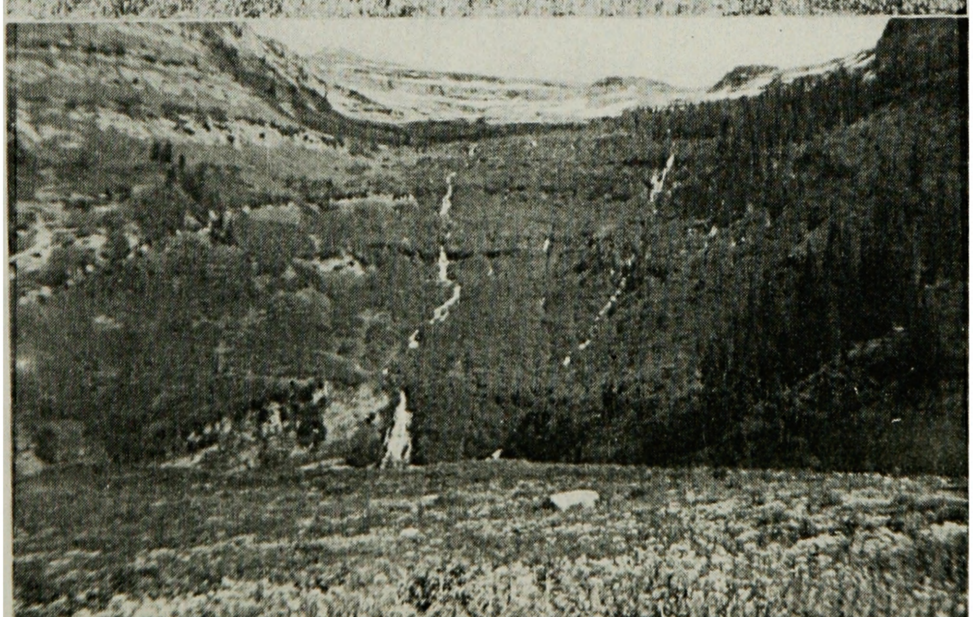
(Photo 14). Dominant taxa found in hydric microsites included Saxafraga arguta, Caltha leptosepala, Polygonum bistortoides, Zigadenus elegans, and Kalmia polifolia. Taxa that typically grew on well-drained microsites within the type included Erythronium grandiflorum, Phyllodoce empetriformis, and Vaccinium scoparium.

3) Tallgrass/Senecio triangularis VT: Small openings occurred in the mesic and cool Abies lasiocarpa/Calamagrostis canadensis and Abies lasiocarpa/Luzula hitchcockii habitat types of cirque basins (Photo 15). These partially-shaded openings exhibited luxuriant growth of grasses and forbs. Senecio triangularis was the dominant forb species on such sites, and showed a cover and occurrence of 28% and 100% respectively. Calamagrostis canadensis, often 1 m high, was the dominant grass (19% cover). Other dominant taxa were Erigeron spp., Veratrum viride, Thalictrum occidentale, and Osmorhiza occidentalis.

Photo 13. The shortgrass/*Phyllodoce empetriformis* vegetation type (subalpine meadow habitat component).

Photo 14. The hydromesic herbaceous meadow vegetation type (subalpine meadow habitat component).

Photo 15. The tallgrass/*Senecio triangularis* vegetation type (subalpine meadow habitat component) (In foreground).



Alpine Complex Habitat Component

Sites exhibiting characteristic alpine taxa were generally found above an elevation of 2310 m in the study area. Alpine sites occupied the higher mountain peaks such as Gordon, Fossil, and Una mountains and Pilot Peak in the interior of the study area. Complex combinations of glaceated aretes and horns supported alpine vegetation on the Swan Range (Photo 16).

The nontimbered alpine vegetation consisted of open xeric fellfields and mesic forb/sedge meadows. Timbered sites were found on slopes leeward to predominant wind direction and in relatively low elevation swales and mountain saddles. Small islands of flagged-krumholz were observed on exposed ridges and in windy meadows. Exposed bedrock, boulderfields, and sparsely-vegetated cobblefields comprised large areas of this component. The alpine zone of the Swan Range exhibited a severly sharp, broken, and jagged topography. For this reason, alpine plants were dispersed on the Swan Range, with large expanses of intervening bedrock.

Three vegetation types were identified for the alpine zone and are described below. Physical data are given in Table 18. The dominant taxa of each type are given in Table 19, and a complete taxa list for each type is given in Appendix J.

1) Fellfield VT: Fellfields were located on the most severely exposed and wind-swept surfaces of mountain peaks (Photo 17). All taxa of this well-drained VT were dwarf or mattlike. Rock and mosses had a combined cover value of 63%. Soil development was poor and plants generally grew in rock crevices. Cushion plants were conspicuous in fellfields and included Eritrichium nanum, Douglasia montana, Smelowskia calycina, and Draba oligosperma. Other forbs included Potentilla ovina, Ranunculus eschscholtzii, and Dodecatheon conjugens. Dryas octopetala was the sub-shrub with the greatest cover (5%), while Potentilla fruiticosa and Arctostaphylos uva-ursi exhibited less shrub cover.

2) Mesic Alpine Meadow VT: Mesic alpine meadows were found directly below sites of high snow accumulation and summer snow-melt provided a source of water to the vegetation (Photo 17). The 2 most conspicuous forbs in this VT were Ranunculus eschscholtzii and Sibbaldia procumbens. Other dominant forbs included Gentiana calycosa, Potentilla

Table 18. Physical data collected in 3 vegetation types of the alpine complex habitat component.

Vegetation type	Average plot elevation (m)	Elevation range (m)	Average plot aspect (degrees)	Aspect range (degrees)
Fellfield	2523	2450-2536	131	45-331
Mesic alpine meadow	2446	2410-2460	214	35-355
Vegetated rock/talus	2312	2242-2485	120	61-156

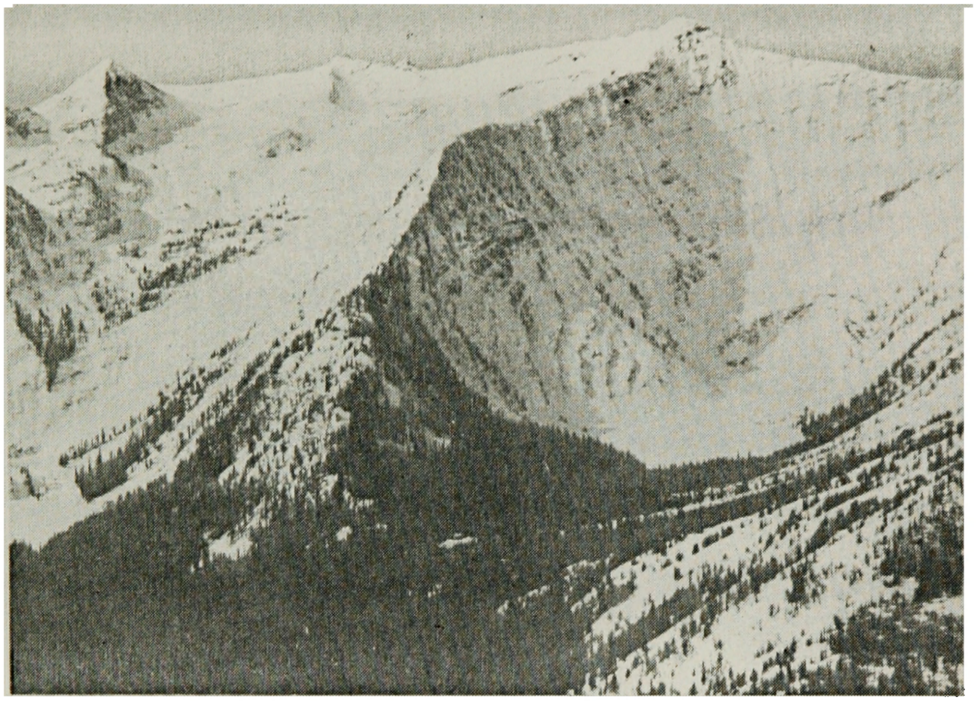
Table 19. Dominant taxa of the alpine complex habitat component %cover/%occurrence

	Vegetation type		
	Fellfield n = 15	Mesic alpine meadow n = 25	Vegetated rock/talus n = 58
FORBS:			
Potentilla ovina	2/73	1/68	
Eritrichium nanum	1/53[1]		
Dodecatheon conjugens	t/67		
Pedicularis contorta	t/67		
Erigeron simplex	2/60		
Ranunculus eschscholtzii		6/76	4/47
Sibbaldia procumbens		5/48	
Gentiana calycosa		1/48	
Arnica spp.			9/45
Valeriana sitchensis			2/26
Eriogonum flavum			1/38
Aster foliaceus			2/38
SHRUBS: (0-0.9 m)			
Dryas octopetala	5/13		
Potentilla fruiticosa	t/13		
Vaccinium scoparium			1/3
GRAMINEAE/CYPERACEAE:	14/70	12/100	5/80
NONVASCULAR COVER:	63/100	42/100	53/100

[1] t= < 0.5 % cover.

Photo 16. Panoramic view of the Swan Range.

Photo 17. Two vegetation types of the alpine complex habitat component.
A. Fellfield.
B. mesic alpine meadow.




B
A

ovina, and Pedicularis contorta. Salix arctica was the only shrub occuring in sample plots. Gramineae and Cyperaceae showed a combined cover of 12%. Nonvascular ground cover was 42%. Lomatium cous and L. macrocarpum were 2 Umbelliferae species located on sites with poor water-holding capacity.

3) Vegetated rock/talus VT: Unstable rock and talus slopes constituted large areas of the alpine complex. This type was typically found as a part of cirque basin headwalls or at the base of sheer mountain cliffs. Unsorted rock of variable size supported numerous taxa in crevices. Ranunculus eschscholtzii was abundant on moist microsites of the Swan Mountain Range. Arnica latifolia, Aster foliaceus, Eriogonum flavum, were dominant herbs. Three shrub species present in plots were Potentilla fruiticosa, Vaccinium scoparium, and Phyllodoce empetriformis. Nonvegetated ground (rock) had an cover value of 53%.

Seasonal Ranking of Vegetation Types

The vegetation types and forested habitat types were evaluated for 2 foraging seasons: an herbaceous foraging season (den emergence to 31 July), and a fruit foraging season (1 August to den entry). Results of the seasonal analyses and the relative contribution "key" food items made to each vegetation type are reported.

Three assumptions were made in the seasonal analyses of habitat that will clarify the results to follow. These assumptions, listed below, will be further expanded in the Discussion section.

1) Four major categories of foods would be selected by grizzly bears. These categories would be selected during those seasons when the foods were phenologically available. The 4 food categories were:

   a) succulent vegetation (both seasons),
   b) underground roots, corms, and bulbs (modified stems) dug by grizzly bears in both seasons),
   c) fruit (fruit foraging season); and
   d) Pinus albicaulis nuts (both seasons).

2) A grizzly bear would forage in a small vegetation type if preferred foods (as dictated by food category) were present, even if the vegetation type importance value as a whole exhibited a low seasonal value. Grizzly bears would select sites with the greatest cover and occurrence values of these preferred foods.

3) Grizzly bears would find adequate cover and occurrence of grasses and sedges (Gramineae and Cyperaceae) in all vegetation types. Elimination of grasses and sedges from seasonal rankings would provide a more reliable indication of the forageing value of vegetation types.

Seasonal evaluations of habitat were based on the percent cover and seasonal preference ranks of specific food items of each food category (Table 20). With few exceptions, the food items used in these analyses were collated from pertinent food habits literature.

Table 20. Grizzly bear food items and preference ranks.

Food Item	Vegetation	Modified stems	Fruit
FORBS:			
Achillea millefolium	1		
Allium cernuum		2	
Allium schoenprasum		2	
Allium spp.		2	
Angelica arguta	3		
Aster conspicuus	1		
Aster foliaceus	1		
Aster occidentalis	1		
Aster spp.	1		
Astragalus alpinus		2	
Astragalus bourgovii		2	
Astragalus robbinsii		2	
Astragalus spp.		2	
Castilleja spp.	1		
Cirsium spp.	2		
Claytonia lanceolata		3	
Equisetum arvense	3		
Equisetum spp.	3		
Erythronium grandiflorum		3	
Fragaria virginiana	3		
Hedysarum occidentale	1		
Heracleum lanatum	3		
Ligusticum canbyi	2		
Ligusticum spp.	2		
Lomatium dissectum		1	
Lomatium cous		3	
Lomatium macrophyllum		3	
Lomatium sandbergii		3	
Lomatium spp.		3	
Osmorhiza chilensis	3		
Osmorhiza purpurea	3		
Osmorhiza occidentalis	3		
Osmorhiza spp.	3		
Oxytropis campestris		3	
Polygonum bistortoides	2		
Senecio triangularis	2		
Trifolium spp.	3		
Taraxacum spp.	3		
Valeriana sitchensis	2		
Valeriana occidentalis	2		
Veratrum viride	2		
SHRUBS:			
Amelanchier alnifolia			3
Arctostaphylos uva-ursi			2
Cornus stolonifera			2
Prunus virginiana			2
Rhamnus alnifolia			2
Ribes lacustre			1
Ribes viscosissimum			1
Ribes inerme			1
Ribes hudsonianum			1
Ribes spp.			1
Rosa acicularis			1
Rosa woodsii			1
Rosa spp.			1
Rubus idaeus			1
Rubus spp.			1
Shepherdia canadensis			3
Sorbus scopulina			3
Vaccinium scoparium			2
Vaccinium caespitosum			2
Vaccinium globulare			3

Monthly Availability of Habitat Components

Habitat components were considered to be available to grizzly bears during all snow-free months. The relationships among component availability, food categories, and foraging season are given in Table 21. All habitat components except the slabrock, subalpine meadow, and alpine complex components were available throughout the grizzly bears' active season.

Comparison of Vegetation Types during the Herbaceous Foraging Season (Den emergence to 31 July)

The vegetation type ranks during the herbaceous foraging season are given in Table 22. Ranks were obtained for succulent vegetation and for underground modified stems.

Succulent Vegetation Food Category: The tallgrass/*Senecio triangularis* VT ranked the highest of all types for vegetative food items and was available to grizzlies in July. This subalpine meadow type was significantly greater in vegetative food items than the closest ranking *Alnus* spp. shrubfield VT of the avalanche chute component (M-W p= 0.04). The *Alnus* spp. shrubfield VT and the riparian *Picea engelmannii* VT (floodplain complex)

Table 21. Relationships between component availability, food categories, and foraging season.

Foraging Season:	Herbaceous			Fruit			
Month:	May	June	July	Aug.	Sept.	Oct.	Nov.
Food category:	vegetation, modified stem root/corm			modified stem root/corm, fruit, pinenuts			
	monthly availability[1]						
Habitat component							
Floodplain complex	X	X	X	X	X	X	X
Timbered creekbottom	X	X	X	X	X	X	X
Avalanche chute complex	X	X	X	X	X	X	X
Mountain sidehill park	X	X	X	X	X	X	X
Open burn shrubfield							
Temperate zone	X	X	X	X	X	X	X
Subalpine zone			X	X	X	X	
Timbered habitat types[2]				X	X	X	X
Subalpine cirque meadow			X	X	X	X	
Slabrock			X	X	X	X	
Alpine complex			X	X	X	X	

[1]Availability refers only to snow-free months.

[2]Habitat types were not evaluated for the herbaceous foraging season.

Table 22. Vegetation type rankings for the herbaceous foraging season (highest ranking types only; den emergence to 31 July).

Rank	Vegetation type	Habitat component	Vegetation type importance value	No. bear foods per preference rank 1	2	3	First month of availability
		VEGETATIVE FOOD CATEGORY					
1	Tallgrass/*Senecio triangularis*	Subalpine meadow	88	0	5	3	July
2	*Alnus* spp. shrubfield	Avalanche chute complex	61	2	3	6	May
3	Riparian *Picea engelmannii*	Floodplain complex	54	1	4	7	May
4	Glade	Timbered creekbottom	40	3	5	8	May
5	Mesic herbaceous fan	Avalanche chute complex	40	4	3	6	May
6	Streamside	Avalanche chute complex	37	4	5	4	May
7	Mesic herbaceous meadow	Floodplain complex	36	1	2	8	May
8	Xeric herbaceous fan	Avalanche chute complex	32	3	1	5	May
9	*Xerophyllum tenax*	Avalanche chute complex	27	3	1	4	May
10	Closed timber	Timbered creekbottom	14	2	5	8	May
		MODIFIED STEM FOOD CATEGORY					
1	Sand bar	Floodplain complex	5	0	5	2	May
2		Slabrock	4	0	2	4	July
3	Mesic alpine meadow	Alpine complex	3	0	1	4	July
3	*Xerophyllum tenax*	Avalanche chute complex	3	0	2	4	July
3	Temperate zone burn shrubfield	Burn shrubfield	3	0	4	3	May

ranked second and third respectively. These 2 types were available in May.

The cover and occurrence of several "key" succulent foods per vegetation type are given in Table 23. Gramineae/Cyperaceae was present in all types, and showed the highest cover values of all foods. Heracleum lanatum occurred in moist and cool vegetation types. The streamside VT and small openings in the Alnus spp. shrubfield VT had higher cover values of this food item than other avalanche chute types. The mesic herbaceous fans of north-facing and west-facing chutes also showed high cover values of this species. In the floodplain component, Salix spp. flats and mesic herbaceous meadows showed high cover values of Heracleum lanatum as compared to other The tallgrass/Senecio triangularis subalpine meadow also exhibited relatively high cover of this species.

Equisetum spp. had the greatest observed cover in the Glade VT of timbered creekbottoms. In the floodplain component, this food showed the highest cover in the riparian Picea engelmannii and the Salix spp. flat types. Equisetum spp. was noticeably absent in all avalanche chute types, suggesting the importance of a moist, cool, and shaded micro-environment as a growth medium.

Table 23. Coverage and occurrence of several "key" vegetative food items per vegetation type (% cover/% occurrence).

Habitat component	Vegetation type	*Heracleum lanatum*	*Angelica arguta*	*Ligusticum canbyi*	*Osmorhiza occidentalis*	Gramineae/ Cyperaceae	*Equisetum* spp.
Avalanche chute	Streamside	6/47	2/43	t/8[1]		6/100	
	Alnus shrubfield	6/52	1/10	1/14	1/15	2/72	
	Mesic herbaceous fan	3/40	1/18		1/36	19/100	
	Xerophyllum tenax		t/5		2/20	8/100	
	xeric, warm aspect	t/3			t/8	25/100	
	xeric herbaceous fan	t/9	t/6		5/38	21/81	
Floodplain complex	*Salix* flat	4/73	t/65	t/4	t/8	32/100	4/46
	Mesic herbaceous meadow	2/62	1/92		t/15	39/100	1/77
	Riparian *Picea*	1/63	t/56			16/100	2/59
	Populus trichocarpa	t/25	t/25			17/75	t/25
	Terrestrial *Picea*					4/100	
	Graval bar					3/74	t/15
	Sand bar	t/7				8/69	
	Xeric graminoid meadow					27/100	
Timbered creek bottom	Glade	t/46	t/46			21/100	6/82
	Closed timber	1/48	2/40			24/100	1/53
Subalpine meadow	Tallgrass/*Senecio triangularis*	4/31		2/35	7/50	26/100	
	Hydromesic			t/25		20/100	t/8
	Shortgrass/*Phyllodoce empetriformis* VT					49/100	t/4
Mountain sidehill park	Mixed graminoid					44/100	
	Xeric bunchgrass				t/2	10/90	
Burn shrub-field	Temperate zone		t/1			14/100	
	Subalpine zone		t/7			6/90	
Slabrock						16/100	
Alpine complex	Vegetated rock/talus					5/80	
	Fellfield					14/70	
	Mesic meadow					12/100	

[1]t= < 0.5% cover

Modified Stem Food Category: The sand bar VT (floodplain complex component) ranked the highest of of all types for roots, corms, and bulbs (Table 22). Prior to July, the *Xerophyllum tenax* VT (avalanche chute component) and the temperate zone burn shrubfield VT also ranked relatively high. In July, the slabrock habitat component and the mesic alpine meadow VT ranked 2 and 3 respectively. There was no significant difference between the sand bar VT and the slabrock habitat component (M-W p= 0.30).

A summary of those food items whose underground parts would be dug by grizzly bears is presented in Table 24. During the early portion of the herbaceous foraging season, *Allium* spp. and *Astragalus* spp. were the most widely distributed taxa. *Erythronium grandiflorum* would be available in the avalanche chute, mountain sidehill park, and the burn shrubfield habitat components prior to July.

The mountain sidehill park component had the highest occurrence of *Lomatium* spp. of those component available prior to July. The Slabrock component and the alpine complex component would become available for root and corm digging in July. Two instances of digging by grizzly bears were observed during August in these 2 components. *Hedysarum occidentale* digs were observed in the vegetated rock/talus type (alpine complex component), and digs for

Table 24. Percent cover and occurrence of root, corm, and bulb food item per vegetation type (% cover/% occurrence).

Habitat component	Vegetation type	Astragalus spp.	Oxytropus spp.	Erythronium grandiflorum	Polygonum bistortoides	Claytonia spp.	Hedysarum occidentale	Allium spp.	Lomatium spp.
Floodplain complex	Xeric graminoid meadow							t/5	
	Mesic herbaceous meadow	t/23[1]						1/31	
	Sand bar	t/39	2/46					t/54	t/8
	Populus trichocarpa	1/75						t/50	
	Salix spp. flat	t/27						t/15	
	Terrestrial Picea engelmannii	t/4						t/13	
	Riparian Picea engelmannii	t/7						t/15	
	Graval bar	t/26	t/4					t/4	
Avalanche chute complex	Mesic herbaceous fan								t/4
	Streamside			t/6			t/2		t/2
	Xeric, warm aspect	t/5		t/2					t/22
	Xerophyllum tenax	t/4		t/12			1/28		t/5
	Xeric herbaceous fan							t/6	
Mountain sidehill park	Mixed graminoid			t/12					t/24
	Xeric bunchgrass	t/2		t/32				t/4	t/24
Burn shrubfield	Temperate zone burn shrubfield	t/10		t/5			1/23	t/51	[illegible]
	Subalpine zone burn shrubfield	t/16		t/13			1/52		
Timbered creekbottom	Glade	t/4						t/8	
	Closed timber	t/11						t/21	
Subalpine meadow	Hydromesic herbaceous			t/17	t/71			t/71	
	Tallgrass/Senecio triangularis							t/22	
Slabrock		t/5		1/40	1/39	t/13		t/6	t/21
Alpine complex	Mesic meadow				t/52	t/12			1/48
	Vegetated rock/talus	t/16					t/3		1/32
	Fellfield	t/27							t/40

[1] t= <0.5% cover.

Lomatium sandbergii were seen in the slabrock component (Photo 12). *Polygonum bistortoides* was present in the subalpine cirque meadow component and the slabrock component.

Comparisons of Vegetation Types for the Fruit Forage Season (1 August to Den Entry)

Fruit Food Category: The vegetation type rankings for the fruit forage season are given in Table 25. The Abies lasiocarpa/Xerophyllum tenax-Vaccinium globulare forest habitat type ranked the highest of all components and vegetation types and was significantly greater in fruit-bearing taxa (% cover and preference rank) than the second ranking terrestrial Picea engelmannii VT (floodplain complex) (M-W p= 0.01). There was also a significant difference in the second ranking terrestrial P. engelmannii VT and the third ranking subalpine zone burn shrubfield VT (M-W p= 0.06).

Vaccinium globulare occurred in 3 VT's and all 3 forest habitat types. The greatest cover was in the Abies lasiocarpa/Xerophyllum tenax-Vaccinium globulare habitat type (Table 26). Open-timbered (30-60% canopy cover) stands of this habitat type were observed to have the the greatest fruit production of V. globulare of components or habitat types. Such productive sites existed as stringers in the Xerophyllum tenax VT of the avalanche chute component. The subalpine zone burn shrubfield VT, and the A. lasiocarpa/Luzula hitchcockii -Vaccinium scoparium habitat type both had 3% cover of this "key" food item.

Table 25. Vegetation type rankings for the fruit foraging season (highest ranking types only; 1 August to den entry).

Rank	Vegetation type or habitat type	Habitat component or forest habitat type	Vegetation type importance value	No food items per preference rank: 1	2	3
		FRUIT FOOD CATEGORY				
1	Abies lasiocarpa/ Xerophyllum tenax-Vaccinium globulare	Forest habitat type	92	0	1	4
2	Terrestrial Picea engelmannii	Floodplain complex	47	1	2	3
3	Subalpine zone burn shrubfield	Burn shrubfield	43	1	1	1
4	Abies lasiocarpa/Luzula hitchcockii Vaccinium scoparium	Forest habitat type	38	0	1	2
5	Temperate zone burn shrubfield	Burn shrubfield	36	4	3	4
6	Xeric herbaceous fan	Avalanche chute complex	26	1	1	0
7	Mesic herbaceous meadow	Floodplain complex	25	5	1	3
8	Populus trichocarpa	Floodplain complex	25	2	1	2
9	Closed timber	Timbered creekbottom	16	6	3	2
10	Mixed graminoid	Mountain sidehill park	14	2	3	3
		MODIFIED STEM FOOD CATEGORY				
1	Sand bar	Floodplain complex	5	0	5	2
2		Slabrock	4	0	2	4
3	Mesic alpine meadow	Alpine complex	3	0	1	4
3	Xerophyllum tenax	Avalanche chute complex	3	0	2	4
3	Temperate zone burn shrubfield	Burn shrubfield	3	0	4	3

Amelanchier alnifolia was widely distributed among forest habitat types and habitat components (Table 26). This food item reached the highest percent cover and occurrence in the subalpine zone burn shrubfield VT, however ungulate browsing pressure (during the winter months) appeared to be severe in this type. The xeric, warm-aspect VT of the avalanche chute component also had relatively high cover of *A. alnifolia*.

The terrestrial *Picea engelmannii* VT (floodplain benches) showed the highest observed cover of *Shepherdia canadensis* of all types. Species of *Ribes* and *Rosa* had the greatest observed cover values in several VT's of the floodplain complex riparian zone.

Modified Stem Food Category: The rankings of vegetation types for modified stems during the fruit foraging season is the same as given in Table 22 for July. Slabrock areas, and the alpine complex VT's were available at this time.

Pinus albicaulis Food Category: *Pinus albicaulis* grew at elevations above 2128 m. Grizzly bears seeking this food item would necessarily travel to habitats at or above this elevation.

Table 26. Cover and occurrence of "key" shrub food items (% cover/% occurrence)

Habitat component or habitat type	Vegetation type	Vaccinium globulare	Amelanchier alnifolia	Vaccinium caespitosum	Cornus stolonifera	Shepherdia canadensis	Sorbus spp.	Rhamnus alnifolia	Vaccinium scoparium	Ribes spp.	Rosa spp.
Floodplain complex	Xeric, graminoid meadow										t/5
	Mesic herbaceous opening		t/8		2/15[1]	1/23				t/54	7/100
	Sand bar									t/15	2/62
	Populus trichocarpa				24/75	2/75				t/25	1/100
	Salix flat		t/4			t/4		t/12		5/[illegible]	1/77
	Terrestrial Picea		t/17	22/91		5/13					t/4
	Riparian Picea				2/52	t/15				t/26	2/81
	Gravel bar										t/4
Avalanche chute complex	Alnus shrubfield						3/17	t/2		t/22	
	Mesic herbaceous fan			t/13			t/2		t/2	4/33	
	Streamside				t/1		1/8		t/2	3/10	
	Xeric, warm aspect		4/51	t/2			t/1		t/3		
	Xerophyllum tenax		1/26			t/2	1/6	t/1	4/21		
	Xeric herbaceous fan							18/28		3/19	
Burn shrubfield	Temperate zone		9/86		t/3	2/24	t/20		1/5	t/22	t/1
	Subalpine zone	3/13							16/100		t/3
Abies lasiocarpa/ Xerophyllum tenax Vaccinium globulare habitat type		22/97	t/32			1/15	t/35				
Timbered creek-bottom	Glade				6/21			t/4		1/57	t/29
	closed	t/5		t/5	12/37					1/45	1/29
Abies lasiocarpa/ Menziesia ferruginea habitat type		t/92									
Mountain sidehill park	Mixed graminoid	t/6	2/71	t/6	2/6						t/18
	Xeric bunchgrass		1/20								
Subalpine meadow	Hydromesic								t/12		
	Shortgrass/ Phyllodoce empetriformis								t/21		
Slabrock									2/19		
Alpine complex	Vegetated rock/talus								1/3		

Comparison of Habitat Components with Landtype Associations and Constituent Elements

Habitat component and landtype association (LTA) (USDA 1978) maps were overlayed to compare and contrast the 2 systems (Appendix K). Objective 3 of this thesis was to determine if the broad-based and relatively easily-mapped LTA's could be used for delineating grizzly bear habitat in lieu of the more labor-intensive habitat component system. The ultimate purpose of this analysis was to compare habitat components with the USDA Forest Service LTA's and Constituent Elements (LTA's were supposedly used to map Constituent Elements; see Definition of Terms section). However, for the following reasons, Objective 3 could not be fully met.

1) The LTA's of the study area were not accurately nor consistently mapped. For example, in the Pilot Peak quadrangle, LTA VI (peaks and alpine ridges-sparsely vegetated rock land) was inaccurately mapped to an elevation of 1642 m and included subalpine and temperate forested zones. The alpine zone in the study area occurred at elevations exceeding 2310 m.

2) Because of time constraints, the U.S. Forest Service cou not use a systematic and quantitative method to evaluate LTA's for grizzly bear foods, and combine these LTA's in constituent elements. Rather, the Wilderness constituent elements were mapped following the general pattern of elevation-use by grizzly bears per season.

3) The original ECOCLASS (LTA) method was altered by Butte (1978) because at several levels of the ECOCLASS hierarc some categories of the classification were hybrids withi the system. The newer version of ECOCLASS, termed modifi

ECOCLASS was not used in the Bob Marshall study area.

The LTA's of the study area were remapped for comparison with habitat components. The distribution of habitat components within the various LTA's is given in Table 27. For these analyses, several overlapping LTA's were combined.

Habitat components that were restricted to a single elevational zone corresponded well to the LTA system. For example, the alpine component was restricted to LTA VI. The floodplain and the timbered creekbottom habitat components also corresponded well to the LTA system. Habitat components that transcended elevational zones (Avalanche chutes), or were based on site history (burn shrubfields) did not correlate well. These results show for example, that the greatest areal extent of an avalanche chute is in the higher elevation LTA's. These high elevation bowls in most instances were either sparsely vegetated, or dominanted by *Xerophyllum tenax*.

Table 27. Distribution of grizzly bear habitat components within landtype associations.

