

An analysis of pack and saddle stock grazing areas in the Bob Marshall Wilderness, Montana
by Thomas Willard Johnson

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Range Science
Montana State University
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Abstract:
A study was conducted in the South Fork of the Flathead River drainage, Bob Marshall Wilderness for the purpose of describing and classifying the principal grazing areas used by recreational pack and saddle stock. Forty-two sample stands were subjectively chosen to represent the range in types of grazing areas. Quantitative sampling methods were used to determine species canopy coverage, productivity and physical characteristics of sample stands. Stand groupings were determined using cluster analysis and a two-dimensional ordination technique, as well as field observations. Six community types and five phases were identified as follows: Festuca scabrella-Stipa richardsonii community type, Artemisia tridentata phase, Festuca idahoensis phase; Agropyron spicatum-Festuca idahoensis community type; Stipa occidentalis-Koeleria cristata community type, Danthonia unispicata phase, Poa oratensis phase, Phleum oratense phase; Poa oratensis community type; Pinus contorta-Calamagrostis rubescens community type; SymDhoricaroos albus-Amelanchier alnifolia community type. Environmental and vegetational characteristics of each of these community types are described. Environmental factors possibly important in the distribution, composition and maintenance of these communities are discussed.

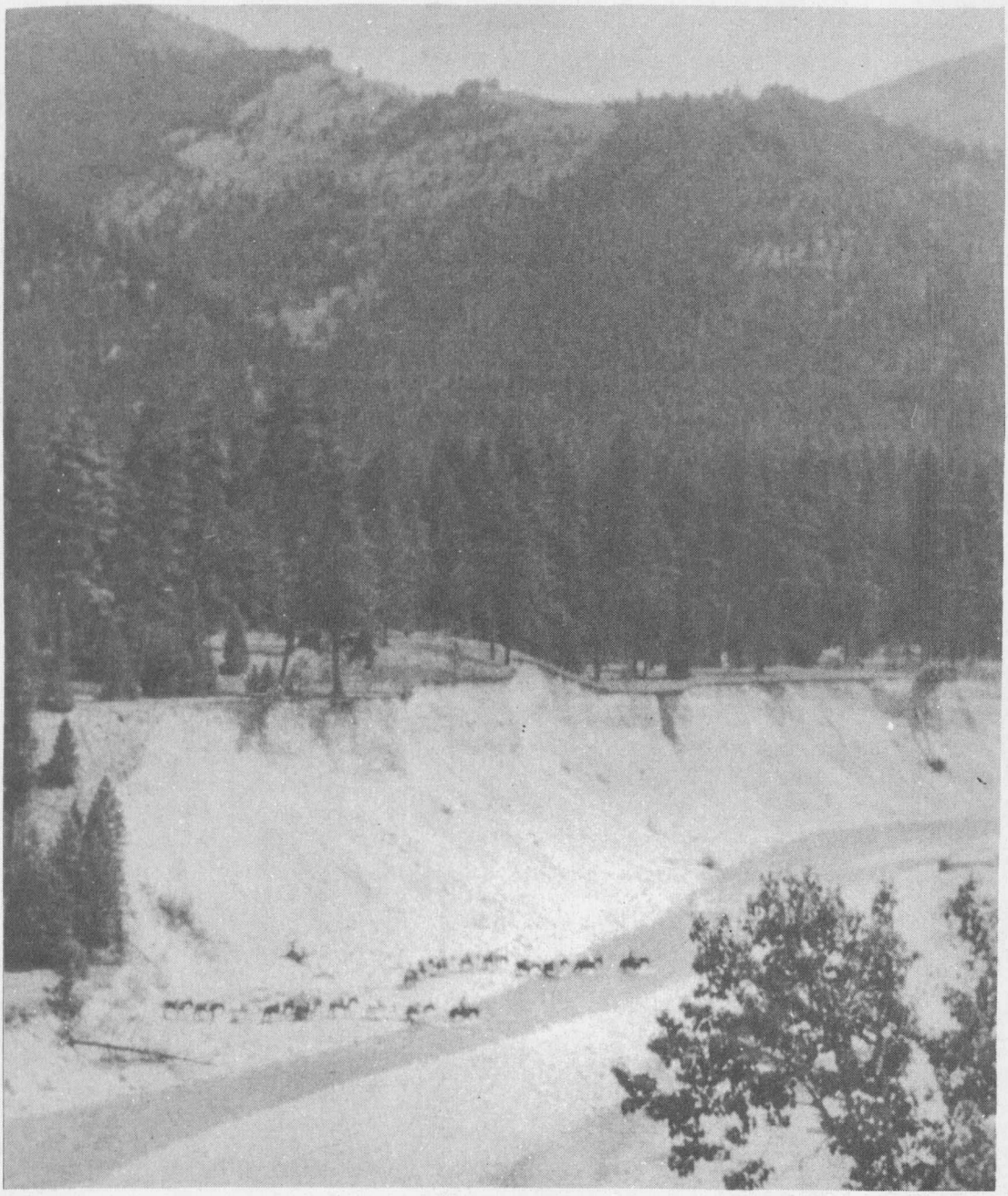
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Date 5/19/82

FRONTISPIECE



Pack strings crossing White River, Bob Marshall Wilderness

# AN ANALYSIS OF PACK AND SADDLE STOCK GRAZING AREAS IN THE BOB MARSHALL WILDERNESS, MONTANA

by

THOMAS WILLARD JOHNSON

A thesis submitted in partial fulfillment
of the requirements for the degree

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in

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Approved:

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Head, Major Department

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# ABSTRACT

A study was conducted in the South Fork of the Flathead River drainage, Bob Marshall Wilderness for the purpose of describing and classifying the principal grazing areas used by recreational pack and saddle stock. Forty-two sample stands were subjectively chosen to represent the range in types of grazing areas. Quantitative sampling methods were used to determine species canopy coverage, productivity and physical characteristics of sample stands. Stand groupings were determined using cluster analysis and a two-dimensional ordination technique, as well as field observations. Six community types and five phases were identified as follows: Festuca scabrella-Stipa richardsonii community type, Artemisia tridentata phase, Festuca idahoensis phase; Agropyron spicatum-Festuca idahoensis community type; Stipa occidentalis-Koeleria cristata community type, Danthonia unispicata phase, Poa pratensis phase, Phleum pratense phase; Poa pratensis community type; Pinus contorta-Calamagrostis rubescens community type; Symphoricarpos albus-Amelanchier alnifolia community type. Environmental and vegetational characteristics of each of these community types are described. Environmental factors possibly important in the distribution, composition and maintenance of these communities are discussed.

# INTRODUCTION

The Wilderness Act of 1964, Public Law 88-577, defines a wilderness as ". . . an area untrammeled by man . . . retaining its primeval character and influence . . . which is protected and managed so as to preserve its natural conditions and which generally appears to have been affected by the forces of nature with the imprint of man's work substantially unnoticeable . . .". Since recreation is the most obvious use of our wilderness areas (Hendee, Stankey and Lucas 1978), the effects of recreational use on the "primeval character" of wilderness are of primary concern to wilderness managers. Cole (1981) divided the ecological impacts of recreation in the Bob Marshall Wilderness into those resulting from: 1) human camping activities, 2) the construction and use of trails, and, 3) the grazing of pack and saddle stock. Concern over this third type of impact was the primary factor in the initiation of this study.

The Bob Marshall Wilderness historically has been considered a "horse wilderness" (Merriam 1963; USDA 1972). In some areas of the wilderness, forage availability may be the factor limiting visitor carrying capacity. Thus, information on forage availability is important to wilderness managers if they are to properly disperse visitors, insure adequate forage to meet both wildlife and livestock needs, and protect the wilderness resource. Personnel of the Spotted Bear Ranger District recognized a need to gather range resource information and to develop a management action plan to reduce the

adverse impacts of recreational stock use in the Bob Marshall.

In developing a management plan for a wilderness, key ecological data are essential. Franklin (1978) suggested that these data should include at least a general knowledge of the ecosystems and their properties: 1) what kinds of ecosystems are present? (classification), 2) where are they located? (distribution and mapping), 3) what are their biological and physical characteristics? (e.g. description of biotic composition, soils), 4) what are their dynamic properties? (rates and directions of change or successional trends), and 5) what are the key factors affecting the dynamics? Answering the last two questions requires periodic monitoring of changes within ecosystems. The first three questions deal with essentially descriptive data at one time, and are the focus of this study.

The specific objectives of this study were:

1) To obtain quantitative descriptions of the plant species composition of the principal recreational livestock grazing areas within the South Fork Flathead River Drainage, Bob Marshall Wilderness.

2) To construct a phytosociological classification of these plant communities.

3) To describe the general topographic, physiographic and edaphic characteristics of each community type.

4) To provide an estimate of forage productivity for each of these community types.

## DESCRIPTION OF THE AREA

### Location and Physiography

The Bob Marshall Wilderness encompasses 385,000 hectares (950,000 acres) of mountain country straddling the Continental Divide in northwestern Montana (Figure 1). The South Fork of the Flathead River originates in the Bob Marshall and flows in a northerly direction as it drains most of the wilderness area west of the Divide. This report deals with that portion of the Bob Marshall which is drained by the South Fork (Figure 2). The study area covers approximately 300,000 hectares (750,000 acres) in Lewis and Clark, Powell, Missoula and Flathead counties. It is bounded on the west by the crest of the Swan Range and on the east by the Continental Divide. The southern boundary is along the low divide separating the Blackfoot River drainage from that of the South Fork.

The valley of the South Fork is a typical intermountain glaciated valley which has been subjected to much stream action since glacial times. The valley ranges from 1.5 to 3 km (1 to 2 miles) wide but is a narrow, steep canyon at the junction of Youngs Creek and Danaher Creek. Elevations on the valley floor range from 1220 m (4000 ft) at Meadow Creek to 1650 m (5400 ft) on the Dry Fork - Flathead Divide at the head of Danaher Creek. From the valley floor, the mountains rise abruptly to elevations of over 2100 m (7000 ft). Swan Peak at 2822 m (9253 ft) is the highest peak within the study area.

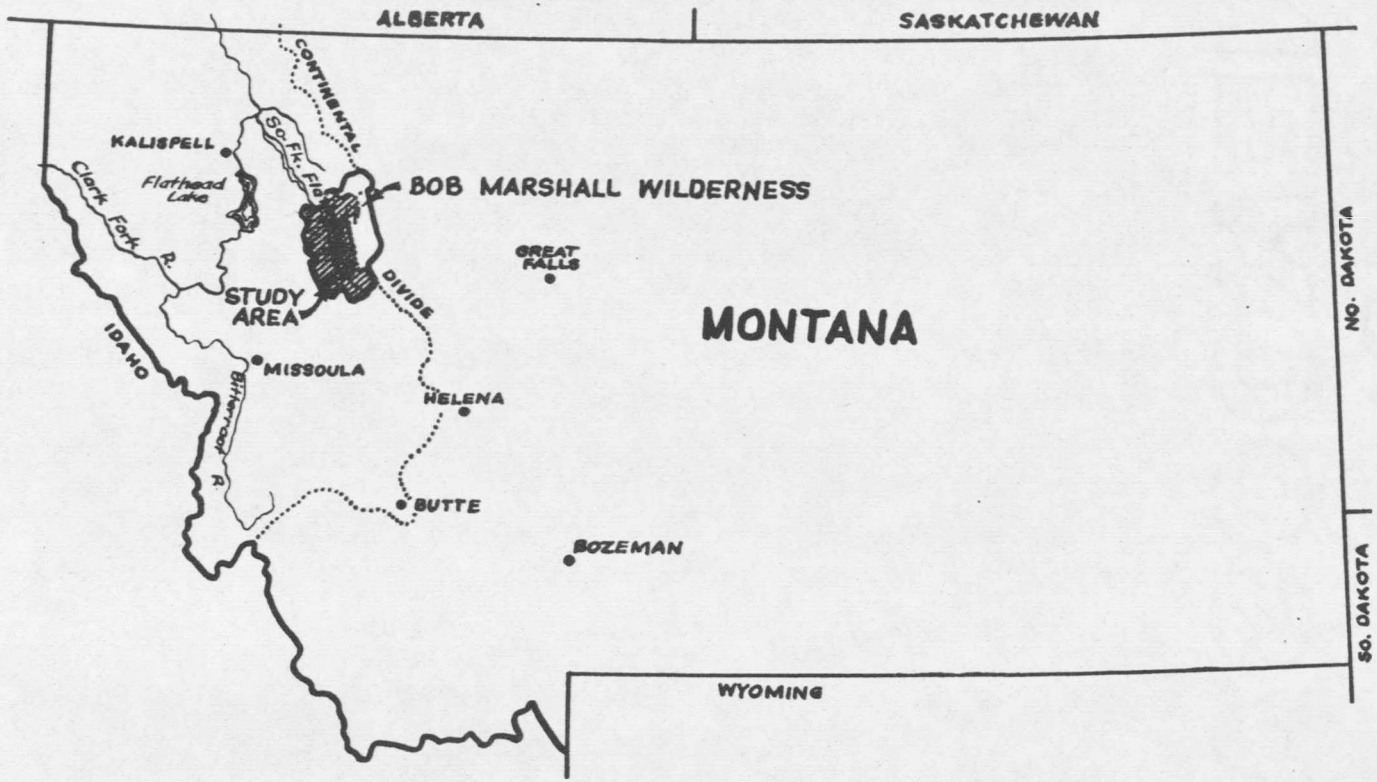



Figure 1. Study area location.

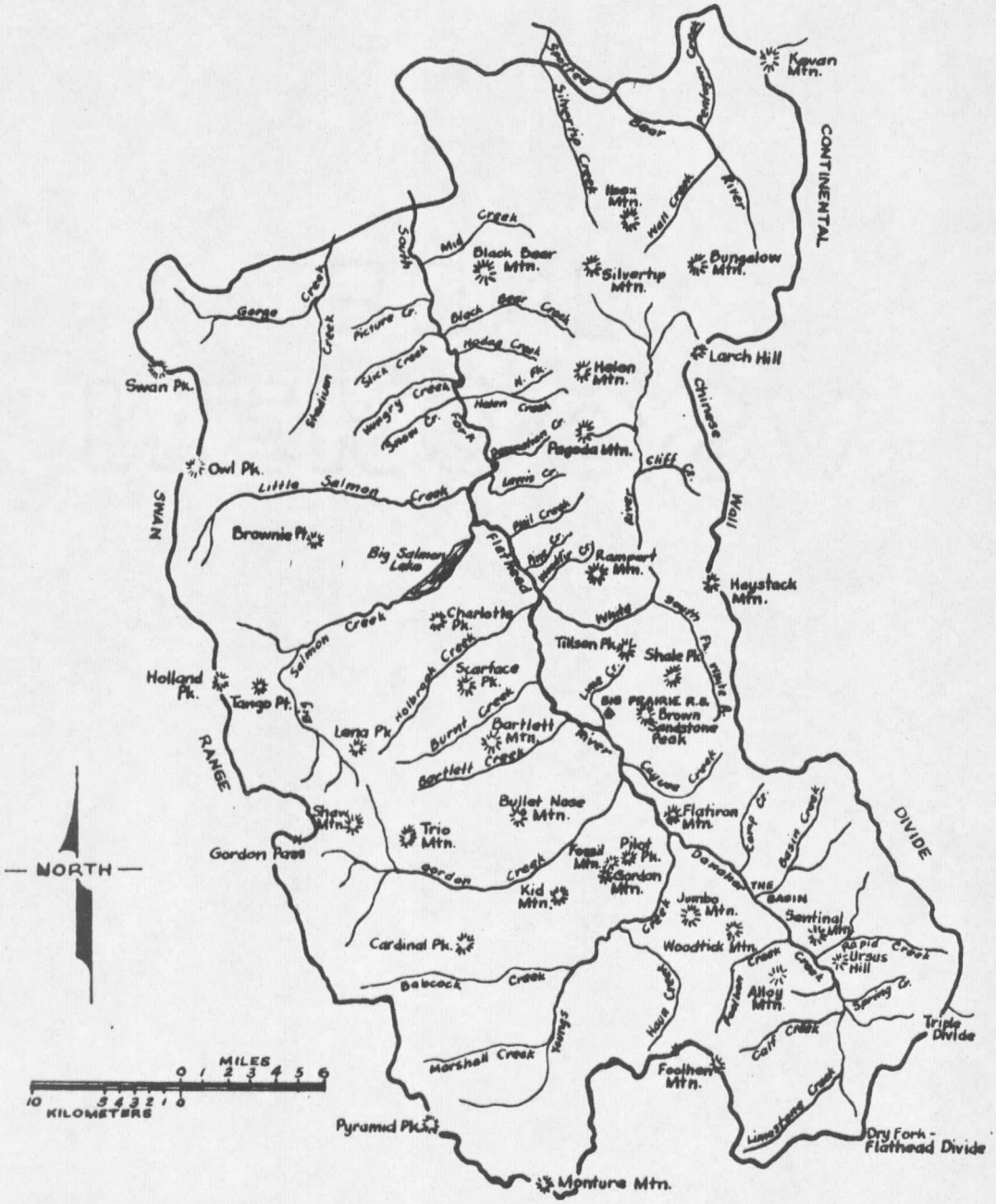



Figure 2. Study area: South Fork of the Flathead River Drainage, Bob Marshall Wilderness.

Roads are entirely lacking within the study area and travel is restricted to foot or horseback. The major access points are the National Forest trailheads at Meadow Creek, Holland Lake, and Benchmark. There also are a number of other lesser-used trailheads on both sides of the Continental Divide.

## Climate

The climate of the study area is strongly modified by easterly moving air masses from the North Pacific Ocean. This results in milder, more cloudy weather and precipitation which is more evenly distributed throughout the year (commonly with a July-August drought) than the continental climate east of the Continental Divide (U.S. Dept. of Commerce 1971). The mountainous topography results in many combinations of altitude, slope and aspect within the study area. For this reason, it is logical to expect much variation in local climatic conditions.

Various estimates of annual precipitation have been proposed for the study area. Steele (1960) estimates 53 cm (21 in.) per year for the entire Bob Marshall west of the Continental Divide. Holdorf et al. (1980) report a range of from 51-76 cm (20-30 in) on the valley floor to 200 cm (80 in) or more on some of the peaks and alpine ridges. Snow provides approximately 40 percent of the annual precipitation at lower elevations and as much as 80 percent in the higher elevations (Holdorf et al. 1980). Snow is generally present

from October through May in depths from 30 cm (12 in) in the valley to depths of 1.8 to 2.4 m (6 to 8 ft) at higher elevations (Gabriel 1976). Snow cover typically disappears from the valley in March or April and from the higher areas as late as July or August. May and June are normally moderately wet months while July and August are dry.

There are no year-round weather records kept for any location within the Bob Marshall. The only year-long weather station located within the entire South Fork drainage is at the Hungry Horse Dam, 95 km (60 mi) north of the wilderness boundary. The closest year-long weather station to the wilderness is located at Ovando, Montana, about 65 km (40 mi) south of the Big Prairie guard station. Table 1 summarizes the long term average precipitation records for these two stations and indicates what might be expected (at least on the valley floor) in the study area. Also presented in Table 1 are the monthly precipitation data from these two stations during the years 1980 and 1981 in which this study was conducted. It was my observation that moistness increases as one travels downstream along the valley of the South Fork from south to north. This observation is somewhat substantiated when one compares the precipitation records from these stations.

Seasonal temperature variation within the wilderness is great, with temperatures ranging from 35°C (95°F) summer highs to near -45°C (-50°F) lows in winter. (Pengelly 1960). Long-term average

TABLE 1. SUMMARY OF PRECIPITATION DATA FROM HUNGRY HORSE DAM AND OVANDO, MONTANA. 1/

| | Hungry Horse Dam 2/ | | | Ovando 3/ | | |
|---|---|---|---|---|---|---|
| | 33-year mean monthly ppt. (cm) | 1980 mean monthly ppt. (cm) | 1981 mean monthly ppt. (cm) | 78-year mean monthly ppt. (cm) | 1980 mean monthly ppt. (cm) | 1981 mean monthly ppt. (cm) |
| Jan | 9.7 | 7.5 | 3.0 | 4.4 | 2.9 | 0.7 |
| Feb | 6.8 | 6.5 | 9.9 | 3.1 | 1.6 | 2.6 |
| Mar | 5.5 | 8.1 | 2.7 | 2.7 | 2.4 | 1.6 |
| Apr | 5.6 | 6.2 | 11.6 | 2.3 | 3.1 | 0.9 |
| May | 6.7 | 10.6 | 15.6 | 4.8 | 13.7 | 8.3 |
| June | 8.3 | 13.9 | 17.3 | 5.5 | 7.2 | 5.3 |
| July | 4.2 | 3.8 | 6.2 | 2.6 | 3.2 | 2.8 |
| Aug | 5.4 | 9.2 | 2.2 | 2.6 | 3.2 | 1.6 |
| Sept | 5.8 | 8.1 | 4.4 | 3.2 | 3.1 | 2.6 |
| Oct | 7.7 | 3.4 | 2.6 | 2.9 | 2.3 | 2.8 |
| Nov | 8.7 | 7.2 | 7.5 | 3.7 | 1.3 | 2.3 |
| Dec | 9.3 | 18.1 | 10.3 | 4.4 | 3.5 | 3.6 |
| Annual | 83.6 | 102.5 | 93.3 | 42.4 | 47.6 | 35.1 |

1/ From: U.S. Dept. of Commerce. 1961. Climatography of the United States no. 86-20. Decennial Census of the United States Climate, Climatic Summary of the United States Climate Supplement for 1951-1960, Montana.