Habitat Component (Map Code)	Landtype Association[1]									
	I	I,Ia,Ib,III	II,VIII	II,VII	IV,VIII,	V	Vc	VI	VII	VIII
Burn Shrubfields:										
Temperate Zone Burn Shrubfield (B_1) n=16					13[2]		6	38	6	38
Subalpine Zone Burn Shrubfield (B_2) n=34			35			15		29	9	12
Avalanche Chute Complex:										
Chutes dominated by Xeric, Warm-aspect VT or *Xerophyllum tenax* VT (C_x) n=89			1	8				52		39
Chutes dominated by mesic VT's (C) n=36				19				64	8	8
Combination of C_x and B_1 (C_x+ B_1) n=4			100							
Floodplain Complex (F) n=4		100								
Timbered Creekbottom (T) n=7	86									14
Alpine Complex (A) n=75								99	1	
Slabrock (S) n=5			60					40		
Subalpine Meadow (M) n=4				75				25		
Mountain Sidehill Park:										
Xeric bunchgrass VT (P_1) n=28			7	7				21	39	29
Mixed Graminoid VT (P_2) n=7								43	14	57

[1] I= Forested floodplain
Ia= Wet, Grass-sedge meadows
Ib= Grass and forested stream terraces
III= Forested ground moraine
II= Glacial cirque basins
IV= Slump land
Va= Forested high elevation ridges
Vc= Forested moderately dissected residual slopes
VI= Peaks and alpine ridges-sparsely vegetated rock land
VII= Forested, cool aspect break lands
VIII= Forested, warm aspect break lands

[2] percent of random dots in that component or vegetation type

DISCUSSION

Observation of Grizzly Bears or Their Sign In the Study Area

It was initally assumed that field data could be collected on habitat use and food item selection from grizzly bears resident to the study area. Such data were to be incorporated into the habitat component system and seasonal ranking of vegetation types. However, in 2 field seasons of study, 2 instances of grizzly bear foraging activity were observed (digs), and only 2 probable grizzly bear scats were collected. No grizzly bears or their tracks were observed at any of the locations sampled nor on the trail system. Several observations of tracks were reported to me by Wilderness visitors and I attempted to verify all such observations if they were within a days walk. In all instances the tracks were judged to have been left by black bear (*Ursus americanus*). The tracks and scats of 3 grizzly bears were observed during June of 1983 in the northwestern portion of the Wilderness, and 1 grizzly bear track was observed during a 10 day survey of the White River drainage.

The Habitat Component System

The habitat system previously described was developed in 2 field seasons. Although the major components and vegetation types were sampled and incorporated, expansion and additional vegetative sampling would be possible. Additionally, minimal time was spent sampling the forest habitat types, thus only limited inference is possible regarding the forage value of forested zones.

The similarity coefficients developed for those vegetation types sampled in more than 1 location should be considered conservative estimates of taxa similarity. Difficulties in keying several plant taxa to the species level served to deflate coefficients and greater concordance would have been achieved if for example, the *Erigerons* and *Asters* could have been consistently keyed to species.

Field reconnaissance and vegetation sampling suggested that although specific habitat components and their associated vegetation types could be extrapolated to other parts of the Bob Marshall Wilderness Area, the areal extent and juxtaposition of the components and types could not be extrapolated. Ground reconnaissance and the literature (Habeck 1967, Johnson 1982) suggested that several precipitation zones are present in the Bob Marshall Wilderness Area. Major Pacific storm tracts move into the Bob Marshall from the northwest, and much of the precipitation (rain and snow) is deposited on or near the Swan Mountain Range. However, in the southern 1/2 of the Wilderness, some precipitation is lost to the Mission Mountains rather than the Wilderness. As a result, the southern Bob Marshall is drier than northern portions adjacent to the Swan Range. Plant indicators of relatively moist habitats , such as *Pachistima myrsinites* and *Clintonia uniflora* (Pfister et al. 1977), were observed much less often in the southern study area than in Gorge, Stadium, and Trickle creeks in the northwestern portion of the Wilderness. Daubenmire (1969) stated that most of the precipitation is lost before reaching the Continental Divide. Thus the portion of the Bob Marshall east of the South Fork of the Flathead River is also relatively dry. If grizzly bear habitat quality is related to precipitation, population densities may be naturally variable within the Wilderness boundaries.

Virtually no grizzly bear life history or habitat use information is available for the Bob Marshall Wilderness. The various assumptions developed in this thesis presumed that similarities existed among grizzly bears in food habits, movements, and habitat use in northwestern Montana.

If the southern Bob Marshall population of grizzly bears has unique habitat use patterns or requirements, alterations of the system would be necessary. For example, although the floodplains ranked high in forage value during the herbaceous foraging season and the fruit foraging season, these values may be more or less than the adjacent (and non-wilderness) Swan River Valley. If the Wilderness values are lower, and grizzly bears cross the Wilderness boundary during certain seasons, it would suggest the Bob Marshall is not an "intact ecosystem" for the grizzly bear (Hendee et al. 1978).

Those vegetation types which provided relatively high cover and occurrence values of key food items were considered to be superior to those types with lower values. This assumption was corroborated by grizzly bear investigations conducted in open habitats, where study animal observability was relatively high. Stelmock (1981), working in Denali Park, Alaska stated that "Habitat use during the summer was mainly confined to very specific vegetation types which provided dense cover of favored plant foods. Habitat use patterns closely followed the seasonal variations in quantity and quality of important foods."

Selective feeding on specific food items was also considered. If a grizzly bear sought a specific food (to the exclusion of all other foods), determining which vegetation types provided that item was possible. Craighead et al. (1982, page 65) provided evidence of a highly developed foraging behavior in the grizzly bear rather than a random or opportunistic one. My personal observations of grizzly bear feeding sites in non-Wilderness areas of Montana and British Columbia (Canada) correlate well with these findings.

Habitat preference or use may be modified by inter- or intraspecifc stress (Partridge 1978). Unknown behavioral traits, such as curiosity (Bacon 1980), may dictate how the grizzly bear uses its environment and could alter the seasonal rankings developed.

The influence of man on grizzly bear habitat use or movements could not be incorporated into the seasonal rankings. However, it is possible that physiological and psychological stresses (Ream 1978) from human activities are displacing grizzly bears from high quality habitat. This displacement or harrassment may be occurring in several valley bottoms where human recreational use is high. Elk (*Cervus elaphus*) were often observed in the bottom lands during June, but vanished from such areas on or near 4 July, when human traffic began. Alteration of the natural fire regime by man has played an important, albeit unknown role in habitat quality and interspersion.

Seasonal Ranking of Vegetation Types

The complex foraging activities of the grizzly bear throughout the non-denning period precluded the use of spring, summer, and autumn seasonal delineations. Such delineations are useful for human understanding, but grizzly bear use of habitat does not comfortably fit into these seasons. For example, during the early portion of the "summer" season, grizzly bears feed on succulent vegetation (generalization), but shift to a diet high in fruit by mid-summer. Rating of habitat on the basis of major food item categories was felt to be more meaningful.

Only "key" grizzly bear foods obtained from the literature were used in the seasonal rankings of vegetation types. The seasonal rankings developed should place the grizzly bear in relatively high quality habitat even if several unknown food items were not used in the analyses. For example, although *Goodyeara oblongifolia* was not considered a food item, this species was closely associated with other moist-site food taxa that were evaluated. If at a later date *G. oblongifolia* is determined to be a food of the grizzly bear, it could be incorporated into the system. Grasses and sedges were used in the first analysis of seasonal rankings, but were later omitted because they tended to mask the importance of other key foods. Although grasses and sedges should be considered a staple food item, Craighead et al. (1982) theorized that grasses and sedges are more readily utilized because they are more available and abundant than other food items. The capability of shrubs to produce fruit in different habitats were not investigated nor were failures in fruit production predictable. Sites that were unproductive during 1982 and 1983 may be quite productive at other times.

Herbaceous Foraging Season

Grizzly bears would find abundant succulent vegetation in the floodplain complex of the Bob Marshall Wilderness during the herbaceous foraging season, particularly in riparian *Picea engelmannii* sites, and the mesic herbaceous meadows. However, the roots of *Hedysarum sulpherscens* are not likely an important food item in the southern Bob Marshall as only 1 *H. sulpherscens* plant was observed. *Oxytropis* spp. were present in the Sand bar VT in trace amounts. Greater cover of *Oxytropis* spp. was observed on the floodplain benches of the White River. No "digging activity" was observed in any floodplain types.

The observed quantity of plant foods in the avalanche chutes suggested they would be an important spring and early summer component of habitat, especially the *Alnus* spp. shrubfields and the mesic herbaceous fans. The overall forage quality of the avalanche chute component appeared to be increased if the chute contained a stream course, was on a northern or western exposure, and was not dominated by a closed canopy of *Alnus* spp. Shrubfields that were visited in June of both years did not have high cover values of *Erythronium grandiflorum* or *Claytonia* spp.

Variation existed in plant taxa among the 6 avalanche chutes sampled. The average value of similarity coefficients for all vegetation types varied from 32-37%. However, when only grizzly bear foods were evaluated, the average value of coefficients varied from 36-53%. The avalanche chutes were extremely variable in the areal extent of vegetation types. For example, the *Xerophyllum tenax* VT was quite small (0.4 ha) in the east and west-facing chutes, but was the dominant type in chutes of a southern exposure. Because the *Xerophyllum tenax* VT ranked relatively low during the vegetative foraging season, individual chutes composed predominantly of this type would have a low overall forage value. In summary, a "typical" avalanche chute did not exist in the study area.

Openings in the timbered creekbottoms of the study area (the glade VT) provided high cover values of *Equisetum* spp., grasses and sedges, and several Umbellifereae. Creekbottom areas with a closed canopy were less productive in herbaceous food items than glades. It was probable however, that preferred food items in these timbered sites would be relatively high in protein and moisture content for prolonged periods as compared to more dry and open areas (Graham 1978).

The Mixed Graminoid VT showed high cover of grasses and sedges, and very low cover of herbaceous grizzly bear foods. However, such sites might be attractive to grizzlies foraging only on grasses and sedges. Several food items dug by grizzly bears were found in mountain sidehill parks. Personal observations suggested that this component would provide grizzly bears with an abundance of ants (*Formicideae*).

Data analyses and field observations suggested that the slabrock habitat component in the Bob Marshall is important "digging" habitat beginning in July. However, the fire history of this subalpine zone habitat appeared to effect the presence of key food items. Slabrock areas that burned in the past 50 years exhibited increased cover of *Xerophyllum tenax* and conifers. In burned areas, the occurrence of *Lomatium* spp. was generally less than areas that did not burn. Old and recent grizzly digs (for *Lomatium sandbergii*) were observed in slabrock areas with low *X. tenax* cover.

Although less intensive, the results of my vegetation studies in the alpine correlated well with those of Craighead et al. (1982). Herbaceous foods were not abundant in the alpine complex but ranked high in foods that would be dug by grizzly bears. No insect concentrations were observed in the alpine areas of the Bob Marshall study area. Although not sampled specifically, grizzly bears would find abundant *Pinus albicaulis* nuts during years of good cone crops in the subalpine and alpine zones. However, intense high-elevation burns could limit the availability of this food in certain areas, as *P. albicaulis* does not mature for several decades following stand-replacing fire (Fischer and Clayton 1983).

Fruit Foraging Season (1 August to Den Entry)

The *Abies lasiocarpa/Xerophyllum tenax-Vaccinium globulare* habitat type exhibited the highest cover of *V. globulare* of all habitat types or habitat components. Mid-elevation, open-timbered stands on southern exposures were quite productive. These productive sites often existed within large and south-facing avalanche chutes. Martin (1979) stated that *V. globulare* is a late-seral or climax, meso-seral fruit producer. The most productive *V. globulare* sites in Martins' western Montana study were those that had been disturbed within the previous 50 years, and were at mid-elevations. On southern exposures, the overstory canopy of trees was not related to fruit production (Martin 1979).

The terrestrial *Picea engelmannii* (floodplain complex) and the subalpine burn shrubfield VT's ranked 2 and 3, respectively, for this season. In the terrestrial *Picea engelmannii* type, *Vaccinium caespitosum* and *Shepherdia canadensis* were the 2 fruit items of the greatest cover and occurrence. Fruit production of *S. canadensis* was considered very good on open to open-timbered floodplain benches during both years of study. Conversely, virtually no *C. caespitosum* fruit production occurred in this floodplain type. Those portions of the subalpine zone burn shrubfield that occurred within the *Abies lasiocarpa/Xerophyllum tenax-Vaccinium globulare* habitat type showed a relatively high cover value of *V. globulare*.

Overall cover of *V. globulare* in subalpine zone burns was low because of its patchy distribution, a probable result of it's vegetative mode of reproduction. However, relatively large and productive patches were observed, and grizzly bears no doubt seek out these areas.

Burn shrubfields of the temperate zone showed high cover values of *Amelanchier alnifolia* and *Shepherdia canadensis*. *Vaccinium globulare* was absent in this type. All burns sampled were of a *Pseudotsuga menziesii* habitat series, and burned in 1926 (58 years ago). Literature could not be found that reported the length of time *A. alnifolia* or *S. canadensis* could be expected to maintain fruit production in these low-elevation and southern-exposure burns.

Tisch (1961) found the *Abies lasiocarpa/Menziesia ferruginea* habitat type to be the most productive site for *V. globulare* production the Whitefish Range, Montana. The low cover values of this species in the Bob Marshall may be a reflection of a small sample size for this habitat type. Mace and Jonkel (1980) reported the importance of these cool and north-facing sites to grizzly bears during years of low rainfall, when drier sites were less productive because of plant dessication.

MANAGEMENT AND RESEARCH CONCERNS

The results of this thesis suggest several points of interest to wildlife biologists and land managers concerned with grizzly bear habitat in the wilderness and non-wilderness areas of Montana.

1) The habitats selected by the grizzly bear are perhaps the most diverse and environmentally complex of any large mammal in Montana. The complexity of these habitats and the variability within them are often ignored by researchers and managers. This complexity should not, however, preclude our ability to judge the overall quality of specific types of habitat, for we can no longer rely only on the largeness of the land for big game production (Wolfe 1978). In this thesis, only the forage values of habitat were evaluated. However, there are other features of habitat that are needed to assess overall quality. These include space, isolation, sanitation, denning, and safety (Craighead et al. 1982). To concentrate well-intended management activities on habitats without regard to all features may decrease anticipated benefits that are designed to preserve those habitats.

2.) The foraging quality of a specific habitat component depends on: a) the number of vegetation types present, b) the seasonal value of those vegetation types, and c) the areal extent and juxtaposition of the vegetation types.

3) It will be important that habitat impact analyses be conducted with accurate and reliable information. Trails, roads, or timber sales could be designed to lessen possible impacts on the grizzly bear and its' habitat. These site-specific management activities will require detailed knowledge of habitat characteristics. It will be increasingly difficult to justify or propose expensive mitigative strategies (at the site-specific level) on those features of grizzly bear habitat of which we know virtually nothing. Forage abundance is but one feature of habitat altered by mans activities, yet may not be the sole factor limiting population size. Increased grizzly bear use of those habitats altered by man does not necessarily indicate an increase in bear population, but may reflect only a redistribution of a static population (Wolfe 1978). Habitat improvements (e.g. prescribed burning) should be used in areas which would provide grizzly bears with maximum security.

4) The general habitat use trends of the grizzly bear are well understood in several local areas. Because of variation in the apparent quality among individual habitat components within a small area, extrapolations between areas will be even more difficult without good habitat descriptions and habitat-use information. Attempts to correlate the density of grizzly bear populations with habitat quality will require detailed formation.

5) Research and management efforts to assess the impacts of human activities on the grizzly will require detailed descriptions of habitat. Studies of habitat "effectiveness" for example, will be hampered by lack of specific habitat and habitat-use information. Simple maps of habitat components will be of marginal value, as there is no current basis for making comparisons of habitat quality. To investigate the amount of habitat lost or habitat gained by human activities will have little meaning, if it is unclear what the relative value of those habitats were.

6) The habitat investigations in the Bob Marshall showed that seasonal forge values rankings can not be assessed from a small number of plot samples. Similarity coefficients, using a conservative number of grizzly bear food items, were rarely over 50% for each vegetation type. In other words, if only one avalanche chute was intensively

sampled, it would be less than 50% similar (in bear foods) to other chutes in the area. Rating the quality of a specific habitat component, which will be necessary for site-specific management (e.g. should the new trail be placed in location A or B), will be difficult without knowledge of how that individual component relates to other components in the area.

7) The value of the forested zone to grizzly bears should not be ignored, as grizzly bears do not live only in open habitats. Several forest habitat types are known to be important to grizzly bears throughout the year and should be included in habitat mapping efforts. It is incorrect to assume that grizzly bears only use forested zones for traveling. Forested areas of a specific successional stage contain fruits used by grizzly bears. It is incorrect to assume that all burns are equal producers of fruit, or that all burns are better producers of fruit than several forest habitat types.

LITERATURE CITED

Arno, S. F. 1979. Forest regions of Montana. U.S. Dept. Agric., For. Serv. Inter. Mtn. For. and Range Exp. Stn. Res. Pap. INT-215. 39pp.

__________. 1980. Forest fire history of the northern Rockies. J. For. 78(8):460-465.

Aune, K., and T. Stivers. 1982. Rocky Mountain front grizzly bear monitoring and investigation. Montana Dept. Fish, Wildl. and Parks, Helena. 143pp.

Bacon, E. S. 1980. Curiosity in the American black bear. Pp. 153-158 in C. J. Martinka and K. L. McArthur, eds. Bears-their Biology and Management. Bear Biol Assoc. Conf. Ser. 3, U.S. Gov. Printing Off., Washington, D.C.

Barbour, M. G., J. H. Burk, and W. D. Pitts. 1980. Terrestrial plant ecology. The Benjamin/Cummings Publ. Co., Inc. Menlo Park, Calif. 604pp.

Buttery, R. F., J. Corliss, F. Hall, W. Mueggler, D. On, and J. Barclay. 1973. Ecoclass-a method for classifying ecosystems-a task force analysis. U.S. Dept. Agric., For. Serv. 52pp.

______________. 1978. Modified ecoclass-a Forest Service method for classifying ecosystems. Pp. 157-168 in Proc. Workshop. Integrated inventories of renewable natural resources. U.S. Dept. Agric. For. Serv. Gen. Tech. Rep. RM-55. Rocky Mtn. For. and Range Exp. Stn. Fort Collins, Colo. 482pp.

Chapman, J. A., J. I. Romer, and J. Stark. 1953. Ladybird beetles and army cutworm adults as food for grizzly bears in Montana. Ecology. 36:156-158.

Craighead, F. C. 1976. Grizzly bear ranges and movements as determined by radio-tracking. Pp. 97-110. in M. Pelton, E. Folk, and J. Lentfer, eds. Bears-Thier Biology and Management. IUCN New. Ser. 40.

Craighead, J., J. Sumner, and G. Scaggs. 1982. A definitive system for analysis of grizzly bear habitat and other wilderness resources. Wildlife-Wildlands Inst. Monogr. 1. Univ. Mont., Missoula. 279pp.

Daubenmire, R. 1968. Plant communities: a textbook of plant synecology. Harper and Row, N.Y. 300pp.

_____________. 1969. Structure and ecology of coniferous forests of the northern Rocky Mountains. Pp. 25-41 in R. Taber, ed. Coniferous forests of the northern Rocky Mountains. Center for Nat. Resour. Univ. Montana, Missoula.

Deiss, C. 1958. Geology of the Bob Marshall Wilderness. in Guide to the Bob Marshall Wilderness. U.S. Dept. Agric. For. Serv. Missoula, MT. 36pp.

Fischer, W. C., and B. D. Clayton. 1983. Fire ecology of Montana forest habitat types east of the Continental Divide. U.S. Dept. Agric. For. Serv. Gen. Tech. Rep. INT-141. Inter. Mtn. For. and Range Exp. Stn. Ogden, Utah. 83pp.

Forcella, F. and T. Weaver. 1977. Biomass and productivity of the subalpine *Pinus albicaulis*-*Vaccinium scoparium* association in Montana. Vegetatio 35(2):95-106.

Gabriel, H. 1976. Wilderness ecology: the Danaher Creek drainage, Bob Marshall Wilderness, Montana. Ph.D Diss. Univ. Montana, Missoula. 224pp.

Gauch, H. G. 1982. Multivariate analysis in community ecology. Cambridge Univ. Press. 298pp.

Graham, D. C. 1978. Grizzly bear distribution, use of habitats and habitat characterization in Pelican and Hayden Valleys, Yellowstone National Park. M.S. Thesis. Montana State Univ., Bozeman. 88pp.

Habeck, J. 1967. The vegetation of Glacier National Park, Montana. Dept. of Bot., Univ. of Montana, Missoula. 132pp.

_________. and R. W. Mutch. 1973. Fire-dependent forests in the northern Rocky Mountains. Quat. Res. 3(3):408-424.

Hamer, D., and S. Herrero. 1983. Ecological studies of the grizzly bear in Banff National Park-final Rep. 1983. Univ. Calgary, Calgary, Alberta. 303pp.

Hendee, J., G. Stankey, and R. Lucas. 1978. Wilderness management. U.S. Dept. Agric. For. Serv. Misc. Publ. 1365. Washington, D.C. 381pp.

Hitchcock, C., and A. Cronquist. 1973. Flora of the Pacific Northwest. Univ. Washington Press, Seattle. 730pp.

Holdorf, H., A. Martinson, and D. On. 1980. Land system inventory of the Scapegoat and Danaher portion of the Bob Marshall. U.S. Dept. Agric. For. Serv. Flathead, Lolo, Lewis and Clark, and Helena Nat. For. 88pp.

Jaccard P., 1912. The distribution of the flora of the alpine zone. New Phytol. 11:37-50.

Johnson, T. W. 1982. An analysis of pack and saddle stock grazing areas in the Bob Marshall Wilderness Area, Montana. M.S. Thesis. Montana State Univ., Bozeman. 85pp.

Kendall, K. C. 1981. Bear use of pine nuts. M.S. Thesis. Montana State Univ., Bozeman. 27pp.

Key, C. H. 1974. Mammalian utilization of floodplain habitat along the North Fork of the Flathead River in Glacier National Park, Montana. M.S. Thesis. Univ. Mont., Missoula. 151pp.

Mace, R. D., P. L. Perry, and C. Jonkel. 1979. Vegetation studies of disturbed habitat in western Montana. in C. Jonkel, ed. Annu. Rep. 4. Border Grizzly Proj. Univ. Mont., Missoula.

__________, and C. Jonkel. 1980. Grizzly bear response to habitat disturbance. Pp. 70-98 in C. Jonkel, ed. Annu. Rep. 5. Border Grizzly Proj. Univ. Mont., Missoula. 222pp.

______________________________. Regional food habits of the grizzly bear in Montana. Int. Conf. of Bears-their Biology and Management. Grand Canyon, AZ. In review.

Madel, M. 1982. Grizzly bear habitat component mapping, in Section II., Cumulative effects analysis process-grizzly habitat component mapping. U.S. Dept. Agric. For. Ser. Kootenai Natl. For.

Martin, P. 1979. Productivity and taxonomy of the *Vaccinium globulare, V. membranaceum* complex in western Montana. M.S. Thesis, Univ. Mont., Missoula. 136pp.

Martinka, C. 1971. Status and management of grizzly bears in Glacier National Park, Montana. 36th. Trans. North Am. Wildl. and Nat. Resour. Conf. 313-322.

McLellan, B. 1982. Akamina-Kishinena grizzly project: progress report, 1980 (year 3). B.C. Fish and Wildl. Branch, Cranbrook, B.C. 65pp. *

__________. and C. Jonkel. 1980. Akamina-Kishinena grizzly project. Pp. 9-48 in C. Jonkel, ed. Annu. Rep. 5. Border Grizzly Proj. Univ. Mont., Missoula. 222pp.

Mendenhall, W. 1971. Introduction to probability and statistics. 3rd. Ed. Duxbury Press, Bellmont, Calif. 466pp.

Montagne, J. and W. McMannis. 1961. Geological resume of the Bob Marshall Wilderness Area. Montana State Col., Bozeman. mimeo.

Mueggler, W. F. 1965. Ecology and seral shrub communities in the cedar-hemlock zone of northern Idaho. Ecol. Monogr. 35(2):165-185.

______________, and W. L. Stewart. 1980. Grassland and shrubland habitat types of western Montana. U.S. Dept. Agric. For. Serv. Gen. Tech. Rep. INT-66. Inter. Mtn. For. and Range Exp. Stn. Ogden, UT. 154pp.

Mueller-Dombois, D., and H. Ellenberg. 1974. Aims and methods of vegetation ecology. John Wiley and Sons. New York, NY. 547pp.

Nelson, R. H., G. Folk Jr., E. Pfeiffer, J. Craighead, C. Jonkel, and D. Steiger. 1983. Behavior, biochemistry, and hibernation in black, grizzly, and polar bears. Pp. 284-290 in E. C. Meslow, ed. Bears-their Biology and Management. Inter. Assoc. for Bear Res. and Manage. 327pp.

Nie, N., C. Hull, K. Steinbrenner, and D. Bent. 1975. Statistical package for the social sciences. Second edition. McGraw-Hill Book Co.,NY. 675pp.

Partridge, L. 1978. Habitat selection. Pp. 351-376 in J. R. Krebs and N. B. Davies, eds., Behavioral ecology-an evolutionary approach. Blackwell Scientific. London.

Pearson, A. 1975. The northern interior grizzly bear. Canadian Wildl. Serv. Rep. Ser. 34. Info. Can., Ottawa. 84pp.

Pfister, R., B. Kovalchik, S. Arno, and R. Presby. 1977. Forest habitat types of Montana. Int. Mtn. For. and Range Exp. Sta. U.S. Dept. Agric. For. Serv. Gen. Tech. Rep. INT-34. 174pp.

__________ . 1977. Ecological classification of forest land in Idaho and Montana. Pp. 329-358. in Proc. Ecological Classification of Forest Land in Canada and Northwestern U.S.A. Univ. B.C., Vancouver.

__________, and R. F. Batchelor 1984. Montana riparian vegetation types. Western Wildlands. 9(4):19-23.

Ream, C. H. 1978. Human conflicts in backcountry: possible solutions. Pp. 153-163 in R. Ittner, D. Potter, J. Agee, and S. Anschell, eds., Recreational impacts in wildlands, Conf. Proc. U.S. Dept. Agric. For. Serv. R-6-001-1979.

Riggs, R. A. and C. Armour. no date. A hypothesis for predicting grizzly bear habitat use in spring floodplain habitat with special reference to reducing human-bear contact rates. Univ. Idaho, Moscow. 27pp.

Rockwell, S., J. Perry, M. Haroldson, and C. Jonkel. 1978. Vegetation studies of disturbed grizzly habitat. Pp. 17-68 in C. Jonkel, ed., Annu. Rep. 3. Border Grizzly Proj. Univ. Mont., Missoula. 256pp.

Russell, R. H., J. W., Nolan, N. A. Woody, and G. Anderson. 1979. A study of the grizzly bear in Jasper National Park, 1975-78. Final report prepared for Parks Canada by Canadian Wildl. Serv., Edmonton. 136pp.

Schaerer, P. A. 1973. Terrain and vegetation of snow avalanche sites at Rogers Pass, British Columbia. Div. Bldg. Res. Tech. Pap. 550.

Schallenberger, A., and C. Jonkel. 1980. Rocky mountain east front studies, 1979. Spec. Rep. 39. Border Grizzly Proj. Univ. Mont., Missoula. 207pp.

Servheen, C. and T. Wojciechowski. 1978. Grizzly bear foods. Pp. 83-107 in C. Jonkel, ed., Annu. Rep. 3. Border Grizzly Proj. Univ. Mont., Missoula. 256pp.

__________, and L.C. Lee. 1979. Mission Mountains grizzly bear studies, and interim report, 1976-78. Montana For. Conserv. Exp. Stn. School of For., Univ. Mont., Missoula. 299pp.

__________. 1981. Denning ecology, food habits, habitat use, and movements of grizzly bears in the Mission mountains, Montana. Ph.D Diss. Univ. Mont., Missoula. 138pp.

Singer, F. J. 1978. Seasonal concentrations of grizzly bears, North Fork of the Flathead River, Montana. Canadian Field-Nat. 92(3):283-286.

Sizemore, D. 1980. Foraging strategies of the grizzly bear as related to its ecological energetics. M.S. Thesis. Univ. Mont., Missoula. 67pp.

Stauffer, J. M. 1976. Ecology and floristics of Ohio Slide and other avalanche tracts in Lost Horse Canyon Bitterroot Mountains, Montana. M.S. thesis. Univ. Mont., Missoula. 146pp.

Stelmock, B. S. 1981. Seasonal activities and habitat use patterns of brown bears in Denali National Park-1980. M.S. Thesis. Univ. Alaska, Fairbanks. 118pp.

Steele, R. 1960. The role of fire in the Bob Marshall Wilderness Area. Montana. For. and Conserv. Exp. Sta., Univ. Mont., Missoula. 33pp.

Sumner, J. 1973. Grizzly bear habitat surveys in the Scapegoat Wilderness, Montana. Montana Coop. Wildl. Res. Unit. Univ. Mont., Missoula. 49pp.

Tisch, E. 1961. Seasonal food habits of the black bear in the Whitefish Range of northwestern Montana. M.S. Thesis, Mont. State Univ., Missoula 108pp.

U.S. DEPARTMENT OF AGRICULTURE. 1974. Seeds of woody plants in the United States. U.S. Dept. Agric. Agric. Handb. 450. 883pp.

______________________________. 1978. Valley bottomland inventories with management implications. A working draft. U.S. Dept. Agric. For. Serv. Inter. Mtn. Region, Ogden, UT. 14pp.mimeo.

______________________________. 1978a. Bob Marshall wilderness, Great Bear Wilderness fire management plan. U.S. Dept. Agric. For. Serv. Region 1, Flathead and Lewis and Clark Nat. For. Missoula, Mont.

______________________________. 1980. Land system inventory of the Scapegoat and Danaher portion of the Bob Marshall Wilderness (land type association, order-4). U.S. Dept. Agric. For. Serv. Flathead, Lolo, Lewis and Clark, and Helena National Forests.

______________________________. 1983. Criteria for mapping grizzly bear habitat constituent elements. U.S. Dept. Agric. For. Serv. Region 1, Missoula, Mont. 31pp.mimeo.

U.S. DEPARTMENT OF INTERIOR 1982. Grizzly bear recovery plan. U.S. Dept. Inter. Fish and Wildl. Serv. 195pp.

Wolfe, M. L. 1978. Habitat changes and management. Pp. 349-366 in J. Schmidt and D. Gilbert, ed., Big game of North America: ecology and management. Stackpole Books. 494pp.

Zager, P. 1980. The influence of logging and wildfire on grizzly bear habitat in northwestern Montana. Ph.D. Diss. Univ. Mont., Missoula. 131pp.

_________, C. Jonkel, and R. D. Mace. 1980. Grizzly bear habitat terminology. Spec. Rep. 41. Border Grizzly Proj. Univ. Mont., Missoula. 13pp.

APPENDIX A

TRANSFORM.PROG fortran program for manipulation of vegetation data sets.

Table A. Transform.prog fortran program for formatting data sets.

```
      DIMENSION D(250,250),FMT(12),IN(80),F(80),ID(10)
      OPEN(UNIT=22,DEVICE='DSK:',FILE='IN.DAT',ACCESS='SEQIN')
      OPEN(UNIT=21,DEVICE='DSK:',FILE='TCON.DAT',ACCESS='SEQOUT')
      OPEN(UNIT=23,DEVICE='DSK:',FILE='FULL.DAT',ACCESS='SEQOUT')
      READ(22,100)NSP,NST,ORDER
100   FORMAT  (2I5,60X,A1)
      READ(22,101)FMT,NUM
101   FORMAT  (12A5,5X,I5)
5     READ(22,FMT)J,(IN(I),F(I),I=1,NUM)
      IF  (J.EQ.0)GO TO 20
      DO 10 I=1,NUM
      IF  (IN(I).EQ.0)GO TO 10
      D(J,IN(I))=F(I)
10    CONTINUE
      GO TO 5
20    DO 50 IST=1,NST
      WRITE(23,200)(D(ISP,IST),ISP=1,NSP)
200   FORMAT(' ',250(F5.1))
50    CONTINUE
      DO 40 IST=1,NST
      I=0
      DO 30 ISP=1,NSP
      IF (D(ISP,IST).EQ.0.0)GO TO 30
      I=I+1
      ID(I)=ISP
      IF(I.LT.10) GO TO 30
      WRITE  (21,102)IST,((ID(K),D(ID(K),IST)),K=1,10)
102   FORMAT (' ',I3,10(I4,F6.2))
      I=0
30    CONTINUE
      IF (I.GT.0)WRITE (21,102)IST,((ID(K),D(ID(K),IST)),K=1,I)
40    CONTINUE
      WRITE (21,104)
104   FORMAT(' 0')
      END
```

APPENDIX B

Floral list of the study area.

Appendix B. Botanical and common names of taxa of the study area.

Botanical name	Common name	Family
Abies lasiocarpa	Subalpine fir	Pinaceae
Acer glabrum	Mountain maple	Aceraceae
Achillea millefolium	Yarrow	Compositae
Actaea rubra	Red baneberry	Ranunculaceae
Adenocaulon bicolor	Trail plant	Compositae
Agastache urticifolia	Nettleleaf giant hyssop	Labiatae
Agropyron caninum	Cutting wheatgrass	Gramineae
Agropyron spicatum	Bluebunch wheatgrass	Gramineae
Agoseris aurantiace	Orange agoseris	Compositae
Agoseris glauca	Pole agoseris	Compositae
Allium schoenoprasum	Wild chive	Liliaceae
Allium cernuum	Nodding onion	Liliaceae
Allium spp.	Wild onion	Liliaceae
Alnus spp.	Mountain alder	Betulaceae
Alopecurus pratensis	Meadow foxtail	Gramineae
Amelanchier alnifolia	Serviceberry	Rosaceae
Anaphalis margaritacea	Pearly everlasting	Compositae
Anemone occidentalis	Mountain anemone	Ranunculaceae
Anemone parviflora	Small-flowered anemone	Ranunculaceae
Anemone multifida	Cliff anemone	Ranunculaceae
Anemone spp.	Anemone	Ranunculaceae
Angelica arguta	Sharptooth angelica	Umbelliferae
Antennaria alpina	Alpine pussy-toes	Compositae
Antennaria lanata	Woolly pussy-toes	Compositae
Antennaria luzuloides	Woodrush pussy-toes	Compositae
Antennaria microphylla	Rosy pussy-toes	Compositae
Antennaria neglecta	Field pussy-toes	Compositae
Antennaria racemosa	Raceme pussy-toes	Compositae
Antennnaria spp.	Pussy-toes	Compositae
Apocynum androsaemifolium	Spreading dogbane	Apocynaceae
Aquilegia flavescens	Yellow columbine	Ranunculaceae
Arabis divaricarpa	Springingpod rockgress	Cruciferae
Arabis drummondii	Drummond's rockcress	Cruciferae
Arabis glabra	Towermustard	Cruciferae
Arabis holboellii	Holboell's rockcress	Cruciferae
Arabis nuttallii	Nuttall's rockcress	Cruciferae
Arabis spp.	Rockcress	Cruciferae
Arctostaphylos uva-ursi	Kinnikinnick	Ericaceae
Arenaria capillaris	Fescue sandwort	Caryphyllaceae
Arenaria lateriflora	Bluntleat sandwort	Caryphyllaceae
Arenaria obtusiloba	Alpine sandwort	Caryphyllaceae
Arenaria spp.	Sandwort	Caryphyllaceae
Arnica rydbergii	Rydberg's arnica	Compositae
Arnica chamissonis	Meadow arnica	Compositae
Arnica cordifolia	Heartleaf arnica	Compositae
Arnica latifolia	Mountain arnica	Compositae
Arnica longifolia	Seep-spring arnica	Compositae
Arnica spp.	Arnica	Compositae
Artemisia tridentata	Big sagebrush	Compositae

Artemisia ludoviciana	Prairie sagebrush	Compositae
Aster conspicuus	Showy aster	Compositae
Aster foliaceus	Leafy-bract aster	Compositae
Aster integrifolius	Entire-leaved aster	Compositae
Aster occidentalis	Western Moutana aster	Compositae
Aster spp.	Aster	Compositae
Astragalus alpinus	Purple milk-vetch	Leguminosae
Astragalus bourgovii	Bourgeau´s milk-vetch	Leguminosae
Astragalus miser	Weedy milk-vetch	Leguminosae
Astragalus robbinsii	Robbin´s milk-vetch	Leguminosae
Astragalus spp.	Milk-vetch	Leguminosae
Athyrium filix-femina	Lady fern	Polypodiaceae
Balsamorhiza sagittata	Arrowleaf balsamroot	Compositae
Berberis repens	Oregon grape	Berberidaceae
Betula glandulosa	Scrub birch	Betulaceae
Botrychium virginianum	Virginia adder´s-tongue	Ophiglossaceae
Bromus ciliatus	Fringed brome-grass	Gramineae
Calamagrostis canadensis	Bluejoint reedgrass	Gramineae
Calamagrostis rubescens	Pinegrass	Gramineae
Calochortus apiculatus	Pointed sego Lily	Liliaceae
Caltha leptosepala	Elkslip marigold	Ranunculaceae
Campanula parryi	Parry´s harebell	Campanulaceae
Campanula spp.	Harebell	Campanulaceae
Campanula rotundifolia	Roundleaf harebell	Campanulaceae
Cardimine rupicolor	Cliff toothwort	Cruciferae
Carex geyeri	Elk sedge	Cyperaceae
Carex spp.	Sedge	Cyperaceae
Castilleja spp.	Indian-paintbrush	Scrophulariaceae
Ceanothus velutinus	Evergreen ceanothus	Rhamnaceae
Cerastium arvense	Field chickweed	Caryophyllaceae
Chimaphila umbellata	Prince´s pine	Ericaceae
Cirsium spp.	Thistle	Compositae
Circaea alpina	Enchanter´s nightshade	Compositae
Claytonia lanceolata	Lanceleaf spring beauty	Portulacaceae
Clematis columbiana	Columbis virgins-bower	Ranunculaceae
Clintonia uniflora	Queencup beadlily	Liliaceae
Collinsia parviflora	Small-flowered blue-eyed Mary	Scrophulariaceae
Collomia linearis	Narrow-leaf Collomia	Polemoniaceae
Collomia debilis	Alpine Collomia	Polemoniaceae
Cornus canadensis	Bunchberry	Cornaceae
Cornus stolonifera	Red-osier dogwood	Cornaceae
Crepis atrabarba	Slender hawksbeard	Compositae
Crepis runcinata	Meadow hawksbeard	Compositae
Cystopteris fragilis	Brittle bladder-fern	Polypodiaceae
Danthonia intermedia	Timber oatgrass	Gramineae
Delphinium bicolor	Little larkspur	Ranunculaceae
Delphinium nuttallianum	Upland larkspur	Ranunculaceae
Delphinium spp.	Larkspur	Ranunculaceae
Dodecatheon conjugens	Slimpod shooting star	Primulaceae
Dodecatheon pulchellum	Dark-throat shooting star	Primulaceae
Dodecatheon spp.	Shooting dtar	Primulaceae
Douglasia montana	Mountain douglasia	Primulaceae
Draba lonchocarpa	Lancefruit draba	Cruciferae
Draba oligosperma	Few-seeded draba	Cruciferae
Dryas drummondii	Yellow mountain-avens	Rosaceae
Dryas octopetala	White dryas	Rosaceae

Elymus glaucus	Western ryegrass	Gramineae
Epilobium alpinum	Alpine willow-weed	Onagraceae
Epilobium angustifolium	Fireweed	Onagraceae
Epilobium glandulosum	Common willow-weed	Onagraceae
Epilobium latifolium	Red willow-weed	Onagraceae
Epilobium paniculatum	Autumn willow-weed	Onagraceae
Epilobium spp.	Willow-weed	Onagraceae
Equisetum arvense	Field horsetail	Equisetaceae
Equisetum spp.	Horsetail	Equisetaceae
Erigeron compositus	Dwarf mountain fleabane	Compositae
Erigeron corymbosus	Long-leaf fleabane	Compositae
Erigeron perigrinus	Subsalpine daisy	Compositae
Erigeron speciosus	Showny fleabane	Compositae
Erigeron simplex	Alpine daisy	Compositae
Erigeron spp.	Fleabane	Compositae
Eriogonum flavum	Yellow buckwheat	Polygonaceae
Eriogonum ovalifolium	Cushion buckwheat	Polygonaceae
Eriogonum spp.	Buckwheat	Polygonaceae
Eriogonum umbellatum	Sulfur buckwheat	Polygonaceae
Eritrichium nanum	Pale alpine forget-me-not	Boraginaceae
Erythronium grandiflorum	Yellow dogtooth-violet	Liliaceae
Festuca idahoensis	Idaho fescue	Gramineae
Festuca scabrella	Rough fescue	Gramineae
Fragaria virginiana	Wild strawberry	Rosaceae
Galium boreale	Northern bedstraw	Rubiaceae
Galium triflorum	Fragrant bedstraw	Rubiaceae
Gentiana calycosa	Gentian	Gentianaceae
Geranium viscosissimum	Sticky purple geranium	Geraniaceae
Gaillardia aristata	Blanket-flower gaillardia	Compositae
Geum aleppicum	Yellow avens	Compositae
Geum macrophyllum	Largeleaved avens	Rosaceae
Geum rivale	Purple avens	Rosaceae
Geum spp.	Avens	Rosaceae
Geum triflorum	Praire smoke avens	Rosaceae
Glyceria elata	Tall mannagrass	Gramineae
Goodyeara oblongifolia	Western rattlesnake plantain	Orchidaceae
Gymnocarpium dryopteris	Oak-fern	Polypodiaceae
Habenaria dilatata	White bog-orchid	Orchidaceae
Habenaria obtusata	Blunt-leaf bog-orchid	Orchidaceae
Hackelia jessicae	Blue stickweed	Boraginaceae
Haplopappus lyallii	Lyall´s goldenweed	Compositae
Hedysarum occidentale	Western hedysarum	Leguminosae
Hedysarum sulpherenscens	Yellow hedysarum	Leguminosae
Heracleum lanatum	Cow parsnip	Umbelliferae
Heuchera cylindrica	Roundleaf alumroot	Saxifragaceae
Hieracium albertinum	Western hawkweek	Compositae
Hieracium cynoglossoides	Hounds-tongue hawkweed	Compositae
Hieracium spp.	Hawkweed	Compositae
Hydrophyllum capitatum	Ballhead waterleaf	Hydrophyllaceae
Hypericum formosum	Western St. John´s-wort	Hypernaceae
Juncus parryi	Parry´s rush	Juncaceae
Juncus spp.	Rush	Juncaceae
Juniperus communis	Common juniper	Cupressaceae
Juniperus horizontalis	Creeping juniper	Cupressaceae
Juniperus scopulorum	Rocky Mountain juniper	Cupressaceae
Kalmia polifolia	Alpine laurel	Ericaceae

Larix occidentalis	Western larch	Pinaceae
Larix lyallii	Subalpine larch	Pinaceae
Ledum glandulosum	Western labrador-tea	Ericaceae
Ligusticum canbyi	Canby's licorice-root	Umbelliferae
Ligusticum spp.	Licorice-root	Umbelliferae
Listera cordata	Heart-leaf listera	Orchidaceae
Linum perenne	Blue garden flax	Linaceae
Linnaea borealis	Western twinflower	Caprifoliaceae
Lithophragma parviflora	Smallflowered fringecup	Saxifragaceae
Lithospermum ruderale	Western gromwell	Boraginaceae
Lomatium dissectum	Fern-leaved biscuit-root	Umbelliferae
Lomatium cous	Cous biscuit-root	Umbelliferae
Lomatium macrocarpum	Large-fruit biscuit-root	Umbelliferae
Lomatium sandbergii	Sandberg's biscuit-root	Umbelliferae
Lomatium spp.	Biscuit-root	Umbelliferae
Lonicera involucrata	Black twin-berry	Caprifoliaceae
Lupinus spp.	Lupine	Leguminosae
Luzula hitchcockii	Smooth woodrush	Juncaceae
Melica spectabilis	Showy oniongrass	Gramineae
Mentha spp.	Mint	Labiateae
Menziesia ferruginea	Fool's huckleberry	Ericaceae
Microseris nutans	Nodding microseris	Compositae
Microseris spp.	Microseris	Compositae
Mimulus lewisii	Lewis' monkey-flower	Scrophulariaceae
Mitella breweri	Brewer's mitrewort	Saxifragaceae
Mitella caulescens	Leafy mitrewort	Saxifragaceae
Mitella nuda	Bare-stemed mitrewort	Saxifragaceae
Mitella stauropetala	Starry mitrewort	Saxifragaceae
Mitella spp.	Mitrewort	Saxifragaceae
Osmorhiza purpurea	Purple sweet-cicely	Umbelliferae
Osmorhiza chilensis	Mountain sweet-cicely	Umbelliferae
Osmorhiza occidentalis	Western sweet-cicely	Umbelliferae
Oxytropis campestris	Slender crazyweed	Leguminosae
Oxytropis sericea	Silky crazyweed	Leguminosae
Pachistima myrsinites	Pachistima	Celastraceae
Parnassia fimbricata	Fringed grass-of-parnassas	Saxifragaceae
Pedicularis bracteosa	Bracted lousewort	Scrophulariaceae
Pedicularis contorta	White coiled-beak lousewort	Scrophulariaceae
Pedicularis groenlandica	Elephant's head	Scrophulariaceae
Pedicularis spp.	Lousewort	Scrophulariaceae
Penstemon albertinus	Alberta penstemon	Scrophulariaceae
Penstemon confertus	Yellow penstemon	Scrophulariaceae
Penstemon ellipticus	Elliptic-leaved penstemon	Scrophulariaceae
Penstemon procerus	Small-flowered penstemon	Scrophulariaceae
Penstemon wilcoxii	Wilcox's penstemon	Scrophulariaceae
Perideridia gairdneri	Gairdner's yampah	Umbelliferae
Phacelia hastata	Whiteleaf phacelia	Hydropyllaceae
Phacelia heterophylla	Virgate phacelia	Hydropyllaceae
Phacelia sericea	Silky phacelia	Hydropyllaceae
Phacelia spp.	Phacelia	Hydropyllaceae
Phleum pratense	Common timothy	Gramineae
Phleum alpinum	Alpine timothy	Gramineae
Phyllodoce empetriformis	Pink mountain-heather	Ericaceae
Physocarpus malvaceus	Mallow ninebark	Rosaceae
Picea engelmannii	Engelmann spruce	Pinaceae
Pinus albicaulis	Whitebark pine	Pinaceae
Pinus contorta	Lodgepole pine	Pinaceae
Pinus ponderosa	Ponderosa pine	Pinaceae
Poa alpina	Alpine bluegrass	Gramineae
Poa palustris	Fowl bluegrass	Gramineae

Poa pratensis	Kentucky bluegrass	Gramineae
Polygonum bistortoides	Western bistort	Polygonaceae
Polygonum douglasii	Douglas´ knotweed	Polygonaceae
Polystichum lonchitis	Mountain holly-fern	Polopodicaceae
Populus tremuloides	Quaking aspen	Salicaceae
Populus trichocarpa	Black cottonwood	Salicaceae
Potentilla arguta	Tall cinquefoil	Rosaceae
Potentilla diversifolia	Diverse-leaved cinquefoil	Rosaceae
Potentilla fruticosa	Shrubby cinquefoil	Rosaceae
Potentilla glandulosa	Gland cinquefoil	Rosaceae
Potentilla gracilis	Slender cinquefoil	Rosaceae
Potentilla ovina	Sheep cinquefoil	Rosaceae
Prenanthes sagitatta	Rattlesnake-root	Compositae
Prunella vulgaris	Common selfheal	Labiatae
Prunus virgiana	Chokecherry	Rosaceae
Pseudotsuga menziesii	Douglas-fir	Pinaceae
Pteridium aquilinum	Bracken fern	Polypodiaceae
Pyrola asarifolia	Leafless pyrola	Saxifragaceae
Pyrola minor	Snowline pyrola	Saxifragaceae
Pyrola secunda	Sidebell´s pyrola	Saxifragaceae
Pyrola uniflora	Woodnymph	Saxifragaceae
Pyrola spp.	Pyrola	Saxifragaceae
Ranunculus eschscholtzii	Subalpine buttercup	Ranunculaceae
Ranunculus uncinatus	Little buttercup	Ranunculaceae
Ranunculus spp.	Buttercup	Ranunculaceae
Rhamnus alnifolia	Alderleaf buckthorn	Rhamnaceae
Ribes hudsonianum	Hudson bay currant	Grossulariaceae
Ribes inerme	Whitestem gooseberry	Grossulariaceae
Ribes lacustre	Swamp gooseberry	Grossulariaceae
Ribes montigenum	Alpine prickly current	Grossulariaceae
Ribes viscosissimum	Sticky currant	Grossulariaceae
Ribes spp.	Currant	Grossulariaceae
Rosa acicularis	Prickley rose	Rosaceae
Rosa woodsii	Wood´s rose	Rosaceae
Rosa spp.	Rose	Rosaceae
Rubus idaeus	Red raspberry	Rosaceae
Rubus parviflorus	Thimbleberry	Rosaceae
Rubus spp.	Raspberry	Rosaceae
Salix spp.	Willow	Salicaceae
Salix arctica	Arctic willow	Salicaceae
Sambucus racemosa	Black elderberry	Caprifoliacerae
Saxifraga bronchialis	Matted saxifrage	Saxifragaceae
Saxifraga rhomboidea	Diamondleaf saxifrage	Saxifragaceae
Saxifraga integrifolia	Swamp saxifrage	Saxifragaceae
Saxifraga arguta	Brook saxifrage	Saxifragaceae
Sedum stenopetalum	Wormleaf stonecup	Crassulaceae
Senecio canus	Woolly groundsel	Compositae
Senecio integerrimus	Western groundsel	Compositae
Senecio megacephalus	Large-headed butterweed	Compositae
Senecio pseudaureus	Streambank butterweed	Compositae
Senecio resedifolius	Dwarf arctic butterweed	Compositae
Senecio subnudus	Few-leaved groundsel	Compositae
Senecio triangularis	Arrowleaf groundsel	Compositae
Senecio spp.	Groundsel	Compositae
Shepherdia canadensis	Canada buffalo-berry	Elaegnaceae
Sibbaldia procumbens	Creeping sibbaldia	Rosaceae
Silene parryi	Parry´s silene	Caryophyllaceae

Silene menziesii	Menzies silene	Caryophyllaceae
Sisymbrium altissimum	Jimhill mustard	Cruciferae
Smelowskia calycina	Alpine smelowskia	Cruciferae
Smilacina racemosa	Western solomon's seal	Liliaceae
Smilacina stellata	Starry solomon's seal	Liliaceae
Smilacina spp.	False solomon's seal	Liliaceae
Solidago canadensis	Canada goldenrod	Compositae
Solidago missouriensis	Missouri goldenrod	Compositae
Solidago multiradiata	Northern goldenrod	Compositae
Solidago spp.	Goldenrod	Compositae
Sorbus scopulina	Cascade mountain-ash	Rosaceae
Spiraea betulifolia	Shiny-leaf spirea	Rosaceae
Spiraea densiflora	Subalpine spirea	Rosaceae
Spiranthes romanzoffiana	Hooded ladies-tresses	Liliaceae
Stellaria spp.	Starwort	Caryphyllaceae
Stipa occidentalis	Western needlegrass	Gramineae
Stipa richardsonii	Richardson's needlegrass	Gramineae
Streptopus amplexifolius	Clasping-leaved twisted-stalk	Liliaceae
Suksdorfia ranunculifolia	Buttercupleaved suksdorfia	Saxifragaceae
Symphoricarpos albus	Common snowberry	Caprifoliaceae
Taraxacum spp.	Dandelion	Compositae
Taxus brevifolia	Pacific yew	Taxaceae
Thalictrum occidentale	Western meadowrue	Ranunculaceae
Tiarella trifoliata	Trefoil foamflower	Grossulariaceae
Tofieldia glutinosa	Sticky tofieldia	Liliaceae
Townsendia parryi	Parry's townsendia	Compositae
Tragopogon dubius	Yellow salsify	Compositae
Trifolium spp.	Clover	Compositae
Trillium ovatum	White trillium	Liliaceae
Urtica dioica	Stinging nettle	Urticaceae
Vaccinium caespitosum	Dwarf huckleberry	Ericaceae
Vaccinium globulare	Globe huckleberry	Ericaceae
Vaccinium scoparium	Grouse whortleberry	Ericaceae
Valeriana edulis	Edible valerian	Valarianaceae
Valeriana dioica	Northern valerian	Valarianaceae
Valeriana occidentalis	Western valerian	Valarianaceae
Valeriana sitchensis	Sitka valerian	Valarianaceae
Veratrum viride	American false hellebore	Liliaceae
Veronica cusickii	Cusick's speedwell	Scrophulariceae
Veronica serpyllifolia	Thyme-leaved speedwell	Scrophulariceae
Veronica wormskjoldii	American alpine speedwell	Scrophulariceae
Viola macloskeyi	Small white violet	Violaceae
Viola adunca	Early blue violet	Violaceae
Viola canadensis	Canada violet	Violaceae
Viola nuttallii	Nuttall's violet	Violaceae
Viola orbiculata	Round-leaved violet	Violaceae
Viola spp.	Violet	Violaceae
Xerophyllum tenax	Beargrass	Liliaceae
Zigadenus elegans	Glaucous zigadenus	Liliaceae
Zigadenus venenosus	Meadow death-camas	Liliaceae
Zigadenus spp.	Death-camas	Liliaceae

APPENDIX C

Data from 9 vegetation types of the floodplain complex habitat component.

Table C-1. Plant taxa in the Salix spp. flat VT (floodplain complex) (% cover % occurrence) (n=26).

NONVASCULAR COVER:		
Soil	t*	23
Rock	t	4
Mosses/lichens/litter	t	35
Water	t	12
GRAMINEAE/CYPERACEAE:	32	100
FORBS AND FERNS:		
Achillea millefolium	t	23
Adenocaulon bicolor	t	8
Allium schoenoprasum	t	15
Angelica arguta	t	65
Antennaria microphylla	t	15
Arabis glabra	t	4
Arenaria lateriflora	t	23
Arnica chamissonis	t	12
Arnica cordifolia	t	54
Arnica spp.	t	4
Aster foliaceus	t	23
Aster spp.	t	8
Astragalus alpinus	t	27
Cerastium arvense	1	42
Cirsium spp.	t	38
Collomia linearis	t	8
Cornus canadensis	t	8
Epilobium angustifolium	t	23
Epilobium spp.	t	12
Equisetum spp.	4	46
Eriogonum flavum	t	38
Fragaria virginiana	1	65
Galium boreale	t	65
Galium triflorum	t	12
Geum aleppicum	t	8
Geum macrophyllum	t	38
Geum rivale	t	23
Gymnocarpium dryopteris	t	4
Habenaria dilatata	t	8
Heracleum lanatum	4	73
Ligusticum canbyi	t	4
Mitella caulescens	t	4
Mitella nuda	t	8
Mitella spp.	t	4
Osmorhiza occidentalis	t	8
Pedicularis groenlandica	t	35
Penstemon confertus	t	4
Potentilla gracilis	t	27
Potentilla spp.	t	8
Pyrola asarifolia	t	8
Ranunculus spp.	t	4
Saxifraga arguta	t	15
Senecio pseudaureus	2	62
Senecio triangularis	t	12
Smilacina racemosa	t	8
Smilacina stellata	t	38
Solidago canadensis	t	38
Spiranthes romanzoffiana	t	4
Streptopus amplexifolius	t	8
Taraxacum spp.	t	58
Thalictrum occidentale	1	69
Trifolium spp.	t	42
Trillium ovatum	t	46
Unknown forbs	t	23
Urtica dioica	t	8
Valeriana sitchensis	t	8
Viola macloskeyi	t	8
Viola spp.	t	8
TALL SHRUBS:		
Alnus spp.:		
0-0.9 m	t	27
0.9-2.0 m	t	8
> 2.0 m	1	8
Lonicera involucrata:		
0-0.9 m	3	85
0.9-2.0 m	t	8
Rhamnus alnifolia:		
0-0.9 m	t	12
Salix spp.:		
0-0.9 m	4	81
0.9-2.0 m	42	85
> 2.0 m	4	85
OTHER SHRUBS (0-0.9 m):		
Arctostaphylos uva-ursi	3	27
Amelanchier alnifolia	t	4
Populus tremuloides	t	4
Potentilla fruticosa	t	35
Ribes lacustre	t	4
Ribes spp.	5	81
Rosa spp.	1	77
Rubus parviflorus	t	19
Rubus spp.	t	19
Shepherdia canadensis	t	4
TREES:		
Abies lasiocarpa:		
0-0.9 m	t	15
Picea spp.		
0-0.9 m	3	46
Pinus contorta:		
0-0.9 m	1	19
Pseudotsuga menziesii:		
0-0.9 m	t	8

* t= < 0.5 % cover.

Table C-2. Plant taxa in the sand bar VI, floodplain complex (% cover % occurrence) (n=13).

NONVASCULAR COVER:		
Logs	1	23
Mosses/Lichens	17	77
Rock	1	5
Soil (sand)	16	69
GRAMINEAE CYPERACEAE:	8	69
FORBS:		
Achillea millefolium	t*	100
Agoseris glauca	t	15
Allium spp.	t	54
Antennaria microphylla	1	23
Antennaria spp.	t	23
Astragalus miser	t	31
Astragalus spp.	t	8
Castilleja spp.	t	23
Cirsium spp.	t	15
Crepis runcinata	t	23
Epilobium angustifolium	t	23
Epilobium spp.	t	15
Erigeron compositus	t	54
Erigeron spp.	1	23
Eriogonum flavum	t	62
Fragaria virginiana	t	23
Galium boreale	t	31
Geum spp.	t	8
Heracleum lanatum	t	7
Lithospermum ruderale	t	15
Lomatium spp.	t	8
Lupinus spp.	2	54
Oxytropis campestris	2	46
Penstemon confertus	t	8
Perideridia gairdneri	t	8
Potentilla gracilis	t	15
Pyrola uniflora	t	8
Sedum stenopetalum	t	69
Senecio canus	t	38
Senecio pseudaureus	1	85
Smilacina stellata	t	23
Solidago canadensis	t	8
Taraxacum spp.	t	31
Thalictrum occidentale	t	15
Trifolium spp.	1	15
Unknown forbs	t	23
SHRUBS (0-0.9 m)		
Arctostaphylos uva-ursi	1	31
Berberis repens	t	15
Linnaea borealis	t	8
Ribes spp.	t	15
Rosa spp.	2	62
Salix spp.	t	23
Symphoricarpos albus	t	15
TREES:		
Picea engelmannii:		
0-0.9 m	t	23
0.9-2.0 m	1	8
2.0-9.0 m	1	15
Pinus contorta:		
0-0.9 m	t	8
0.9-2.0 m	t	8
>9.0 m	t	8

* t = < 0.5 % cover

Table C-3. Plant taxa in the gravel bar VT, floodplain complex, (% cover % occurrence) (n=27).

NONVASCULAR COVER:		
Logs	t*	7
Mosses/Lichens	t	11
Rock	71	96
Soil (sand)	6	11
GRAMINEAE/CYPERACEAE:	3	74
FORBS:		
Achillea millefolium	t	33
Agoseris glauca	t	15
Allium spp.	t	4
Artemisia ludoviciana	t	15
Aster spp.	t	4
Astragalus alpinus	t	46
Cirsium spp.	t	11
Dryas drummondii	t	4
Epilobium angustifolium	t	7
Epilobium glandulosum	t	4
Epilobium latifolium	4	70
Epilobium spp.	t	7
Equisetum spp.	t	15
Erigeron compositus	t	7
Erigeron spp.	t	37
Fragaria virginiana	t	15
Galium boreale	t	4
Lithospermum ruderale	t	4
Oxytropis campestris	t	4
Phacelia heterophylla	t	4
Phacelia spp.	t	7
Potentilla diversifolia	t	4
Prunella vulgaris	t	15
Sedum stenopetalum	t	4
Solidago canadensis	t	12
Taraxacum spp.	t	54
Trifolium spp.	t	44
Unknown forbs	t	7
SHRUBS (0-0.9 m):		
Salix spp.	2	37
Rosa spp.	t	4

* t= < 0.5% cover

Table C-4. Plant taxa in the *Carex* spp. VT, Floodplain complex, (% cover % occurrence) (n=6).

NONVASCULAR COVER:		
Mosses/Lichens	t*	33
Litter	8	83
GRAMINEAE/CYPERACEAE/ JUNCACEAE:	81	100
FORBS AND FERNS:		
Adenocaulon bicolor	1	83
Angelica arguta	t	17
Equisetum spp.	t	50
Fragaria spp.	t	17
Geum macrophyllum	1	66
Pedicularis spp.	t	50
Habenaria dilatata	t	17
Pyrola uniflora	t	67
SHRUBS:		
Salix spp. (0.9-2.0 m):	7	50

* t= < 0.5 % cover

Table C-5. Plant taxa in the mesic herbaceous meadow VT, floodplain complex (% cover % occurrence) (n=13).

NONVASCULAR COVER:		
Soil	t*	8
Mosses/lichens/litter	1	8
Logs	4	54
GRAMINEAE/CYPERACEAE:	39	100
FORBS AND FERNS:		
Achillea millefolium	t	31
Angelica arguta	1	92
Antennaria spp.	t	8
Arnica cordifolia	t	46
Astragalus alpinus	t	23
Botrychium virginianum	t	8
Cirsium spp.	t	39
Epilobium angustifolium	2	69
Equisetum spp.	1	77
Erigeron spp.	t	15
Fragaria virginiana	3	85
Galium boreale	1	69
Galium triflorum	t	31
Geum aleppicum	t	8
Geum macrophyllum	t	39
Habenaria dilatata	t	8
Heracleum lanatum	2	62
Mitella caulescens	t	31
Mitella nuda	t	8
Osmorhiza chilensis	t	15
Osmorhiza occidentalis	t	15
Osmorhiza purpurea	t	8
Pedicularis groenlandica	t	23
Potentilla gracilis	t	8
Prenanthes sagittata	t	54
Pyrola asarifolia	t	23
Pyrola uniflora	t	8
Senecio pseudaureus	t	54
Senecio spp.	t	39
Senecio triangularis	t	31
Smilacina racemosa	1	92
Solidago canadensis	t	39
Streptopus amplexifolius	t	8
Taraxacum spp.	t	77
Thalictrum occidentale	16	85
Trifolium spp.	t	37
Unknown forbs	t	8
Valeriana sitchensis	t	8

TALL SHRUBS:		
Alnus spp.:		
0-0.9 m	t	15
0.9-2.0 m	t	8
Cornus stolonifera:		
0-0.9 m	2	15
Lonicera involucrata:		
0-0.9 m	2	77
0.9-2.0 m	t	8
Salix spp.:		
0-0.9 m	t	23
0.9-2.0 m	t	8
> 2.0 m	t	8
OTHER SHRUBS (0-0.9 m):		
Actaea rubra	1	31
Amelanchier alnifolia	t	8
Berberis repens	t	15
Cornus canadensis	t	8
Linnaea borealis	t	15
Potentilla fruticosa	t	8
Ribes lacustre	t	8
Ribes spp.	1	46
Rosa spp.	4	69
Rosa woodsii	3	31
Rubus spp.	t	15
Shepherdia canadensis	1	23
Symphoricarpos albus	t	8
Vaccinium ceaspitosum	t	8
TREES:		
Abies lasiocarpa:		
2.0-9.0 m	t	8
Picea engelmannii:		
0-0.9 m	5	46
0.9-2.0 m	3	23
2.0-9.0 ma:	t	23
> 9.0 m	3	85
Pseudotsuga menziesii:		
2.0-9.0 m	1	8
> 9.0 m	1	8
Populus tremuloides:		
2.0-9.0 m	1	8

* t= < 0.5 % cover.