U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration Climatological Data. Annual Summaries, 1961-1981.

2/ 78 years of record, 1903-1980.

3/ 33 years of record, 1948-1980.

temperature data from the Hungry Horse Dam and Ovando weather stations are summarized in Table 2.

## Fire

This section of the Rocky Mountains is subject to severe lightning storms, particularly during the months of August and September. These storms are often accompanied by little or no precipitation and are capable of initiating dozens of forest fires within a few hours (Habeck 1967). Fires of such origin have played a prominent role in the ecology of forest communities in the Bob Marshall.

Ayres (1900) described past fires in the Flathead Forest Reserve which included the area now known as the Bob Marshall Wilderness. Steele (1960) described the fire history of the Bob Marshall as it is known from Forest Service records. Gabriel (1976) investigated the fire history of the Danaher Creek portion of the Bob Marshall and reported patterns of fire frequency, spread and occurrence.

Over 35% of the Bob Marshall has been burned over by large fires since 1885 (Steele 1960). The worst years for fires were 1889 and 1910. Huge fires in these years burned over much of the valley bottom and hillsides from the mouth of Big Salmon Creek to Burnt Creek and all but a few hundred acres in the White River. In 1889, two fires burned over 6,000 hectares (15,000 acres) in the Big Prairie and Basin Creek area. The Basin Creek flats and hillsides were burned again in

TABLE 2. SUMMARY OF TEMPERATURE DATA FROM HUNGRY HORSE DAM AND OVANDO, MONTANA. 1/

| | Hungry Horse Dam | | | Ovando | | |
|---|---|---|---|---|---|---|
| | Mean monthly temp C | Mean monthly maximum temp C | Mean monthly minimum temp C | Mean monthly temp C | Mean monthly maximum temp C | Mean monthly minimum temp C |
| Jan | - 6.9 | - 2.6 | -11.4 | - 8.8 | - 2.4 | -15.2 |
| Feb | - 4.1 | 0.9 | - 9.1 | - 6.9 | 0.0 | -13.7 |
| Mar | - 1.7 | 4.7 | - 7.0 | - 2.1 | 4.8 | - 8.9 |
| Apr | 4.9 | 10.9 | - 1.2 | 4.4 | 12.2 | - 3.3 |
| May | 10.6 | 17.6 | 3.6 | 9.0 | 17.6 | - 0.4 |
| June | 14.2 | 21.2 | 7.2 | 12.6 | 21.7 | 3.6 |
| July | 18.3 | 27.1 | 9.6 | 16.5 | 27.6 | 5.3 |
| Aug | 17.2 | 25.8 | 8.7 | 15.3 | 26.8 | 3.9 |
| Sept | 12.4 | 20.0 | 4.7 | 10.6 | 38.7 | 0.2 |
| Oct | 6.2 | 11.7 | 0.6 | 5.2 | 13.9 | - 3.6 |
| Nov | - 0.3 | 3.3 | - 4.0 | - 1.6 | 4.7 | - 8.0 |
| Dec | - 3.2 | 0.2 | - 6.8 | - 6.7 | - 1.2 | -12.2 |
| Annual | 5.7 | 11.7 | - 0.4 | 3.9 | 12.2 | - 4.3 |

1/ From: U.S. Dept. of Commerce. 1961. Climatography of the United States No. 86-20. Decennial Census of the United States Climate, Climatic Summary of the United States Climate Supplement for 1951-1960, Montana.

1910 (Gaffney 1941). A significant portion of the upper Danaher Creek drainage was also burned in these two years (Gabriel 1976). The only part of the study area of appreciable size to be burned since 1910 is a 1926 burn along Youngs Creek which extends from Hahn Creek to about 6.5 km 94 mi.) downstream. Fire suppression activities were initiated by the Forest Service in 1905 (Steele 1960). Forest Service policy since that time has been to detect and suppress all fires as soon as possible. Since 1926 this policy has been very effective in eliminating large fires from the wilderness.

## Geology

The geology of the study area was described by Phyllis Marsh, Geologist, Flathead National Forest (Personal Communication) as follows:

> During late Precambrian time, about 600 million years ago, western Montana was located in a downwarp of the earth's crust that was covered with a shallow sea. For millions of years the crust sank gently. Fine grained sediments were transported into the ocean as the ocean floor sank. Eventually, about 50,000 feet of sediment accumulated. Most of the sediments were clay, silt, sand and carbonate deposits.
>
> In the Big Prairie Area, two ranges of mountains, the Swan Range and the Flathead Range, were formed about 70 million years ago. Between the two ranges is a fault, the line along which the two ranges broke apart. Each of the ranges was uplifted and tilted to the east. The amount of tilt varies from 10 degrees to 80 degrees, depending upon local structure within the range. The South Fork River flows approximately along the fault. For most of its length the fault is covered with sediment eroded from the mountain ranges by water and/or glacial ice.

In the Swan Range rock formations are (from west to east) Precambrian Spokane, Empire, Helena, Snowslip, Shepard, Mt. Shields, Bonner, McNamara, and Garnet Range formations and Paleozoic Cambrian and Devonian formations. These are red, green, gray and buff argillite, siltite, quartzite and limestone.

In the Flathead Range from the South Fork River to Brown Sandstone Mountain, the westernmost rock formation is Precambrian Helena followed by Snowslip, Shepard, Mt. Shields, Bonner, McNamara, and Garnet Range. Paleozoic Cambrian and Devonian rock extend eastward from the McNamara formation. Dip of bedrock changes from eastward dipping west of Brown Sandstone Mountain to westward dipping east of Brown Sandstone Mountain. Brown Sandstone Mountain lies on the axis of a syncline.

Most of the mountain building occurred about 70 million years ago. Minor adjustments continue today. After the mountains were uplifted, they were eroded and the sediments were deposited along the bottom flank of both ranges and across the main South Fork Valley. These deposits are of Tertiary age, 60 to 1 million years old. Tertiary sediments are dominantly sand and small gravel partly cemented with calcium carbonate.

During Pleistocene time (1 million to 10,000 years ago) glaciers advanced down the South Fork Valley scouring existing rocks and transporting eroded material down the valley. Tributary valleys, as well as the main South Fork Valley, were glaciated. Resulting glacial till (Quaternary in age) is a mixture of silt and sand with some gravel and minor amounts of clay.

As the glaciers melted, large volumes of water were available to erode and transport tremendous volumes of sediment. Glacial deposits and underlying Tertiary deposits were reworked to form a series of terraces in the valley of the South Fork. As stream channels shifted, sediments were deposited in some places and eroded in others, existing terraces may have been covered with new materials. The net result is a series of terraces, some showing a mate on the opposite side of the river at the same elevation. Vertical distance of one terrace above another varies. A thin veneer of stream-laid deposits

(alluvium) overlies the terraces.

A generalized geological cross section from Bartlett Mountain to Brown Sandstone Peak is shown in Figure 3.

## Soils

The soils of the study area are best discussed in relation to three landform groupings: 1) erosional lands, 3) depositional lands and 3) breaklands. The following discussion has been derived from Holdorf et al. (1980) and Albin Martinson, Soil Scientist, Flathead National Forest (Personal Communication).

Erosional lands are primarily landforms that have been scoured by glacial ice. These landforms occur on moderate to high elevation ridges and upper valley side slopes. Soils have developed from the residual rock or on materials moved only short distances by gravity. Over much of the area, particularly on the north and east exposures, a layer of silty volcanic ash material overlies the stony, loamy material weathered from the underlying bedrock. Soils range from 100 to 150 cm (40 to 60 in) deep on north and east exposures, and 50 to 150 cm (20 to 60 in) on south and west exposures. Soils are classified as Typic or Andic Cryochrepts in loamy skeletal families. Inclusions of Typic or Lithic Haploborolls occur on some of the shallower soils on southerly exposures supporting grass dominated vegetation.

Soils on depositional landforms have developed on materials which

| | |
|---|---|
| Qa | Quaternary Alluvium (gravel, sand, silt and clay) |
| Qg | Quaternary Glacial Deposits (gravel, sand, silt and clay) |
| T | Tertiary Deposits (conglomerate, gravel, sand, silt and clay) |
| Du | Devonian (grayish-brown carbonate) |
| Eu | Cambrian (dominantly carbonate with shale, light gray color) |
| Ygr | Precambrian Garnet Range Formation |
| Ym | Precambrian McNamara Formation (grayish-green siltite and reddish-brown quartzite) |
| Ybo | Precambrian Bonner Formation (pink quartzite) |
| Yms | Precambrian Mount Shields Formation (reddish-brown siltite, argillite and quartzite) |
| Ysh | Precambrian Shepard Formation (greenish-gray siltite and argillite) |
| Ysn | Precambrian Snowslip Formation (red and green argillite and quartzite) |
| Yh | Precambrian Helena Formation (gray silty limestone) |

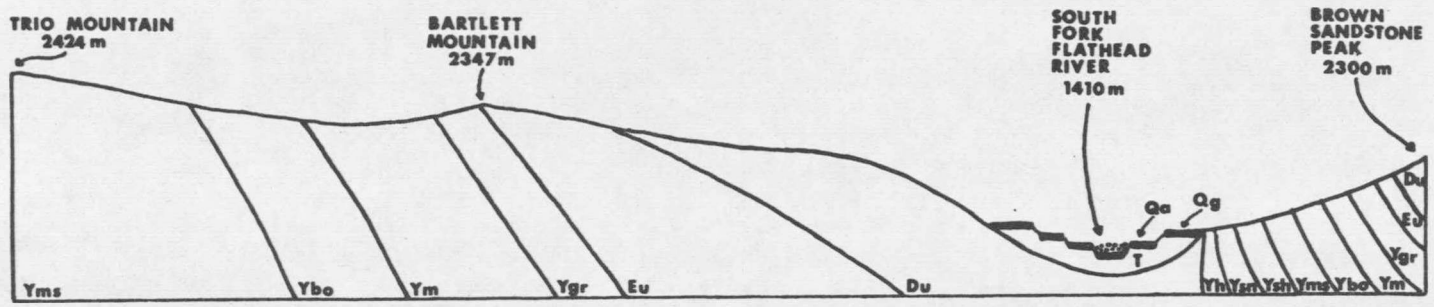



Figure 3. Generalized geological cross-section from Trio Mountain to Brown Sandstone Peak (courtesy of Phyllis Marsh, Geologist, Flathead National Forest).

have been transported by water or glacial ice. Soils developed in glacial ice deposits occur from the valley floor to the lower valley side slopes. These soils have developed in loamy or clayey glacial till material which is often overlain by wind deposited volcanic ash. Soil depths range from 100 to 150 cm (40 to 60 in) or greater. These glacial till derived soils are typically classified as Typic or Andic Cryoboralfs in loamy or clayey skeletal families.

Water deposited materials occur on the step-like terraces and alluvial fans of the valley bottom. Soils on the higher terraces have developed in stratified sand, gravel and cobble deposited during the Pinedale glaciation. These soils range in depth from 50 to 100 cm (20 to 40 in). Soils supporting forest vegetation are typically classified as Typic Cryochrepts or Typic Cryoboralfs. Soils supporting grassland inclusions are classified as Typic Ustochrepts and Typic Haploborolls. Soils on the lower terraces have developed in stratified silts, sands and gravels which have been more recently deposited and reworked by the river. These soils range from 25 to 50 cm (10 to 20 in) deep. These young soils show little development and are classified as Typic Ustorthents or Typic Ustochrepts in sandy skeletal families.

Breaklands occur primarily on the oversteepened slopes of glacial trough walls. On the upper slopes, soils have developed in loamy material weathered from the bedrock. On the lower slopes, soils

have developed from loamy or gravelly glacial tills and colluvial materials. Soils on the northerly exposures are usually mantled with a layer of silty volcanic ash. Soils are typically classified as Typic Cryochrepts and Lithic Cryandepts on these northerly exposures and as Typic Cryochrepts and Typic Ustochrepts on the southerly exposures.

## Vegetation

The South Fork drainage falls within the Douglas fir and spruce-fir zones of Daubenmire (1943), but the existing plant communities vary according to past fire history and site conditions. The vegetation is a complex mosaic of different aged stands of *Pinus contorta* intermixed with *Pseudotsuga menziesii*, *Larix occidentalis*, *Picea* spp. and *Abies lasiocarpa*.

*Abies lasiocarpa* is probably the climax dominant over a majority of the study area, but due to fires, it has often been replaced by seral species, particularly in the lower elevations. *Abies lasiocarpa* dominated stands are fairly frequent at middle and upper elevations. Undergrowth unions in these stands are commonly dominated by *Xerophyllum tenax* on southerly exposures and *Menziesia ferruginea* on northerly exposures. On the higher ridges, *Pinus albicaulis* is found in association with *Abies lasiocarpa*. On exposed sites, these two species take on a typical krummholz or "crooked wood" appearance. *Larix lyallii* is an occasional associate of *Abies lasiocarpa* in some

of the highest elevations.

Pseudotsuga mensiesii is believed to be the climax dominant on sites which are too dry to support Abies lasiocarpa or Picea spp. (Gaffney 1941). On some of the drier sites in this zone, Pseudotsuga menziesii is associated with an understory in which Calamagrostis rubescens, Carex geyeri, Arnica cordifolia and Fragaria virginiana are the most abundant herbaceous species. Common shrubs include Arctostaphylos uva-ursi, Berberis repens, Symphoricarpos albus and Juniperus communis. More mesic sites support an understory in which Linnaea borealis, Berberis repens, Arctostaphylos uva-ursi, Lonicera involucrata, Shepherdia canadensis, Calamagrostis rubescens and Fragaria virginiana are conspicuous. On these moister sites, Larix occidentalis is an indicator of past fires (Pfister et al. 1977) and is fairly extensive on the lower and mid slopes along the South Fork from the northern boundary of the wilderness to the junction of Danaher and Youngs Creeks.

Pinus contorta is probably the most abundant coniferous species found throughout the study area in all but the highest elevations. Pinus contorta is less shade tolerant than either Pseudotsuga menziesii or Abies lasiocarpa and in this region it has been maintained primarily by wildfire (Pfister et al. 1977). It occurs in all densities and age class distributions, but is frequently in pure, even-aged stands which are certainly indicative of a fire origin.

Pinus ponderosa is found to a limited extent on some of the dry sites at low elevations. The major concentrations of this species are the open, park-like stands found around the mouth of the White River, on Murphy Flat and near the mouth of Lime Creek. Understories in these stands are dominated by Agropyron spicatum and Festuca scabrella along with other bunchgrass species. These stands are presently composed of mature timber with very little reproduction of Pinus ponderosa evident. Scattered Pseudotsuga menziesii and Pinus contorta are associated species and account for most of the reproduction. It is probable that Pinus ponderosa was formerly much more abundant within the study area. Gabriel (1976) presents a map (from Ayers 1900) showing the distribution of this species within the Danaher Creek drainage in the year 1899. This map shows Pinus ponderosa occuring in a narrow band along the entire length of the Danaher Creek drainage. Today, this species is represented in this drainage by only a very few scattered, old-age individuals.

Picea sp. (probably Picea engelmanii x Picea glauca (Habeck and Weaver 1969)) grows over a wide altitudinal range on sites where there is abundant soil moisiture. Within the study area it is found primarily on discrete sites in the riparian areas and associated with Abies lasiocarpa on mesic northerly slopes.

Water tolerant shrub communities dominated by Betula glandulosa and Salix spp. occur primarily in the Danaher Creek drainage. The

major concentration of this vegetation is the wet lowland area known as Danaher Meadows. Other riparian communities which occur as inclusions along streams include Populus trichocarpa and Salix spp.

Meadows or grassland communities cover a relatively small proportion of the area in the South Fork. However, due to their role of providing forage for both domestic and native herbivores, the importance of these grassland areas is far out of proportion to their areal extent. These grassland communities occur primarily on the alluvial landforms of the valley bottoms and occasionally on the south facing mountain slopes. Artemisia tridentata - grassland communities occupy very limited areas on some of the alluvial fans in the Danaher and Youngs Creek drainages.

## History and Land Use

On May 20, 1931, most of the upper South Fork drainage was designated the South Fork Primitive Area under Forest Service administrative regulation L-20. In August of 1940, the Bob Marshall Wilderness was established under regulation U-1. It was composed of the South Fork and two contiguous primitive areas, the Sun River and Pentagon. On September 3, 1964, the Wilderness Act designated the Bob Marshall Wilderness a unit of the National Wilderness Preservation System.

Merriam (1963) described the history of the Bob Marshall and investigated the nature and economics of established uses. He

concluded that in 1960, wilderness was the best socio-economic use for the Bob Marshall.

Allowable land uses within the wilderness are clearly limited by the provisions of the Wilderness Act. This act states that "Wilderness areas shall be devoted to the public purposes of recreational, scenic, scientific, educational, conservation and historical use." Currently the most obvious on-site land use in the Bob Marshall is wilderness recreation.

Recreation use is in itself a broad category which includes many diverse activities. Recreational activities in the Bob Marshall vary considerably with the seasons. Summer use has been dominated by stock-oriented trail rides, fishing and sightseeing. River floating, another summer activity, has increased since 1979 when the portion of the South Fork within the study area was classified as "wild" under the Wild and Scenic Rivers Act. Fall use within the study area is dominated by hunting. It is estimated that over 90 percent of fall visitors to the Bob Marshall hunt (Lucas 1980). In addition to providing a high quality hunting experience, wilderness areas like the Bob Marshall offer the main remaining opportunity for an adventure involving travel by pack trains and isolated tent-camp living.

Method of travel is a variable in wilderness recreation which has great implications for resource impacts. The predominant method of travel in most wilderness areas is hiking (Hendee et al. 1978). The

Bob Marshall is a notable exception in that it has historically, and continues to be visited now, primarily by horse users. Studies by Lucas (1980) show that about two-thirds of Bob Marshall visitors use horses. The reasons for such a high percentage of horse use are not entirely clear, but my observations were that the size of the area and local traditions are probably contributing factors.

In addition to public visitor use, there is a substantial amount of commercial recreational use in the Bob Marshall. In 1981 there were 35 outfitters licensed to take visitors into the South Fork portion of the wilderness. Except for one outfitter who brings only backpackers into the wilderness, all of these outfitters use pack and saddle stock. It has been estimated that about one-third of the visitors to this wilderness employ the services of outfitters. However, outfitter use appears to be more important in the fall during hunting season. Lucas's (1980) figures show that the percentage of visitors served by outfitters rose from 29 percent in the summer to 47 percent in the fall.

Some of the statistics compiled by Lucas (1980) on use patterns and characteristics of visitors to the Bob Marshall are presented in Table 3. These statistics were compiled from 1970 visitor survey data.

TABLE 3. VISITOR CHARACTERISTICS AND USE PATTERNS, BOB MARSHALL WILDERNESS. 1/

Length of Stay

| Average Stay (days) | Percent of total for each length of stay (days) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8-10 | 11-21 |
| 5.7 | 14 | 10 | 13 | 11 | 3 | 7 | 0 | 20 | 15 |

Party Size

| Average size | Percent of total parties of indicated size | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5-10 | 11-20 | 21-30 |
| 4.7 | 6 | 21 | 15 | 13 | 42 | 0 | 2 |

Method of Travel

| Percent of total individual visits | | | |
|---|---|---|---|
| Hike | Horseback | Hike with Pack Stock | Other |
| 31 | 59 | 6 | 4 |

Activities Participated In

| Percent of total visits involving activity | | | | | | |
|---|---|---|---|---|---|---|
| Fish | Hunt | Hike | Photography | Nature Study | Swim | Other |
| 61 | 34 | 58 | 58 | 28 | 11 | 18 |

Time of Entry by Month

| Percent of total visitors | | | | | |
|---|---|---|---|---|---|
| June | July | August | September | October | November |
| 2 | 47 | 11 | 18 | 20 | 2 |

1/From Lucas 1980.

## Grazing

### Commercial Livestock Operations

Two homesteads were settled in the study area in 1898 for the purpose of raising livestock. These homesteads were located on that portion of the Danaher drainage known as Danaher Meadows. The homesteaders sowed 24 hectares (60 acres) to timothy and grazed nearly 200 head of cattle and horses (Merriam 1960). The stock were pastured on forest land in the summer and on native grass and hay in the winter. These livestock operations were adversely affected by climate, insufficient hay for wintering stock and the long distance to market over poor trails (Gabriel 1976). By 1907, both of these homesteads were abandoned. Since that time, there has been no grazing by domestic cattle or sheep within the study area.

### Recreational and Administrative Grazing

The season of use is largely controlled by climatic patterns. Except for a small amount of administrative use, which normally begins in mid-May, very little use occurs before July 1. Prior to this date, recreational use is discouraged by snowfilled mountain passes, rainy weather and wet, muddy trails. The heaviest prolonged use probably occurs during the hunting season from September 15 to October 31. By the end of October, cold weather and the threat of winter snows again discourage most use.