Table C-6. Plant taxa in the riparian Picea engelmannii VT, floodplain complex (% cover % occurrence) (n=27).

NONVASCULAR COVER:		
Soil	7	70
Rock	t	19
Mosses/Lichens	2	56
Logs	6	85
GRAMINEAE/CYPERACEAE:	16	100
FORBS AND FERNS:		
Achillea millefolium	t	15
Adenocaulon bicolor	t	4
Allium cernuum	t	4
Allium schoenoprasum	t	11
Angelica arguta	t	56
Arnica cordifolia	t	22
Arnica latifolia	t	4
Arnica spp.	t	4
Aster conspicuus	2	37
Astragalus alpinus	t	7
Astragalus spp.	t	7
Athyrium filix-femina	t	11
Cirsium spp.	t	41
Epilobium angustifolium	t	4
Equisetum spp.	2	59
Erigeron spp.	1	22
Eriogonum flavum	t	4
Fragaria virginiana	6	82
Galium boreale	t	52
Galium triflorum	3	74
Geum aleppicum	t	18
Geum macrophyllum	t	30
Geum rivale	t	4
Goodyeara oblongifolia	t	4
Habenaria obtusata	t	7
Heracleum lanatum	1	63
Hieracium cynoglossoides	t	4
Ligusticum canbyi	t	30
Mitella caulescens	t	22
Mitella nuda	t	7
Osmorhiza chilensis	t	44
Prenanthes sagittata	1	44
Pyrola asarifolia	t	37
Pyrola secunda	t	41
Pyrola uniflora	t	41
Saxifraga arguta	t	7
Senecio pseudaureus	2	56
Senecio triangularis	t	37
Smilacina stellata	1	63
Solidago canadensis	t	11
Solidago missouriensis	t	7
Streptopus amplexifolius	t	41
Taraxacum spp.	t	52
Thalictrum occidentale	12	63
Trifolium spp.	4	41
Unknown forbs	t	44
Veratrum viride	t	7

TALL SHRUBS:		
Alnus spp.:		
0.9-2.0 m	2	70
> 2.0 m	t	15
Cornus stolonifera:		
0-0.9 m	2	52
0.9 2.0 m	t	4
Lonicera involucrata:		
0-0.9 m	2	74
0.9-2.0 m	1	11
Salix spp.:		
0-0.9 m	t	11
OTHER SHRUBS (0-0.9 m):		
Actaea rubra	t	52
Berberis repens	t	33
Cornus canadensis	2	22
Juniperus communis	t	7
Juniperus scopulorum	t	7
Linnaea borealis	3	56
Potentilla fruticosa	t	4
Ribes lacustre	t	11
Ribes spp.	t	15
Rosa spp.	2	70
Rosa woodsii	1	11
Rubus idaeus	t	30
Rubus parviflorus	t	7
Rubus spp.	t	11
Shepherdia canadensis	t	15
Spiraea betulifolia	t	4
Symphoricarpos albus	t	37
TREES:		
Abies lasiocarpa:		
0-0.9 m	1	7
Picea engelmannii:		
0-0.9 m	2	48
0.9-2.0 m	3	48
2.0-9.0 m	5	44
> 9.0 m	11	26
Pinus contorta:		
> 9.0 m	18	37
Populus tremuloides:		
> 9.0 m	2	7
Pseudotsuga menziesii:		
0-0.9 m	14	48
0.9-2.0 m	2	15
2.0-9.0 m	1	7

* t= < 0.5% cover

Table C-7. Plant taxa in the Populus trichocarpa VT, floodplain complex (% cover % occurrence) (n=4).

NONVASCULAR COVER:		
Soil	4	100
Rock	2	100
Mosses/Lichens	1	100
Logs	8	100
GRAMINEAE/CYPERACEAE:	17	75
FORBS AND FERNS:		
Achillea millefolium	1	100
Allium spp.	t	50
Anenome multifida	t	25
Angelica arguta	t	25
Antennaria spp.	t	25
Arnica spp.	t	50
Artemisia ludoviciana	t	25
Aster foliaceus	t	50
Astragalus miser	1	75
Astragalus robbinsii	1	25
Chimaphila umbellata	t	50
Cirsium spp.	t	50
Crepis runcinata	t	75
Epilobium angustifolium	1	75
Epilobium spp.	4	75
Equisetum spp.	t	25
Fragaria virginiana	2	75
Galium boreale	1	75
Heracleum lanatum	t	25
Lithospermum ruderale	t	25
Lupinus spp.	t	25
Potentilla diversifolia	t	25
Prenanthes sagittata	t	25
Pyrola secunda	t	25
Senecio pseudaureus	3	50
Silene menziesii	t	25
Smilacina stellata	t	50
Solidago missouriensis	3	50
Taraxacum spp.	2	25
Thalictrum occidentale	t	50
Trifolium spp.	1	25
Unknown forbs	1	100
Viola canadensis	t	50
SHRUBS:		
Alnus spp.:		
0-0.9 m	t	25
Cornus stolonifera:		
0-0.9 m	24	75
Lonicera involucrata:		
0-0.9 m	t	25
Salix spp.:		
0-0.9 m	1	25
Rosa spp.	1	100
Ribes spp.	t	25
Shepherdia canadensis	2	75
Berberis repens	t	25
Symphoricarpos albus	t	25
Juniperus communis	1	50
Juniperus horizontalis	2	100
Arctostaphylos uva-ursi	17	50
TREES:		
Picea engelmannii:		
0-0.9 m	t	50
>9.0 m	2	50
Pseudotsuga menziesii:		
0-0.9 m	t	25
>9.0 m	88	25
Pinus contorta:		
0-0.9 m	t	25
0.9-2.0 m	76	25
2.0-9.0 m	t	25
Populus trichocarpa:		
0-0.9 m	t	25
>9.0 m	46	100

* t= < 0.5% cover

Table C-8. Plant taxa in the terrestrial Picea engelmannii VT, floodplain complex (% cover % occurrence) (n=23).

NONVASCULAR COVER:		
Mosses/Lichens	t*	13
Rock	t	4
Soil	1	13
GRAMINEAE/CYPERACEAE	4	100
FORBS:		
Achillea millefolium	t	17
Allium schoenoprasum	t	13
Arnica cordifolia	t	9
Aster conspicuus	1	13
Astragalus alpinus	t	4
Castilleja spp.	t	13
Chimaphila umbellata	t	4
Cirsium spp.	t	9
Epilobium angustifolium	t	65
Erigeron spp.	t	65
Fragaria virginiana	t	38
Galium boreale	t	13
Heuchera cylindrica	t	17
Hieracium cynoglossoides	t	4
Lupinus spp.	t	44
Pedicularis spp.	t	44
Pyrola asarifolia	t	9
Senecio pseudaureus	t	4
Thalictrum occidentale	t	9
Trillium ovatum	t	22
SHRUBS (0-0.9 m):		
Amelanchier alnifolia	t	17
Arctostaphylos uva-ursi	16	91
Berberis repens	3	65
Juniperus communis	t	4
Linnaea borealis	t	13
Pachistima myrsinites	t	13
Rosa woodsii	t	4
Rubus parviflorus	t	4
Salix spp.	t	13
Shepherdia canadensis	5	13
Spiraea betulifolia	1	44
Symphoricarpos albus	t	9
Vaccinium caespitosum	22	91
TREES:		
Picea engelmannii:		
0-0.9 m	t	30
0.9-2.0 m	t	9
2.0-9.0 m	1	4
> 9.0 m	t	4
Pseudotsuga menziesii:		
0-0.9 m	t	44
0.9-2.0 m	t	9
2.0 -9.0 m	1	9
Pinus contorta:		
0-0.9 m	2	56
0.9-2.0 m	t	56
2.0-9.0 m	17	78
>9.0 m	21	70

*t= < 0.5% cover

Table C-9. Plant taxa in the xeric graminoid meadow VT, floodplain complex (% cover % occurrence) (n=20).

NONVASCULAR COVER:		
Soil	1	100
Rock	t*	100
Mosses/lichens	42	90
GRAMINEAE/CYPERACEAE:	27	100
FORBS:		
Achillea millefolium	t	20
Allium cernuum	t	5
Antennaria spp.	1	75
Epilobium angustifolium	t	15
Erigeron spp.	t	35
Eriogonum umbellatum	2	50
Fragaria virginiana	2	30
Geranium viscosissimum	t	5
Geum triflorum	1	55
Lupinus spp.	2	50
Pedicularis spp.	t	15
Penstemon spp.	3	85
Potentilla spp.	2	45
Sedum stenopetalum	t	45
Unknown forbs	t	15
SHRUBS (0-0.9 m)		
Artemisia tridentata	2	20
Berberis repens	t	15
Rosa spp.	t	5
TREES:		
Pinus contorta:		
0-0.9 m	t	20

* t= < 0.5 %

APPENDIX D

Data from 6 vegetation types of the avalanche chute complex habitat component.

Table D-1. Plant taxa in the streamside VT, avalanche chute complex (%cover % Occurrence) (n=129).

NONVASCULAR COVER:		
Soil	t*	4
Rock	3	58
Mosses/Lichens	1	32
Logs	2	33
GRAMINEAE/CYPERACEAE:	6	100
FORBS AND FERNS:		
Achillea millefolium	t	3
Agoseris aurantiace	2	23
Anemone occidentalis	t	9
Angelica arguta	2	43
Antennaria lanata	t	4
Antennaria microphylla	t	2
Aquilegia flavescens	t	6
Arabis drummondii	t	4
Arabis nuttallii	t	2
Arabis spp.	t	20
Arenaria spp.	t	1
Arnica latifolia	1	22
Arnica longifolia	t	4
Arnica spp.	2	16
Artemisia ludoviciana	t	2
Aster foliaceus	t	1
Aster integrifolius	t	5
Aster spp.	t	12
Calochortus apiculatus	t	2
Campanula spp.	t	5
Castilleja spp.	t	2
Cirsium spp.	t	1
Delphinium spp.	t	9
Dodecatheon spp.	t	1
Epilobium alpinum	t	16
Epilobium glandulosum	t	9
Erigeron perigrinus	t	14
Erigeron speciosus	t	7
Erigeron spp.	t	2
Eriogonum umbellatum	1	17
Erythronium grandiflorum	t	6
Fragaria virginiana	1	12
Galium boreale	t	2
Galium triflorum	1	24
Gentiana calycosa	t	1
Geranium viscosissimum	t	6
Geum macrophyllum	t	4
Habenaria dilatata	1	30
Habenaria obtusata	t	2
Hackelia jessicae	1	20
Hedysarum occidentale	t	2
Heracleum lanatum	6	47
Hieracium cynoglossoides	t	5
Hydrophyllum capitatum	1	25
Hypericum formosum	t	2
Ligusticum canbyi	t	8
Lomatium sandbergii	t	2
Mentha spp.	t	2
Mimulus lewisii	t	5
Mitella caulescens	t	4
Mitella nuda	t	6
Mitella spp.	1	17
Pedicularis bracteosa	t	1
Pedicularis groenlandica	t	3
Pedicularis spp.	t	4
Penstemon albertinus	t	1
Phacelia spp.	t	5
Polystichum lonchitis	t	8
Potentilla glandulosa	t	4
Prunella vulgaris	t	6
Pyrola minor	t	11
Saxifraga arguta	t	4
Sedum stenopetalum	2	32
Senecio pseudaureus	5	59
Senecio subnudus	t	2
Senecio triangularis	15	70
Smilacina racemosa	t	8
Taraxacum spp.	2	30
Thalictrum occidentale	t	3
Tragopogon dubius	t	1
Trillium ovatum	t	5
Unknown forbs	t	2
Urtica dioica	t	1
Valeriana sitchensis	t	6
Veratrum viride	4	46
Viola spp.	t	16
Xerophyllum tenax	t	33
Zigadenus elegans	t	1
Zigadenus venenosus	t	4
SHRUBS:		
Alnus sinuata:		
0-0.9 m	t	1
0.9-2.0 m	t	10
>2.0 m	4	15
Ribes lacustre	2	5
Actaea rubra	2	10
Rubus parviflorus	1	8
Lonicera involucrata:		
0-0.9 m	2	18
0.9-2.0 m	1	9
> 2.0 m	t	1
Sorbus scopulina:		
0-0.9 m	1	8
0.9-2.0 m	t	2
> 2.0 m	t	1
Spiraea betulifolia	t	4
Vaccinium scoparium	t	2
Rhamnus alnifolia:		
0.9-2.0 m	3	10
Salix spp.:		
0.9-2.0 m	3	15
> 2.0 m	t	3
Cornus stolonifera:		
0-0.9 m	t	1
Pachistima myrsinites	t	5
Berberis repens	t	2
Ribes hudsonianum	1	5
Sambucus racemosa	t	1
Vaccinium caespitosum	t	5

* t= < 0.5 % cover

Table D-2. Plant taxa in the Alnus spp. VT, avalanche chute complex, (% cover % occurrence) (n=52).

NONVASCULAR COVER:		
Soil	15	81
Rock	1	40
Mosses/Lichens	2	58
Logs	2	65
GRAMINEAE/CYPERACEAE:	2	72
FORBS AND FERNS:		
Achillea millefolium	t*	2
Agastache urticifolia	t	4
Angelica arguta	1	10
Aquilegia flavescens	2	23
Arnica latifolia	1	23
Arnica spp.	t	4
Aster conspicuus	t	4
Athyrium filix-femina	3	21
Cirsium spp.	t	4
Epilobium alpinum	t	4
Epilobium angustifolium	t	12
Epilobium glandulosum	t	4
Erigeron spp.	1	2
Fragaria virginiana	t	2
Galium boreale	t	17
Galium triflorum	2	52
Gymnocarpium dryopteris	t	8
Habenaria dilatata	t	4
Heracleum lanatum	6	52
Hieracium cynoglossoides	t	2
Ligusticum canbyi	1	14
Mitella breweri	t	25
Mitella spp.	t	10
Osmorhiza chilensis	t	4
Osmorhiza occidentalis	1	15
Polystichum lonchitis	t	10
Pyrola spp.	t	2
Saxifraga arguta	1	29
Senecio triangularis	9	75
Smilacina stellata	t	6
Streptopus amplexifolius	1	42
Taraxacum spp.	t	8
Thalictrum occidentale	5	50
Tiarella trifoliata	t	25
Trillium ovatum	t	2
Unknown forbs	t	10
Urtica dioica	t	15
Veratrum viride	9	54
Viola orbiculata	t	8
Viola spp.	t	2
Xerophyllum tenax	t	4
SHRUBS:		
Actaea rubra	1	25
Alnus spp.:		
0-0.9 m	2	67
0.9-2.0 m	40	89
> 2.0 m	38	71
Berberis repens	t	4
Lonicera involucrata:		
0-0.9 m	1	6
0.9-2.0 m	1	2
> 2.0 m	t	2
Menziesia ferruginea	1	8
Rhamnus alnifolia:		
0-0.9 m	t	2
0.9-2.0 m	t	2
Ribes spp.	t	12
Ribes lacustre	t	10
Rubus parviflorus	t	15
Sambucus racemosa	1	12
Sorbus spp.:		
0-0.9 m	t	12
0.9-2.0 m	3	17
> 2.0 m	t	9
Vaccinium globulare	t	4

* t= < 0.5% cover

Table D-3. Plant taxa in the Xerophyllum tenax VT, avalanche chute complex, (% cover % occurrence) (n=93).

NONVASCULAR COVER:		
Soil	16	100
Rock	3	52
Mosses/Lichens	1	21
Logs	t*	39
GRAMINEAE/CYPERACEAE:	8	60
FORBS:		
Achillea millefolium	t	73
Agastache urticifolia	t	1
Agoseris aurantiace	t	1
Anemone occidentalis	t	12
Angelica arguta	t	5
Antennaria luzuloides	t	7
Antennaria microphylla	t	5
Antennaria racemosa	t	3
Arenaria capillaris	t	8
Arenaria spp.	t	4
Arnica latifolia	t	9
Arnica spp.	t	4
Artemisia ludoviciana	t	4
Aster spp.	t	4
Astragalus spp.	t	4
Balsamorhiza sagittata	t	5
Calochortus apiculatus	t	30
Campanula parryi	t	9
Campanula spp.	t	3
Castilleja spp.	t	15
Dodecatheon spp.	t	1
Epilobium angustifolium	1	52
Erigeron speciosus	1	21
Erigeron spp.	4	39
Eriogonum flavum	t	10
Eriogonum umbellatum	1	12
Erythronium grandiflorum	t	12
Fragaria virginiana	5	63
Hackelia jessicae	t	1
Hedysarum occidentale	1	28
Heracleum lanatum	t	3
Heuchera cylindrica	t	1
Hieracium cynoglossoides	t	23
Hydrophyllum capitatum	t	1
Lithospermum ruderale	1	6
Lomatium dissectum	t	3
Lomatium sandbergii	t	2
Lomatium spp.	t	1
Mitella nuda	t	1
Osmorhiza occidentalis	2	20
Pedicularis spp.	t	4
Penstemon confertus	t	1
Penstemon procerus	t	11
Penstemon spp.	1	21
Phacelia hastata	t	1
Potentilla glandulosa	t	3
Potentilla spp.	t	3
Sedum stenopetalum	t	8
Senecio integerrimus	t	6
Senecio megacephalus	t	6
Senecio pseudaureus	t	11
Thalictrum occidentale	1	35
Xerophyllum tenax	45	82
Zigadenus venenosus	t	2
SHRUBS:		
Alnus sinuata:		
0-0.9 m	t	3
0.9-2.0 m	1	3
Actaea rubra	t	3
Arctostaphylos uva-ursi	t	3
Amelanchier alnifolia	1	26
Berberis repens	t	7
Pachistima myrsinites	t	3
Populus trichocarpa	t	4
Potentilla fruticosa	t	2
Rhamnus alnifolia:		
0-0.9 m	t	1
Rubus spp.	t	3
Spiraea betulifolia	t	3
Spiraea densiflora	t	1
Shepherdia canadensis	t	2
Sorbus spp.	1	6
Symphoricarpos albus	1	7
Vaccinium globulare	1	11
Vaccinium scoparium	4	21

* t= < 0.5 % cover

Table D-4. Plant taxa in the xeric, warm-aspect VT, avalanche chute complex (% cover % occurrence) (n=114).

NONVASCULAR COVER:		
Soil	25	98
Rock	13	90
Mosses/Lichens	t*	25
Logs	t	19
GRAMINEAE/CYPERACEAE:	25	100
FORBS:		
Achillea millefolium	t	82
Agastache urticifolia	t	2
Agoseris aurantiace	t	6
Allium cernuum	t	20
Antennaria lanata	t	6
Antennaria microphylla	1	49
Antennaria racemosa	t	4
Apocynum androsaemifolium	t	9
Arabis nuttallii	t	1
Arenaria capillaris	t	15
Arenaria spp.	t	10
Arnica latifolia	t	6
Arnica spp.	t	4
Artemisia ludoviciana	t	6
Aster foliaceus	t	20
Aster spp.	t	18
Astragalus spp.	t	5
Balsamorhiza sagittata	2	25
Calochortus apiculatus	t	33
Campanula parryi	t	13
Campanula spp.	t	14
Caryophyllaceae	t	1
Castilleja spp.	t	11
Cirsium spp.	t	2
Clematis columbiana	t	2
Collinsia parviflora	t	8
Delphinium bicolor	t	1
Epilobium angustifolium	t	6
Erigeron speciosus	1	14
Erigeron spp.	t	13
Eriogonum flavum	t	33
Eriogonum spp.	t	2
Eriogonum umbellatum	t	30
Erythronium grandiflorum	t	2
Fragaria virginiana	t	45
Geum macrophyllum	t	1
Hedysarum occidentale	t	2
Heuchera cylindrica	t	25
Hieracium cynoglossoides	t	45
Lomatium dissectum	t	19
Lomatium sandbergii	t	4
Lomatium spp.	t	4
Lupinus spp.	t	17
Mitella nuda	t	3
Osmorhiza occidentalis	t	8
Pedicularis contorta	t	3
Pedicularis spp.	t	2
Penstemon albertinus	t	14
Penstemon confertus	t	1
Penstemon procerus	t	10
Penstemon spp.	t	6
Phacelia hastata	t	1
Potentilla arguta	t	6
Potentilla glandulosa	t	10
Potentilla gracilis	t	2
Potentilla spp.	t	6
Sedum stenopetalum	t	60
Senecio integerrimus	t	2
Smilacina spp.	t	2
Taraxacum spp.	t	2
Thalictrum occidentale	t	2
Unknown forbs	t	13
Xerophyllum tenax	t	7
Zigadenus venenosus	t	11
SHRUBS (0-0.9 m):		
Acer glabrum	t	1
Amelanchier alnifolia	4	51
Berberis repens	t	35
Juniperus communis	t	3
Pachistima myrsinites	t	9
Prunus virginiana	t	1
Sorbus scopulina	t	1
Spiraea betulifolia	t	18
Spiraea densiflora	t	1
Vaccinium caespitosum	t	2
Vaccinium scoparium	t	3

* t= < 0.5% cover

Table D-5. Plant taxa in the mesic herbaceous fan VT, avalanche chute complex (% cover % occurrence) (n= 45).

NONVASCULAR COVER:		
Soil	3	76
Rock	1	33
Mosses/Lichens	t*	36
Logs	5	49
GRAMINEAE/CYPERACEAE:	19	100
FORBS AND FERNS:		
Achillea millefolium	2	38
Agastache urticifolia	t	4
Agoseris aurantiace	t	2
Angelica arguta	1	18
Arabis drummondii	t	9
Arnica latifolia	t	36
Arnica spp.	2	27
Aster foliaceus	1	24
Aster spp.	2	18
Caryophyllaceae	t	7
Castilleja spp.	t	9
Epilobium angustifolium	t	31
Epilobium spp.	t	2
Erigeron perigrinus	t	20
Fragaria virginiana	t	18
Galium triflorum	t	36
Gentiana calycosa	t	2
Hackelia jessicae	t	22
Heracleum lanatum	3	40
Lomatium spp.	t	4
Mitella nuda	t	2
Mitella spp.	t	13
Osmorhiza chilensis	t	2
Osmorhiza occidentalis	1	36
Pedicularis spp.	t	4
Polystichum lonchitis	t	2
Potentilla arguta	t	2
Potentilla glandulosa	t	
Potentilla spp.	3	22
Ranunculus uncinatus	t	13
Senecio triangularis	11	73
Streptopus amplexifolius	t	2
Taraxacum spp.	t	13
Thalictrum occidentale	5	78
Tiarella trifoliata	t	2
Unknown forbs	t	2
Urtica dioica	t	9
Valeriana sitchensis	1	22
Veratrum viride	1	42
Xerophyllum tenax	7	36
SHRUBS:		
Actaea rubra	1	18
Alnus sinuata:		
0.9-2.0 m	t	2
Lonicera involucrata:		
0-0.9 m	t	24
Menziesia ferruginea	1	9
Ribes spp.	t	11
Ribes lacustre	4	22
Rubus idaeus	1	9
Sambucus racemosa	t	13
Sorbus scopulina:		
0-0.9 m	t	2
Spiraea betulifolia	t	2
Vaccinium caespitosum	t	13
Vaccinium globulare	t	4
Vaccinium scoparium	t	2
TREES:		
Abies lasiocarpa:		
0-0.9 m	t	22
0.9-2.0 m	t	18
2.0-9.0 m	t	9
Picea engelmannii:		
0-0.9 m	t	9
0.0-2.0 m	t	7
2.0-9.0 m	t	4
Pseudotsuga menziesii:		
0-0.9 m	t	2

* t= < 0.5% cover

Table D-6. Plant taxa in the xeric herbaceous fan VT, avalanche chute complex (% cover % occurrence) (n=26).

NONVASCULAR COVER:		
Soil	t*	66
Rock	t	44
Logs	t	66
GRAMINEAE/CYPERACEAE:	14	100
FORBS AND FERNS:		
Achillea millefolium	1	91
Agastache urticifolia	1	39
Agoseris aurantiace	t	41
Allium cernum	t	6
Anenome occidentalis	t	28
Angelica arguta	t	6
Artemisia ludoviciana	t	3
Aster spp.	6	75
Calochortus apiculatus	t	9
Campanula spp.	1	53
Castilleja spp.	t	41
Cirsium spp.	1	13
Epilobium angustifolium	1	66
Erigeron spp.	1	41
Eriogonum umbellatum	2	41
Fragaria virginiana	4	78
Galium boreale	3	25
Galium triflorum	t	12
Geranium viscosissimum	1	59
Hackelia jessicae	t	3
Heracleum lanatum	t	9
Lithospermum spp.	t	3
Lupinus spp.	t	3
Osmorhiza occidentalis	3	38
Penstemon spp.	t	25
Perideridia gairdneri	t	75
Potentilla glandulosa	t	9
Potentilla gracilis	t	16
Sedum stenopetalum	t	3
Senecio pseudaureus	t	19
Solidago canadensis	3	38
Taraxacum spp.	t	13
Thalictrum occidentale	t	13
Unknown forbs	1	50
Urtica dioica	1	22
Xerophyllum tenax	t	3
SHRUBS (0-0.9 m):		
Berberis repens	t	19
Rhamnus alnifolia	11	28
Ribes lacustre	2	19
Spiraea betulifolia	t	3
Symphoricarpos albus	3	16

* t= < 0.5 % cover

APPENDIX E

Data from 2 vegetation types of the timbered creekbottom habitat component.

Table E-1. Plant taxa in the closed timber VT, timbered creekbottom (% cover % occurrence) (n=40).

NONVASCULAR COVER:		
Soil	15	52
Rock	1	52
Mosses/Lichens	2	40
Logs	3	65
GRAMINEAE/CYPERACEAE:	24	100
FORBS AND FERNS:		
Achillea millefolium	t*	10
Adenocaulon bicolor	t	5
Allium cernum	t	18
Allium spp.	t	3
Anaphalis margaritacea	t	5
Angelica arguta	2	40
Antennaria spp.	t	15
Aquilegia flavescens	t	8
Arnica latifolia	1	25
Arnica spp.	1	40
Aster conspicuus	t	8
Astragalus alpinus	t	8
Astragalus spp.	t	3
Botrychium virginianum	t	3
Cirsium spp.	t	33
Clematis columbiana	t	5
Cornus canadensis	t	28
Epilobium glandulosum	t	5
Equisetum spp.	1	53
Erigeron perigrinus	t	8
Erigeron spp.	t	48
Fragaria virginiana	1	68
Galium boreale	t	23
Galium triflorum	t	65
Geum aleppicum	t	5
Geum macrophyllum	t	30
Goodyeara oblongifolia	t	3
Habenaria dilata	t	3
Heracleum lanatum	1	48
Ligusticum canbyi	t	10
Mitella caulescens	t	8
Mitella nuda	t	3
Osmorhiza chilensis	t	33
Osmorhiza occidentalis	t	3
Osmorhiza purpurea	t	3
Prenanthes sagittata	1	23
Prunella vulgaris	t	5
Pyrola asarifolia	t	48
Pyrola uniflora	t	25
Saxifraga arguta	t	10
Senecio triangularis	1	40
Smilacina stellata	t	50
Solidago canadensis	t	20
Streptopus amplexifolius	t	30
Taraxacum spp.	t	2[illegible]
Thalictrum occidentale	3	9[illegible]
Tiarella trifoliata	t	28
Trifolium spp.	t	3
Unknown forbs	t	8
Urtica dioica	t	3
Veratrum viride	t	3
Xerophyllum tenax	t	8

TALL SHRUBS (> 2.0 m):		
Acer glabrum:		
0-0.9 m	t	8
Alnus sinuata:		
0-0.9 m	t	45
0.9-2.0 m	3	40
> 2.0 m	1	23
Cornus stolonifera:		
0-0.9 m	4	30
0.9-2.0 m	12	37
Lonicera involucrata:		
0-0.9 m	7	72
0.9-2.0 m	3	18
Salix spp.:		
0-0.9 m	t	3
0.0-2.0 m	3	22
> 2.0 m	3	23
SHRUBS (0-0.9 m):		
Actaea rubra	t	33
Arctostaphylos uva-ursi	t	8
Cornus canadensis	t	28
Juniperus communis	1	33
Juniperus scopulorum	t	25
Linnaea borealis	t	25
Ribes lacustre	1	40
Ribes spp.	t	5
Rosa spp.	t	3
Rosa woodsii	1	53
Rubus ideaus	t	25
Rubus parviflorus	t	8
Rubus spp.	t	23
Spiraea betulifolia	1	13
Symphoricarpos albus	2	40
Vaccinium caespitosum	t	5
Vaccinium globulare	t	25
Vaccinium scoparium	1	5
TREES:		
Abies lasiocarpa:		
0-0.9 m	1	25
0.9-2.0 m	1	33
2.0-9.0 m	2	23
> 9.0 m	2	13
Picea engelmannii:		
0-0.9 m	1	55
0.9-2.0 m	3	43
2.0-9.0 m	2	38
> 9.0 m	15	60
Pinus contorta:		
0-0.9 m	t	3
0.9-2.0 m	t	3
> 9.0 m	2	13
Populus tremuloides:		
0-0.9 m	t	3
0.9-2.0 m	t	3
> 9.0 m	3	15
Pseudotsuga menziesii:		
0-0.9 m	2	50
0.9-2.0 m	3	43
2.0-9.0 m	1	23
> 9.0 m	7	30

Table E-2. Plant taxa in the glade VT, timbered creekbottom (% cover % occurrence) (n=28).

NONVASCULAR COVER:		
Soil	6	86
Rock	t*	32
Mosses/Lichens	5	79
Logs	3	68
GRAMINEAE/CYPERACEAE:	21	100
FORBS:		
Achillea millefolium	t	46
Allium spp.	t	4
Anaphalis margaritacea	t	7
Angelica arguta	t	46
Antennaria microphylla	t	11
Arnica spp.	t	25
Aster conspicuus	t	4
Astragalus alpinus	t	4
Astragalus spp.	t	4
Castilleja spp.	t	11
Chimaphila umbellata	t	4
Cirsium spp.	t	46
Epilobium angustifolium	t	14
Epilobium glandulosum	t	29
Epilobium spp.	t	7
Equisetum arvense	6	82
Erigeron perigrinus	t	29
Erigeron spp.	t	46
Fragaria virginiana	4	61
Galium boreale	t	14
Galium triflorum	t	54
Geum macrophyllum	t	29
Habenaria obtusata	t	7
Heracleum lanatum	t	46
Ligusticum canbyi	t	46
Mitella caulescens	t	21
Mitella nuda	t	4
Osmorhiza chilensis	t	11
Osmorhiza occidentalis	t	14
Potentilla diversifolia	t	11
Potentilla spp.	t	7
Prenanthes sagittata	t	4
Prunella vulgaris	t	4
Pyrola asarifolia	t	21
Pyrola uniflora	t	14
Saxifraga arguta	t	18
Senecio pseudaureus	t	4
Senecio triangularis	3	50
Smilacina stellata	t	18
Solidago canadensis	t	18
Streptopus amplexifolius	t	29
Taraxacum spp.	t	29
Thalictrum occidentale	3	79
Tiarella trifoliata	t	14
Unknown forbs	t	36
Valeriana sitchensis	t	7
Valeriana edulis	t	4
Veratrum viride	t	18
Viola macloskeyi	t	14
Xerophyllum tenax	2	22

TALL SHRUBS (0-0.9 m):		
Alnus sinuata:		
0-0.9 m	t	11
0.9-2.0 m	2	14
> 2.0 m	2	14
Cornus stolonifera:		
0-0.9 m	t	4
0.9-2.0 m	6	21
Lonicera involucrata:		
0-0.9 m	2	68
0.9-2.0 m	t	7
Rhamnus alnifolia:		
0-0.9 m	t	4
Salix spp.:		
0-0.9 m	6	61
0.9-2.0 m	22	57
> 2.0 m	2	14
OTHER SHRUBS (0-0.9 m):		
Actaea rubra	t	4
Arctostaphylos uva-ursi	t	18
Menziesia ferruginea	t	11
Ribes lacrustre	1	57
Rosa woodsii	t	29
Rubus parviflorus	t	14
Sambucus racemosa	t	4
Spiraea betulifolia	t	7
Symphoricarpos albus	t	11
TREES:		
Abies lasiocarpa:		
0-0.9 m	t	18
0.9-2.0 m	t	25
2.0-9.0 m	1	14
> 9.0 m	2	11
Picea engelmannii:		
0-0.9 m	1	47
0.9-2.0 m	1	29
2.0-9.0 m	2	36
> 9.0 m	1	14
Populus tremuloides:		
0-0.9 m	2	25
Populus trichocarpa:		
2.0-9.0 m	t	4
Pseudotsuga menziesii:		
0-0.9 m	t	36
0.9-2.0 m	1	36
2.0-9.0 m	t	7

* t= < 0.5% cover

APPENDIX F

Data from 2 vegetation types of the burn shrubfield habitat component.

Table F-1. Plant taxa in the temperate zone burn shrubfield VT, (% cover % occurence) (n=78).

NONVASCULAR COVER:		
Soil	15	100
Rock	9	72
Mosses/Lichens	1	5
Logs	7	90
GRAMINEAE/CYPERACEAE:	14	100
FORBS:		
Achillea millefolium	t*	90
Agoseris aurantiace	t	6
Allium spp.	t	51
Anemone multifida	t	5
Angelica arguta	t	1
Antennaria luzuloides	1	13
Antennaria microphylla	t	3
Antennaria racemosa	t	3
Antennaria spp.	t	26
Apocynum androsaemifolium	t	10
Arenaria capillaris	t	1
Arnica cordifolia	t	9
Arnica latifolia	t	10
Arnica spp.	t	8
Aster conspicuus	1	30
Astragalus miser	t	1
Astragalus spp.	t	9
Balsamorhiza sagittata	2	51
Calochortus apiculatus	t	22
Campanula rotundifolia	t	4
Castilleja spp.	t	36
Cirsium spp.	t	1
Clematis columbiana	t	4
Crepis atrabarba	t	10
Epilobium angustifolium	t	47
Epilobium paniculatum	t	15
Erigeron compositus	t	6
Erigeron perigrinus	t	1
Erigeron speciosus	t	8
Erigeron spp.	t	40
Eriogonum flavum	t	11
Eriogonum spp.	t	5
Eriogonum umbellatum	t	12
Erythronium grandiflorum	t	5
Fragaria virginiana	t	42
Galium boreale	t	6
Geranium viscosissimum	t	23
Geum triflorum	t	1
Hedysarum occidentale	1	23
Heuchera cylindrica	t	18
Hieracium cynoglossoides	t	51
Linum perenne	t	8
Lithospermum ruderale	t	18
Lomatium dissectum	t	14
Lomatium sandbergii	t	11
Lupinus spp.	t	22
Penstemon albertinus	t	35
Pedicularis groenlandica	t	11
Penstemon procerus	t	4
Penstemon spp.	t	6
Penstemon confertus	t	3
Phacelia spp.	t	3
Phacelia heterophylla	t	10
Phacelia sericea	t	1
Sedum stenopetalum	t	23
Senecio megacephalus	t	3
Senecio pseudaureus	t	1
Senecio spp.	t	6
Senecio triangularis	t	1
Smilacina racemosa	t	5
Smilacina stellata	t	19
Solidago canadensis	t	3
Xerophyllum tenax	t	3
Zigadenus venenosus	t	1
SHRUBS (0-0.9 m):		
Acer glabrum	1	18
Amelanchier alnifolia	9	86
Arctostaphylos uva-ursi	t	3
Berberis repens	2	77
Ceanothus velutinus	12	54
Cornus stolonifera	t	3
Juniperus communis	t	6
Prunus virginiana	t	5
Ribes montigenum	t	3
Ribes viscosissimum	t	19
Rosa spp.	t	1
Rubus parviflorus	t	8
Rubus spp.	t	9
Salix spp.	t	4
Shepherdia canadensis	2	24
Sorbus scopulina	t	20
Spiraea betulifolia	6	76
Symphoricarpos albus	1	36
Vaccinium scoparium	1	5
TREES:		
Abies lasiocarpa:		
0-0.9 m	t	18
0.9-2.0 m	t	20
2.0 m-9.0 m	1	13
> 9.0 m	t	1
Picea engelmannii:		
0-0.9 m	t	6
0.9-2.0 m	t	3
2.0-9.0 m	t	1
Pinus albicaulis:		
0-0.9 m	t	9
0.9-2.0 m	1	8
2.0 m-9.0 m	t	4
> 9.0 m	t	1
Pinus contorta:		
0-0.9 m	t	5
0.9-2.0 m	1	2
2.0 m-9.0 m	1	11
< 9.0 m	1	2
Pseudotsuga menziesii:		
0-0.9 m	t	13
0.9-2.0 m	t	11
2.0-9.0 m	t	6
> 9.0 m	t	5

* t= < 0.5 % cover

Table F-2. Plant taxa in the subalpine zone burn shrubfield, (% cover % occurrence) (n=31).

NONVASCULAR COVER:		
Logs	5	39
Mosses and Lichens	t	35
Rock	2	93
Soil	7	55
GRAMINEAE/CYPERACEAE:	6	90
FORBS:		
Achillea millefolium	t	19
Agoseris aurantiace	t	3
Anaphalis margaritacea	t	3
Angelica arguta	t	7
Antennaria lanata	t	13
Antennaria neglecta	t	3
Antennaria spp.	t	3
Arenaria capillaris	t	16
Arnica latifolia	t	23
Arnica spp.	t	13
Aster integrifolius	t	26
Astragalus miser	t	16
Balsamorhiza sagittata	t	36
Castilleja spp.	t	10
Cirsium spp.	t	42
Collomia linearis	t	3
Epilobium angustifolium	t	45
Erigeron spp.	t	45
Erythronium grandiflorum	t	13
Fragaria virginiana	t	32
Gentiana calycosa	t	61
Hedysarum occidentale	1	52
Hieracium cynoglossoides	t	10
Penstemon confertus	t	3
Pyrola minor	t	3
Sedum stenopetalum	t	16
Senecio triangularis	1	58
Taraxacum spp.	t	32
Thalictrum occidentale	t	19
Valeriana sitchensis	t	58
Veratrum viride	t	16
Xerophyllum tenax	51	100
SHRUBS (0-0.9 m):		
Menziesia ferruginea	t	3
Rosa woodsii	t	3
Sambucus racemosa	t	3
Spiraea betulifolia	t	3
Vaccinium globulare	3	13
Vaccinium scoparium	16	100
TREES:		
Abies lasiocarpa:		
0-0.9 m	1	64
0.9-2.0 m	5	55
2.0-9.0 m	3	48
Picea engelmannii:		
0-0.9 m	t	10
Pinus albicaulis:		
0-0.9 m	1	55
0.9-2.0 m	1	29
2.0-9.0 m	1	13
Pinus contorta:		
0-0.9 m	t	10
0.9-2.0 m	t	13
Larix layalii:		
0-0.9 m	t	3
0.9-2.0 m	t	3

*t = cover < 0.5 %

APPENDIX G

Data from 2 vegetation types of the mountain sidehill park habitat component.

Table G-1. Plant taxa in the mixed graminoid VT, sidehill park, (% cover % occurrence) (n=17).

NONVASCULAR COVER:		
Soil	16	100
Rock	t*	11
Log	t	18
GRAMINEAE/CYPERACEAE:	44	100
FORBS:		
Achillea millefolium	1	94
Anaphalis margaritacea	t	47
Antennaria microphylla	t	29
Arabis spp.	1	94
Arenaria capillaris	t	18
Arenaria spp.	t	12
Arnica cordifolia	t	6
Aster conspicuus	t	6
Balsamorhiza sagittata	8	77
Calochortus apiculatus	t	77
Castilleja spp.	t	53
Cerastium spp.	t	65
Epilobium angustifolium	t	29
Erigeron speciosus	t	24
Eriogonum flavum	t	59
Eriogonum spp.	t	12
Erythronium grandiflorum	t	12
Fragaria virginiana	t	35
Galium boreale	t	35
Geranium viscosissimum	t	41
Heuchera cylindrica	t	18
Hieracium cynoglossoides	t	53
Hydrophyllum capitatum	t	12
Lithophragma parviflora	t	24
Lithospermum ruderale	t	29
Lomatium dissectum	t	24
Lupinus spp.	2	94
Pedicularis contorta	t	6
Pedicularis spp.	t	35
Penstemon procerus	t	18
Penstemon spp.	t	18
Phacelia heterophylla	t	41
Potentilla glandulosa	t	29
Potentilla gracilis	t	18
Pyrola spp.	t	6
Sisybrium altissimum	t	18
Sedum stenopetalum	t	71
Senecio integerrimus	t	41
Senecio spp.	t	12
Taraxacum spp.	t	12
Thalictrum occidentale	t	6
Tragopogon dubius	t	29
Unknown forbs	t	18
Xerophyllum tenax	t	6
Zigadenus venenosus	t	12
SHRUBS (0-0.9 m):		
Acer glabrum	t	6
Amelanchier alnifolia	2	71
Arctostaphylos uva-ursi	t	6
Berberis repens	1	71
Ceanothus velutinus	t	29
Cornus stolonifera	2	6
Prunus virginiana	1	41
Rosa spp.	t	18
Rubus spp.	t	6
Spiraea betulifolia	t	41
Symphoricarpos albus	t	4
Vaccinium caespitosum	t	6
Vaccinium globulare	t	6

* t= < 0.5 % cover

Table G-2. Plant taxa in the xeric bunchgrass VT, sidehill park (% cover % occurrence) (n=50).

NONVASCULAR COVER:		
Soil	19	90
Rock	24	96
Mosses/Lichens	12	44
Logs	t*	2
GRAMINEAE/CYPERACEAE:	10	90
FORBS:		
Achillea millefolium	t	70
Allium spp.	t	4
Anemone spp.	t	38
Antennaria luzuloides	t	18
Antennaria racemosa	1	8
Arenaria capillaris	t	14
Arnica cordifolia	t	4
Astragalus spp.	t	2
Balsamorhiza sagittata	t	2
Calochortus apiculatus	t	38
Cerastium arvense	t	30
Cystopteris fragilis	t	24
Dodecatheon spp.	t	2
Epilobium angustifolium	t	2
Eriogonum flavum	1	16
Eriogonum umbellatum	t	10
Erythronium grandiflorum	t	32
Fragaria virginiana	1	12
Geum rivale	t	2
Habenaria dilatata	t	4
Heuchera cylindrica	2	60
Hieracium cynoglossoides	t	2
Hydrophyllum capitatum	t	2
Lomatium sandbergii	t	16
Lomatium spp.	t	8
Mitella nuda	t	8
Osmorhiza occidentalis	t	2
Pteridium aquilinum	t	12
Potentilla glandulosa	t	8
Saxifraga integrifolia	t	22
Sedum stenopetalum	t	68
Senecio spp.	t	18
Stellaria spp.	t	30
Suksdorfia ranunculifolia	t	6
Taraxacum spp.	t	14
Unknown forbs	t	24
Zigadenus spp.	t	8
SHRUBS (0–0.9 m):		
Acer glabrum	t	20
Amelanchier alnifolia	1	2
Berberis repens	t	4
Pachistima myrsinites	2	6
Rubus parviflorus	t	2
Spiraea betulifolia	t	12
Spiraea densiflora	1	6

* t= <0.5 % cover

APPENDIX H

Data from the slabrock habitat component.

Table H. Plant taxa in the slabrock habitat component, (% cover % occurrence) (n=82).

NONVASCULAR COVER:		
Rock	15	89
Soil	14	90
Logs	1	19
Mosses/Lichens	2	30
GRAMINEAE/CYPERACEAE:	16	100
FORBS:		
Allium schoenprasum	t*	6
Anemone occidentalis	t	19
Antennaria luzuloides	8	87
Arenaria capillaris	t	37
Arenaria spp.	t	5
Arnica latifolia	4	63
Astragalus spp.	t	5
Caltha leptosepala	t	6
Castilleja spp.	t	24
Claytonia lanceolata	t	13
Erigeron compositus	t	28
Erigeron perigrinus	1	23
Eriogonum spp.	t	1
Erythronium grandiflorum	1	40
Gentiana calycosa	t	4
Hieracium spp.	t	2
Hypericum formosum	t	4
Kalmia polifolia	t	2
Lomatium sandbergii	t	21
Pedicularis bracteosa	t	21
Pedicularis contorta	t	2
Penstemon spp.	t	1
Polygonum bistortoides	1	39
Potentilla diversifolia	t	6
Ranunculus eschscholtzii	1	38
Saxifraga integrifolia	t	1
Sedum stenopetalum	t	6
Senecio subnudus	t	17
Senecio triangularis	1	2
Tofieldia glutinosa	t	4
Unknown forbs	t	26
Valeriana sitchensis	t	4
Veratrum viride	t	2
Xerophyllum tenax	6	33
SHRUBS (0-0.9 m):		
Phyllodoce empetriformis	3	29
Vaccinium scoparium	2	19

* t= < 0.5 % cover

APPENDIX I

Data from 3 vegetation types of the subalpine meadow habitat component.

Table I-1. Percent cover and occurrence of taxa in the shortgrass/*Phyllodoce empetriformis* VT (subalpine meadow habitat component) (n=24).

	% Cover	% Occurrence
NONVASCULAR COVER:		
Logs	t*	8
Mosses/Lichens	10	87
Rock	t	8
Soil	6	38
GRAMINEAE/CYPERACEAE:	49	100
FORBS:		
Anemone occidentalis	t	8
Antennaria luzuloides	t	29
Arnica latifolia	t	4
Caltha leptosepala	t	38
Equisetum spp.	t	4
Erigeron spp.	t	46
Pedicularis groenlandica	t	30
Pedicularis spp.	t	29
Ranunculus eschscholtzii	t	17
Senecio subnudus	6	88
Senecio triangularis	t	8
Tofieldia glutinosa	t	29
Veronica cusickii	t	12
Xerophyllum tenax	t	4
SHRUBS (0-0.9 m):		
Kalmia polifolia	t	29
Menziesia ferruginea	t	4
Phyllodoce empetriformis	5	75
Salix spp.	2	46
Vaccinium scoparium	t	21

* t= < 0.5 % cover

Table I-2. Percent cover and occurrence of taxa in the hydromesic meadow VT (subalpine meadow habitat component) (n=24).

	% Cover	% Occurrence
NONVASCULAR COVER:		
Rock	t*	17
Soil	2	42
Mosses/Lichens	17	75
Logs	t	4
GRAMINEAE/CYPERACEAE	20	100
FORBS:		
Allium schoenoprasum	t	71
Anemone occidentalis	t	8
Antennaria luzuloides	t	25
Arnica latifolia	3	62
Caltha leptosepala	4	71
Delphinium spp.	t	42
Dodecatheon spp.	t	25
Equisetum spp.	t	8
Erigeron spp.	8	67
Erythronium grandiflorum	t	17
Geum macrophyllum	t	4
Habenaria dilatata	t	54
Hypericum formosum	t	71
Ligusticum canbyi	t	25
Mimulus lewisii	t	17
Mitella nuda	t	12
Pedicularis bracteosa	t	25
Pedicularis groenlandica	t	71
Pedicularis spp.	t	8
Polygonum bistortoides	t	71
Ranunculus eschscholtzii	t	25
Saxifraga arguta	t	21
Senecio subnudus	t	83
Senecio triangularis	1	54
Tofieldia glutinosa	t	62
Valeriana sitchensis	t	12
Veratrum viride	t	4
Viola adunca	t	79
Viola spp.	t	4
Xerophyllum tenax	t	8
Zigadenus elegans	t	29
SUBSHRUBS (0-0.9 m):		
Kalmia polifolia	t	29
Vaccinium scoparium	t	12
Salix spp.	3	12
Phyllodoce empetriformis	t	42

* t= < 0.5 % cover

Table I-3. Percent cover and occurrence of taxa in the Tallgrass/ Senecio triangularis VT (subalpine meadow habitat component) (n=32).

	% Cover	% Occurrence
NONVASCULAR COVER:		
Mosses/Lichens	t*	6
Rock	4	28
Soil	1	38
GRAMINEAE/CYPERACEAE:	26	100
FORBS:		
Allium schoenoprasum	t	22
Aquilegia flavescens	t	3
Arnica latifolia	t	16
Cirsium spp.	t	12
Epilobium angustifolium	12	16
Epilobium glandulosum	t	19
Erigeron spp.	12	91
Fragaria virginiana	t	12
Hackelia jessicae	t	9
Heracleum lanatum	4	31
Hypericum formosum	t	6
Ligusticum canbyi	2	35
Osmorhiza occidentalis	7	50
Polygonum douglasii	t	41
Ranunculus eschscholtzii	t	6
Senecio triangularis	28	100
Thalictrum occidentale	6	59
Tiarella trifoliata	t	31
Unknown forbs	t	28
Viola spp.	t	50
Valeriana sitchensis	t	9
Veratrum viride	5	53
Veronica cusickii	t	3

*t= < 0.5% cover

APPENDIX J

Data from 3 vegetation types of the alpine complex habitat component.

Table J-1. Percent cover and occurrence of taxa found in the Fellfield VT (alpine complex habitat component) (n=15).

	% Cover	% Occurrence
NONVASCULAR COVER:		
Soil	15	100
Rock	27	100
Mosses/lichens	6	100
Logs	t*	5
GRAMINEAE/CYPERACEAE/JUNCACEAE:	14	70
FORBS:		
Achillea millefolium	t	33
Anemone multifida	t	33
Anemone parviflora	t	7
Antennaria spp.	1	7
Arabis nuttallii	t	20
Arenaria obtusiloba	t	48
Astragalus bourgovii	t	27
Castilleja spp.	t	7
Cirsium spp.	t	13
Dodecatheon conjugens	t	67
Douglasia montana	t	40
Draba oligosperma	t	13
Erigeron compositus	t	13
Erigeron simplex	2	60
Eritrichium nanum	1	53
Gentiana calycosa	t	7
Lomatium cous	t	40
Oxytropis sericea	t	20
Pedicularis contorta	t	67
Penstemon confertus	t	67
Potentilla ovina	2	73
Ranunculus eschscholtzii	t	33
Saxifraga integrifolia	t	27
Sedum spp.	t	40
Smelowskia calycina	t	7
Townsendia parryi	t	7
Unknown forbs	t	13
SHRUBS (0-0.9 m)		
Arctostaphylos uva-ursi	t	7
Dryas octopetala	5	13
Potentilla fruiticosa	t	13

* t= cover < 0.5 %

Table J-2. Percent cover and occurrence of taxa in the mesic alpine meadow VT (alpine complex habitat component) (n=25).

	% Cover	% Occurrence
NONVASCULAR COVER:		
Soil	16	60
Rock	17	64
Mosses/Lichens	9	72
Logs	t*	4
GRAMINEAE/CYPERACEAE/ JUNCACEAE:	12	100
FORBS:		
Achillea millefolium	t	60
Anemone spp.	t	20
Antennaria alpina	t	24
Antennaria spp.	t	4
Arabis nuttallii	t	36
Arenaria capillaris	t	16
Arnica spp.	t	8
Astragalus bourgovii	t	28
Castilleja spp.	t	24
Claytonia lanceolata	t	12
Delphinium nuttallianum	t	8
Dodecatheon conjugens	t	32
Erigeron compositus	t	24
Erigeron simplex	t	8
Erigeron spp.	1	40
Gentiana calycosa	1	48
Lomatium cous	t	32
Lomatium macrocarpum	t	16
Oxytropis sericea	t	8
Penstemon confertus	1	64
Polygonum bistortoides	t	52
Potentilla ovina	1	68
Ranunculus eschscholtzii	6	76
Senecio resedifolius	t	44
Senecio spp.	t	12
Sibbaldia procumbens	5	48
Townsendia parryi	t	44
Valeriana dioica	t	12
Veronica wormskjoldii	t	32
Viola spp.	t	4
Zigadenus elegans	t	28

* t= cover < 0.5 %

Table J-3. Percent cover and occurrence of taxa in the vegetated rock/ talus VT (alpine complex habitat component) (n=58).

	% Cover	% Occurrence
NONVASCULAR COVER:		
Soil	11	63
Rock	42	100
Mosses/Lichens	t*	9
GRAMINEAE/CYPERACEAE/ JUNCACEAE:	5	80
FORBS:		
Achillea millefolium	t	35
Anemone occidentalis	2	29
Aquilegia flavescens	2	19
Arenaria spp.	t	29
Arnica latifolia	9	45
Arnica longifolia	t	5
Artemisia ludoviciana	t	2
Aster foliaceus	2	38
Astragalus miser	t	16
Caryopyllaceae	t	3
Castilleja spp.	t	29
Cirsium spp.	t	2
Collomia debilis	t	2
Epilobium angustifolium	1	16
Eriogonum flavum	1	38
Eriogonum spp.	t	2
Hedysarum occidentale	t	3
Hieracium cynoglossoides	t	5
Hypericum formosum	2	29
Lomatium dissectum	1	32
Penstemon confertus	t	14
Phacelia hastata	t	7
Ranunculus eschscholtzii	4	47
Sedum spp.	t	35
Senecio spp.	1	21
Solidago multiradiata	1	14
Unknown forbs	t	12
Valeriana sitchensis	2	26
Xerophyllum tenax	t	2
SHRUBS (< 0.9 m):		
Potentilla fruiticosa	t	5
Phyllodoce empetriformis	t	2
Spiraea densiflora	t	3
Vaccinium scoparium	1	3

* t= cover < 0.5 %

APPENDIX K

Habitat components and land type associations of the study area

Key to Maps

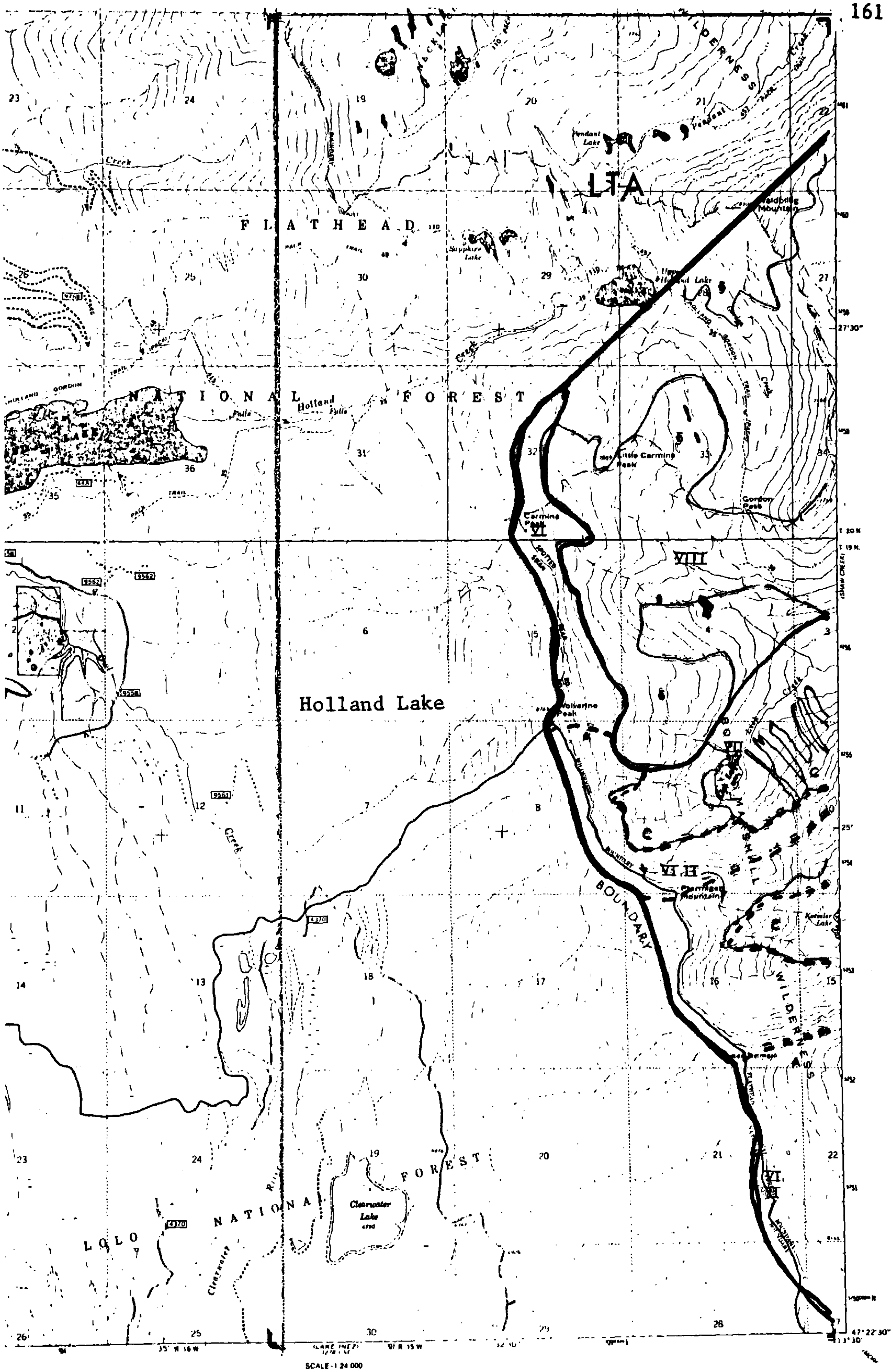
Holland Peak	Shaw Creek	Una Mountain	Pilot Peak
	Morrell Lake	Crimson Peak	

<u>Landtype Association Codes</u>:

I. Forested floodplain
Ia. Wet, grass-sedge meadow
Ib. Grass and forested stream terrace
II. Glacial cirque basin
III. Forested ground moraine
IV. Slump land
Va. Forested high elevation ridges
Vc. Forested, moderately dissected residual slopes
VI. Peaks and alpine ridges-sparsely vegetated rock land
VII. Forested, cool aspect break land
VIII. Forested, warm aspect break land

<u>Habitat Component Codes</u>:

B_1: Temperate zone burn shrubfield
B_2: Subalpine zone burn shrubfield
C_x: Avalanche chute dominated by <u>Xerophyllum</u> <u>tenax</u> or xeric, warm-aspect vegetation type
C: Avalanche chute dominated by more mesic vegetation types
F: Floodplain complex
T: Timbered creekbottom
A: Alpine complex
S: Slabrock
M: Subalpine meadow
P_1: Mountain sidehill park (xeric bunchgrass vegetation type)
P_2: Mountain sidehill park (mixed graminoid vegetation type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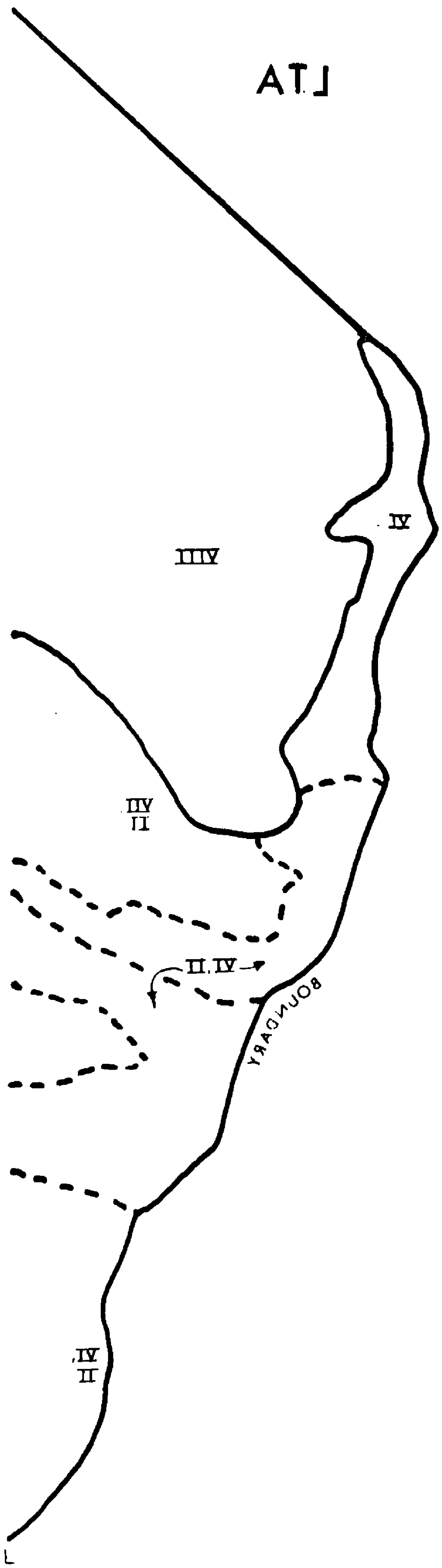
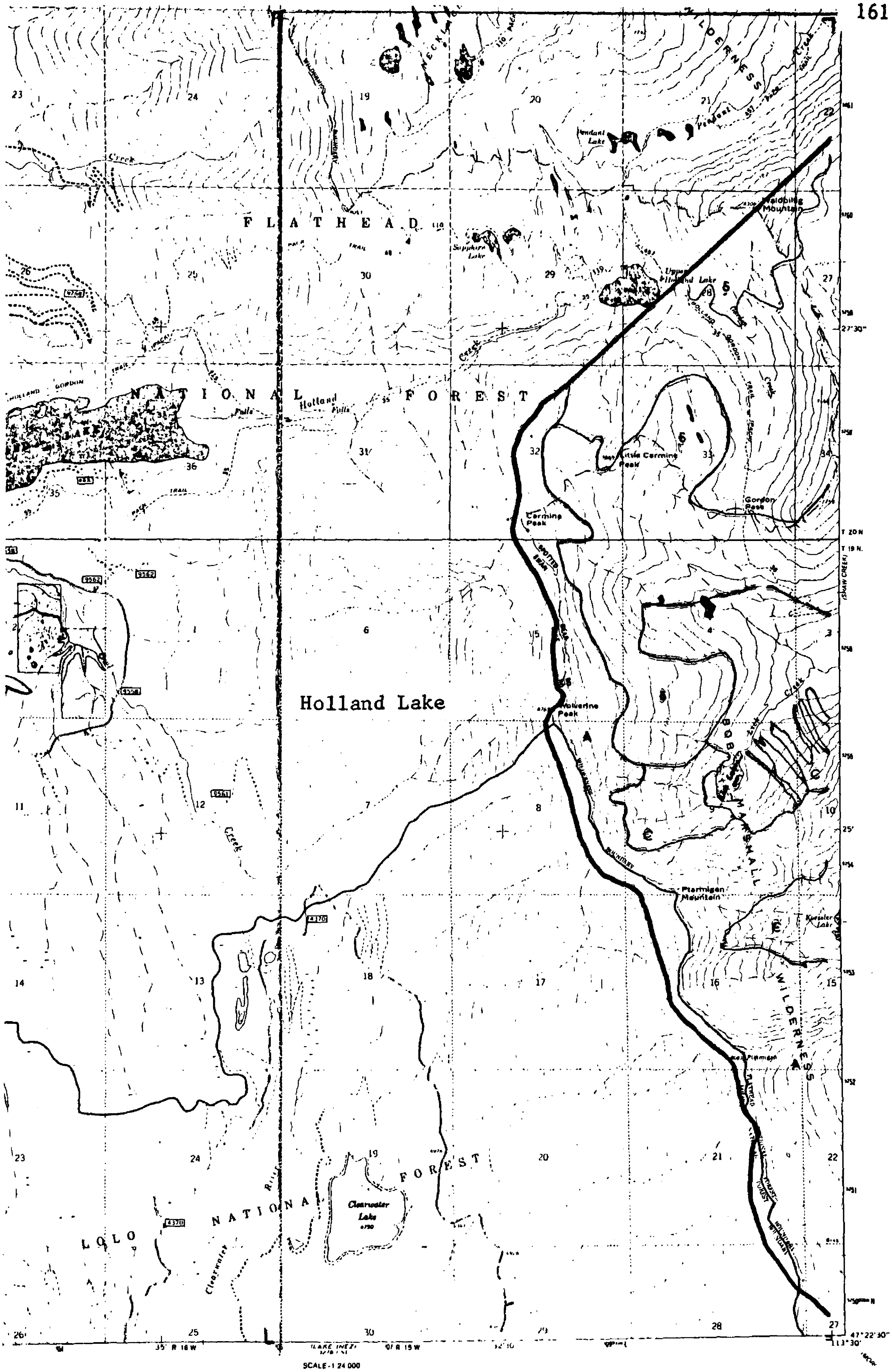
LTA
WILDERNESS
Pendant Lake
Sapphire Lake
Upper Holland Lake
Holland Falls
Little Carmine Peak
Carmine Peak
Gordon Peak
Wolverine Peak
Ptarmigan Mountain
Koessler Lake
Holland Lake
BOUNDARY
MARSHALL
WILDERNESS
LOLO NATIONAL FOREST
Clearwater Lake
VI
VII
VIII
SCALE 1:24 000
47°22'30"
27'30"
25'