U.S. Forest Service estimates for the 1981 season show that

outfitters' stock accounted for approximately 650 horse months of grazing and Forest Service administrative stock accounted for approximately 80 horse months. No records are kept for non-outfitted recreational use but studies by Lucas (1980) suggest that close to half the visitors to the Bob Marshall using horses were not with outfitters. Actual stock use figures for an area like the Bob Marshall, however, are nearly meaningless unless they are tied to very specific locations within the wilderness.

Distribution problems are chronic. Horse use in wilderness tends to be more concentrated than hiking use (Hendee et al. 1979). Horse parties go farther but they tend to stay on the main trails. In addition, horse parties are generally limited to campsites where horse feed is available. As a result, wilderness areas with a high proportion of horse users tend to have more concentrated use than backpacking areas. In a study of the use patterns of eight wilderness and primitive areas in Montana and Idaho, Lucas (1980) found the Bob Marshall to have the most concentrated use.

Much of the stock use in the Bob Marshall is concentrated at certain destination points along habitual travel routes. These travel routes are partially set by the desire of many users to visit certain natural scenic areas. Probably the key attraction within the study area is the South Fork of the Flathead River itself. Most of the major forage areas are along the river corridor and these areas

certainly receive a large share of the grazing use. Other key scenic attractions responsible for setting use patterns are the Chinese Wall and Big Salmon Lake. Coupled with the high interest in these scenic areas is the situation in which a very few access points into the wilderness account for most of the use. In the entire Bob Marshall, 75 percent of the visitor use is accounted for by only three trailheads (Lucas 1980). When a majority of the visitors are starting at the same few points and often have the same destinations, it follows that a few travel routes will have the greatest share of use.

Primary concentrations of stock use along these major travel routes are located at established camping areas where there is good water and horse feed, at popular campsites at a distance of one days travel from the trailhead, at the natural scenic areas, or where fishing is especially good. At many locations along these travel routes, forage is very limited and few alternative camping areas exist for horse parties.

Other major concentrations of stock use are located in the vicinity of outfitter base camps and U.S. Forest Service administrative sites. In the summer months outfitted parties generally take roving trips through the wilderness, but during the hunting season most outfitters operate out of fixed base camps. The foraging areas near these camps are often used throughout the hunting season. Foraging areas near Forest Service administrative sites at

Black Bear and Big Prairie are used season-long by administrative stock in addition to recreational stock use.

Wildlife Grazing

The early history of elk in the South Fork is fragmentary. Apparently elk had been present in the South Fork drainage long before the first white man saw the area, as it is known that this drainage was a favorite hunting ground for both the Flathead and Blackfoot Indians (Gabriel 1976). Prior to 1900, records of big game merely mentioned the scarcity or abundance of a species in a particular region and these records suggest that fluctuation in big game numbers probably occurred (Pengelly 1960).

During the first half of this century, Forest Service personnel made winter trips through the South Fork to check on winter wildlife numbers and distribution. Reports from these trips show a definite increase in the elk population during the 1920's and the 1930's (Pengelly 1960). Gaffney (1941) presented what he believed to be a conservative estimate of 2600 elk wintering in the South Fork portion of the wilderness in 1937. By 1959, the total for the entire South Fork drainage was estimated by the Forest Service at 1550 head with only 550 head estimated for the wilderness portion of the drainage. The reliability of these estimates is certainly questionable when one considers the difficulty of obtaining an accurate census. There is no doubt, however, that the South Fork herd increased in the 20's and

30's and subsequently declined at least through the 1950's.

The reasons for the increase and later decline are not entirely clear. Pengelly (1960) suggested that the increase was encouraged in part by an increased forage supply provided by seral shrub stages which followed the large forest fires of 1889 and 1910. The gradual decrease in elk numbers since 1940 parallels the passing of these shrub stages into timber stages.

The South Fork herd has probably been maintained at fairly stable numbers in recent years. Total counts of game animals are no longer attempted in the study area. Instead, the Montana Department of Fish, Wildlife and Parks keeps records of various productivity factors such as cow-calf ratios, cow-bull ratios and harvest ratios.

The seasonal distribution of elk in the study area was described by Gaffney (1941) as follows: "In summer the elk range over the entire district. The winter range is confined to the valley bottoms, to the lower portions of the narrow tributary canyons and to hillsides to an elevation of about 2000 m (6500 ft) on south and west exposures, and about 1675 m (5500 ft) on north and east exposures."

The most favored elk feeding areas on the winter range are the open hillsides on south and west exposures. These sites are naturally preferred because the snow is less deep in such areas than on other parts of the range, allowing greater freedom of movement and making the forage available. Following heavy snowfalls there is a tendency

for the elk to be forced down toward the flats of the valley bottom, as elk travel more easily on flat terrain than on a hillside when snow is deep (Pengelly 1960).

The snow recedes rapidly from the lower slopes on south and west exposures after the first of April and the flats are usually bare between April 15 and May 1. The importance of the grassy flats in the valley bottom for elk spring range was strongly evidenced by the 1981 Department of Fish, Wildlife and Parks spring elk counts. On an April 15 flight, biologists observed 103 elk on Murphy Flats, 151 near the mouth of the White River, 122 at Big Prairie, 23 on Holbrook airstrip, 156 in the Danaher flats area, 81 in the Basin Creek area and 112 in the Youngs Creek area (Personal Communication, James Cross, Wildlife Biologist, Montana Dept. of Fish, Wildlife and Parks).

By the first part of July, most of the elk have left the valley bottoms and moved to summer ranges at higher elevations. In 1981 I entered the wilderness in mid-May. For several weeks I observed elk in the valley bottom almost daily. Through June, sightings became less frequent and by the end of June and thereafter I seldom saw elk in the valley.

A current concern of Bob Marshall Wilderness managers is the competition between elk and domestic stock for forage. As previously mentioned, much of the recreational grazing area is concentrated in the lower valleys that form an important part of the elk winter and

spring range. The effect of this recreational stock use on wintering elk is difficult to estimate but certainly the potential for competition exists.

## METHODS

### Stand Selection

During the summers of 1980 and 1981, 42 stands were selected for field sampling. These stands were subjectively chosen during field reconnaissance to represent the range in the types of primary grazing areas used by recreational livestock. The number of stands chosen to represent a type of grazing area was roughly proportional to the amount and importance of that type in the South Fork drainage. Of the 42 stands chosen, 34 were located on alluvial landforms in the river valleys and eight were on mountain slopes. After selecting a sample stand, its position was located on a USGS topographic map and the legal location was recorded.

### Vegetation

Within each stand selected for study, a 25 m (82 ft) transect was laid out using a chalkline and metal pins. The position of the transect within the stand was subjectively chosen so as to be as representative as possible of the stand as a whole. An additional consideration in transect placement was that it be as uniform as possible in both vegetation and soils. When the stand under consideration was on sloping ground, the transect line was placed either entirely on a rise or entirely in a swale.

Sampling was accomplished by placing a 2 x 5 dm (7.9 x 19.7 in) frame-plot at meter intervals along the transect line for a total of 25 plots per line. Canopy coverage of each vascular plant species

(except for trees) in the stand was estimated using the method described by Daubenmire (1959). Coverage values for litter, bare soil, surface rock (cobble size and larger), and surface gravel were determined in the same manner.

Stand productivity was estimated from standing crop measurements. Standing crop was measured in both 1980 and 1981 on 19 of the 42 stands. The remaining 23 stands were measured in only one of the two years. Standing crop sampling was done at the same time and using the same 25 plots as the cover sampling. Ideally it would have been desirable to schedule these measurements at the time of peak standing crop but logistical limitations made this unfeasible.

Standing crop of each vascular plant species was measured using the biomass partitioning method of Klapp (1929). This method is based on dry weight proportions as estimated from fresh weight proportions under field conditions (Mueller-Dombois and Ellenberg 1974). Initially, the dry weight proportions of the major life form categories (graminoids, forbs and shrubs) were estimated as a percentage of the total standing crop in each plot. The relative amounts of each species within a life form category were then partitioned in the same manner. All of the current year's growth within the plot was then clipped to ground level and weighed with a 100 x 1 gm (3.5 x .035 oz) spring scale. The clippings from every fifth plot (i.e., 5 plots/stand) were sacked and air-dried for a

minimum of two months. These were then reweighed to provide a correction factor for moisture content.

Plant species encountered in each plot were either identified in the field with the aid of applicable keys or were assigned an identification number until subsequently identified. A number of the indigenous plant species did not occur in the stand analysis plots so an effort was made to collect and identify as much of the flora as possible. Specimens were pressed and dried in the field and later verified by Alma Plantenberg, Biology Department, Montana State University. Of the 186 species identified during the course of this study, 150 were verified and are represented by voucher specimens on file at the Spotted Bear Ranger District, Flathead National Forest. Plant nomenclature follows Hitchcock and Cronquist (1973).

## Site and Soils

Site data recorded at each stand included slope, exposure (aspect), elevation and landform. The slope was measured with a clinometer, aspect was determined with a pocket compass and elevation was determined from USGS topographic maps.

Physical and descriptive characteristics of the soils occuring at 40 of the 42 study stands were determined through field measurements and laboratory analyses. A soil pit excavated to a depth of 65 cm (25 in) was centrally located within each of these stands. Observations noted within the pit included depth of mollic epipedon (if present)

and the general textural characteristics of the profile. A soil sample was collected from the upper 25 cm (10 in) of each pit. This sample was air-dried and screened to remove the coarse fragments (particles greater than 2 mm diam.). Percentage of coarse fragments by weight was then calculated for each sample. The screened sample was oven dried at 100°C (212°F) for 24 hours and then analyzed for percentage of sand, silt and clay by the Bouyoucos (1939) hydrometer method.

A composite soil sample was collected from the upper 25 cm (10 in) of three additional pits within each stand. This composite sample was made into a paste with the addition of distilled water and pH was determined with a glass electrode pH meter. Organic matter was determined by ashing a 15 g (.525 oz) subsample at 580°C (1076°F) for 18 hours. The difference in weight following ashing was assumed to be roughly equal to the amount of organic matter in the sample.

Soil profile descriptions were recorded at eight of the sample stands with the assistance of Albin Martinson, Flathead National Forest Soil Scientist. These stands were selected to represent a variety of the plant communities studied.

## Data Analysis

Vegetation data were subjected to computer analyses using ordination and cluster analysis techniques to assist in the grouping of stands. Cluster analysis procedures followed the linkage method

described by Sokal and Sneath (1963). This method uses a product-moment correlation coefficient to determine similarity of stands.

A two dimensional ordination of stands was obtained using a similarity ordination program. This program follows the method described by Swan et al. (1969) and uses Sorensen's (1948) index to determine similarity of stands. Although a three dimensional ordination was constructed, it was apparent that a majority of the intercommunity compositional variation was satisfactorily described with the stand arrangement along the primary and secondary axes.

## RESULTS AND DISCUSSION

### Results of the Cluster Analysis

The results of the cluster analysis are illustrated by the dendrograms presented in Figures 4 and 5. These dendrograms were developed using species canopy coverage values (Figure 4) and percent composition by weight values (Figure 5). Values from each of the 130 species encountered in the stand analysis plots were used to produce the dendrograms.

As one might expect, the dendrograms developed from the coverage values and composition by weight values showed very similar results. Both of these dendrograms distinguish five major groupings of stands (clusters A-E). One residual stand, stand 12, shows very little similarity with the other stands, and therefore remains unclustered. All stands were consistant as to affiliation with a major cluster group except stands 25, 30, 33 and 41 which oscillated between clusters A and B. Several stands, although consistant as to affiliation with a group, clustered with their respective groups at much lower levels of similarity than the "core" stands. Examples of this are stands 28, 31 and 13 (cluster E). These outlier stands can probably best be considered as subgroups of the primary stand group.

An effective way of determining which species contribute most to the definition of cluster groups and therefore to the major community types is to rearrange both species and stands in the construction of an association table. In Table 4, the species are arranged along the

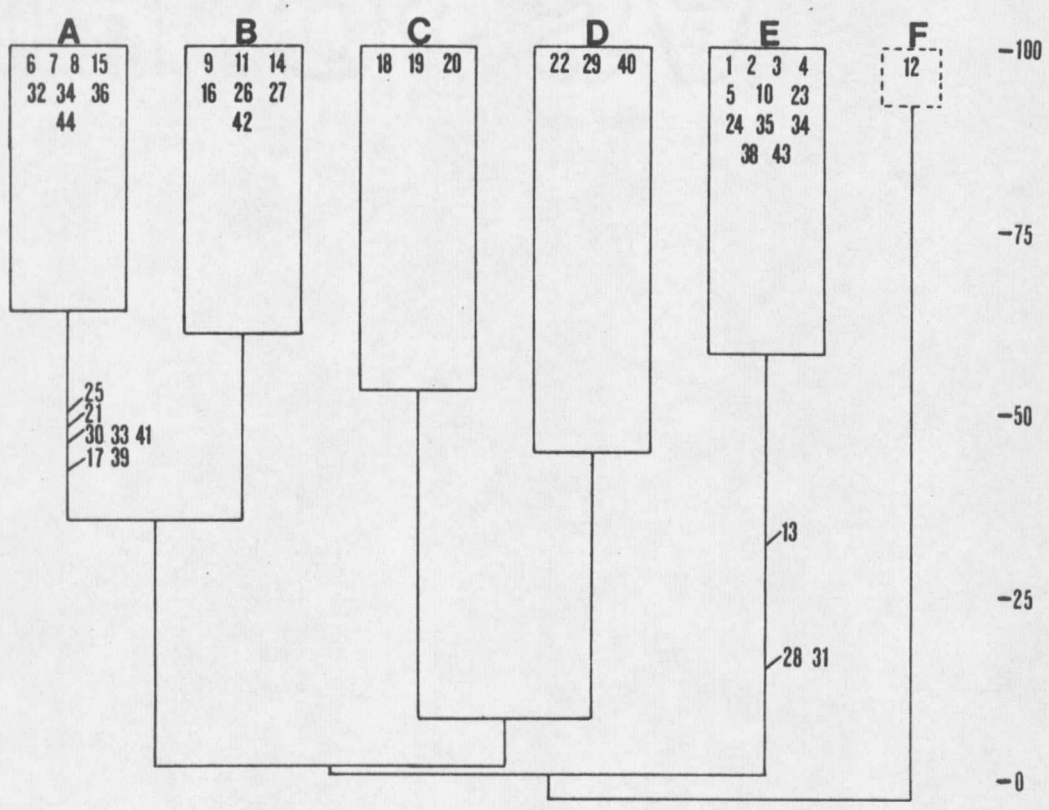



Figure 4. Dendrogram derived from cluster analysis of 42 stands using species coverage values. The scale at the right of the figure indicates level of similarity.

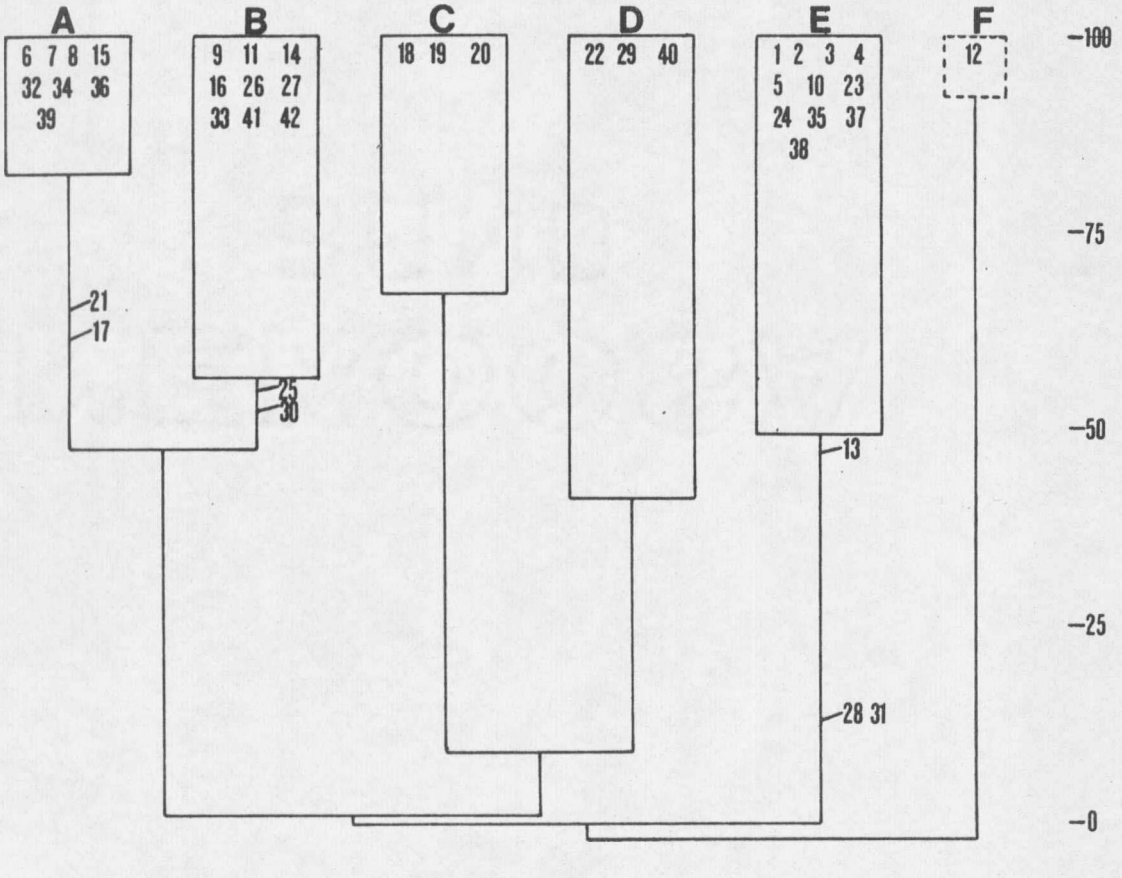
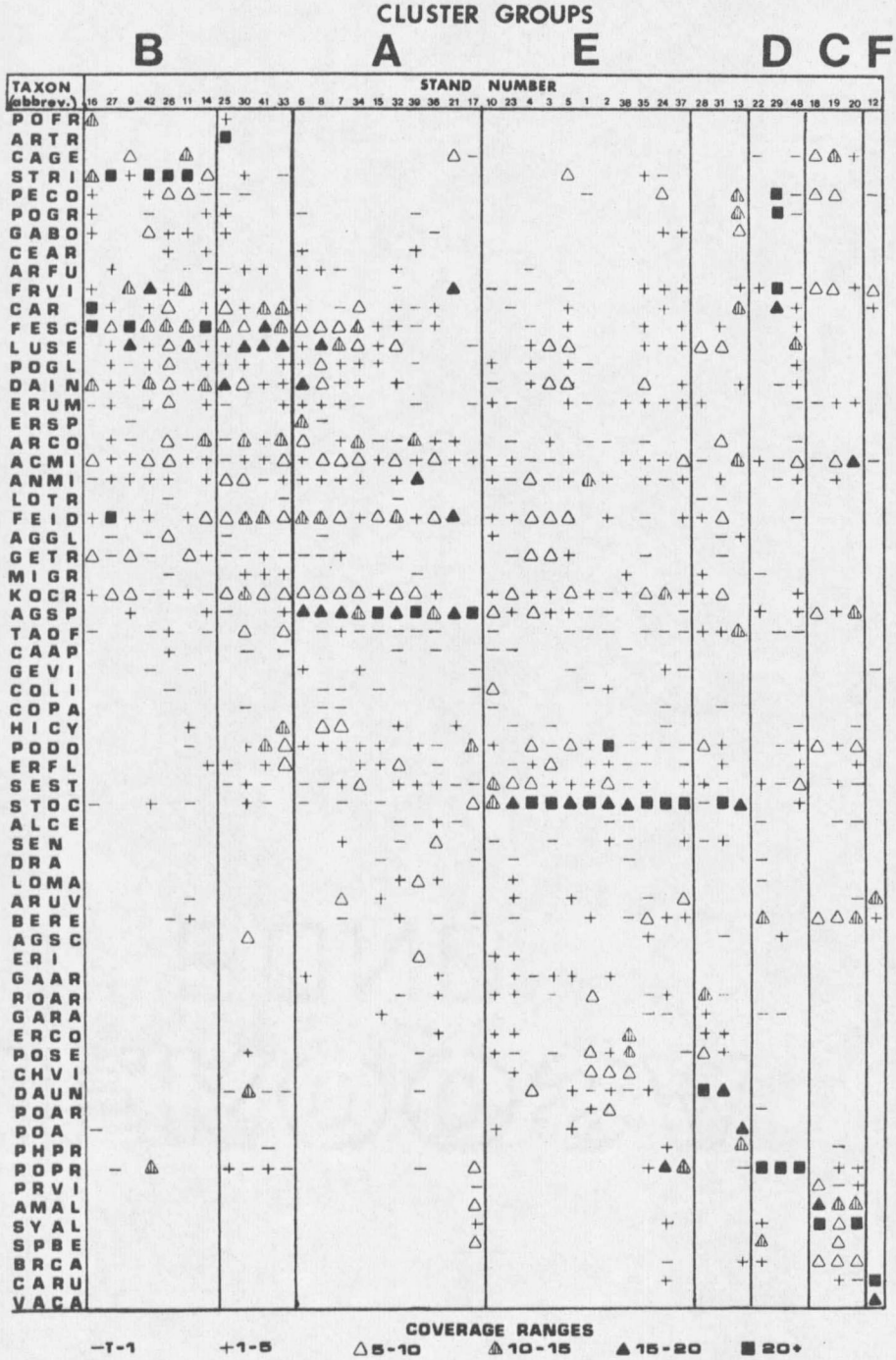



Figure 5. Dendrogram derived from cluster analysis of 42 stands using species composition by weight values. The scale at the right of the figure indicates level of similarity.