ATL
VI
VIII
VII
II
II, VI
BOUNDARY
VI
II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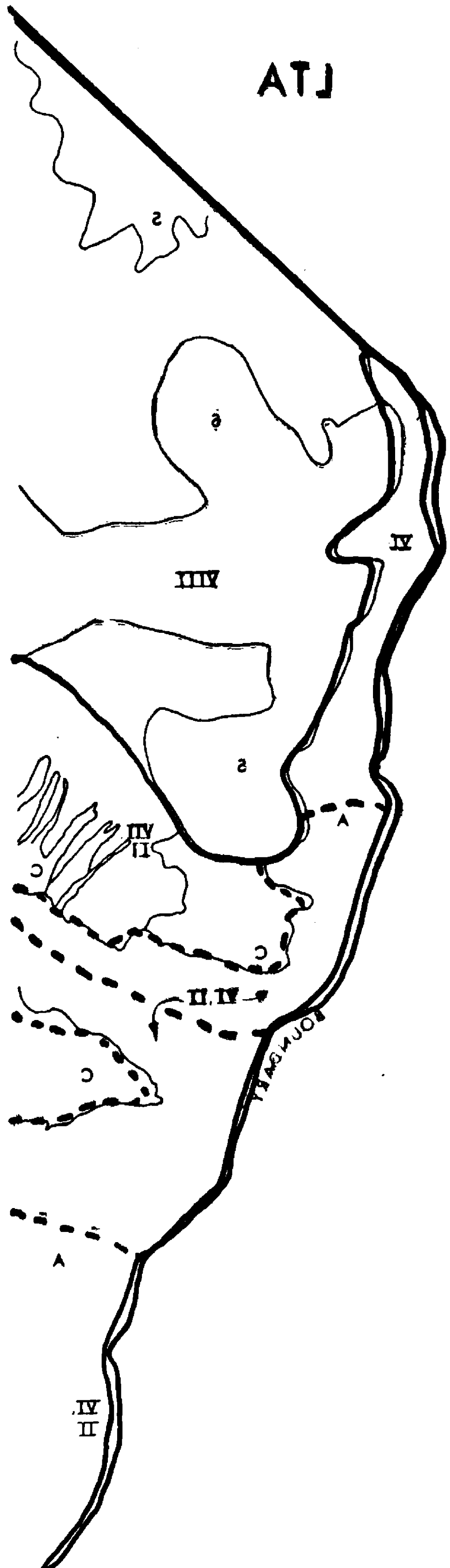
Holland Lake
Holland Falls
Upper Holland Lake
Pendant Lake
Sapphire Lake
Waldbillig Mountain
Little Carmine Peak
Carmine Peak
Gordon Pass
Wolverine Peak
Ptarmigan Mountain
Koessler Lake
BOB MARSHALL WILDERNESS
LOLO NATIONAL FOREST
Clearwater Lake
T 20 N
T 19 N.
47°22'30"
113°30'
R 16 W
R 15 W
SCALE 1:24 000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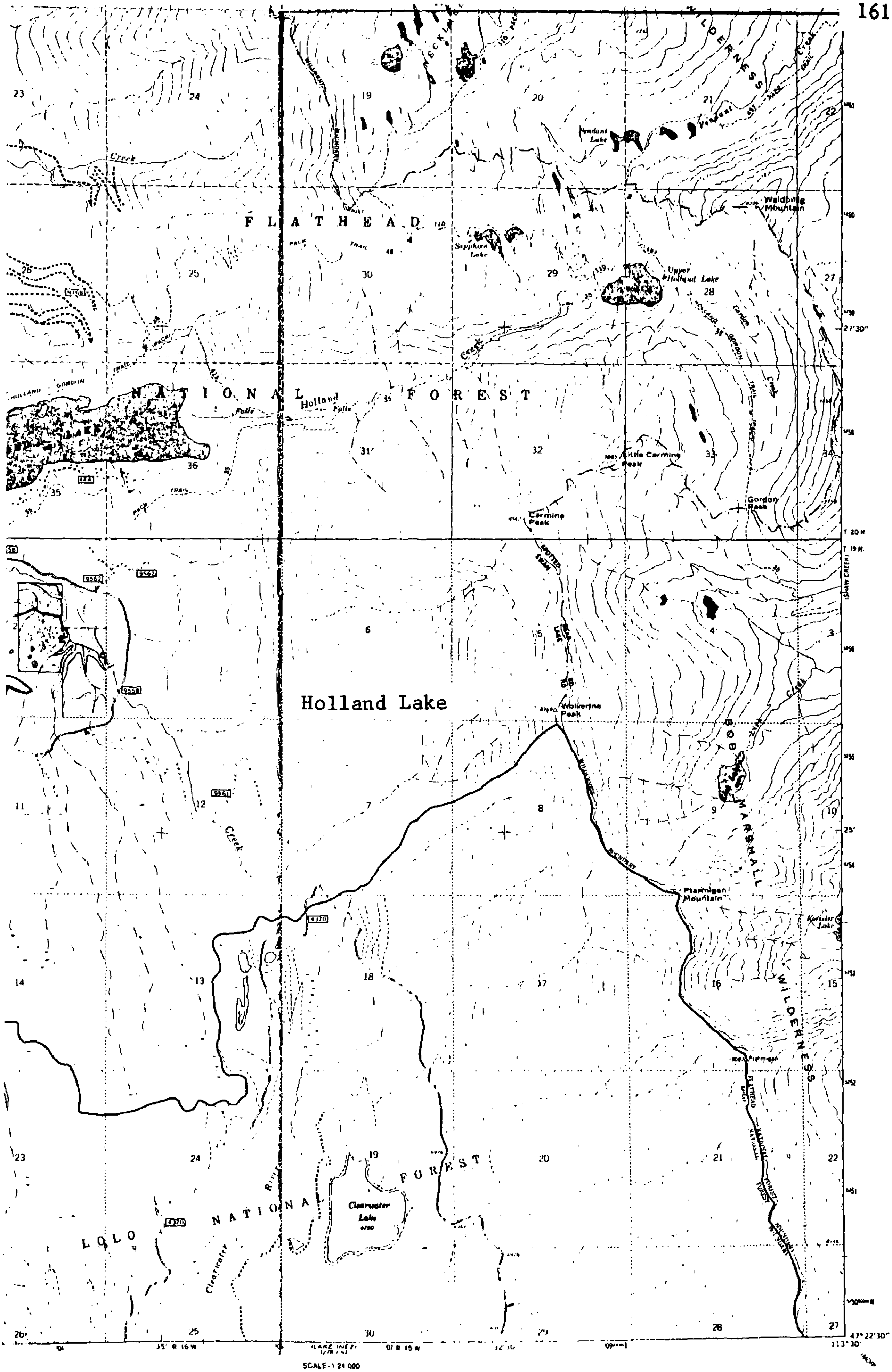
S
A
C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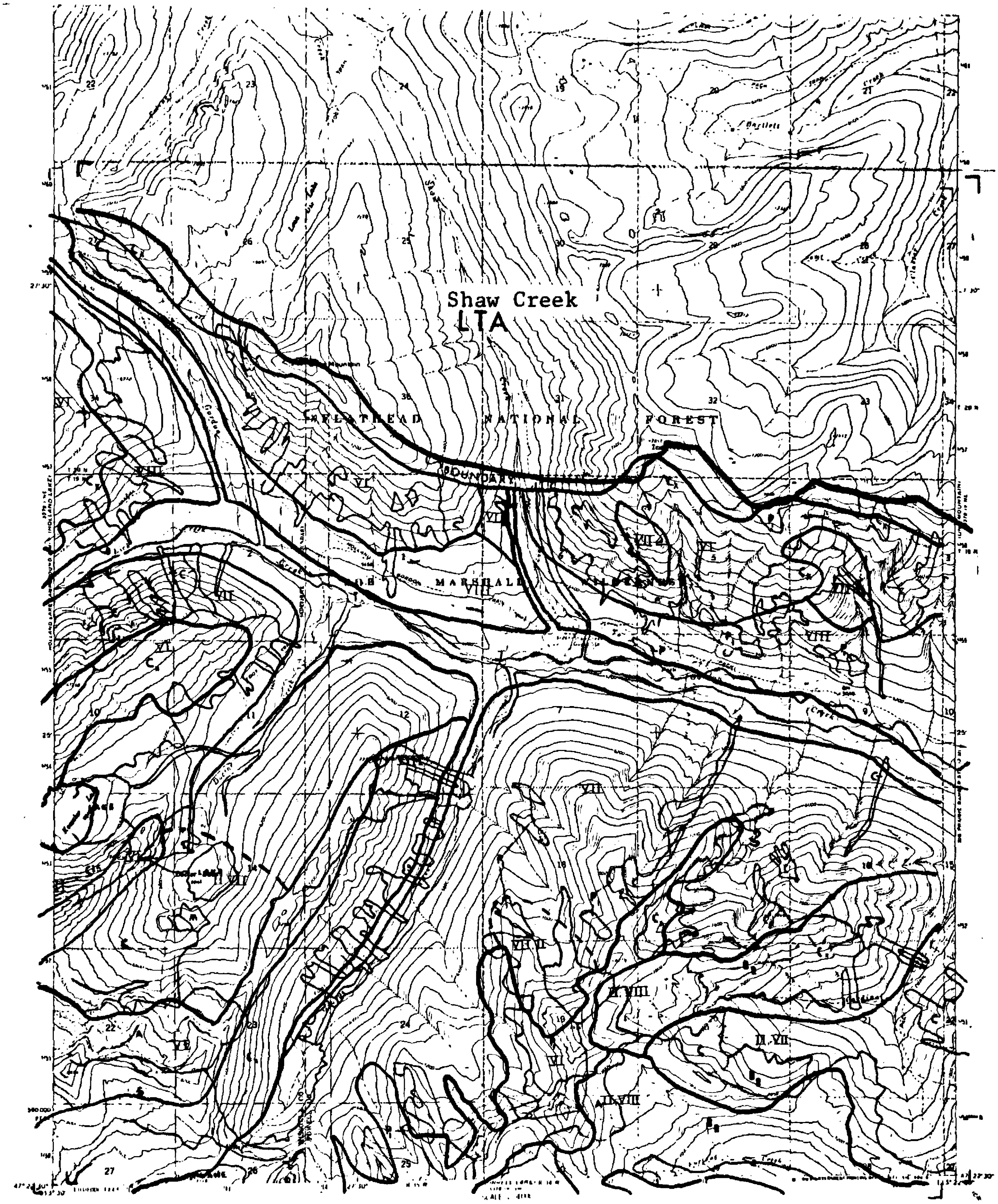
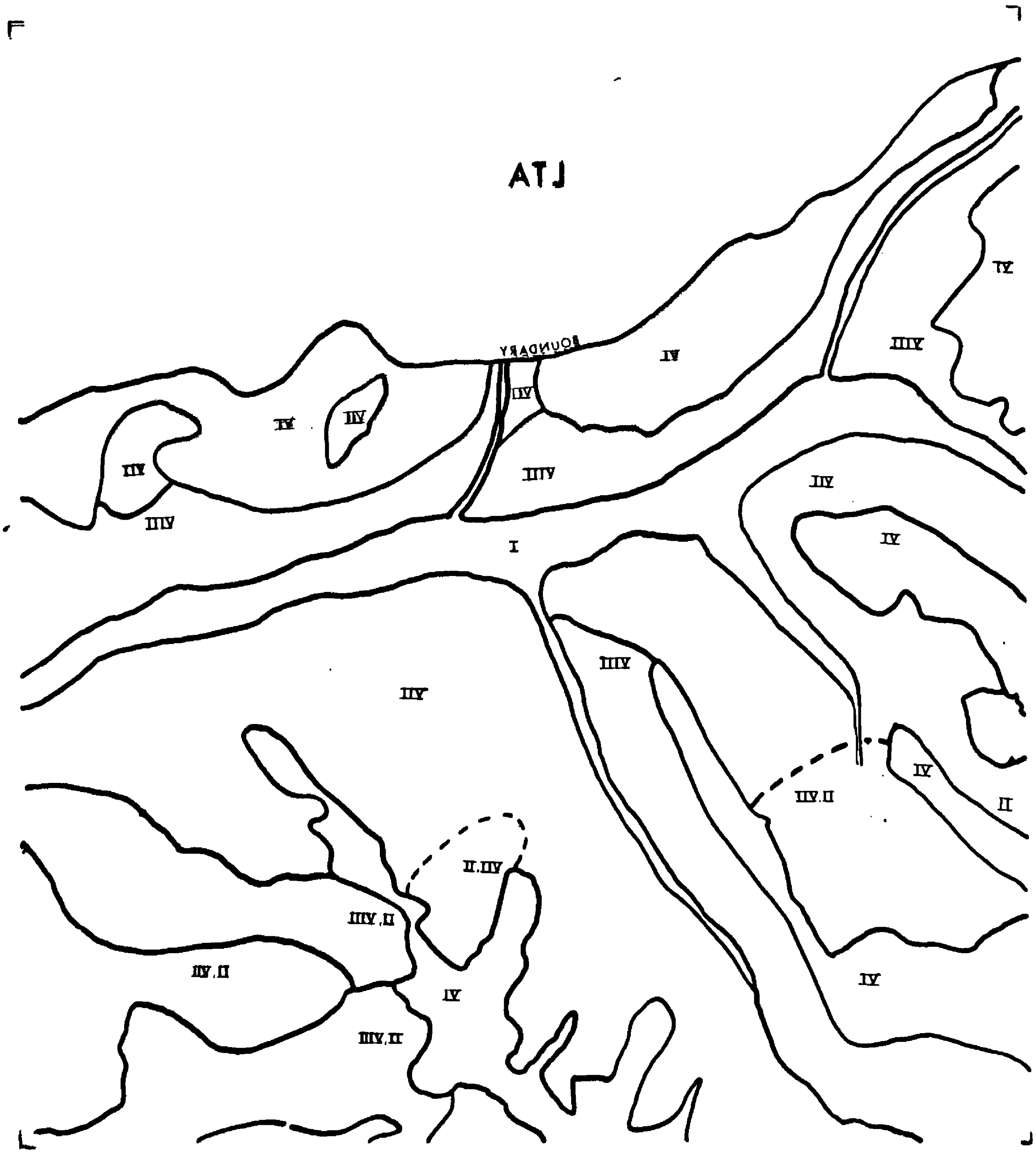
Holland Lake
Pendant Lake
Waldbillig Mountain
Sapphire Lake
Upper Holland Lake
Holland Falls
Little Carmine Peak
Carmine Peak
Gordon Peak
Wolverine Peak
Ptarmigan Mountain
BOB MARSHALL WILDERNESS
Koessler Lake
Clearwater Lake
LOLO NATIONAL FOREST
T 20 N
T 19 N
R 16 W
R 15 W
113°30'
47°22'30"
27'30"
SCALE 1:24 000


Shaw Creek
LTA
FLATHEAD NATIONAL FOREST
BOUNDARY
MARSHALL
VIII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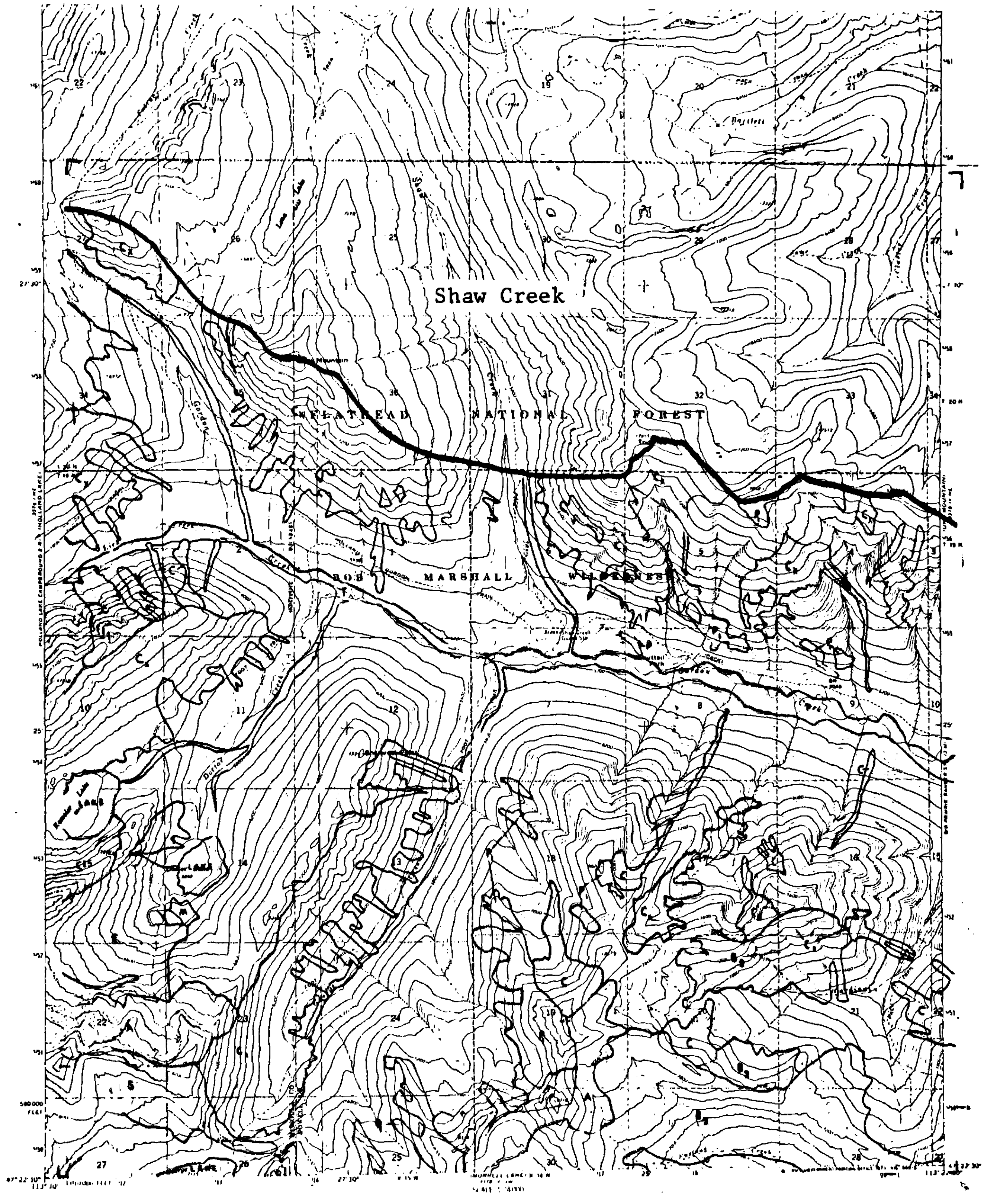
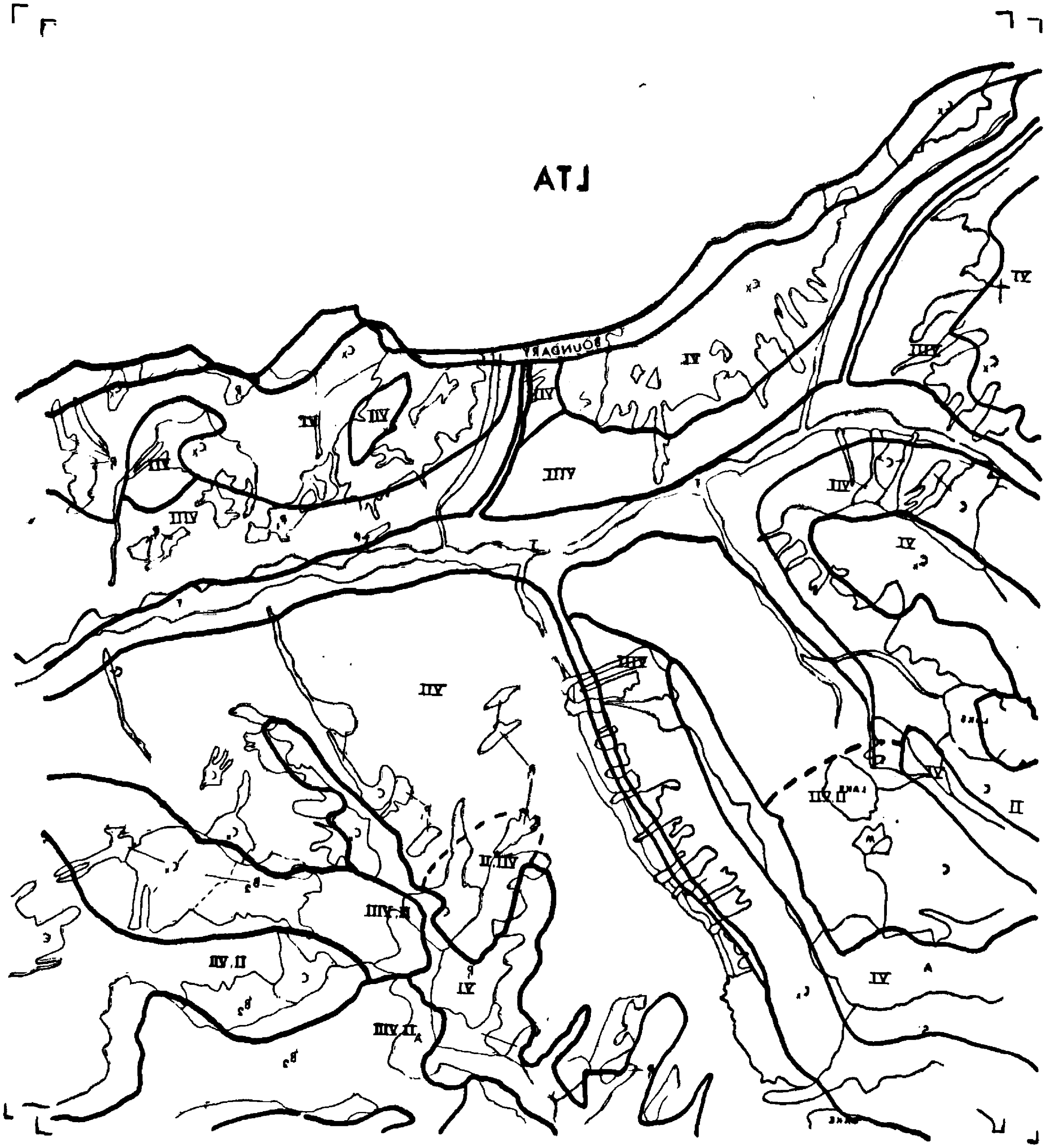
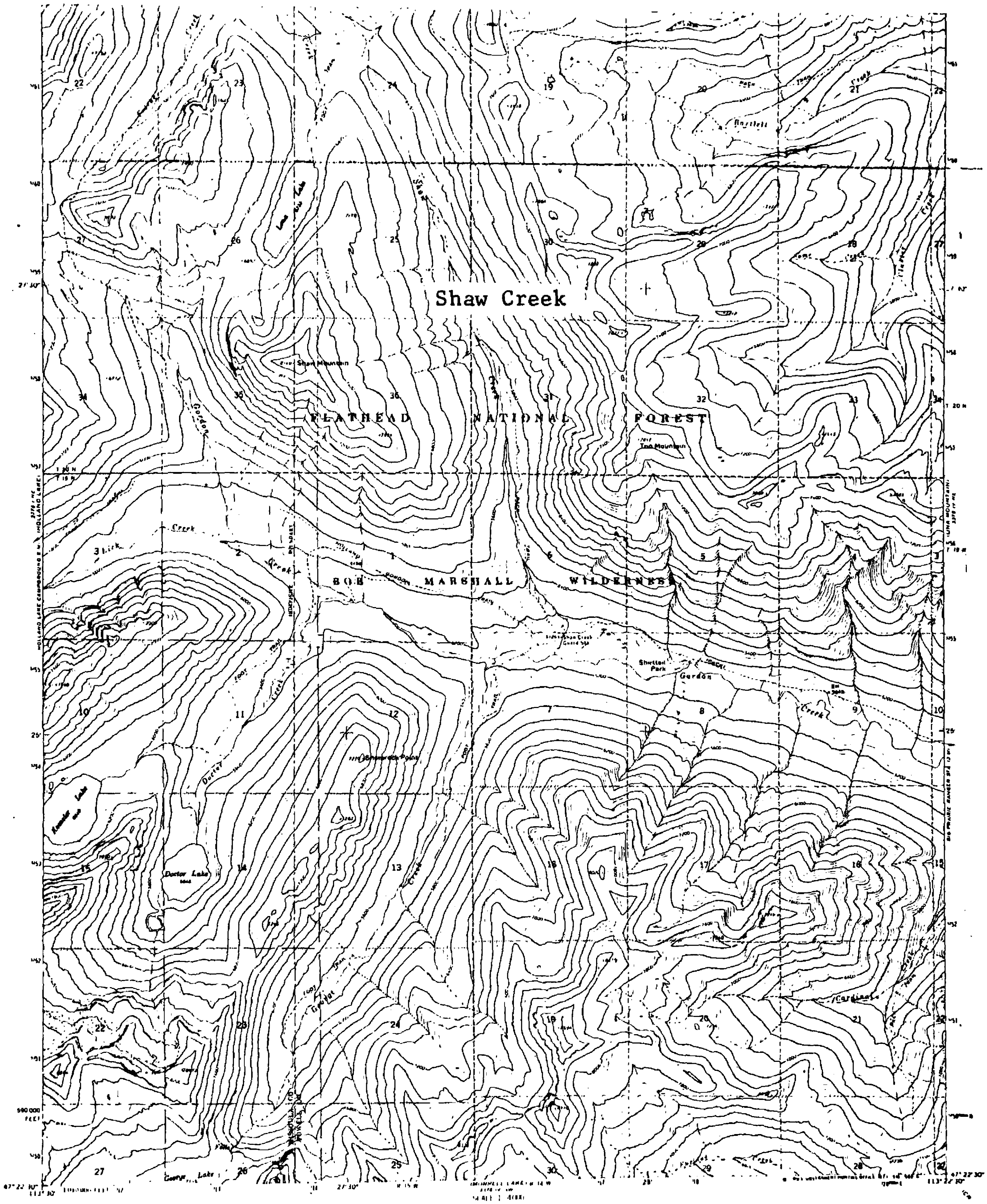
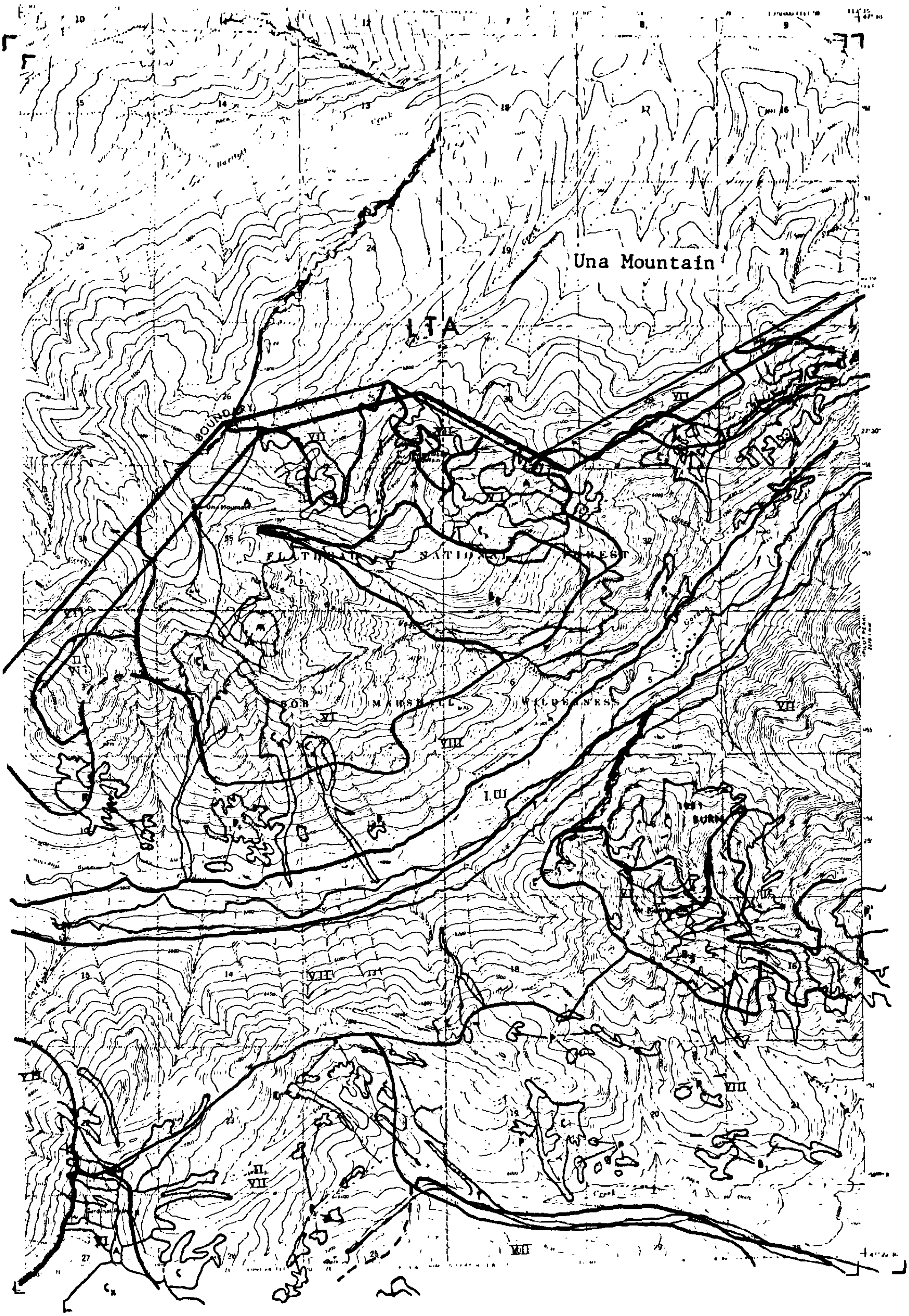
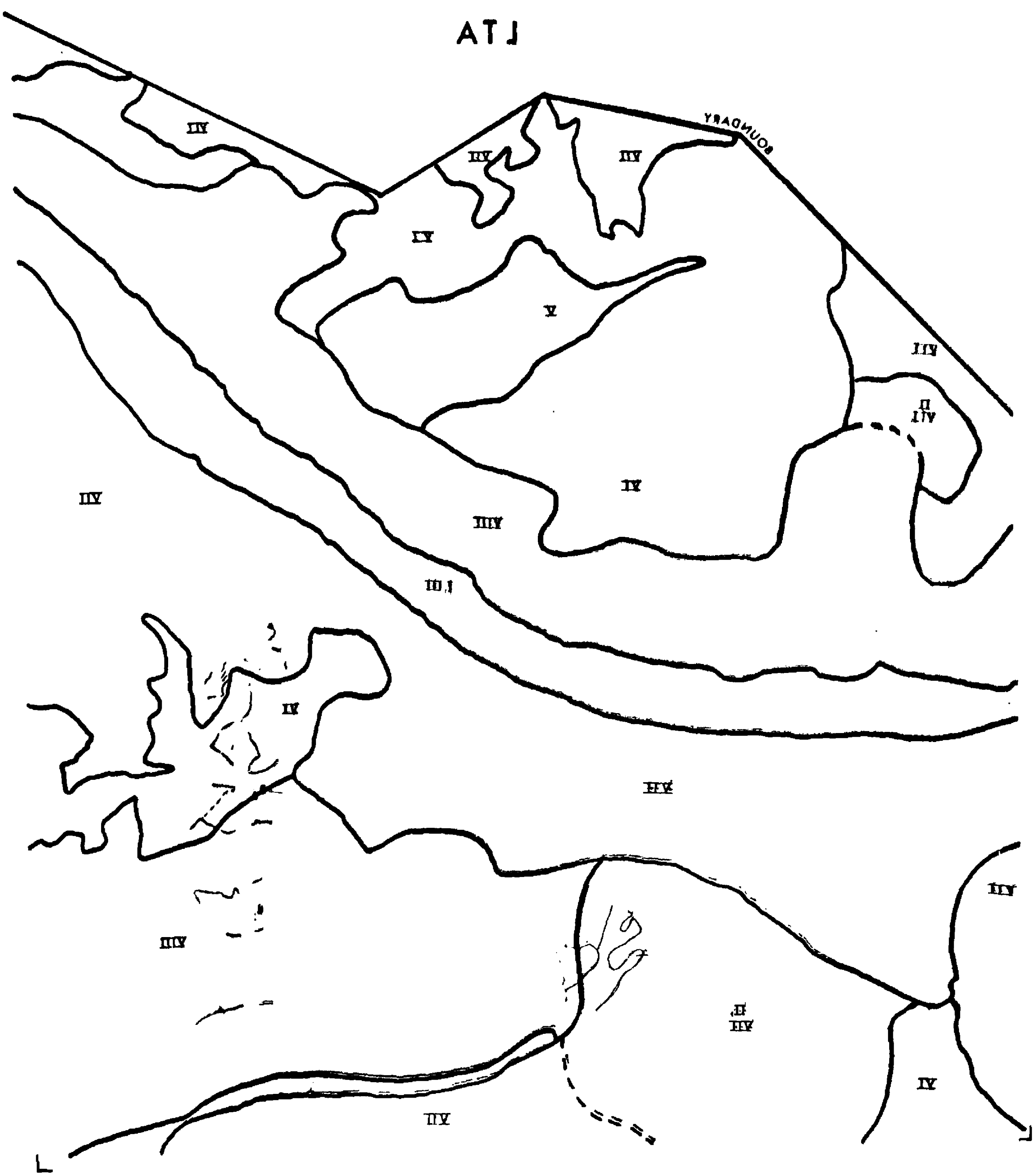
BOUNDARY
I
II
IV
VI
VII
VIII
II, VII
II, VIII