TABLE 4. ASSOCIATION TABLE BASED ON SPECIES COVERAGE VALUES.



side of the table in a sequence intended to emphasize as much as possible the compositional relationships of the clusters. Species included in this table are those which were present in three or more stands or which attained a coverage value of at least 10 percent in any one of the stands.

The stand clusters are arranged along the top of the table in a sequence intended to emphasize their compositional relationships. Stands which either oscillated between clusters or appeared as outliers of a single major group are positioned between the major cluster groups.

Examination of the association table suggests that the major clusters may be distinguished most meaningfully as follows: Cluster A (Agropyron spicatum - Festuca idahoensis communities, 10 stands), Cluster B (Festuca scabrella - Stipa richardsonii communities 7 stands), Cluster C (Symphoricarpos albus - Amelanchier alnifolia communities, 3 stands), Cluster D (Poa pratensis communities, 3 stands), Cluster E (Stipa occidentalis - Koeleria cristata communities, 11 stands). Although not readily apparent from this Table, stand 12 can best be identified as a Pinus contorta - Calamogrostis rubescens community. The remaining seven stands are best considered as outliers of clusters B and E.

## Results of the Ordination

The community ordination presented in Figure 6 was developed from

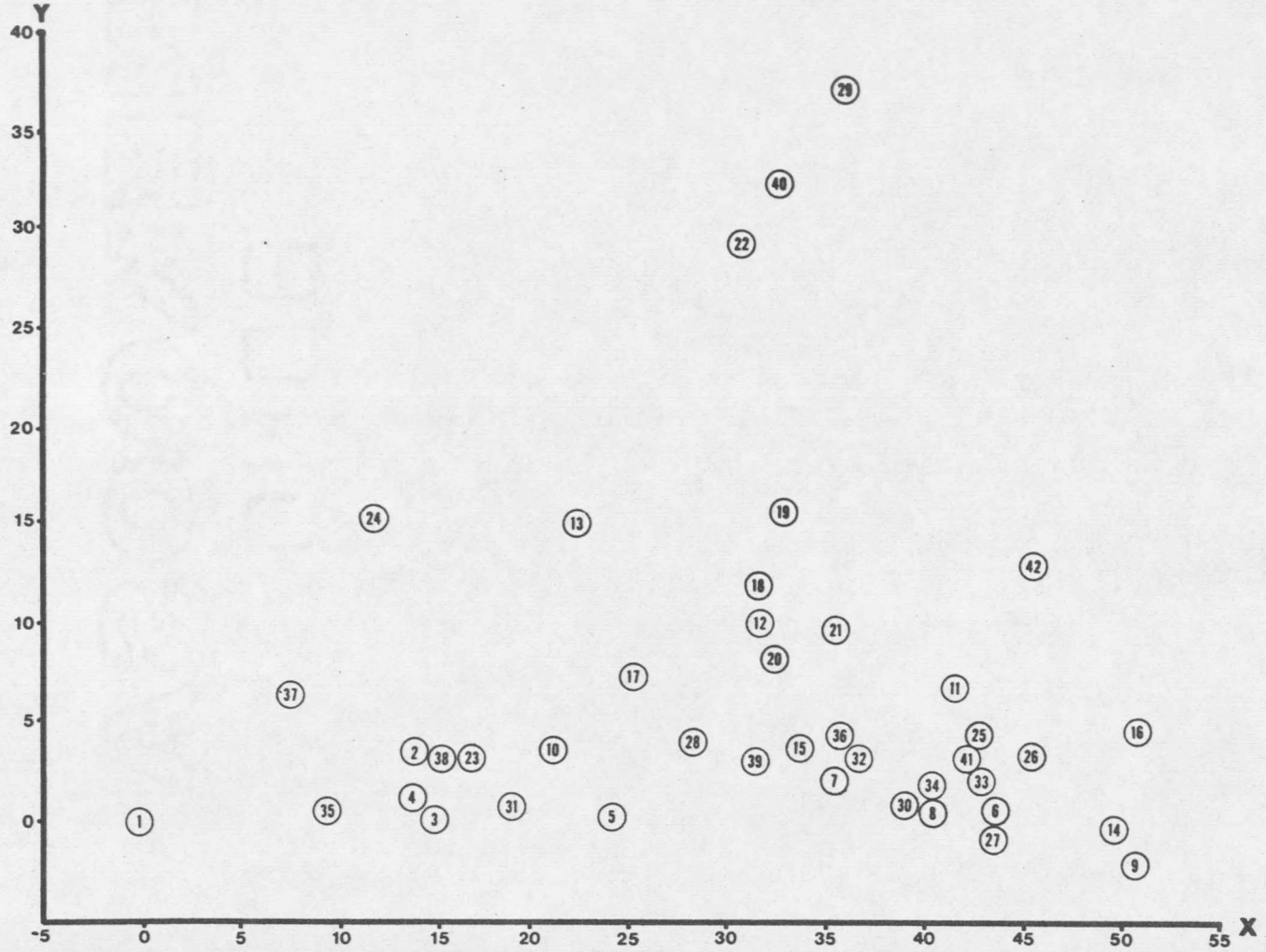



Figure 6. Two dimensional ordination of 42 stands based on species coverage values.

species coverage values. As with the cluster analysis, values for each of the 130 species encountered in the stand analysis plots were used.

By plotting the stand coverage values for each species on the ordination field as circles of different sizes, the species that have the most influence on the definition of stand groupings can be determined (Stringer 1973). The following grass species appear to have the greatest influence on the distribution of stands on the ordination field: Agropyron spicatum, Festuca idahoensis, Festuca scabrella, Poa pratensis, Stipa occidentalis, and Stipa richardsonii. A series of ordinational diagrams for each of these species is presented in Figure 7. These diagrams have been arranged within the figure to emphasize the compositional shifts which occur primarily along the X (horizontal) axis and to a lesser extent along the Y (vertical) axis of the ordination.

Stands in the lower left hand corner of the ordination are strongly dominated by Stipa occidentalis. Although this species occurs in minor amounts in other stands, there is a relatively abrupt compositional shift between stands dominated by this species and the stands in the lower right hand portion of the ordination.

Agropyron spiciatum is nearly ubiquitous throughout the ordination but reaches its maximum values in the lower central portion of the ordination. Festuca idahoensis, a common associate of

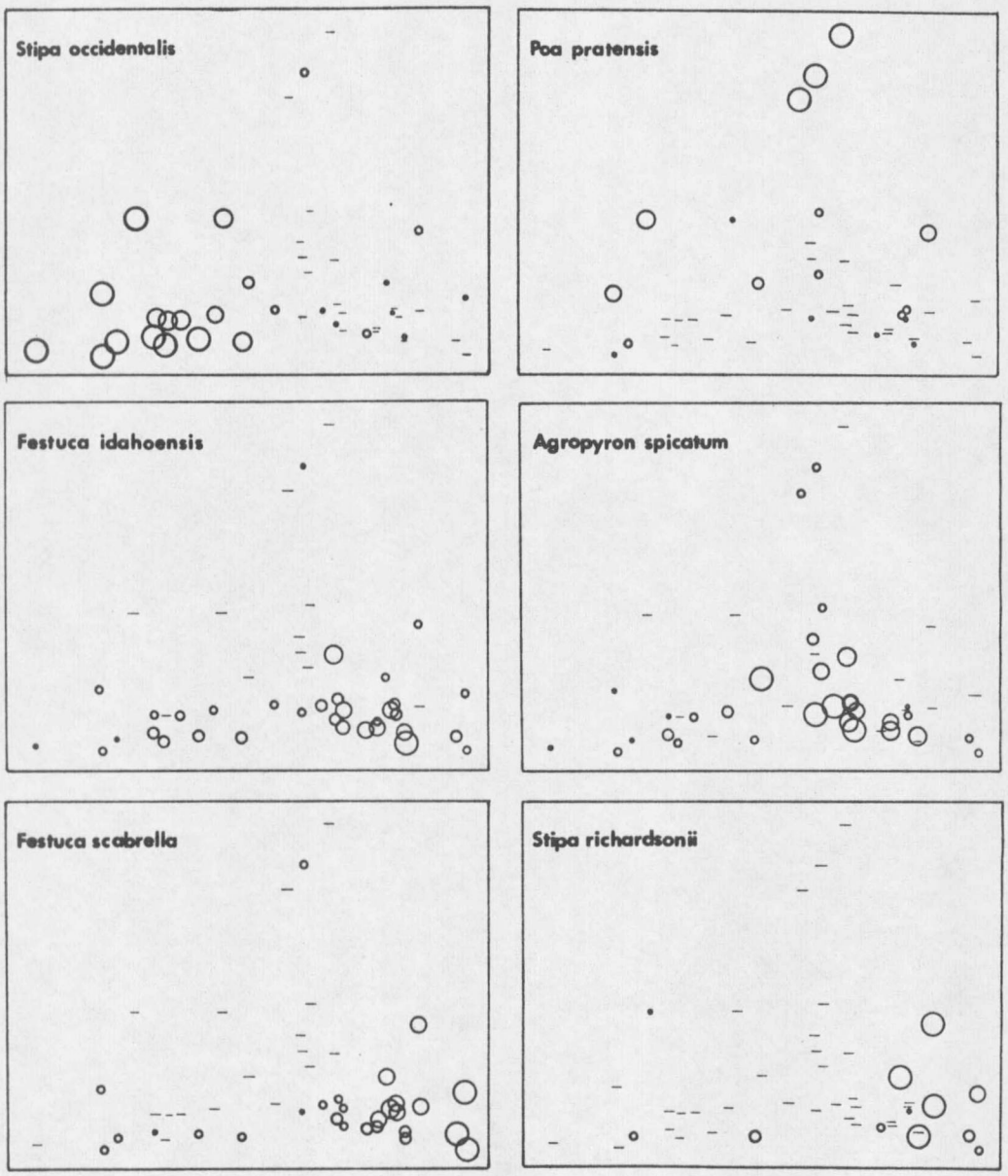



Figure 7. The distribution patterns of six grass species on the 42 stand ordination. Progressively larger circles represent species coverage percentages of 0-1, 1-5, 5-10, 10-15 and 20+; absence represented by a dash.

Agropyron spicatum in western Montana grassland communities, shows a similar distribution here although it does not reach the high coverage values shown by Agropyron spicatum.

Festuca scabrella represents another shift within the ordination with its highest coverage values concentrated in the lower right portion. Stipa richardsonii demonstrates a distribution pattern very much like that of Festuca scabrella except that its distribution appears much more restricted. Compositional changes between stands dominated by Agropyron spicatum and Festuca idahoensis and stands dominated by Festuca scabrella and Stipa richardsonii, although apparent on the ordination, are relatively gradual and show some degree of overlap.

Poa pratensis, an exotic rhizomatous species, represents the only major compositional shift along the vertical axis of the ordination. This species reaches its maximum coverage values within the three stands at the top of the ordination field and gradually decreases toward the bottom.

## Community Classification

The study locations were assigned to groupings on the basis of the results from the cluster analysis, ordination and field observations. The 42 locations were divided into six major community types with one of these groups containing two phases and one group containing three phases. This classification is shown in Table 5.

The term "phase" is used here to distinguish stands which, although bearing a compositional similarity with the stands in a community type (usually through the dominant species), differed enough to warrant separate description.

This classification differs from the habitat type concept of classification (Daubenmire 1952) in that it reflects similarities in the existing vegetation without regard to the permanence of the groupings. The habitat type approach is based on classification of the potential climax vegetation and does not necessarily reflect similarities in current vegetation (Pfister 1981). Based on field experience, most of the parkland communities in the South Fork are

TABLE 5. PLANT COMMUNITY CLASSIFICATION BASED ON 42 SAMPLE STANDS

| |
|---|
| *Festuca scabrella* - *Stipa richardsonii* community type |
| Typical phase |
| *Festuca idahoensis* phase |
| *Artemisia tridentata* phase |
| *Agropyron spicatum* - *Festuca idahoensis* community type |
| *Stipa occidentalis* - *Koeleria cristata* community type |
| Typical phase |
| *Phleum pratense* phase |
| *Poa pratensis* phase |
| *Danthonia unispicata* phase |
| *Poa pratensis* community type |
| *Symphoricarpos albus* - *Amelanchier alnifolia* community type |
| *Pinus contorta* - *Calamagrostis rubescens* community type |

believed to represent stages in primary or secondary successions. It is further believed that these seral stages are frequently more useful as a grazing resource than the potential climax. An assessment and classification of the existing vegetation is therefore probably more useful to managers in this situation than a classification based on the potential climax vegetation.

## Description of Communities

### *Festuca scabrella* - *Stipa richardsonii* Community Type

This community type (Figure 8) occurs primarily on the glacial outwash terraces and alluvial fans of the valley floor along the Danaher Creek drainage. Other major concentrations of this type are

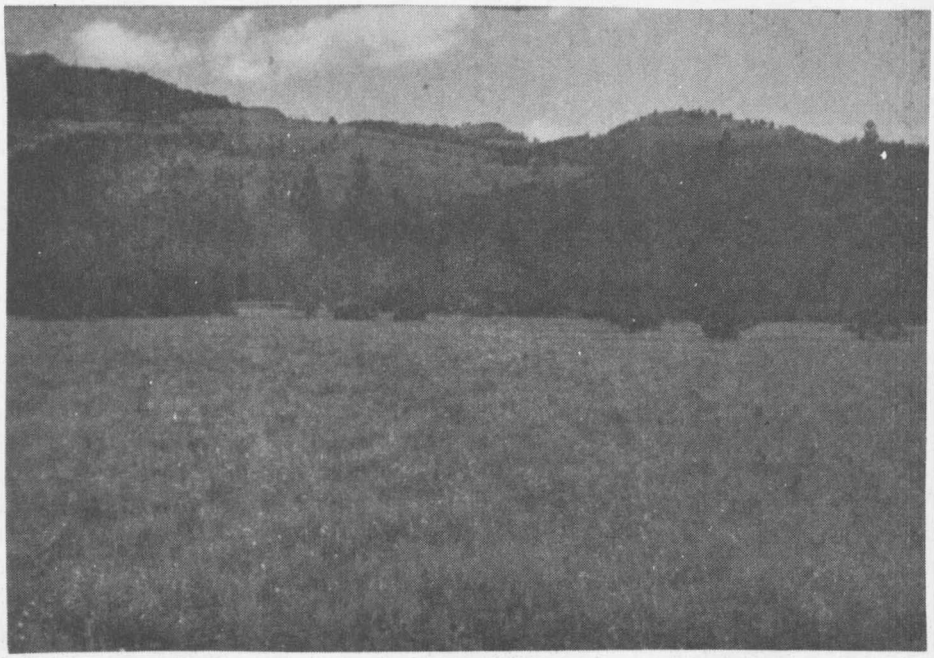


Figure 8. *Festuca scabrella*-*Stipa richardsonii* community type near the mouth of Camp Creek.

found in the Lime Creek area, on White River Park and portions of Murphy Flats. It generally occurs on level or gently sloping ground (0-5% slope).

Soils were classified as Inceptisols and Mollisols. These soils are in a frigid temperature regime and are loamy skeletal or loamy over sandy skeletal families. Mollic epipedons or at least intergrades to mollic epipedons were observed on all of these sites. Surface soil textures varied from loamy sands to loams. Soil reaction was moderately acid with pH values ranging from 5.4 to 6.0 in the surface horizons. Very little bare soil or rock is exposed in this community type.

Festuca scabrella and Stipa richardsonii are species which are generally associated with a mesic grassland environment (Stickney 1960; Mueggler and Stewart 1980). Similarly, field observations indicate that this community type is among the most mesic of those sampled during the course of this study.

These Festuca scabrella - Stipa richardsonii communities occur both as understory unions beneath a canopy of mature Pinus ponderosa and as open meadows. One of the sample stands (stand 16) was under a canopy of Potentilla fruticosa but was included with this group because of its overall floristic similarities. The total coverage of vascular plants was quite high with a mean of 112 percent coverage. Species diversity was fairly low with the seven stands averaging only

21 species per stand.

Dominance is shared by Festuca scabrella and Stipa richardsonii. Agropyron spicatum and Stipa occidentalis occur in some stands but are generally inconspicuous. Danthonia intermedia, a species which is nearly ubiquitous in all of the communities studied, reaches its greatest abundance in this community type. Other important graminoid species include Festuca idahoensis, Koeleria cristata and various species of Carex. Lupinus sericeus and Fragaria virginiana are the most conspicuous and abundant forb species. Other commonly occurring forbs are Penstemon confertus, Geum triflorum, Achillea millefolium, Eriogonum umbellatum, Potentilla glandulosa and Arenaria congesta. Shrubs are seldom encountered in these communities except in the Potentilla fruticosa stands in the Danaher Creek drainage.

The open meadows of this community type fit within the Stipa richardsonii phase of the Festuca scabrella/Festuca idahoensis habitat type described by Mueggler and Stewart (1980). An exception is stand 16 which probably best fits within their Potentilla fruticosa/Festuca scabrella habitat type. Stands occuring as understory unions beneath Pinus ponderosa fit within the Pseudotsuga menziesii/Festuca scabrella habitat type described by Pfister et al. (1977).

This group of stands produced the most forage of any of the major community types sampled. Standing crop of all vegetation ranged from 1030 to 1535 kg/ha (920 to 1370 lb/acre) of which approximately 75

percent was perennial graminoids and the remainder mostly forbs. Mueggler and Stewart (1981) reported a range of 1200 to 1825 kg/ha (1072 to 1630 lb/acre) for similar vegetation in their Festuca scabrella/Festuca idahoensis habitat type.

Graminoid standing crop ranged from 670 to 1175 kg/ha (600 to 1050 lb/acre). The two dominant grass species, Festuca scabrella and Stipa richardsonii, comprised nearly half of the total standing crop in all stands sampled and are clearly the major forage species. Other important forage species include Festuca idahoensis, Danthonia intermedia, Koeleria cristata and Carex spp.

Artemisia tridentata Phase

Artemisia tridentata is not a common plant within the study area. Its occurrence is restricted to some of the subirrigated alluvial fans of the Danaher Creek drainage and near the mouth of Hahn Creek in the Youngs Creek drainage.

The vegetation of these communities (Figure 9) is characterized by the association of Artemisia tridentata and Festuca scabrella. Other prominent graminoid species include Danthonia intermedia, Festuca idahoensis, Koeleria cristata and various species of Carex. Common forbs include Lupinus sericeus, Potentialla glandulosa and Antennaria microphylla. These communities fall within the Artemisia tridentata/Festuca scabrella habitat type described by Mueggler and Stewart (1980).

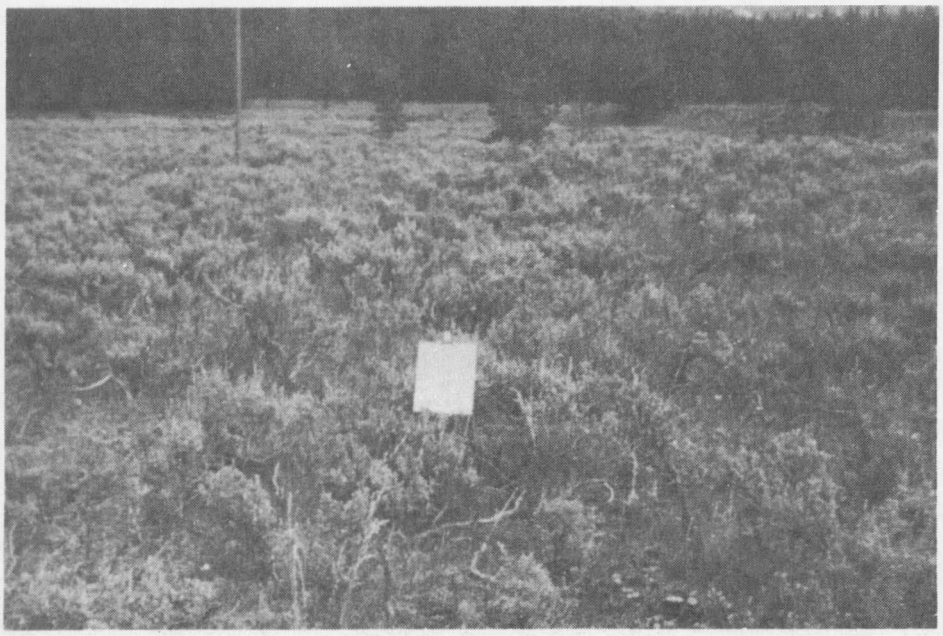


Figure 9. Artemisia tridentata phase near the mouth of Basin Creek.

Total vegetation standing crop on the one sample stand representing these communities (stand 25) was 1003 kg/ha (896 lb/acre) of which 592 kg (529 lb) was graminoids. Although only one stand was sampled, these figures are believed to be representative of this phase.

Festuca idahoensis Phase

Of the three sample sites representing this phase (Figure 10), two were located on outwash terraces and one on an alluvial terrace. All three stands are subjected to fairly heavy grazing by elk in the spring and moderate to heavy horse use in the fall. These sites appear to be drier than those supporting the Festuca scabrella - Stipa

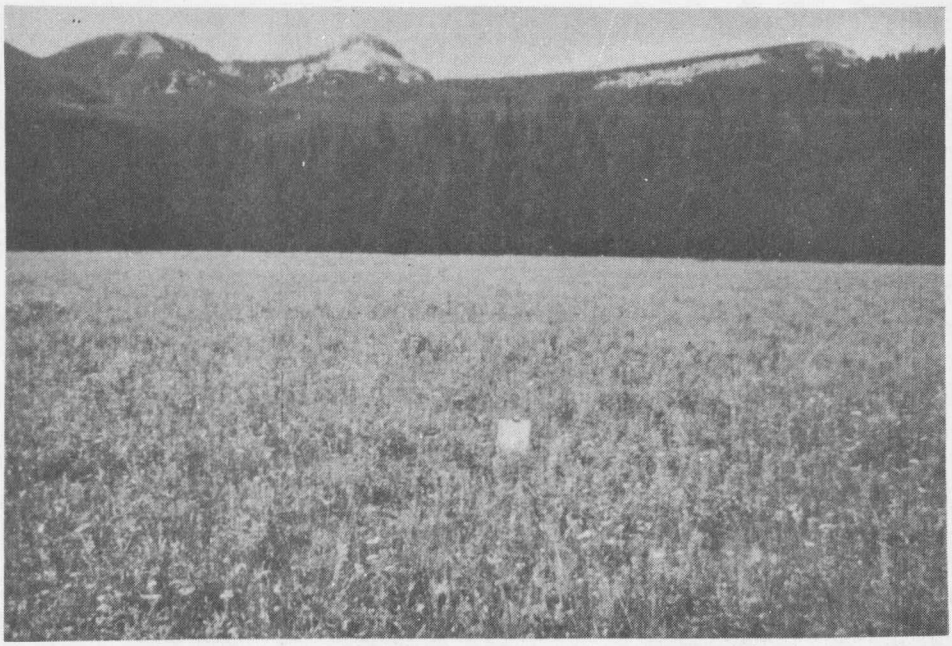


Figure 10. Festuca idahoensis phase near the mouth of Bartlett Creek.

richardsonii communities.

These stands differ compositionally from the Festuca scabrella - Stipa richardsonii group by the scarcity or absence of Stipa richardsonii. Festuca scabrella remains the dominant species but its normally robust stature is greatly reduced. The low vigor of Festuca scabrella is most likely an indicator of excessive grazing pressure.

Total standing crop was generally less than in the Festuca scabrella - Stipa richardsonii communities ranging from 883 to 979 kg/ha (788 to 874 lb/acre). Graminoid standing crop ranged from 468 to 608 kg/ha (418 to 543 lb/acre).

*Agropyron spicatum* - *Festuca idahoensis* Community Type

This community type (Figure 11) was observed on a variety of landforms including recent alluvial terraces, outwash terraces and steep mountain slopes. Elevations of sample sites ranged from 1332 to 2182 m (4370 to 7160 ft). On mountain slopes, these communities are restricted to residual soils on south and west exposures. The moisture holding capacity of these soils is limited as they are shallow to bedrock and generally coarse textured. The low water holding capacity coupled with high evapotranspiration demands on these warm exposures results in sites that are relatively xeric. On the alluvial landforms, water holding capacities of soils supporting this



Figure 11. *Agropyron spicatum*-*Festuca idahoensis* community type near the mouth of Hahn Creek.

vegetation are limited by coarse textures and high percentages of coarse fragments.

On the outwash terraces and mountain slopes, soils are classified as Inceptisols or Mollisols. Soils on the recent alluvial terraces are classified as Inceptisols and Entisols. These soils are in a frigid temperature regime and are in sandy skeletal or loamy over sandy skeletal families. Surface soil pH ranged from 5.6 to 6.6. Organic matter content ranged from 5.0 to 13.2 percent.

This community type occurs either as an understory union beneath a canopy of Pinus ponderosa or Pseudotsuga menziesii or in open meadows. Total canopy coverage of vascular plants averaged about 90 percent. Coverage of graminoids and forbs was nearly equal with mean values of 45 and 43 percent respectively. The number of species encountered in the stand analysis plots ranged from 19 to 27 species per stand.

Agropyron spicatum was clearly the dominant species in these stands. Festuca idahoensis is a constant and abundant species on the alluvial landforms but is occasionally lacking on the residual mountain slopes. On these mountain slopes, Carex geyeri often becomes more prevalent than Festuca idahoenis. Festuca scabrella, Danthonia intermedia and Koeleria cristata are usually present. Lupinus sericeus occurs in most stands and is usually the most conspicuous forb species. Other common forb species include Arnica fulgens,

Potentilla glandulosa, Arenaria congesta, Antennaria microphylla and Sedum stenopetalum.

Shrubs are usually an inconspicuous component of the flora on the alluvial landforms but species such a Amelanchier alnifolia and Symphoricarpos albus are locally abundant on some of the residual slopes.

The vegetation of open meadows in this community type corresponds fairly well with that described by Mueggler and Stewart (1980) for their Festuca idahoensis/Agropyron spicatum habitat type. Stands occuring as forest understory unions are believed to fall within either the Pseudotsuga menziesii/Festuca idahoensis habitat type or the Agropyron spicatum phase of the Pseudotsuga menziesii/Calamogrostis rubescens habitat type described by Pfister et al. (1977).

Although a wide range in production was observed in this community type it was generally intermediate in productivity between the main Stipa occidentalis type and the Festuca scabrella type. Total standing crop of vegetation ranged from 420 to 1130 kg/ha (375 to 1010 lb/acre), with a mean of 820 kg/ha (730 lb/acre). Approximately two-thirds consisted of graminoids and about one-third was forbs. Graminoid standing crop ranged from 263 to 773 kg/ha (235 to 690 lb/acre) with a mean of 526 kh/ha (470 lb/acre). Most of the graminoid production consisted of palatable grasses. Agropyron

spicatum provided from 15 to 25 percent of the herbaceous biomass in these communities. Other important forage species included Festuca idahoensis, Festuca scabrella and Koeleria cristata.

Stipa occidentalis - Koeleria cristata Community Type

This community type (Figure 12) occurs as open meadows on the most recent alluvial terraces along the South Fork River. It is the major meadow community type of these lower terraces from the mouth of Black Bear Creek to the junction of Youngs and Danaher Creeks. These terraces are nearly level, although they are characterized by a rise-and-swale microtopography. Elevations of sample locations ranged from 1244 to 1338 m (4080 to 4390 ft).



Figure 12. Stipa occidentalis-Koeleria cristata community type near the mouth of Hodag Creek.

These sites have geologically young soils, classified as Entisols, in which little development has occurred except for the leaching of calcium carbonates. No evidence of a mollic epipedon was observed on any of these sites. They commonly have a layer of low energy water deposited sediments overlaying high energy deposits of coarse sands and gravels. Textures in the upper layer were classed as gravely sandy loams and gravely loamy sands. This upper layer ranged in depth from 13 to 51 cm (5 to 20 in) with a mean of 28 cm (11 in). Soil pH in the upper 25 cm (10 in) was higher than in the other major community types averaging 6.5. Percentage organic matter ranged from 2.2 to 6.0 percent which was generally lower than in the other communities sampled.

Although no soil moisture measurements were taken, these sites are believed to be among the driest in the study area due to the low water holding capacity of the soils. Field observations indicated that vegetation on these sites was the earliest to dry out and reach summer dormancy.

Total canopy coverage of vascular plants was lower in this community type (mean coverage 84 percent) than in any of the other major community types sampled. Canopy coverage of graminoids and forbs was similar with mean coverage values of 44 and 38 percent respectively. The number of plant species encountered in the stand analysis plots ranged from 19 to 28 species per stand.

The vegetation of these communities is characterized by the dominance of Stipa occidentalis and the frequent presence of Danthonia unispicata and Poa sandbergii. Koeleria cristata and Festuca idahoensis occurred in most stands sampled but are of secondary importance to the dominant Stipa occidentalis. Agropyron spicatum and Festuca scabrella are commonly present but do not attain the high coverage values as in the Agropyron spicatum - Festuca idahoensis or Festuca scabrella - Stipa richardsonii communities.

A variety of forb species occur in this community type. Antennaria microphylla and Sedum stenopetalum are the most consistently occuring forb species. Although these species occur in many of the meadow communities in the South Fork, they generally reach their highest cover values in this community type. Other forb species achieving their highest cover values in these communities include Polygonum douglasii, Eriogonum flavum, Gaillardia aristata and Chrysopsis villosa. Shrubs are an inconspicuous component of the vegetation although Berberis repens, Arctostaphylos uva-ursi and Rosa arkansana are frequently present in minor amounts.

The abundance of Stipa occidentalis as well as the generally low vigor of Agropyron spicatum, Festuca idahoensis and Festuca scabrella suggest that changes in community composition have resulted from excessive grazing on these sites. Mueggler and Stewart (1980) reported that Stipa occidentalis increases with grazing pressure in

their Festuca idahoensis and Festuca scabrella habitat types. Similarly, Reid and Pickford (1946) suggested that an abundance of Stipa occidentalis was indicative of severe overgrazing on mountain meadows in eastern Oregon and Washington. It seems likely that these Stipa occidentalis - Koeleria cristata communities represent a retrogressional stage of the Agropyron spicatum - Festuca idahoensis community type. This view is supported by McLean (1970) and McLean et al. (1971) who reported that as a result of heavy grazing, Stipa occidentalis often replaces Agropyron spicatum and Festuca idahoensis on dry parkland sites in southern British Columbia.

These communities were the least productive of all the major communities sampled. Standing crop of all vegetation ranged from 360 to 917 kg/ha (321 to 819 lb/acre) with a mean of 711 kg/ha (635 lb/acre). Due to the porous nature and low water holding capacity of the soils, productivity may be strongly affected by the seasonal distribution of precipitation. Six of the stands representing this community type were clipped in both years of the study. In all six of these stands, the standing crop in 1981 was less than that in 1980. In 1981, rainfall was well above average in May and June but from the second week in July through the end of August, very little precipitation was received. In 1980, fairly regular rainfall was received through the months of July and August. The summer rains in July and August appear to replenish the soil water and effectively

extend the growing season on these sites.

Grasses and sedges contributed about 55 percent of the total biomass. Standing crop of graminoids ranged from 159 to 606 kg/ha (142 to 541 lb/acre) with a mean of about 392 kg/ha (350 lb/acre). Stipa occidentalis is the major forage producer, contributing over 23 percent of the total biomass in most stands. Other important forage species include Agropyron spicatum, Koeleria cristata, Festuca idahoensis and Poa sandbergii.

Danthonia unispicata Phase

This phase occurs on sites similar to those described for the main Stipa occidentalis - Koeleria cristata community type. This phase is also compositionally similar to the main Stipa occidentalis - Koeleria cristata group except for the dominant status of Danthonia unispicata. Stipa occidentalis is always present in these communities but is generally of secondary importance. Beetle (1977) described Danthonia unispicata as "occuring on open disturbed ground on dry or rock soils near lodgepole pine forests". All of the locations where these communities were observed are subject to heavy grazing by both elk and horses. These communities are therefore believed to represent a grazing-induced retrogressional stage of the Stipa occidentalis - Koeleria cristata community type.

Total standing crop at the two stands (stand 28 and 31) representing this community type was 688 and 860 kg/ha (614 and 768

lb/acre) respectively. Graminoid standing crop was 375 and 592 kg/ha (335 and 529 lb/acre) respectively. The lower figures from stand 28 are believed to be more representative of this phase than those from stand 31.

*Poa pratensis* Phase

This phase was observed on a variety of landforms ranging from steep mountain slopes to level alluvial sites. These sites appear to be more mesic than the main *Stipa occidentalis* - *Koeleria cristata* community type, however data supporting this observation are lacking.

The constant association and abundance of *Poa pratensis* with the *Stipa occidentalis* separates these communities from the main *Stipa occidentalis* - *Koeleria cristata* group. *Poa pratensis* is well recognized as an indicator of past disturbance in mountain grasslands (Daubenmire 1970; USDA 1977) and there is little doubt that this community type has resulted from disturbance. Similar vegetation was observed on the disturbed areas adjacent to trails on some *Agropyron spicatum* - *Festuca idahoensis* and *Festuca scabrella* - *Stipa richardsonii* meadows. All of the sites where this vegetation was observed are believed to be excessively grazed either currently or at some time in the past.

Standing crop of all vegetation on the two study sites representing this community type was 803 and 1114 kg/ha (717 and 995 lb/acre). Graminoid standing crop was 554 and 840 kg/ha (495 and 750

lb/acre) on the two sites.

*Phleum pratense* Phase

This phase is confined to several meadows in the vicinity of the Big Prairie guard station but was sampled because of the importance of these meadows as a grazing resource for both recreational and administrative stock as well as elk. These meadows occur on alluvial fans having deep soils. They are among the most mesic meadow types in the study area.

These communities bear little compositional relationship with the *Stipa occidentalis* - *Koeleria cristata* group except for the abundance of *Stipa occidentalis*. The occurrence of this species as a dominant on some of the most mesic as well as some of the driest sites illustrates its broad ecological amplitude within the study area. *Phleum pratense* is a codominant with the *Stipa*. Other prominent graminoids include *Danthonia intermedia* and various species of *Poa* and *Carex*. The predominant forbs are species that generally tend to increase with grazing pressure. These include *Achillea millefolium*, *Galium boreale*, *Penstemon confertus* and *Taraxacum officinale*. No shrub species were encountered in the stand analysis plots but *Potentilla fruticosa* occurs on some of the sites.

Stand 13, the only representative of this phase, has a history of disturbance. It was formerly used as a hay meadow by the Forest Service. It is currently heavily grazed season-long by elk in the

spring and horses throughout the summer and fall. Despite the level of use, it was the most productive site sampled during the study. Standing crop was approximately 2240 kg/ha (2000 lb/acre) of air-dry vegetation of which about 1680 kg/ha (1500 lb/acre) consisted of graminoids.

Poa pratensis Community Type

These communities (Figure 13) are located on a variety of sites occurring on both alluvial landforms and mountain slopes. A majority of these sites are located near heavily used campsites or Forest Service administrative sites which have been subjected to heavy grazing and trampling by domestic stock.

Total canopy coverage was relatively high in these stands averaging 120 percent. Total number of species encountered ranged from 17 to 24 species per stand.

Compositionally, these communities are quite variable. This is apparent from the data even though only three stands were sampled. The strong dominance of Poa pratensis is the major unifying feature of this community type. Canopy coverage of this species ranged from 35 to 55 percent. Daubenmire (1970) described the ecological status of Poa pratensis as "the most aggressive invader of heavily grazed areas where the soil profile has no lime accumulation". The predominance of this species reflects the severe grazing pressure to which these sites have been subjected.

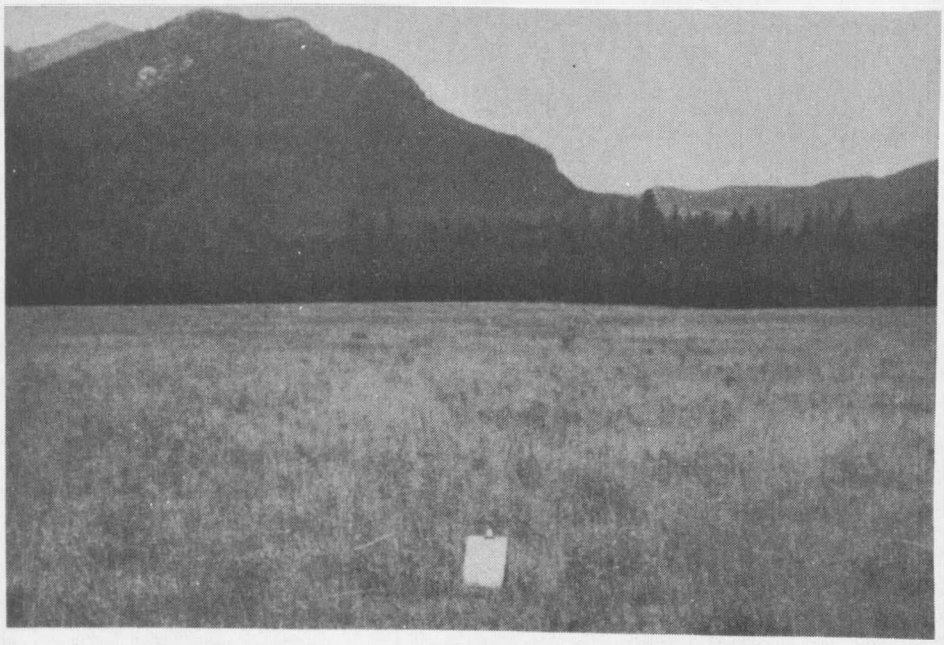


Figure 13. Poa pratensis community type near the mouth of Holbrook Creek.

The only other species occuring in all three of the sampled stands were Fragaria virginia, Achillea millefolium and Sedum stenopetalum. Species reaching coverage values of 10 percent or greater in these stands were Berberis repens and Epilobium paniculatum (stand 22), Potentilla gracilis, Penstemon confertus and Carex spp. (stand 29), and Lupinus sericeus (stand 40).

Total standing crop ranged from 829 to 1378 kg/ha (740 to 1230 lb/acre) while graminoid standing crop ranged from 414 to 690 kg/ha (370 to 615 lb/acre). Poa pratensis was the major producer in stands

22 and 40 contributing about half of the total biomass. In stand 29, Poa pratensis, Penstemon confertus and Potentilla gracilis were the most productive species, each contributing about 25 percent of the total biomass.

Pinus contorta - Calamgrostis rubescens Community Type

Since only one stand (stand 12) was sampled in this community type, the following discussion is largely derived from general field observations. Stands of this community type (Figure 14) occur on the alluvial and glacial outwash terraces and forested ground moraines along the South Fork and its major tributaries. Elevations range from about 1220 to 1675 m (4000 to 5500 ft). Soils were not classified

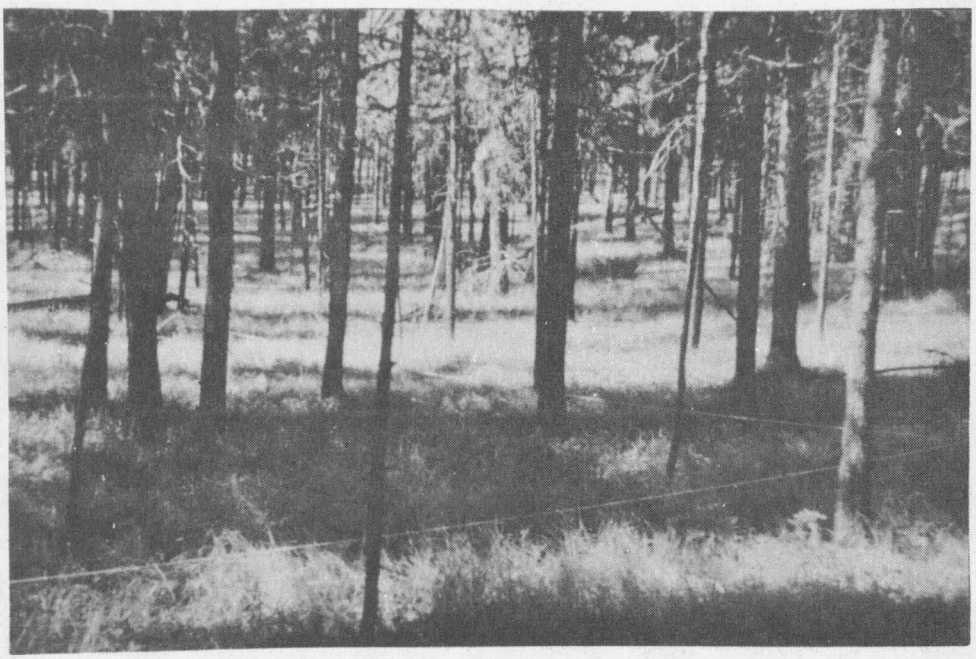


Figure 14. Pinus contorta-Calamagrostis rubescens community type near Big Prairie.

during the course of this study but are most likely classified as Inceptisols and Alfisols (Holdorf et al. 1980).