Shaw Creek
FLATHEAD NATIONAL FOREST
BOB MARSHALL WILDERNESS




Shaw Creek
FLATHEAD NATIONAL FOREST
BOB MARSHALL WILDERNESS
Shaw Mountain
Doctor Lake
Gordon
Creek


Una Mountain
LTA
BOUNDARY
FLATHEAD NATIONAL FOREST
BOB MARSHALL WILDERNESS
VII
VIII
I, III
VI
II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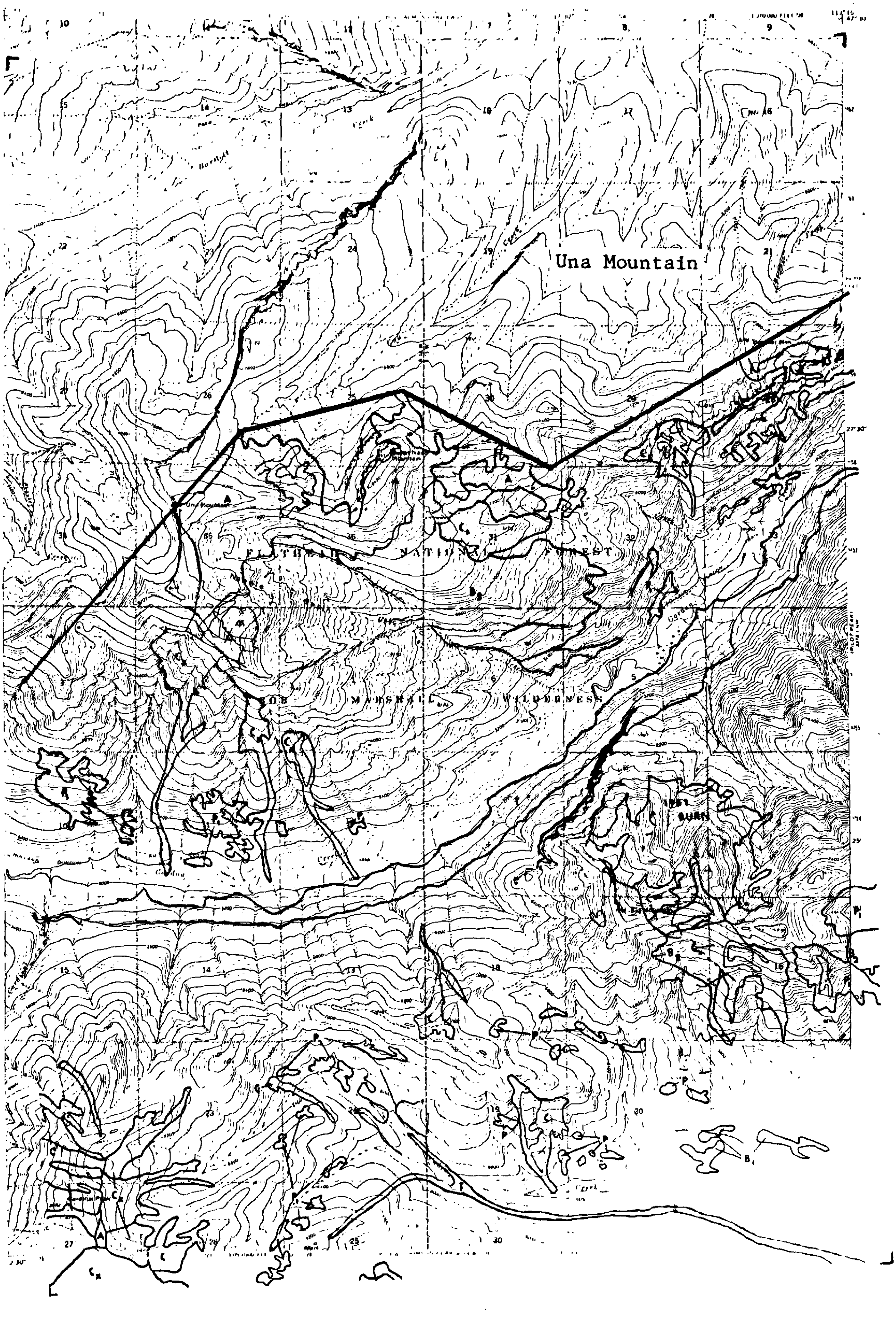
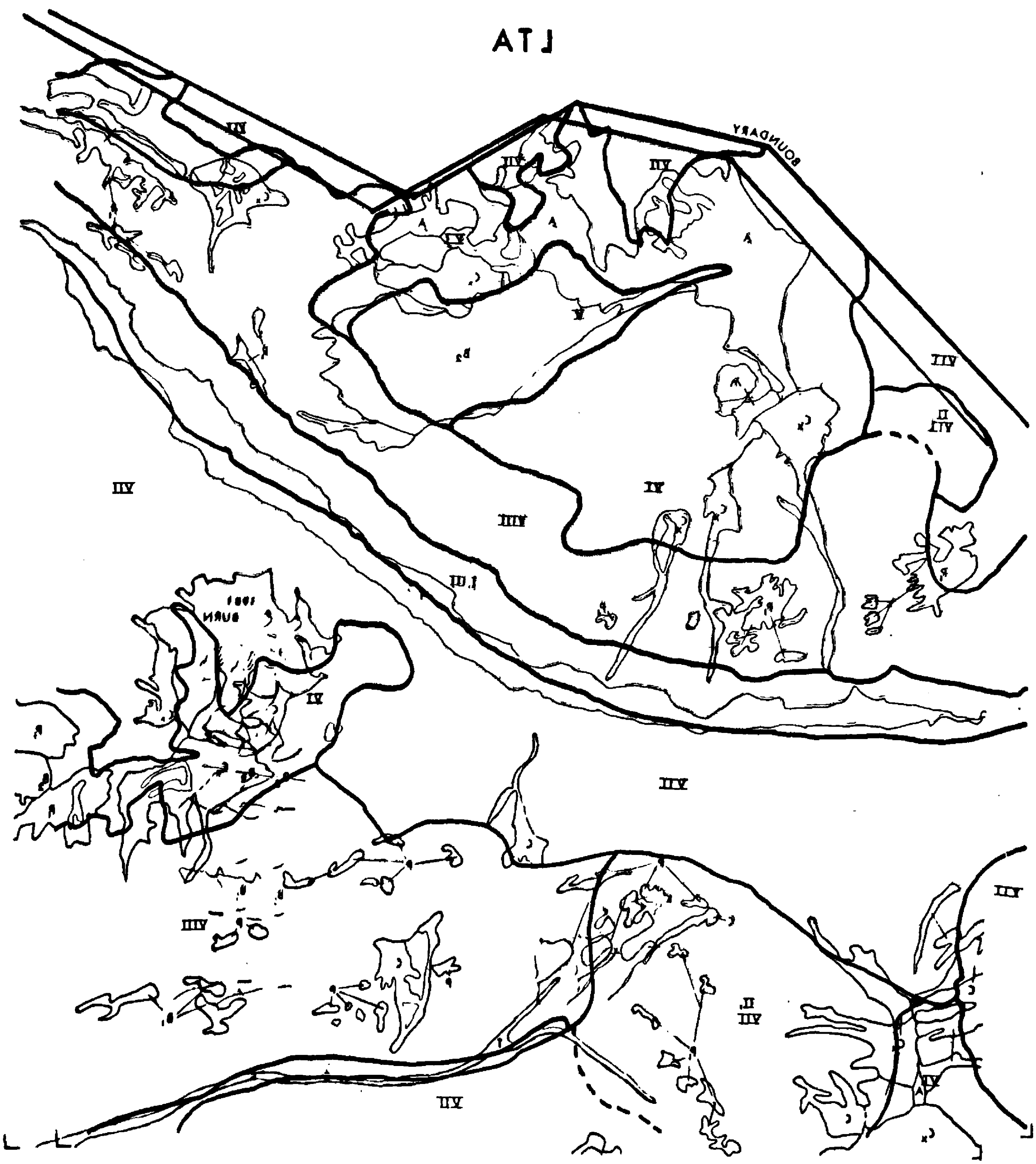
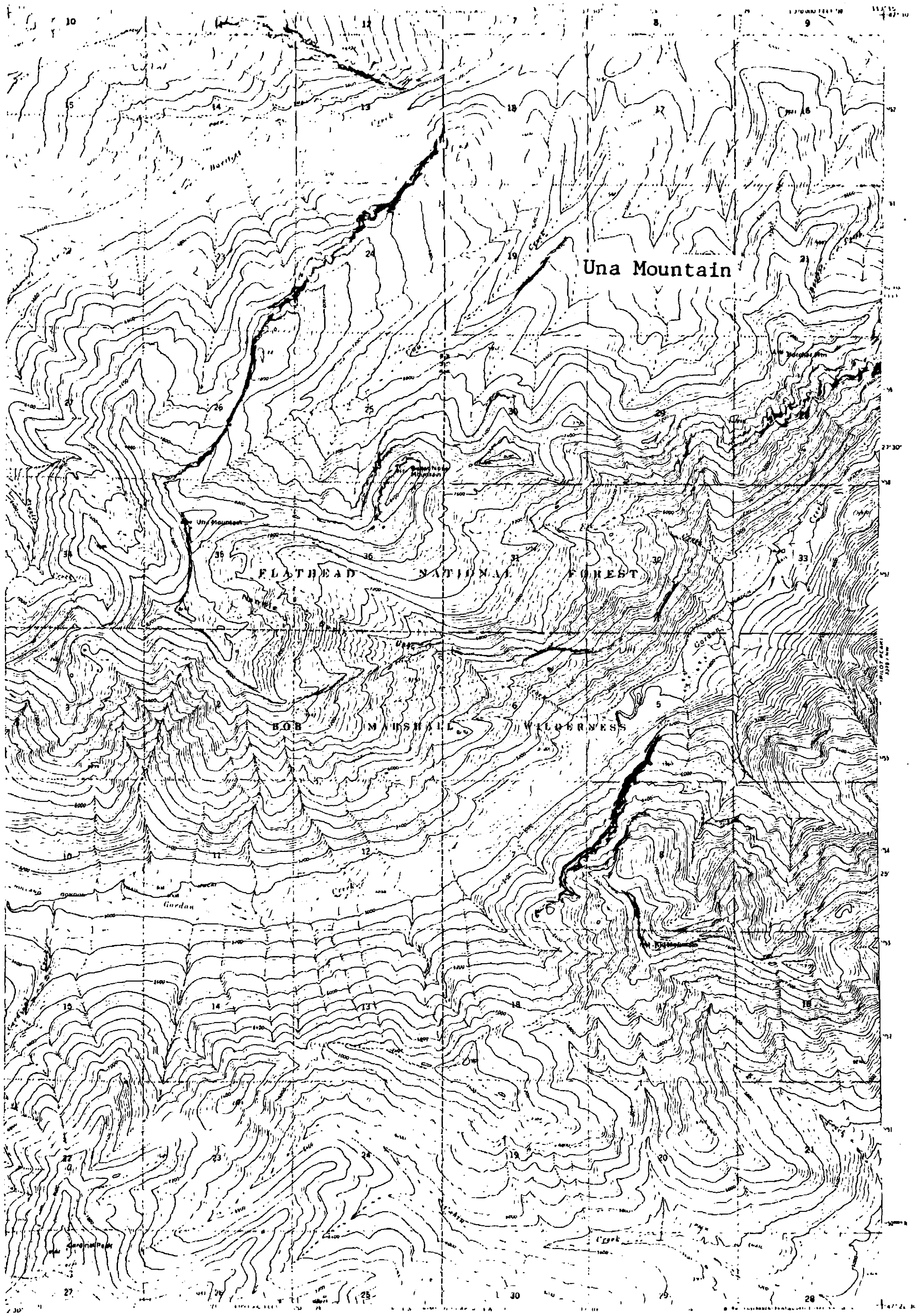
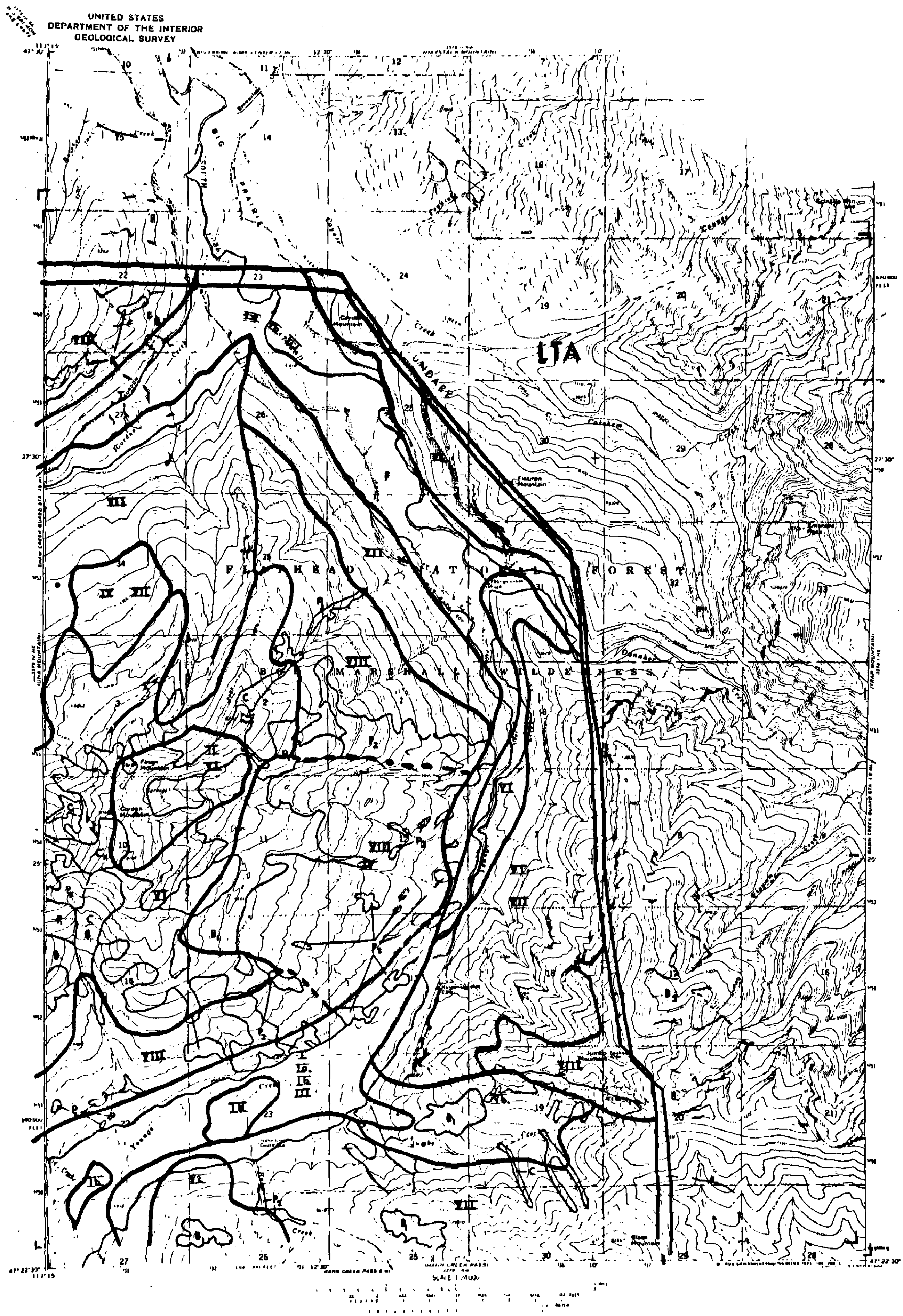

Una Mountain
FLATHEAD NATIONAL FOREST
BOB MARSHALL WILDERNESS
1951 BURN


LTA
BOUNDARY
1981 BURN


Una Mountain
FLATHEAD NATIONAL FOREST
BOB MARSHALL WILDERNESS
Gordon
Creek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DEPARTMENT OF THE INTERIOR
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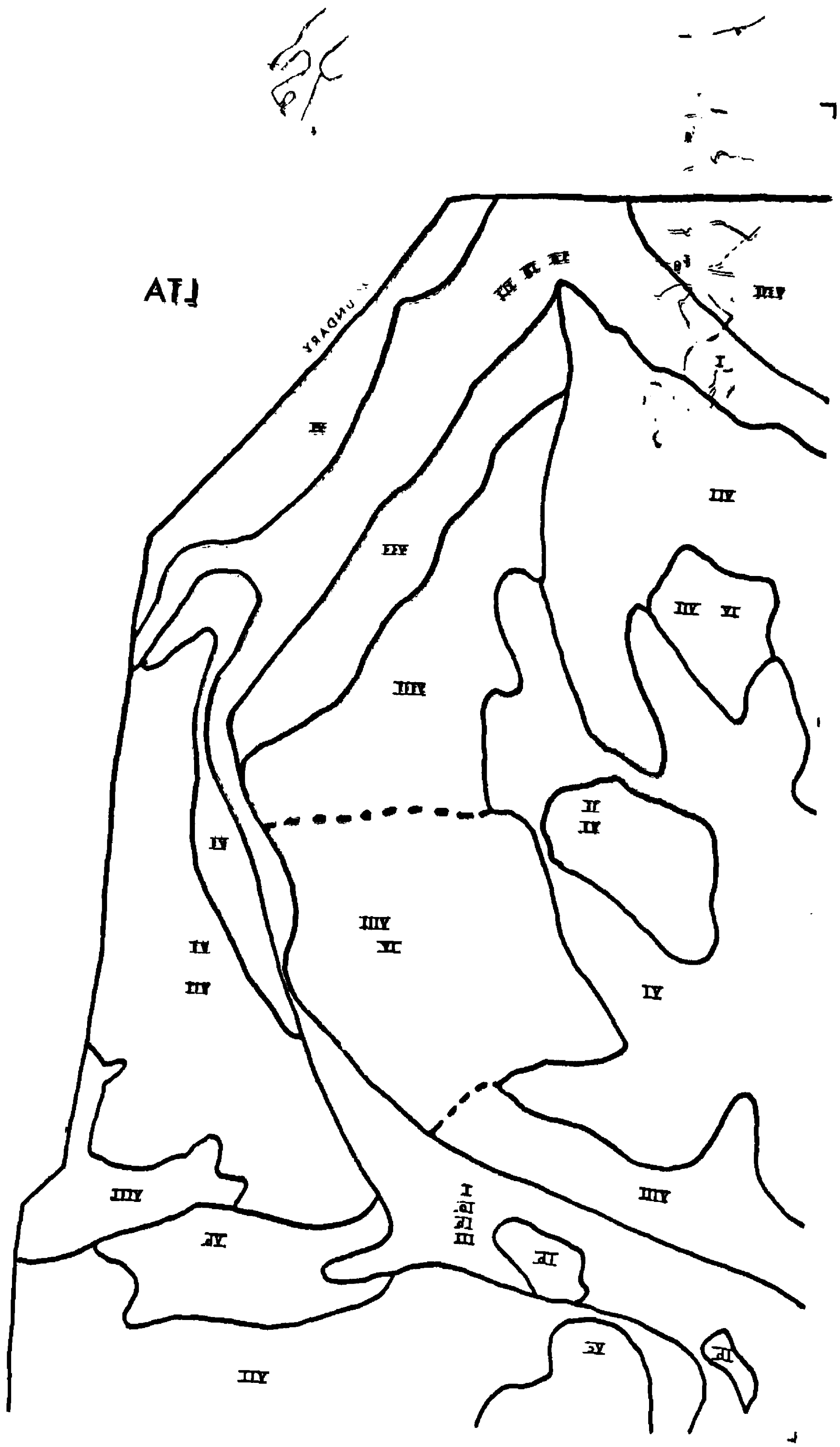
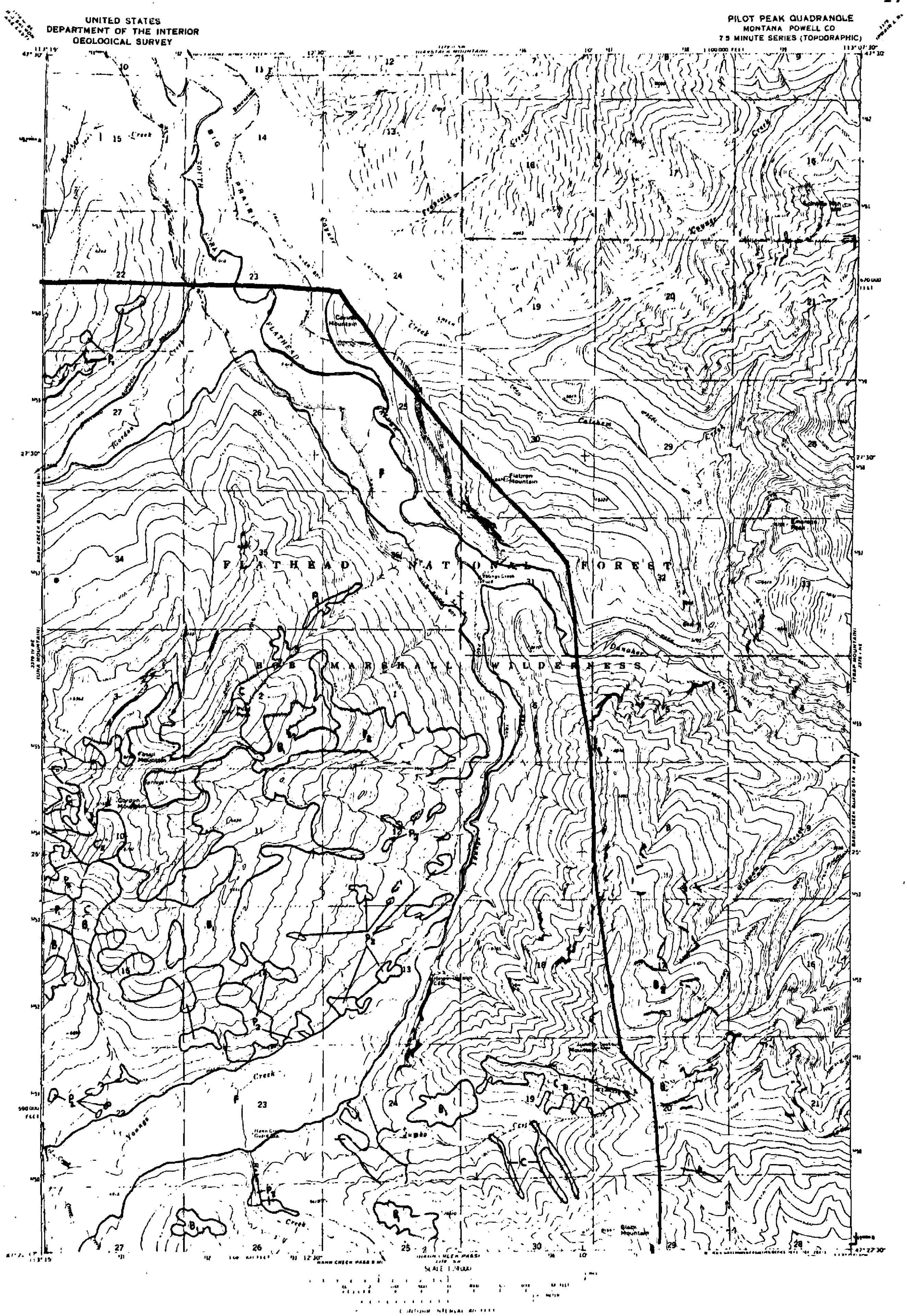
FLATHEAD NATIONAL FOREST
BOB MARSHALL WILDERNESS
LTA
Flatiron Mountain
Slide Mountain
SCALE 1:24000