The vegetation has a relatively open parklike appearance with an overstory dominated by Pinus contorta. Undergrowth unions are dominated by a low dense layer of Calamagrostis rubescens. Various species of Carex are the only other graminoids commonly present. Arnica cordifolia and Fragaria virginiana are probably the major forb species, although forbs are generally an inconspicuous component of the vegetation. Low-stature shrub species including Vaccinium caespitosum, Arctostaphylos uva-ursi and Berberis repens, are abundant in most stands. Stands supporting similar vegetation are described by Pfister et al. (1977) as belonging to either the Pseudotsuga menziesii/Vaccinium caespitosum habitat type or the Abies lasiocarpa/Vaccinium caespitosum habitat type depending on the potential climax tree species.

Total standing crop of understory vegetation in stand 12 was 569 kg/ha (508 lb/acre). Graminoid standing crop was approximately 280 kg/ha (250 lb/acre). This stand is believed to be near the upper limits of forage productivity for this type of vegetation in the study area. Work by other authors indicates that graminoid production in similar vegetation generally ranges from 100 to 225 kg/ha (100 to 200 lb/acre) (Tisdale and McLean 1957; Basil and Jensen 1971).

Symphoricarpos albus - Amelanchier alnifolia (snowslides) Community Type

Snowslide communities (Figure 15) provide an important grazing resource along some of the drainages tributary to the South Fork. These communities occur on steep glaciated slopes at the mid to upper elevations where large amounts of snow accumulate. Slopes range from 15 to 30 percent in the runoff zones and 40 to 80 percent in the starting zone and main track. Snowslides occur on both northerly and southerly exposures. North slope slide areas are not a significant grazing resource as they support a dense vegetation dominated by shrubs such as Menziesia ferruginea and Alnus sinuata with very little



Figure 15. Symphoricarpos albus-Amelanchier alnifolia community type in Big Salmon Creek Drainage.

grass in the understory. Consequently, the three snowslide communities sampled were all on southerly exposures. On the warmer southerly exposures, snow avalanche tracks are broad and slide most frequently in March and April. These are usually slab avalanches (Perla and Martinelli 1976) which slide snow over snow. Soils have developed from the weathering of colluvial material and are classified as Mollisols or Inceptisols. Soil organic matter was the highest of any of the communities sampled averaging 14 percent. Soil reaction was quite acidic with pH values ranging from 4.9 to 5.3.

Total plant cover in this community type ranged from 112 to 118 percent. Shrubs clearly dominated the aspect, averaging 52 percent canopy coverage, while forbs averaged 38 percent and graminoids about 25 percent. The number of plant species encountered ranged from 17 to 26 species per stand. Dominance in the stands sampled was shared by Amelanchier alnifolia and Symphoricarpos albus. Berberis repens was abundant in all three stands but was less conspicuous due to its lower stature. Other common shrub species achieving local abundance include Ceanothus velutinus and Prunus virginiana. The most abundant graminoid species in these avalanche tracks are Agropyron spicatum, Bromus carinatus and Carex geyeri. Achillea millefolium, Penstemon confertus, Fragaria virginiana and Aster spp. are generally the most abundant forbs.

These communities were among the most productive of the

communities sampled in this study. Total standing crop was similar in all three stands ranging from 1200 to 1345 kg/ha (1070 to 1200 lb/acre). Shrubs, forbs and graminoids averaged 55, 30 and 15 percent of the composition by weight respectively.

In contrast to total standing crop, the standing crop of graminoids was among the lowest of all communities sampled averaging only 190 kg/ha (170 lb/acre). The major forage species are Carex geyeri, Bromus carinatus and Agropyron spicatum. Small amounts of Poa pratensis, Phleum pratense and Calamagrostis rubescens are also present. Although these communities do not produce a large volume of forage, they are usually located in heavily timbered drainages where alternative grazing areas are limited.

## Environmental Relationships

### Community Origin and Maintenance

The existence of the grassy parks and pine savanna communities in an otherwise heavily forested drainage is believed to be the result of three major factors; plant-available moisture, fire history and snow avalanches. Plant-available moisture is further the result of a complexity of factors. Seasonal precipitation adds directly to the soil moisture but factors such as temperature, shading, soil texture, soil depth and soil organic matter are important in maintaining it.

The grassy parkland communities are generally restricted to the alluvial landforms of the valley bottom and the steep south facing

mountain slopes. On the alluvial landforms, soils supporting parkland communities are generally in a sandy to sandy loam textural class and contain high percentages of coarse fragments (Appendix C). It is believed that excessive drainage on these coarse textured soils limits plant available moisture during the late growing season and therefore favors the existence of these grassy parkland communities over the adjacent subalpine forest. Koterba (1967) suggested a similar reason for the existence of grassland communities in the valley of the North Fork of the Flathead River. He found that the grassland openings in that valley occupied the sandy loam textured soils while the adjacent Pinus contorta forest occupied the loamy soils.

On the south exposures, moisture holding capacities of soils supporting parkland vegetation are limited by coarse textures and shallow depths. The exhaustion of soil moisture supplies on these south slopes is hastened by the effects of increased insolation, which raises soil temperatures and increases evaporation rates.

In the South Fork, where a July-August dry season is common, it appears that those factors which act as regulators of the soil moisture through this dry season are largely responsible for the vegetation patterns. Absence of growth water for part of the summer season prevents survival of those seedlings which cannot endure it by aestivation (McMinn 1952). The occurrence of seasonal soil drought therefore prevents or slows the spread of the subalpine forest

communities into those areas where soil moisture is more limiting than their constituent species can endure.

Fire history is also believed to have played an important supporting role in developing a habitat suitable for these parkland communities. Ayres (1900) reported that in 1899, many ridges were bare of forests due to fires eliminating the trees which had just been able to exist under the severe conditions of those sites. The same can be said today. Many of the open areas on south facing slopes show evidence of a fire origin by way of old snags and charcoal in the soil profile. In comparison to sites with more suitable growing conditions, forest regeneration and succession proceeds very slowly on these marginal sites and the effects of fire remain visible for many years (Gabriel 1976). With the rigorous fire suppression policies of the Forest Service, only the slowness of conifer reinvasion on these south slopes has helped to maintain this grass dominated component of the landscape.

Fire has apparently played a maintenance role in many of the parkland communities in the South Fork. Gabriel (1976) suggested that many of the grassland communities, the savannas, and the open - communities have been maintained by frequent light fires which killed plants invading from adjacent associations and permitted the dominant trees to achieve old ages.

Snow avalanches play an important maintenance role on very localized sites within the South Fork drainage. The shearing action of sliding snow suppresses the trees on these sites and therefore favors the grass and shrub components.

Community Composition

The present species composition of the parkland communities appears to be largely controlled by plant available moisture. Many of the edaphic properties which act as moisture regulators are in turn closely related to position on the landscape. When the parkland communities in the South Fork are stratified in relation to position on the landscape, three major landforms are evident; 1) the recent alluvial terraces, 2) the outwash terraces and alluvial fans, 3) the steep south facing mountain slopes.

Plant-available water holding capacities of soils on representative sites on each of these landforms have been estimated by Albin Martinson, Flathead Forest Soil Scientist. These estimates were based on texture, percentage of coarse fragments and horizon thicknesses of profiles sampled. He estimated capacities of 1.25 to 2.0 cm (.5 to .75 in) on the recent alluvial terraces and 2.5 to 5 cm (1 to 2 in) on the outwash terraces. Water holding capacities of soils on the south facing slopes were apparently more variable with estimates ranging from 2 to 5 cm (.75 to 2 in).

The recent alluvial terraces occur up to 10 m (30 ft) above the

present river level. Soils on these terraces range from 25 to 50 cm (10 to 20 in) thick and contain considerable amounts of sand and gravel. These soils are geologically young and show very little horizonal development or incorporation of organic matter. The outwash terraces occur from 15 to 60 m (50 to 200 ft) above the present river level. The soils are somewhat deeper ranging from 50 to 75 cm (20 to 30 in) deep. They also contain higher percentages of silt, clay and organic matter in the profile which tends to increase the available water holding capacity. On these alluvial landforms, there appears to be a close relationship between the age of the terraces, soil profile development, and soil moisture holding capacity. The younger terraces are appreciably drier than the older terraces. As the land surface ages, the soils become more loamy, more organic matter is incorporated and more soil moisture is retained.

The relationship between plant communities and landform is illustrated in Figures 16 and 17. It is evident from these figures that the distribution of vegetation is closely related to position on the landscape. Since the edaphic properties characteristic of each of these landforms largely determine the moisture regime, it appears that the arrangement of stands on the ordination (Figure 16) approximates a moisture gradient. Plant-available soil moisture increases on this gradient from a low in the left portion of the ordination field to a high on the right.

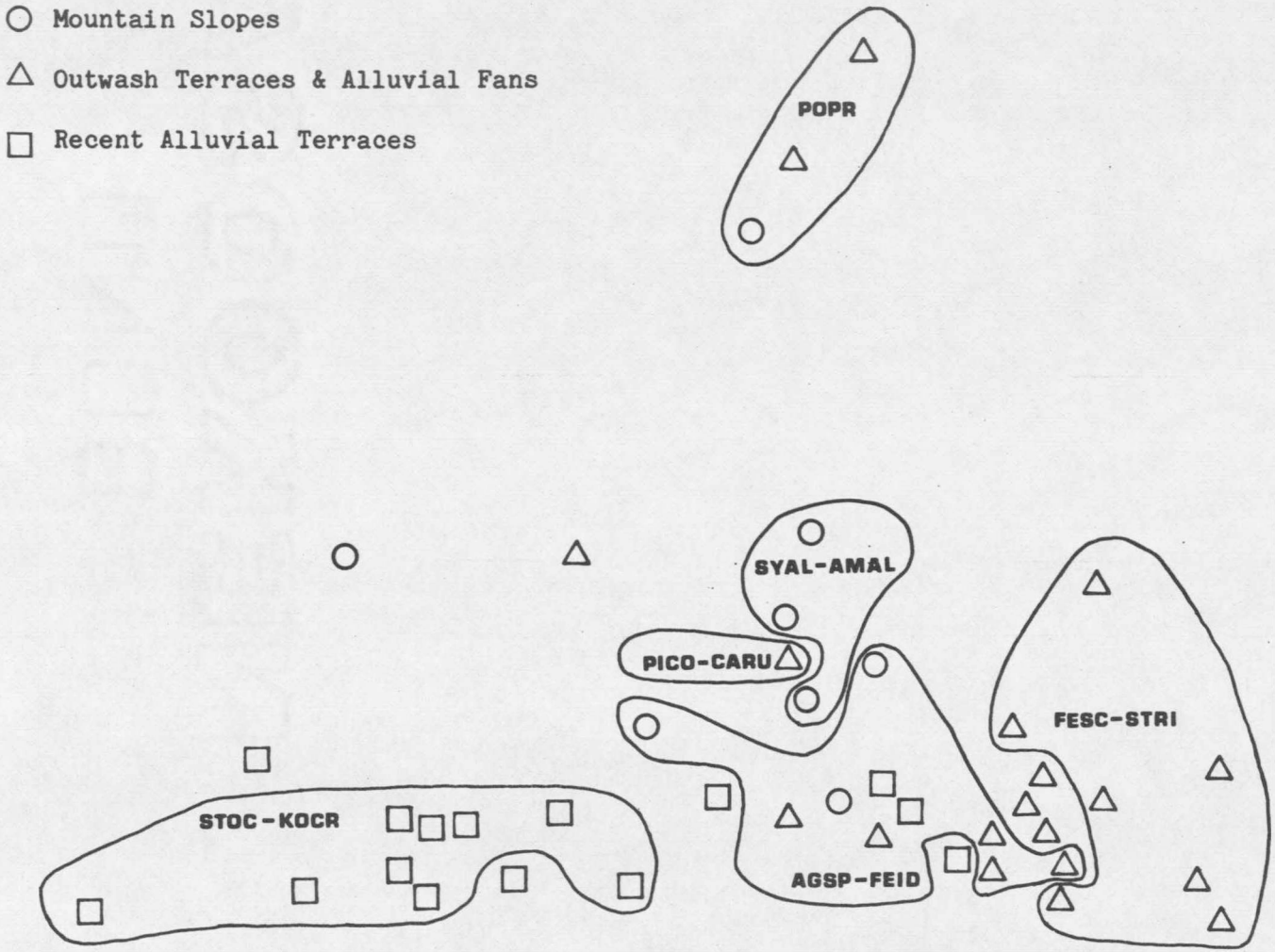



Figure 16. The distribution patterns of landforms and community types on the 42 stand ordination. Stands not included in community type delineations are phases of the primary community types.

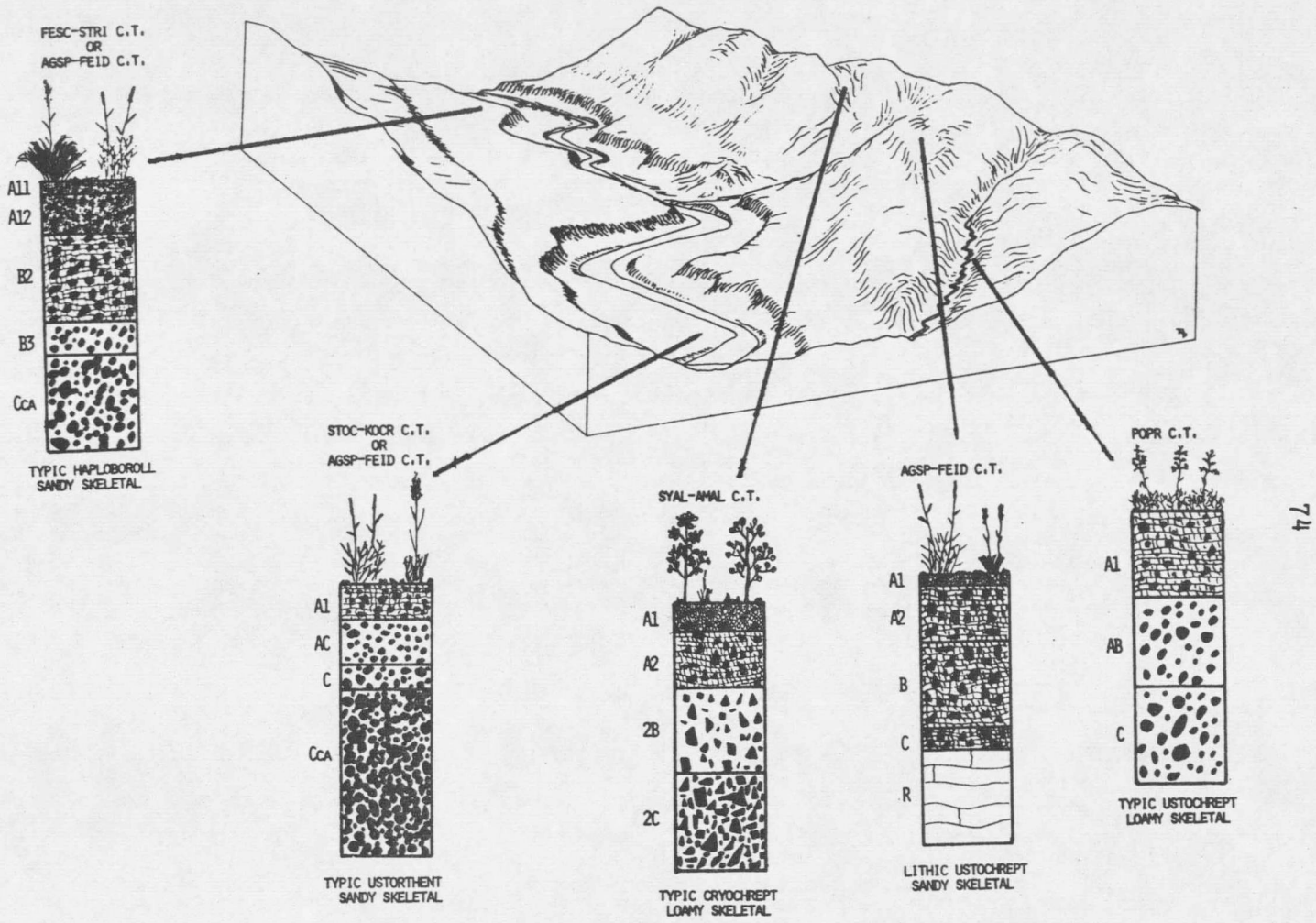



Figure 17. Idealized landscape, South Fork Flathead River, showing typical topographic positions of plant communities and soils.

Supporting evidence for this moisture gradient is found when standing crop measurements are overlain on the ordination (Figure 18). An increase in site productivity would generally be expected as available soil moisture is increased. This seems to be the case as both total vegetation and graminoid standing crop increases from left to right across the ordination.

Soil organic matter exhibits a similar trend as it also increases from left to right across the ordination (Figure 18). Because organic matter possesses colloidal properties, its water holding capacity is relatively high. The organic matter content in soils therefore plays a major role in maintaining soil moisture and an increase in organic matter would probably reflect a more mesic environment.

Although the inherent capability of a site to support a particular flora is closely related to the moisture regime, the existing vegetation on many of these parkland communities has been further influenced by grazing. The community types which appear to show the most disturbance from grazing are those currently dominated by Poa pratensis and Stipa occidentalis.

There is little doubt that stands dominated by Poa pratensis have been greatly altered by grazing. The proximity of most of these stands to heavily impacted campsites and Forest Service administrative sites, as well as personal observations of current heavy use, suggests a history of intense grazing. Poa pratensis is well recognized as an

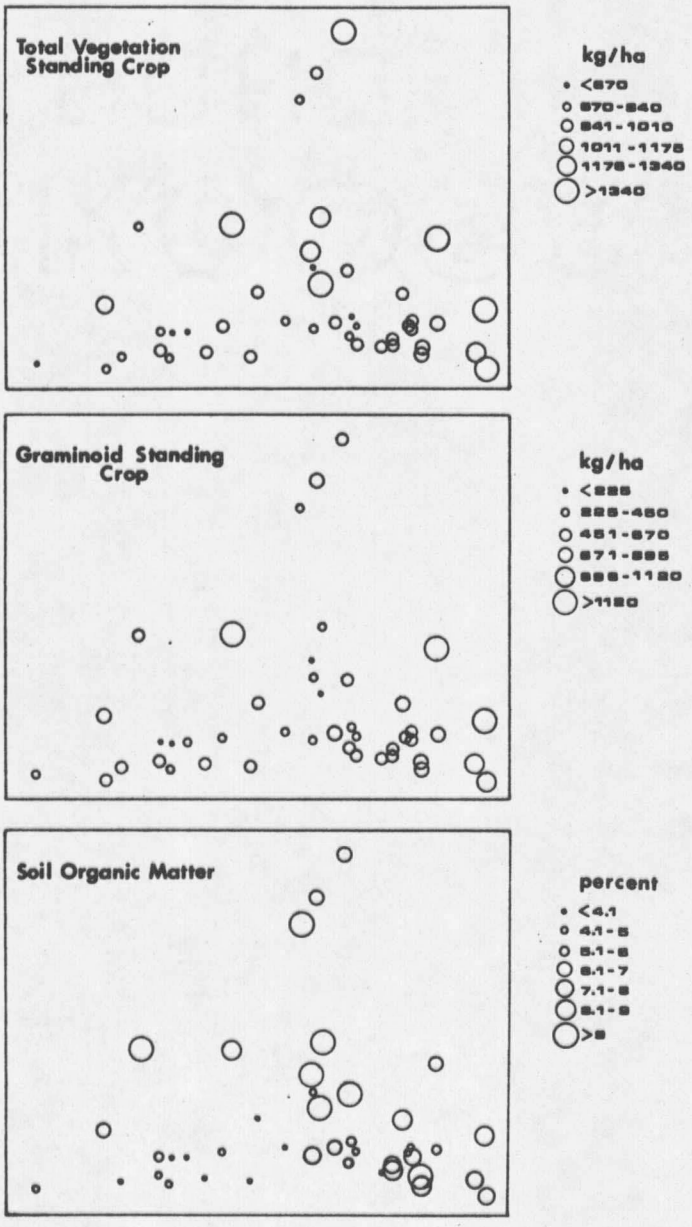



Figure 18. The distribution patterns of standing crop and soil organic matter on the 42 stand ordination.

invader of disturbed grassland sites where moisture is not too limiting. This species is rhizomatous and quite resistant to grazing. It is therefore able to persist on a site even under very intense grazing pressure.

Most of the Stipa occidentalis dominated communities are located on the low terraces adjacent to the South Fork. This river is one of the major attractions for wilderness visitors. As these sites are level and provide ready access to both water and horse feed, they are highly desirable campsites. They therefore receive a disproportionate share of the recreational grazing use. They also receive at least moderate use from elk during the spring. The present composition of these communities is believed to be strongly influenced by this combination of horse and elk grazing.

Although Stipa occidentalis has been considered a "decreaser" species by some (Ross and Hunter 1976; USDA 1977), most reports suggest that it tends to increase with grazing pressure (Reid and Pickford 1946; Hurd 1961; Daubenmire 1970; McLean et al. 1971; Chaffee and Morris 1982). Observations in the South Fork of the locations of these Stipa occidentalis communities, as well as the apparently limited utilization of this species, suggest that it tends to increase with grazing pressure. These observations coupled with the high proportion of associated "increaser" or "invader" species such as Koeleria cristata, Danthonia unispicata and Antennaria microphylla on

the drier sites, and Poa pratensis and Phleum pratense on the more mesic sites, suggest that grazing has altered these communities.

## SUMMARY

A study was conducted in the South Fork of the Flathead River drainage, Bob Marshall Wilderness for the purpose of describing and classifying the principal grazing areas used by recreational pack and saddle stock. Forty-two stands were sampled as representative of these grazing areas. Quantitative methods were used to describe the species composition and physical environment of sampled stands. Stand groupings were determined using cluster analysis and a two-dimensional ordination procedure, as well as field observations. Six community types and five phases have been identified and described.

The principal grazing areas used by domestic livestock are the grassy forest openings and pine savanna communities located primarily on the alluvial landforms of the valley floor and the south facing mountain slopes. Seasonal soil drought, past fires and snow avalanches have been suggested as the major factors responsible for the existance of these communities in this otherwise heavily forested drainage. A shortage of late summer growth water on these sites is believed to be the result of the interacting factors of local climate, soil texture and/or depth, and exposure. The occurrence of a seasonal soil drought apparently favors the existance of the drier parkland communities over the adjacent subalpine forest communities. The role of past fires and snow avalanches has been to remove the trees and therefore favor the grass and shrub components.

Differences in the existing vegetation of these parkland sites

appears to be closely related to plant-available moisture and grazing history. Plant-available moisture is, in turn, related to landscape position, particularly on the alluvial landforms. On the recent alluvial terraces, more sterile, coarse soils predominate. With progression to the older, higher outwash terraces, the soils become more loamy, more organic matter is incorporated, more soil moisture is retained and species that require more moisture predominate. This hypothesis is supported by soil water holding capacity estimates, standing crop measurements and soil organic matter measurements.

The combination of horse and elk grazing has further influenced the present species composition of many of these sites. The community types which appear to have been most strongly affected by grazing are those currently dominated by Poa pratensis and Stipa occidentalis.

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## LITERATURE CITED


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# APPENDICES

## APPENDIX A

TABLE 6. PLANT SPECIES IDENTIFIED IN THE STUDY AREA.

| | |
|---|---|
| ACERACEAF | MAPLE FAMILY |
| *Acer glabrum Torr. | Rocky Mountain maple |
| APIACEAE | PARSLEY FAMILY |
| *Lomatium macrocarpum (Nutt.) C. & R. | big-fruited biscuit root |
| *Lomatium triternatum (Pursh) C. & R. | nine-leaved lomatium |
| *Perideridia gairdneri (H. & A.) Math. | Gairdner's yampa |
| ASTERACEAE | ASTER FAMILY |
| *Achillea millefolium L. | common yarrow |
| *Agoseris glauca (Pursh) Raf. | mountain dandelion |
| *Antennaria sp. | pussytoes |
| *Antennaria microphylla Rydb. (=A. rosea (Eat.) Greene) | pink pussytoes |
| Antennaria rosea (Eat.) Greene (=A. microphylla Rydb.) | pink pussytoes |
| *Arnica cordifolia Hook | heart-leaved arnica. |
| *Arnica fulgens Pursh | orange arnica |
| *Arnica sororia Greene | twin arnica |
| *Artemisia ludoviciana Nutt. | cudweed sagewort |
| *Artemisia tridentata Nutt. | big sagebrush |
| Aster spp. | aster |
| *Aster campestris Nutt. | field aster |
| *Aster laevis L. | smooth aster |
| *Balsamorhiza sagittata (Pursh) Nutt. | arrowleaved balsamroot |
| *Centaurea maculosa Lam. | spotted knapweed |
| *Chrysopis villosa (Pursh) Nutt. | hairy golden-aster |
| Crepis sp. | hawksbeard |
| Erigeron spp. | fleabane |
| *Erigeron compositus Pursh | fernleaved fleabane |
| *Erigeron glabellus Nutt. | smooth fleabane |
| *Filago arvensis L. | field fluffweed |
| *Gaillardia aristata Pursh | blanket-flower |
| *Hieracium albiflorum Hook. | white-flowered hawkweed |
| *Hieracium cynoglossoides Arv.-Touv. | hound's-tongue hawkweed |
| *Microseris nutans (Geyer) Shultz-Bip. | nodding microseris |
| Senecio spp. | groundsel |
| *Senecio canus Hook. | woolly groundsel |

*Plant species marked with an asterisk have been verified by Alma Plantenberg, Biology Department, Montana State University.

TABLE 6 (cont.)

| | |
|---|---|
| [a]*Senecio integerrimus* Nutt. | western groundsel |
| [a]*Senecio serra* Hook. | butterweed groundsel |
| [a]*Taraxacum officinale* Weber | common dandelion |
| [a]*Townsendia parryi* Eat. | Parry's townsendia |
| [a]*Tragopogon dubius* Scop. | yellow salsify |
| BERBERIDACEAE | BARBERRY FAMILY |
| [a]*Berberis repens* Lindl. | creeping Oregon-grape |
| BETULACEAE | BIRCH FAMILY |
| *Alnus sinuata* (Regel) Rydb. | wavy-leaved alder |
| *Betula glandulosa* Michx. | bog birch |
| BORAGINACEAE | BORAGE FAMILY |
| [a]*Cynoglossum officinale* L. | common hound's-tongue |
| [a]*Lithospermum ruderale* Dougl. | western gromwell |
| BRASSICACEAE | MUSTARD FAMILY |
| [a]*Alyssum alyssoides* L. | pale alyssum |
| [a]*Arabis holboellii* Nornem. | Hoelboell's rockcress |
| [a]*Arabis nuttallii* Robins. | Nuttall's rockcress |
| *Draba* spp. | draba |
| [a]*Draba nemorosa* L. | woods draba |
| CAMPANULACEAE | HAREBELL FAMILY |
| [a]*Campanula rotundifolia* L. | harebell |
| CAPRIFOLIACEAE | HONEYSUCKLE FAMILY |
| [a]*Linnaea borealis* L. | twinflower |
| *Lonicera involucrata* (Rich.) Banks | bearberry honeysuckle |
| *Symphoricarpos albus* (L.) Blake | common snowberry |
| CARYOPHYLLACEAE | PINK FAMILY |
| [a]*Arenaria congesta* Nutt. | ballhead sandwort |
| [a]*Arenaria serpyllifolia* L. | thyme-leaved sandwort |
| [a]*Cerastium arvense* L. | field chickweed |
| CELASTRACEAE | STAFF-TREE FAMILY |
| *Pachistima myrsinites* (Pursh) Raf. | mountain-lover |
| CRASSULACEAE | STONECROP FAMILY |
| [a]*Sedum stenopetalum* Pursh. | wormleaved stonecrop |

TABLE 6 (cont.)

| | |
|---|---|
| CUPRESSACEAE | CYPRESS FAMILY |
| *Juniperus communis* L. | common juniper |
| CYPERACEAE | SEDGE FAMILY |
| *Carex* spp. | sedge |
| ¤*Carex filifolia* Nutt. | thread-leaved sedge |
| ¤*Carex geyeri* Boott | elk sedge |
| ¤*Carex lanuginosa* Michx. | wolly sedge |
| ELAEAGNACEAE | OLEASTER FAMILY |
| *Shepherdia canadensis* (L.) Nutt. | russet buffaloberry |
| EQUISETACEAE | HORSETAIL FAMILY |
| ¤*Equisetum laevigatum* A. Br. | smooth scouring-rush |
| ERICACEAE | HEATH FAMILY |
| ¤*Arctostaphylos uva-ursi* (L.) | bearberry |
| ¤*Chimaphila umbellata* (L.) Bart. | prince's pinen |
| *Menziesia ferruginea* Smith | fool's huckleberry |
| ¤*Vaccinium caespitosum* Michx. | dwarf huckleberry |
| EUPHORBIACEAE | SPURGE FAMILY |
| ¤*Euphorbia esula* L. | leafy spurge |
| FABACEAE | PEA FAMILY |
| ¤*Hedysarum occidentale* Greene | western hedysarum |
| ¤*Lupinus sericeus* Pursh | silky lupine |
| ¤*Medicago lupulina* L. | black medic |
| ¤*Oxytropis sericea* Nutt. | silky locoweed |
| *Trifolium* spp. | clover |
| GENTIANACEAE | GENTIAN FAMILY |
| ¤*Gentiana amarella* L. | beloved gentian |
| GERANIACEAE | GERANIUM FAMILY |
| ¤*Geranium viscosissimum* F. & M. | sticky geranium |
| HYDROPHYLLACEAE | WATERLEAF FAMILY |
| *Phacelia* sp. | phacelia |
| ¤*Phacelia hastata* Dougl. | silverleaved phacelia |
| ¤*Phacelia heterophylla* Pursh | virgate phacelia |

TABLE 6 (cont.)

| | |
|---|---|
| HYPERICACEAE | ST. JOHN'S-WORT FAMILY |
| [a]*Hypericum perforatum* L. | common St. John's-wort |
| JUNCACEAE | RUSH FAMILY |
| *Juncus* spp. | rush |
| LAMIACEAE | MINT FAMILY |
| [a]*Agastache urticifolia* (Benth.) Kuntze | nettle-leaved horsemint |
| LILIACEAE | LILY FAMILY |
| [a]*Allium cernuum* Roth | nodding onion |
| [a]*Allium schoenoprasum* L. | chives |
| [a]*Calochortus apiculatus* Baker | pointed mariposa-lily |
| [a]*Camassia quamash* (Pursh) Greene | common camas |
| [a]*Fritillaria pudica* (Pursh) Spreng. | yellowbell |
| [a]*Smilacina stellata* (L.) Desf. | false Solomon's seal |
| *Xerophyllum tenax* (Pursh) Nutt. | beargrass |
| [a]*Zigadenus venenosus* Wats. | meadow death camas |
| LINACEAE | FLAX FAMILY |
| [a]*Linum perenne* L. | blue flowered flax |
| ONAGRACEAE | EVENING PRIMROSE FAMILY |
| *Epilobium angustifolium* L. | fireweed |
| [a]*Epilobium paniculatum* Nutt. | annual willow-herb |
| [a]*Gayophytum ramosissimum* Nutt. | groundsmoke |
| [a]*Oenothera subacaulis* (Pursh) Garrett | long-leaved evening-primrose |
| ORCHIDACEAE | ORCHID FAMILY |
| [a]*Calypso bulbosa* (L.) Oakes | fairy-slipper orchid |
| PINACEAE | PINE FAMILY |
| *Abies lasiocarpa* (Hook.) Nutt. | subalpine fir |
| *Larix lyallii* Parl. | alpine larch |
| *Larix occidentalis* Nutt. | western larch |
| *Picea engelmannii* Parry | Engelmann spruce |
| *Pinus albicaulis* Engelm. | whitebark pine |
| *Pinus contorta* Dougl. | lodgepole pine |
| *Pinus ponderosa* Dougl. | ponderosa pine |
| *Pseudotsuga menziesii* (Mirbel) Franco | Douglas fir |

TABLE 6 (cont.)

| POACEAE | GRASS FAMILY |
|---|---|
| ¤*Agropyron caninum* (L.) Beauv. | slender wheatgrass |
| *Agropyron cristatum* (L.) Gaertn. | crested wheatgrass |
| ¤*Agropyron smithii* Rydb | western wheatgrass |
| *Agropyron spicatum* Pursh (Scribn & Smith) | bluebunch wheatgrass |
| ¤*Agrostis alba* L. | redtop |
| ¤*Agrostis interrupta* L. | interrupted bentgrass |
| ¤*Agrostis scabra* Willd. | ticklegrass |
| ¤*Alopecurus alpinus* Smith | alpine foxtail |
| ¤*Bromus carinatus* Hook. & Arn. | mountain bromegrass |
| ¤*Bromus ciliatus* L. | fringed bromegrass |
| ¤*Bromus inermis* Leys | smooth bromegrass |
| ¤*Bromus tectorum* L. | cheatgrass |
| ¤*Calamagrostis canadensis* (Michx.) Beauv. | bluejoint reedgrass |
| ¤*Calamagrostis purpurascens* R. Br. | purple reedgrass |
| *Calamagrostis rubescens* Buckl. | pinegrass |
| ¤*Dactylis glomerata* L. | orchardgrass |
| ¤*Danthonia intermedia* Vasey | timber oatgrass |
| ¤*Danthonia unispicata* (Thurb.) Munro | onespiked oatgrass |
| ¤*Deschampsia cespitosa* (L.) Beauv. | tufted hairgrass |
| ¤*Deschampsia elongata* (Hool.) Munro | slender hairgrass |
| ¤*Elymus canadensis* L. | Canadian wildrye |
| ¤*Elymus glaucus* Buckl. | blue wildrye |
| ¤*Festuca idahoensis* Elmer | Idaho fescue |
| ¤*Festuca scabrella* Torr. | rough fescue |
| ¤*Koeleria cristata* Pers. | prairie junegrass |
| ¤*Melica spectabilis* Scribn. | showy oniongrass |
| ¤*Muhlenbergia richardsonis* (Trin.) Rydb. | mat muhly |
| ¤*Phleum alpinum* L. | alpine timothy |
| ¤*Phleum pratense* L. | common timothy |
| *Poa* spp. | bluegrass |
| ¤*Poa bulbosa* L. | bulbous bluegrass |
| ¤*Poa juncifolia* Scribn. | alkali bluegrass |
| ¤*Poa palustris* L. | fowl bluegrass |
| ¤*Poa pratensis* L. | Kentucky bluegrass |
| ¤*Poa sandbergii* Vasey | Sandberg's bluegrass |
| ¤*Schizachne purpurascens* (Torr.) Swallen | false melic |
| ¤*Sitanion hystrix* (Nutt.) Smith | bottlebrush squirreltail |
| *Stipa columbiana* Macoun (=*Stipa occidentalis* var. *minor* (Vasey) Hitch.) | Columbia needlegrass |
| ¤*Stipa occidentalis* var. *minor* (Vasey) Hitch. | subalpine needle grass |

TABLE 6 (cont.)

| | |
|---|---|
| (=Stipa columbiana Macoun) | |
| [a]Stipa richardsonii Link. | Richardson's needlegrass |
| POLEMONIACEAE | PHLOX FAMILY |
| [a]Collomia linearis Nutt. | narrow-leaved collomia |
| [a]Linanthus septentrionalis Mason | northern linanthus |
| [a]Microsteris gracilis (Hook.) Greene | pink microsteris |
| [a]Polemonium pulcherrimum Hook. | showy polemonium |
| POLYGONACEAE | BUCKWHEAT FAMILY |
| Eriogonum sp. | buckwheat |
| [a]Eriogonum flavum Nutt. | yellow buckwheat |
| [a]Eriogonum umbellatum Torr. | sulfur buckwheat |
| [a]Polygonum bistortoides Pursh | American bistort |
| [a]Polygonum douglasii Greene | Douglas's knotweed |
| [a]Rumex acetosella L. | sheep sorrel |
| PRIMULACEAE | PRIMROSE FAMILY |
| [a]Dodecatheon conjugens Greene | slimpodded shooting star |
| RANUNCULACEAE | BUTTERCUP FAMILY |
| [a]Anemone multifida Poir. | cliff anemone |
| [a]Anemone nuttalliana DC. | pasque flower |
| [a]Clematis columbiana (Nutt.) T. & G. | Columbian clematis |
| [a]Clematis hirsutissima Pursh | sugarbowl |
| [a]Delphinium bicolor Nutt. | low larkspur |
| RHAMNACEAE | BUCKTHORN FAMILY |
| [a]Ceanothus velutinus Dougl. | black snowbrush |
| [a]Rhamnus alnifolia L. Her. | alder buckthorn |
| ROSACEAE | ROSE FAMILY |
| [a]Amelanchier alnifolia Nutt. | western serviceberry |
| [a]Fragaria virginiana Duchesne | strawberry |
| [a]Geum triflorum Pursh | prairie smoke |
| [a]Potentilla argentea L. | silvery cinquefoil |
| [a]Potentilla fruticosa L. | shrubby cinquefoil |
| [a]Potentilla glandulosa Lindl. | sticky cinquefoil |
| [a]Potentilla gracilis Dougl. | slender cinquefoil |
| [a]Prunus virginiana L. | common chokecherry |
| Rosa sp. | rose |
| [a]Rosa arkansana Porter | Arkansas rose |
| [a]Spiraea betulifolia Pall. | birch-leaved spiraea |

TABLE 6 (cont.)

| | |
|---|---|
| RUBIACEAE | MADDER |
| [a]*Galium boreale* L. | northern bedstraw |
| SALICACEAE | WILLOW FAMILY |
| *Populus tremuloides* Michx. | aspen |
| *Populus trichocarpa* T. & G. | black cottonwood |
| *Salix* spp. | willow |
| SAXIFRAGACEAE | SAXIFRAGE FAMILY |
| [a]*Heuchera cylindrica* Dougl. | roundleaved alumroot |
| [a]*Lithophragma parviflora* (Hook.) Nutt. | small-flowered woodland-star |
| [a]*Saxifraga integrifolia* Hook. | swamp saxifrage |
| SCROPHULARIACEAE | FIGWORT FAMILY |
| [a]*Castilleja cusickii* Greenm. | Cusick's paintbrush |
| [a]*Castilleja hispida* Benth. | harsh paintbrush |
| [a]*Castilleja miniata* Dougl. | scarlet paintbrush |
| [a]*Collinsia parviflora* Lindl. | blue-eyed Mary |
| [a]*Orthocarpus tenuifolius* (Pursh) Benth. | thin-leaved owl-clover |
| [a]*Pedicularis contorta* Benth. | white coil-beaked louse-wort |
| [a]*Penstemon albertinus* Greene | Alberta penstemon |
| [a]*Penstemon confertus* Dougl. | yellow penstemon |
| VIOLACEAE | VIOLET FAMILY |
| [a]*Viola adunca* Sm. | hook violet |
| [a]*Viola nuttallii* Pursh | Nuttall's violet |

## APPENDIX B

TABLE 7. LOCATION OF SAMPLE STANDS.

| Stand No. | Township | Range | Section | Site Name |
|---|---|---|---|---|
| 1 | 23N | 14W | 27 | Hodag Flats No. 1 |
| 2 | 23N | 14W | 27 | Hodag Flats No. 2 |
| 3 | 22N | 14W | 13 | Little Salmon Park |
| 4 | 22N | 14W | 25 | Salmon Forks (east side) No. 1 |
| 5 | 22N | 14W | 25 | Salmon Forks (east side) No. 2 |
| 6 | 21N | 13W | 5 | Grasshopper Park |
| 7 | 21N | 13W | 6 | Murphy Flats |
| 8 | 21N | 13W | 17 | White River Park No. 1 |
| 9 | 21N | 13W | 17 | White River Park No. 2 |
| 10 | 21N | 13W | 32 | Burnt Creek Park (lower terrace) |
| 11 | 20N | 13W | 4 | Lime Creek Meadows No. 1 |
| 12 | 20N | 13W | 4 | Lime Creek Pico-Caru |
| 13 | 20N | 13W | 14 | Cayuse Meadows |
| 14 | 19N | 12W | 11 | Basin Airstrip |
| 15 | 18N | 11W | 5 | Spring Creek Hillside |
| 16 | 18N | 11W | 4 | Spring Creek Meadow |
| 17 | 19N | 13W | 23 | Hahn Creek Burn |
| 18 | 19N | 14W | 6 | Trio Mt. Slides No. 1 |
| 19 | 19N | 14W | 6 | Trio Mt. Slides No. 2 |
| 20 | 23N | 22W | 15 | Big Slide - Little Salmon Cr. |
| 21 | 22N | 13W | 10 | Pagoda Mountain |
| 22 | 23N | 14W | 21 | Black Bear Burn |
| 23 | 21N | 13W | 17 | White River Park (lower terrace) |
| 24 | 19N | 12W | 3 | Camp Creek Burn |
| 25 | 19N | 12W | 14 | Basin Sagebrush Meadow |
| 26 | 19N | 12W | 3 | Camp Creek Meadow |
| 27 | 18N | 11W | 9 | Bar Creek Meadow |
| 28 | 20N | 13W | 10 | Big Prairie Terrace |
| 29 | 19N | 14W | 8 | Shirttail Park |
| 30 | 20N | 13W | 26 | Flatiron Mt. Meadow |
| 31 | 20N | 13W | 10 | Big Prairie (west side) |
| 32 | 21N | 13W | 32 | Burnt Creek Park (upper terrace) |
| 33 | 20N | 13W | 8 | Bartlett Airstrip |
| 34 | 21N | 13W | 18 | Holbrook Airstrip No. 1 |
| 35 | 21N | 13W | 8 | Murphy Flats (south end) |
| 36 | 21N | 13W | 6 | Murphy Flats (north end) |
| 37 | 22N | 14W | 35 | Salmon Forks Pasture |
| 38 | 21N | 13W | 5 | Murphy Flats (east side) |
| 39 | 21N | 13W | 9 | White River Flats |
| 40 | 21N | 13W | 18 | Holbrook Airstrip No. 2 |
| 41 | 20N | 13W | 8 | Bartlett Meadow |
| 42 | 20N | 13W | 3 | Lime Creek Meadows No. 2 |