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MONTANA POWELL CO
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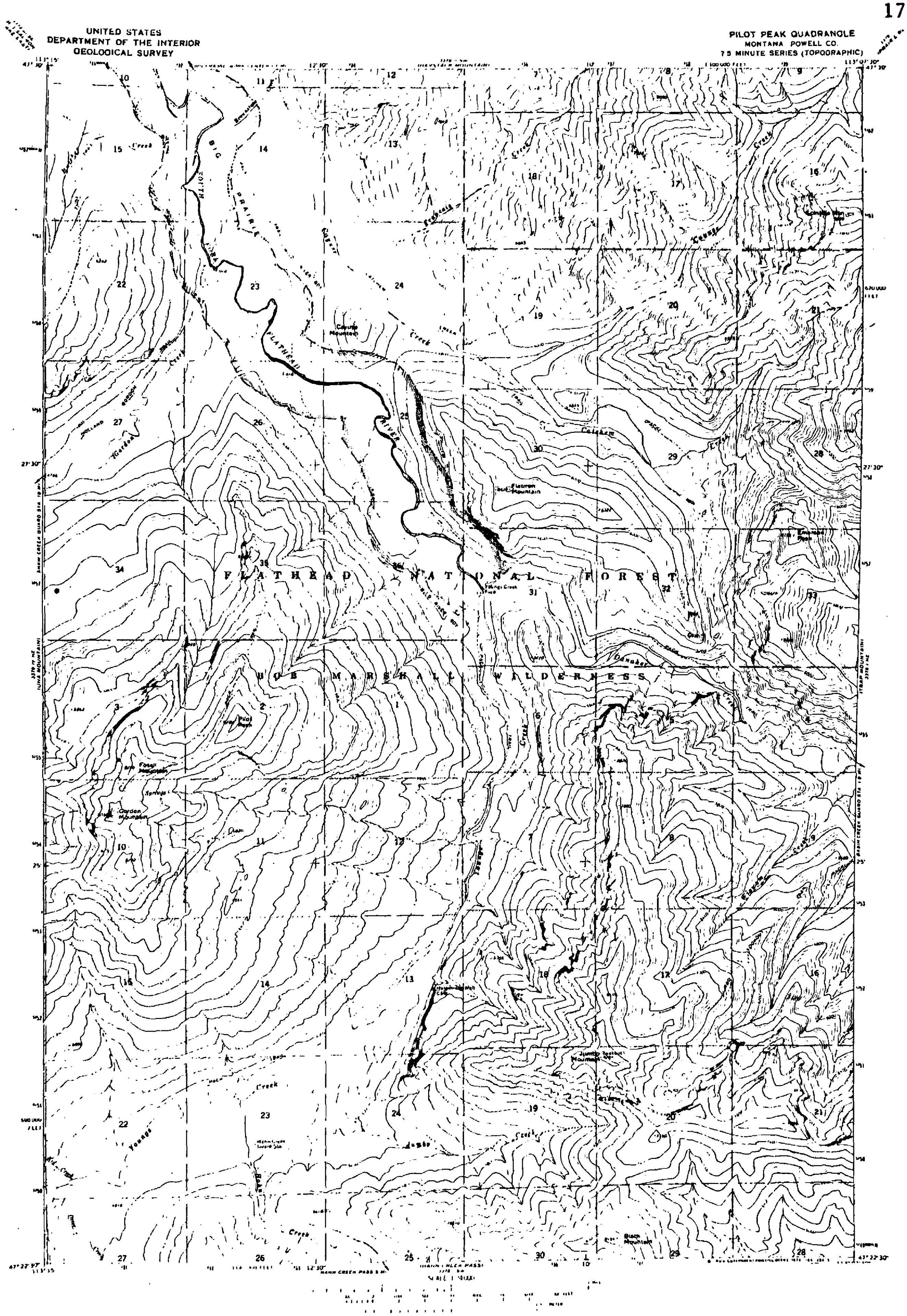
BOB MARSHALL WILDERNESS
Flatiron Mountain
Black Mountain
Creek
Danaher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MONTANA POWELL CO.
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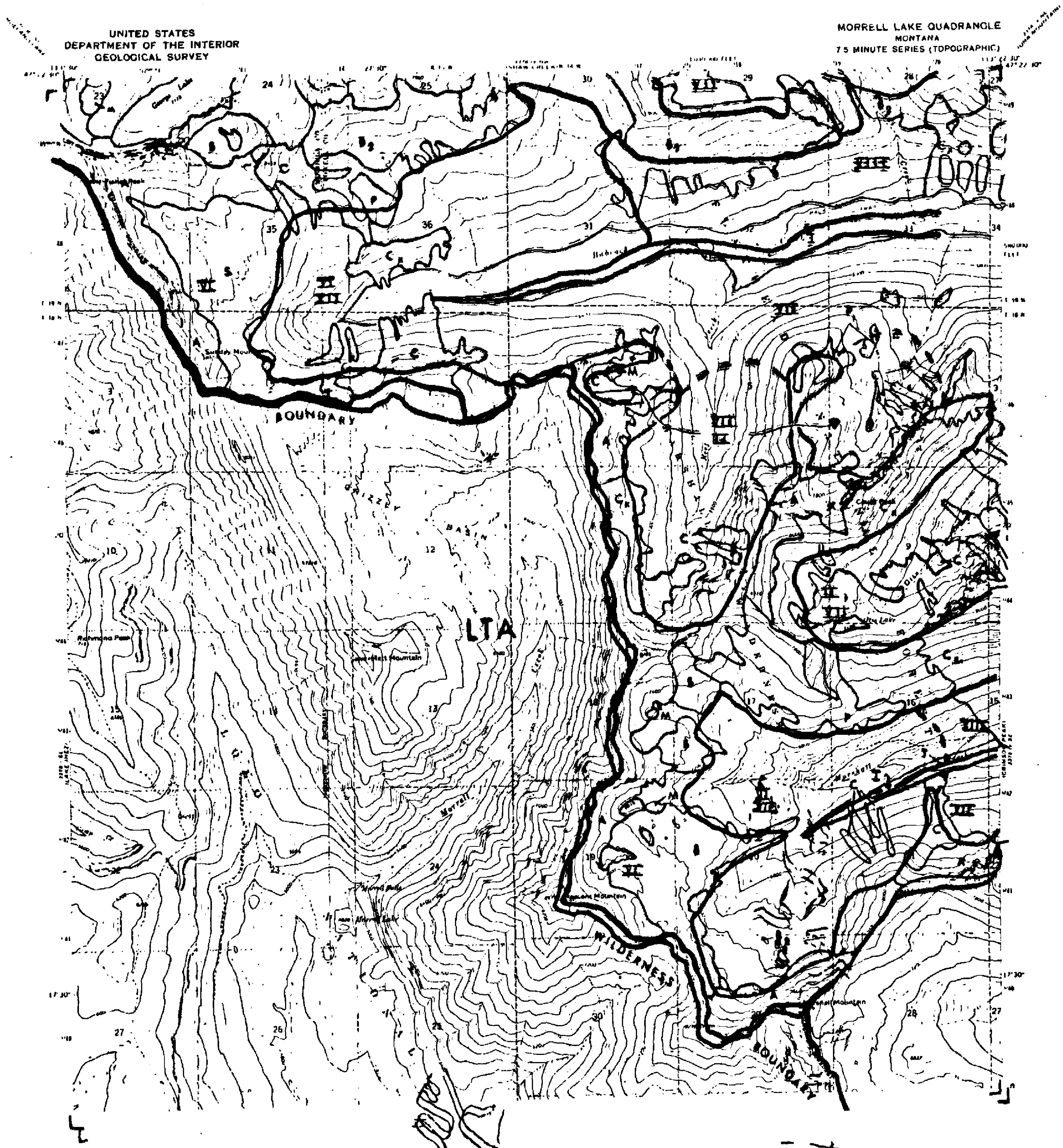
BIG PRAIRIE
SOUTH FORK
FLATHEAD RIVER
Creek
Flatiron Mountain
Pilot Peak
Fossil Mountain
Gordon Mountain
Jumbo Mountain
Black Mountain
FLATHEAD NATIONAL FOREST
BOB MARSHALL WILDERNESS
Danaher
Youngs
Creek
27°30″
25′
47°22′30″
113°15′
12′30″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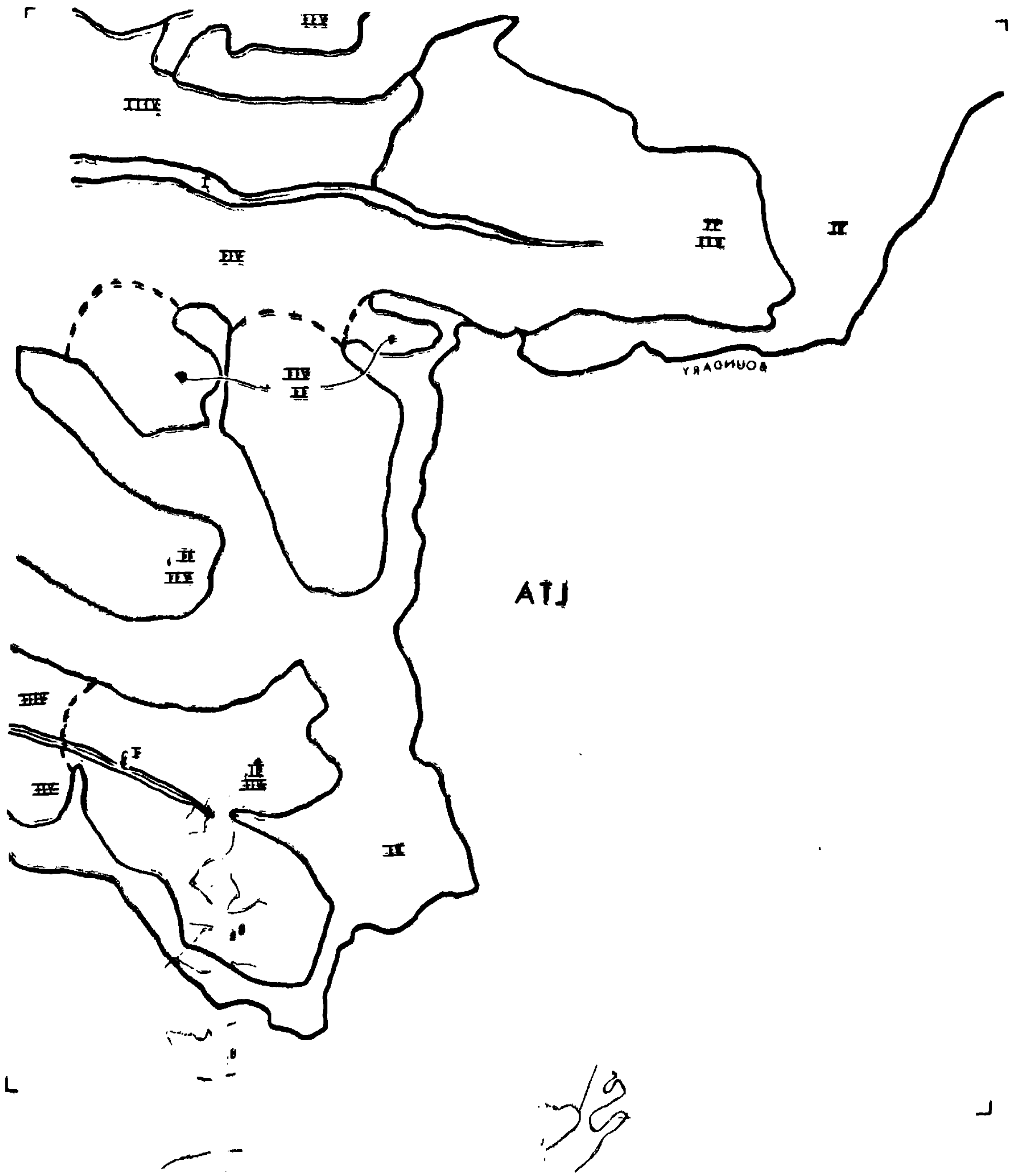
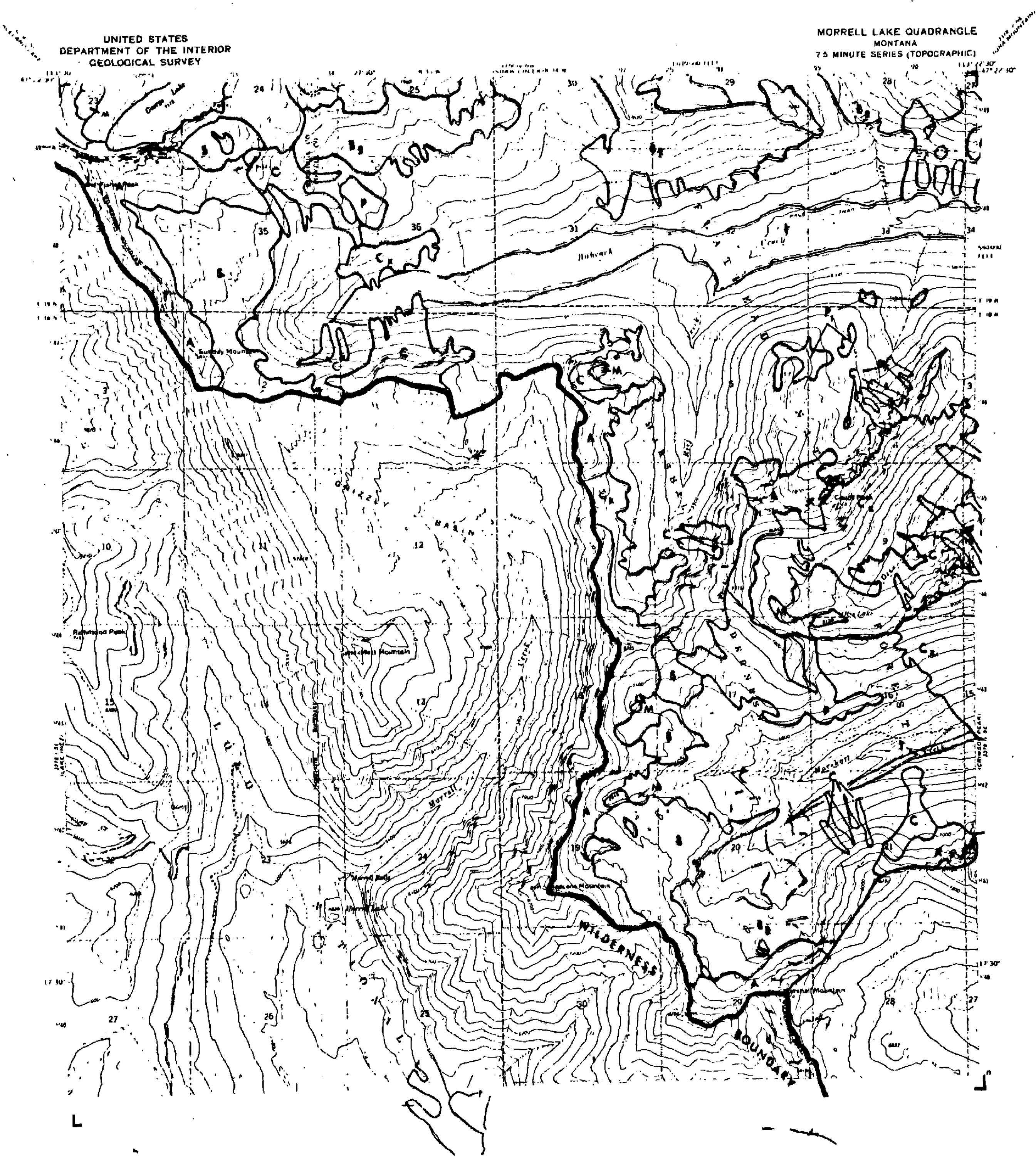
BOUNDARY
GRIZZLY BASIN
LTA
WILDERNESS
BOUNDARY

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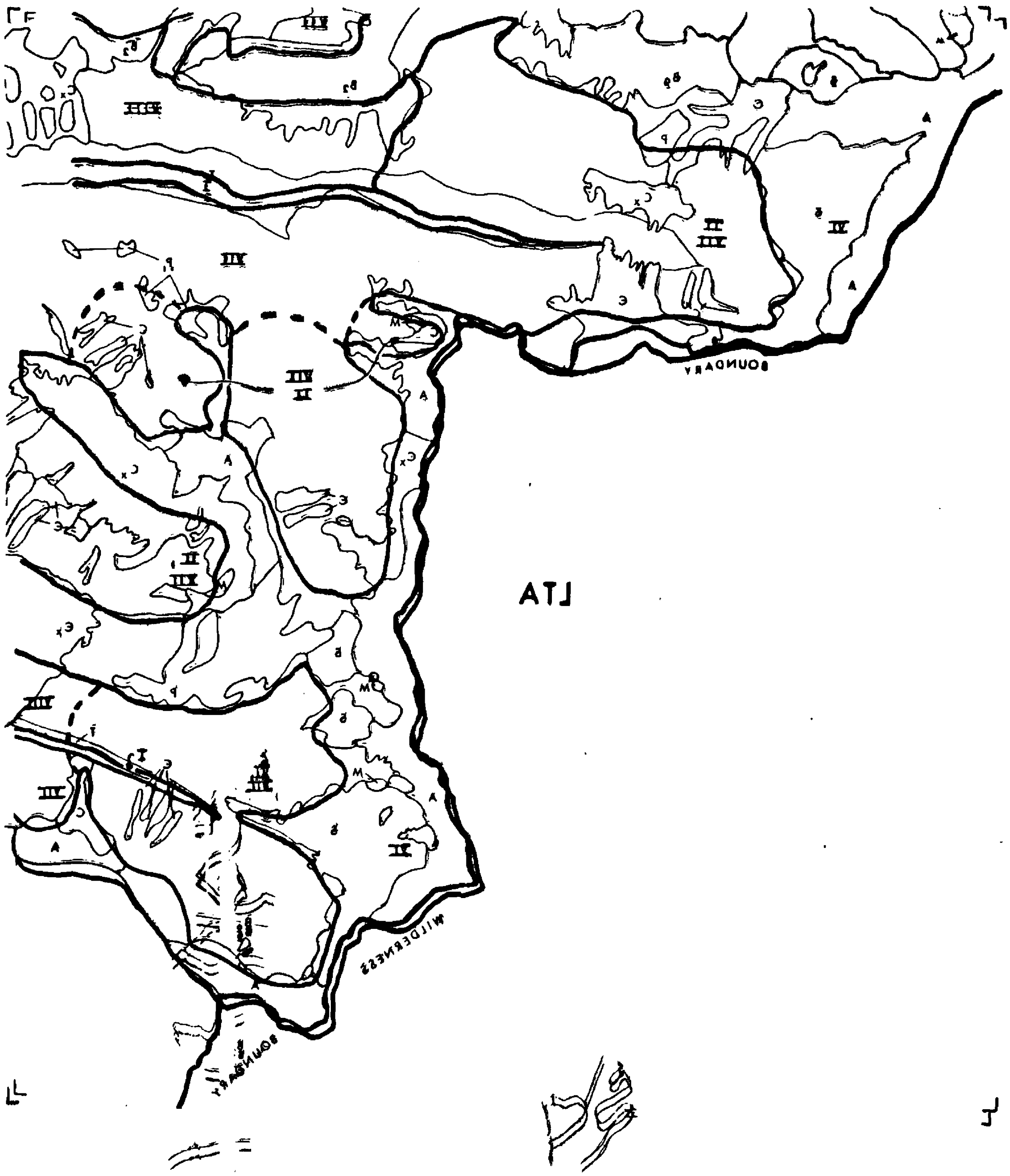
7.5 MINUTE SERIES (TOPOGRAPHIC)
GRIZZLY
BASIN
WILDERNESS
BOUNDARY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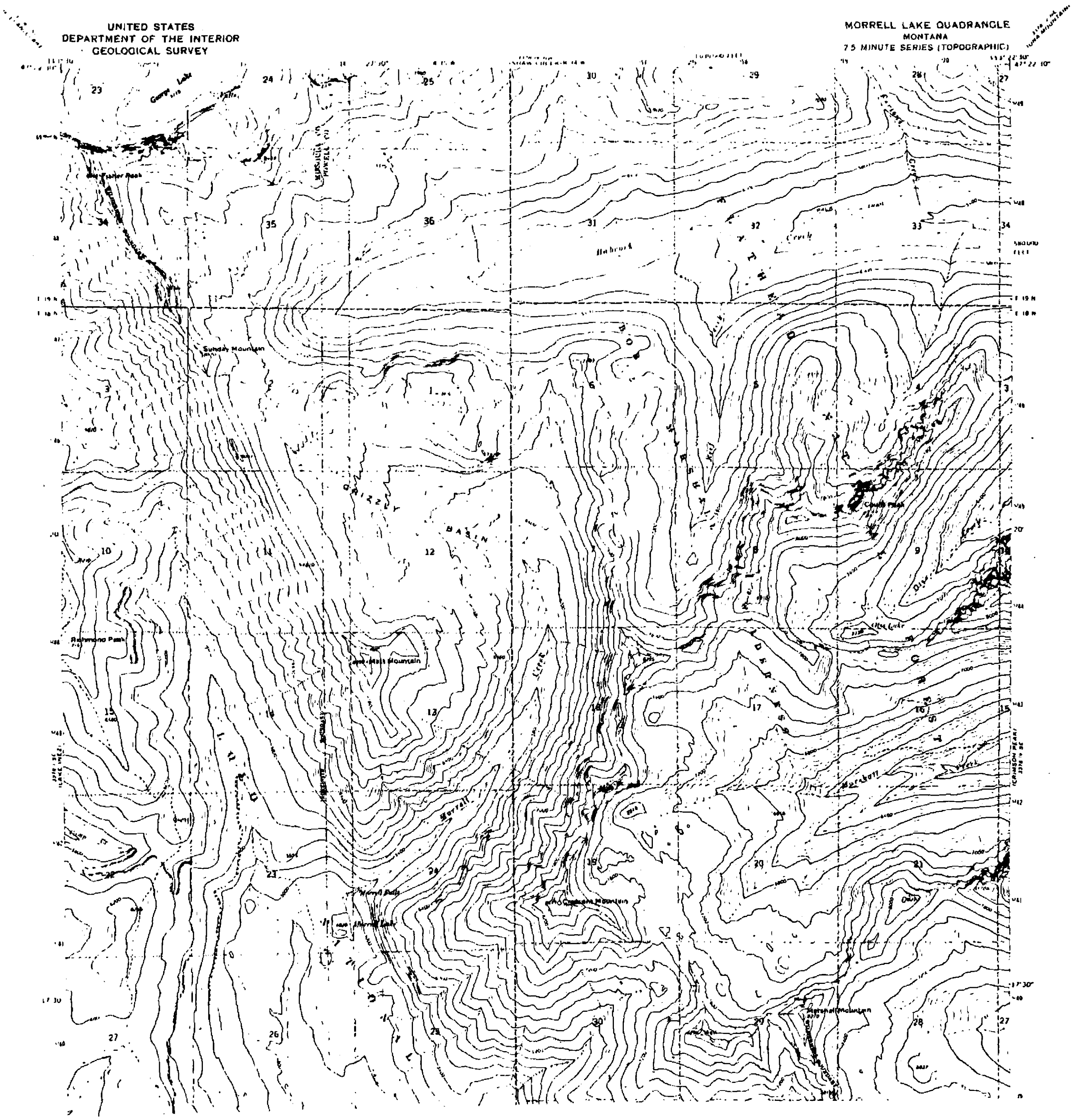
WILDERNESS
BOUNDARY
BOUNDARY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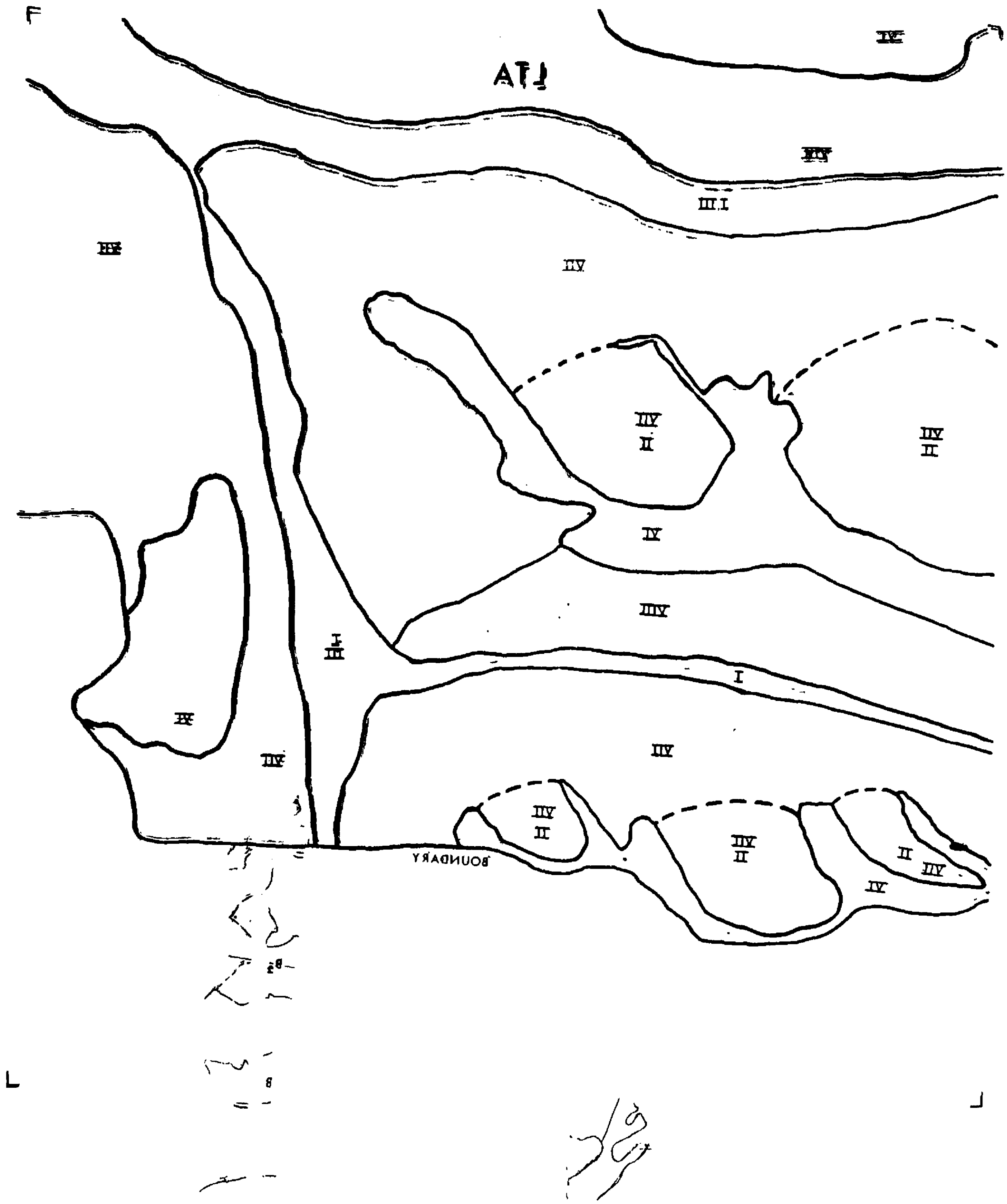
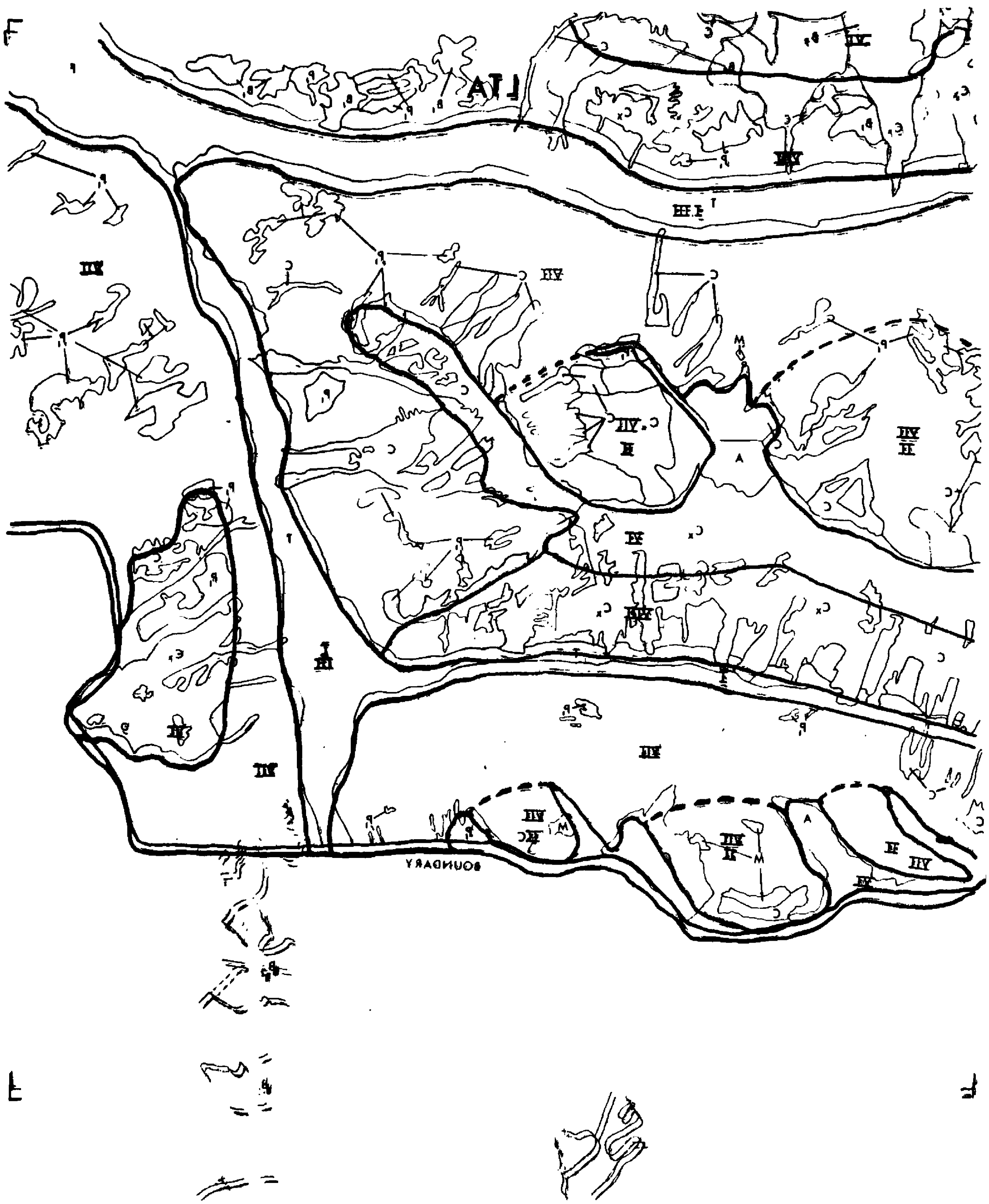
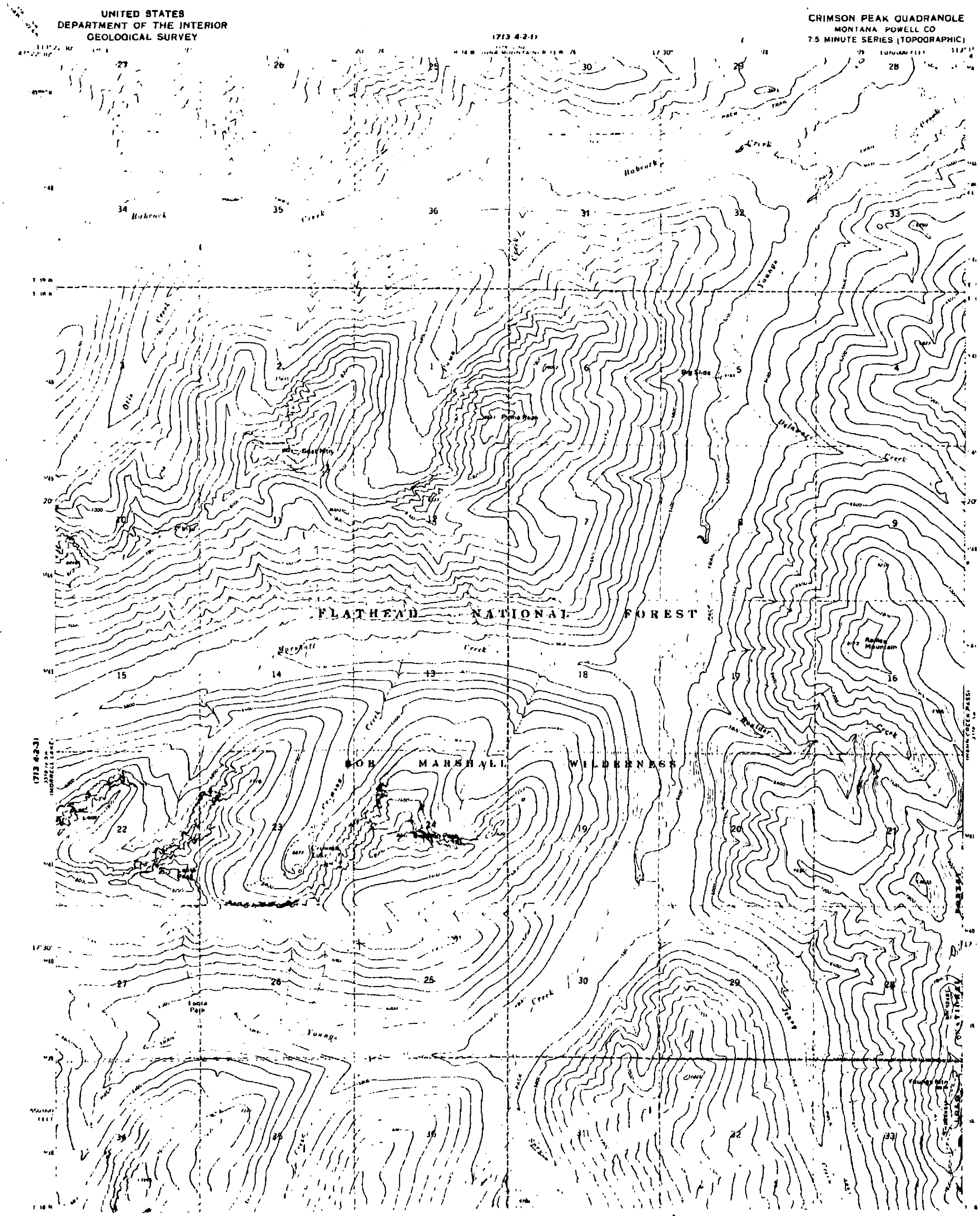
MORRELL LAKE QUADRANGLE
MONTANA
7.5 MINUTE SERIES (TOPOGRAPHIC)
Sunday Mountain
Richmond Peak
Morrell Lake
Morrell Falls

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY


BOUNDARY


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
FLATHEAD NATIONAL FOREST
BOB MARSHALL WILDERNESS




UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
CRIMSON PEAK QUADRANGLE
MONTANA POWELL CO
7.5 MINUTE SERIES (TOPOGRAPHIC)
FLATHEAD NATIONAL FOREST
BOB MARSHALL WILDERNESS
Babcock
Creek
Marshall
Creek
Rodney Mountain
Young Mtn
Big Slide
Prime Peak
Goat Mtn
Lake
Young
Boulder
Creek