## APPENDIX C

## TABLE 8. SITE AND SOIL CHARACTERISTICS OF SAMPLE STANDS.

| Stand Number | Elevation | Aspect | Slope | Soil Texture | | | Coarse Fragments | Soil Organic Matter | Soil pH |
|---|---|---|---|---|---|---|---|---|---|
| | m | | % | Sand % | Silt % | Clay % | % | % | |
| *Agropyron spicatum* - *Festuca idahoensis* community type | | | | | | | | | |
| 6 | 1400 | SW | 3 | 67 | 29 | 4 | 60 | 13.2 | 6.1 |
| 7 | 1380 | NE | 1 | 78 | 20 | 2 | 65 | 5.8 | 6.4 |
| 8 | 1365 | W | 1 | 66 | 29 | 5 | 65 | 8.4 | 5.6 |
| 15 | 1615 | S | 35 | 71 | 27 | 2 | 70 | 6.8 | 6.2 |
| 17 | 1555 | S | 45 | 83 | 13 | 4 | 55 | 3.4 | 6.2 |
| 21 | 2180 | S | 25 | - | - | - | - | 9.4 | 7.4 |
| 32 | 1390 | - | 0 | 69 | 29 | 2 | 70 | 5.0 | 6.3 |
| 34 | 1390 | - | 0 | 79 | 19 | 2 | 75 | 7.4 | 5.9 |
| 36 | 1315 | - | 0 | 78 | 18 | 4 | 75 | 5.8 | 6.6 |
| 39 | 1360 | - | 0 | 10 | 49 | 41 | 40 | 7.8 | 6.6 |
| *Festuca scabrella* - *Stipa richardsonii* community type | | | | | | | | | |
| 9 | 1365 | W | 1 | 66 | 31 | 3 | 65 | 8.5 | 5.6 |
| 11 | 1425 | S | 5 | 70 | 25 | 5 | 60 | 8.4 | 6.0 |
| 14 | 1525 | W | 2 | 75 | 24 | 1 | 60 | 7.7 | 5.5 |
| 16 | 1610 | SW | 2 | 43 | 39 | 18 | 5 | 8.2 | 5.5 |
| 26 | 1525 | - | 0 | 76 | 23 | 1 | 55 | 5.5 | 5.4 |
| 27 | 1615 | W | 2 | 70 | 28 | 2 | 40 | 8.1 | 5.4 |
| 42 | 1425 | W | 2 | 48 | 45 | 7 | 30 | 6.8 | 6.0 |
| *Festuca idahoensis* phase | | | | | | | | | |
| 30 | 1425 | - | 0 | 67 | 29 | 4 | 45 | 4.4 | 5.3 |
| 33 | 1435 | - | 0 | 76 | 20 | 4 | 60 | 7.5 | 5.4 |
| 41 | 1430 | - | 0 | 52 | 40 | 8 | 50 | 4.7 | 5.5 |
| *Artemisia tridentata* phase | | | | | | | | | |
| 25 | 1510 | W | 2 | 64 | 29 | 7 | 5 | 4.4 | 5.5 |
| *Poa pratensis* community type | | | | | | | | | |
| 22 | 1430 | SE | 45 | 33 | 51 | 16 | 60 | 11.4 | 6.7 |
| 29 | 1550 | SE | 4 | 65 | 29 | 6 | 50 | 6.4 | 5.4 |
| 40 | 1390 | - | 0 | 72 | 24 | 4 | 50 | 6.4 | 6.1 |

TABLE 8 (cont.).

| Stand Number | Elevation | Aspect | Slope | Soil Texture | | | Coarse Fragments | Soil Organic Matter | Soil pH |
|---|---|---|---|---|---|---|---|---|---|
| | m | | % | Sand % | Silt % | Clay % | % | % | |
| *Stipa occidentalis* - *Koeleria cristata* community type | | | | | | | | | |
| 1 | 1245 | - | 0 | 64 | 32 | 4 | 60 | 4.8 | 6.8 |
| 2 | 1245 | - | 0 | 65 | 30 | 5 | 75 | 6.0 | 6.6 |
| 3 | 1280 | - | 0 | 78 | 20 | 2 | 65 | 4.9 | 6.4 |
| 4 | 1305 | - | 0 | 79 | 20 | 1 | 55 | 5.0 | 7.0 |
| 5 | 1305 | - | 0 | 74 | 22 | 4 | 30 | 4.0 | 5.8 |
| 10 | 1385 | - | 0 | 83 | 15 | 2 | 65 | 4.2 | 7.0 |
| 23 | 1340 | - | 0 | 52 | 42 | 6 | 60 | 3.3 | 7.0 |
| 35 | 1315 | - | 0 | 71 | 23 | 6 | 5 | 2.2 | 5.9 |
| 38 | 1320 | - | 0 | 75 | 23 | 2 | 75 | 3.8 | 7.0 |
| *Phleum pratense* phase | | | | | | | | | |
| 13 | 1425 | SW | 2 | 50 | 42 | 8 | 10 | 8.4 | 5.8 |
| *Poa pratensis* phase | | | | | | | | | |
| 24 | 1610 | S | 25 | 17 | 57 | 26 | 60 | 9.1 | 7.1 |
| 37 | 1300 | - | 0 | 77 | 19 | 4 | 55 | 6.5 | 6.2 |
| *Danthonia unispicata* phase | | | | | | | | | |
| 28 | 1425 | - | 0 | 82 | 16 | 2 | 45 | 3.6 | 5.9 |
| 31 | 1415 | - | 0 | 69 | 27 | 4 | 65 | 3.1 | 6.1 |
| *Symphoricarpos albus* - *Amelanchier alnifolia* community type | | | | | | | | | |
| 18 | 1675 | S | 45 | 56 | 42 | 2 | 65 | 19.6 | 4.9 |
| 19 | 1675 | S | 45 | 65 | 34 | 1 | 65 | 9.5 | 5.3 |
| 20 | 1450 | S | 25 | - | - | - | - | 14.4 | 5.1 |
| *Pinus contorta* - *Calamogrostis rubescens* community type | | | | | | | | | |
| 12 | 1415 | S | 2 | 19 | 67 | 14 | 5 | 4.8 | 5.6 |

## APPENDIX D

TABLE 9. STANDING CROP DATA FROM SAMPLE STANDS.

| Stand Number | Standing Crop 1980 kg/ha(lb/ac) | Standing Crop 1981 kg/ha(lb/ac) | Percentage of Total Standing Crop Graminoids | Forbs | Shrubs |
|---|---|---|---|---|---|
| *Agropyron spicatum* - *Festuca idahoensis* community type | | | | | |
| 6 | 1131(1010) | 1131(1010) | 68 | 32 | 0 |
| 7 | 737( 658) | 875( 781) | 58 | 35 | 7 |
| 8 | 931( 831) | 924( 825) | 66 | 34 | 0 |
| 15 | 934( 834) | 893( 797) | 77 | 20 | 3 |
| 17 | 888( 793) | - | 62 | 15 | 23 |
| 21 | 1007( 899) | - | 62 | 38 | 0 |
| 32 | - | 665( 594) | 67 | 31 | 2 |
| 34 | - | 869( 776) | 59 | 41 | 0 |
| 36 | - | 421( 376) | 62 | 34 | 4 |
| 39 | - | 675( 603) | 61 | 39 | 0 |
| *Festuca scabrella* - *Stipa richardsonii* community type | | | | | |
| 9 | 1235(1103) | 1746(1559) | 74 | 26 | 0 |
| 11 | 1055( 942) | 1095( 978) | 68 | 30 | 2 |
| 14 | 999( 892) | 1366(1220) | 77 | 23 | 0 |
| 16 | 1542(1377) | 1523(1360) | 77 | 11 | 12 |
| 26 | - | 1127(1006) | 60 | 40 | 0 |
| 27 | - | 1027( 917) | 87 | 13 | 0 |
| 42 | - | 1062( 948) | 75 | 25 | 0 |
| *Festuca idahoensis* phase | | | | | |
| 30 | - | 883( 788) | 69 | 31 | 0 |
| 33 | - | 954( 852) | 49 | 51 | 0 |
| 41 | - | 979( 874) | 62 | 38 | 0 |
| *Artemisia tridentata* phase | | | | | |
| 25 | - | 1004( 896) | 59 | 12 | 29 |
| *Poa pratensis* community type | | | | | |
| 22 | - | 827( 738) | 50 | 25 | 25 |
| 29 | - | 1375(1228) | 39 | 61 | 0 |
| 40 | - | 935( 835) | 74 | 26 | 0 |

TABLE 9 (cont.).

| Stand Number | Standing Crop 1980 kg/ha(lb/ac) | Standing Crop 1981 kg/ha(lb/ac) | Percentage of Total Standing Crop Graminoids | Forbs | Shrubs |
|---|---|---|---|---|---|
| *Stipa occidentalis* - *Koeleria cristata* community type | | | | | |
| 1 | 700( 625) | 642( 573) | 53 | 39 | 8 |
| 2 | 810( 723) | 646( 577) | 22 | 78 | 0 |
| 3 | 799( 713) | 672( 600) | 56 | 43 | 1 |
| 4 | 843( 753) | 750( 670) | 54 | 46 | 0 |
| 5 | 928( 829) | 907( 810) | 66 | 33 | 1 |
| 10 | 1038( 927) | 697( 622) | 44 | 52 | 4 |
| 23 | - | 506( 452) | 52 | 41 | 7 |
| 35 | - | 750( 670) | 79 | 10 | 11 |
| 38 | - | 360( 321) | 61 | 38 | 1 |
| *Phleum pratense* phase | | | | | |
| 13 | 2037(1819) | 2556(2282) | 74 | 26 | 0 |
| *Poa pratensis* phase | | | | | |
| 24 | - | 803( 717) | 69 | 22 | 9 |
| 37 | - | 1114( 995) | 75 | 16 | 9 |
| *Danthonia unispicata* phase | | | | | |
| 28 | - | 688( 614) | 54 | 35 | 11 |
| 31 | - | 860( 768) | 73 | 26 | 1 |
| *Symphoricarpos albus* - *Amelanchier alnifolia* community type | | | | | |
| 18 | 1310(1170) | - | 11 | 21 | 68 |
| 19 | 1202(1073) | - | 22 | 39 | 39 |
| 20 | 1345(1201) | - | 12 | 30 | 58 |
| *Pinus contorta* - *Calamogrostis rubescens* community type | | | | | |
| 12 | 563( 503) | 575( 513) | 50 | 7 | 43 |

# APPENDIX E

The following tables show percent canopy coverage and percent composition by weight (in parenthesis) rounded to the nearest whole number. Values for each plant species encountered in the stand analysis plots are included. Values of less than 0.5 are represented by a p. Species absence is indicated by a dash.

TABLE 10. SPECIES CANOPY COVERAGE AND COMPOSITION BY WEIGHT FOR FESTUCA SCABRELLA-STIPA RICHARDSONII COMMUNITY TYPE.

| Stand Number | 9 | 11 | 14 | 16 | 26 | 27 | 42 |
|---|---|---|---|---|---|---|---|
| GRAMINOIDS | | | | | | | |
| Agropyron caninum | - - | - - | - - | - - | - - | - - | 1( 1) |
| Agropyron spicatum | 3( 4) | - - | 3( 5) | - - | - - | - - | - - |
| Bromus inermis | - - | - - | - - | - - | - - | - - | 1( p) |
| Carex filifolia | - - | - - | - - | 1( 1) | - - | p( p) | - - |
| Carex geyeri | 8( 8) | 11(12) | - - | - - | - - | - - | - - |
| Carex spp. | - - | - - | 4( 4) | 21(21) | 8( 7) | 2( 3) | 1( p) |
| Danthonia intermedia | 4( 4) | 3( 1) | 11(12) | 14( 6) | 10( 8) | 5( 3) | 14( 8) |
| Festuca idahoensis | 2( 1) | 4( 3) | 8( 9) | 4( 3) | - - | 20(27) | 3( 2) |
| Festuca scabrella | 43(48) | 12(15) | 21(35) | 25(28) | 11(16) | 9(12) | 15(19) |
| Juncus sp. | - - | - - | - - | p( p) | - - | - - | - - |
| Koeleria cristata | 7( 5) | 1( 1) | p( p) | 1( 1) | 4( 4) | 6( 4) | 1( 1) |
| Phleum pratense | - - | 1( 1) | - - | - - | - - | - - | - - |
| Poa pratensis | - - | - - | - - | - - | - - | p( p) | 12( 9) |
| Poa spp. | - - | - - | - - | p( p) | - - | - - | - - |
| Stipa occidentalis | - - | 1( 1) | - - | 1( p) | - - | - - | 1( 1) |
| Stipa richardsonii | 4( 6) | 26(34) | 6(12) | 14(16) | 25(25) | 30(37) | 28(35) |
| FORBS | | | | | | | |
| Achillea millefolium | 2( 1) | 2( 1) | 3( 1) | 5( 1) | 6( 1) | 2( 1) | 6( 1) |
| Agoseris glauca | - - | - - | - - | - - | 7( 6) | p( p) | p( p) |
| Arennaria congesta | p( p) | p( 1) | 10( 4) | - - | 8( 4) | 4( 2) | - - |
| Arnica fulgens | - - | 1( 1) | 1( 1) | - - | - - | 4( 2) | - - |
| Aster campestris | - - | - - | - - | - - | - - | - - | 9( 4) |
| Calochortus apiculatus | - - | - - | - - | - - | 2( 1) | - - | - - |
| Campanula rotundifolia | - - | - - | p( p) | - - | - - | - - | - - |
| Cerastium arvense | - - | - - | 2( 2) | - - | 2( 1) | - - | - - |
| Collomia linearis | - - | - - | - - | - - | p( p) | - - | - - |
| Delphinium bicolor | - - | - - | - - | - - | - - | - - | p( p) |
| Equisetum laevigatum | - - | - - | - - | - - | - - | - - | 10( 6) |
| Erigeron spp. | 1( p) | - - | - - | - - | - - | - - | - - |
| Eriogonum flavum | - - | - - | 1( 1) | - - | - - | - - | - - |
| Eriogonum umbellatum | - - | - - | 4( 3) | 1( p) | 5( 2) | 2( 1) | 2( 1) |
| Fragaria virginiana | 10( 4) | 12( 3) | - - | 1( p) | 1( p) | - - | 17( 4) |
| Galium boreale | - - | 2( 2) | - - | 3( 1) | 5( 3) | - - | 8( 3) |
| Geranium viscossissimum | - - | p( p) | - - | - - | - - | - - | p( p) |
| Geum triflorum | 10( 4) | 7( 3) | 1( 1) | 8( 4) | - - | 1( 1) | p( p) |
| Hieracium cynoglossoides | - - | 2( 2) | - - | - - | - - | - - | - - |
| Lithospermum ruderale | - - | 2( 3) | - - | - - | - - | - - | - - |
| Lomatium triternatum | - - | - - | - - | - - | p( p) | - - | - - |
| Lupinus sericeus | 16(14) | 14(14) | 3( 3) | - - | 10(10) | 5( 3) | 4( 2) |
| Microsteris gracilis | - - | - - | - - | - - | p( p) | - - | - - |
| Pedicularis contorta | - - | - - | 1( 1) | - - | - - | - - | - - |
| Penstemon confertus | - - | 5( 3) | 1( 1) | 4( 3) | 6( 5) | - - | 4( 2) |
| Polygonum douglasii | - - | p( p) | - - | - - | - - | - - | - - |
| Potentilla glandulosa | 1( 1) | - - | 3( 2) | - - | 9( 4) | 2( 2) | 3( 1) |
| Potentilla gracilis | - - | - - | 3( 1) | 1( 1) | - - | - - | 1( p) |
| Taraxacum officinale | - - | - - | p( p) | p( p) | 1( p) | - - | p( p) |
| Trifolium sp. | - - | - - | - - | - - | - - | - - | p( p) |
| SHRUBS | | | | | | | |
| Arctostaphylos uva-ursi | - - | p( p) | - - | - - | - - | - - | - - |
| Berberis repens | - - | 3( 1) | - - | - - | p( p) | - - | - - |
| Potentilla fruticosa | - - | - - | - - | 13(12) | - - | - - | - - |

TABLE 11. SPECIES CANOPY COVERAGE AND COMPOSITION BY WEIGHT FOR ARTEMISIA TRIDENTATA AND FESTUCA IDAHOENSIS PHASES.

| | Artr phase | Feid phase | | |
|---|---|---|---|---|
| Stand Number | 25 | 30 | 33 | 41 |
| GRAMINOIDS | | | | |
| Agropyron spicatum | 1( 1) | - - | 3( 4) | - - |
| Agrostis scabra | - - | 9( 7) | - - | - - |
| Carex spp. | 5( 6) | 5( 4) | 13(10) | 11(13) |
| Danthonia intermedia | 18(15) | 10( 8) | 3( 2) | 3( 2) |
| Danthonia unispicata | p( p) | 11(11) | p( p) | 1( 1) |
| Festuca idahoensis | 7( 7) | 11(11) | 5( 5) | 10(10) |
| Festuca scabrella | 14(21) | 10(11) | 13(18) | 16(24) |
| Koeleria cristata | 7( 7) | 11(11) | 9(10) | 10(10) |
| Phleum pratense | - - | - - | - - | 1( p) |
| Poa pratensis | 1( 1) | 1( p) | p( p) | 1( 1) |
| Poa sandbergii | - - | 1( 1) | - - | - - |
| Stipa occidentalis | - - | 3( 3) | - - | p( p) |
| Stipa richardsonii | - - | 2( 2) | 1( p) | - - |
| FORBS | | | | |
| Achillea millefolium | 1( p) | 2( 1) | 5( 2) | 3( 1) |
| Agoseris glauca | p( p) | - - | - - | - - |
| Arennaria congesta | p( 1) | 11( 5) | 11( 5) | 2( 1) |
| Arnica fulgens | p( p) | 4( 2) | - - | 1( 1) |
| Calochortus apiculatus | - - | p( p) | 1( 1) | - - |
| Campanula rotundifolia | - - | - - | 6( 3) | - - |
| Clematis hirsutissima | - - | - - | - - | 1( p) |
| Collinsia parviflora | - - | p( p) | - - | - - |
| Equisetum laevigatum | - - | - - | - - | p( p) |
| Eriogonum flavum | 2( 1) | - - | 6( 4) | 2( 2) |
| Eriogonum umbellatum | 1( 1) | - - | 2( 1) | - - |
| Fragaria virginiana | 4( 1) | - - | - - | - - |
| Galium boreale | 1( p) | - - | - - | - - |
| Geum triflorum | 1( p) | 1( p) | p( p) | 3( 2) |
| Hieracium cynoglossoides | - - | - - | 11( 8) | - - |
| Lomatium triternatum | - - | - - | p( p) | - - |
| Lupinus sericeus | 1( 1) | 17(12) | 16(18) | 17(17) |
| Microsteris gracilis | - - | 1( p) | 2( 1) | 4( 1) |
| Penstemon confertus | p( p) | 1( p) | - - | - - |
| Polygonum douglasii | - - | 1( p) | 6( 4) | 13( 8) |
| Potentilla glandulosa | 1( 1) | 5( 3) | 2( 1) | - - |
| Potentilla gracilis | 1( 1) | - - | - - | - - |
| Sedum stenopetalum | p( p) | 1( 1) | - - | 1( p) |
| Taraxacum officinale | - - | 7( 1) | 6( 2) | - - |
| SHRUBS | | | | |
| Artemisia tridentata | 23(27) | - - | - - | - - |
| Potentilla fruticosa | 2( 2) | - - | - - | - - |

# TABLE 12. SPECIES CANOPY COVERAGE AND COMPOSITION BY WEIGHT FOR AGROPYRON SPICATUM-FESTUCA IDAHOENSIS COMMUNITY TYPE.

| Stand Number | 6 | 7 | 8 | 15 | 17 | 21 | 32 | 34 | 36 | 39 |
|---|---|---|---|---|---|---|---|---|---|---|
| GRAMINOIDS | | | | | | | | | | |
| Agropyron spicatum | 17(23) | 16(27) | 18(28) | 26(50) | 22(45) | 16(26) | 17(28) | 15(24) | 15(33) | 23(45) |
| Bromus tectorum | - - | - - | - - | - - | p( p) | - - | - - | - - | - - | - - |
| Carex geyeri | - - | - - | - - | - - | 1( 1) | 6( 6) | - - | - - | - - | - - |
| Carex spp. | 4( 2) | p( p) | - - | - - | - - | - - | 3( 2) | 5( 5) | 2( 5) | p( p) |
| Danthonia intermedia | 15( 9) | 4( 3) | 8( 5) | - - | - - | - - | 4( 4) | 3( 3) | - - | - - |
| Danthonia unispicata | - - | - - | - - | - - | - - | - - | - - | - - | - - | 1( 2) |
| Festuca idahoensis | 13(13) | 7( 9) | 11(13) | 9(18) | - - | 18(31) | 11(18) | 4( 5) | 6(11) | 3( 5) |
| Festuca scabrella | 10(15) | 6(10) | 8(13) | 2( 4) | - - | - - | 4( 6) | - - | 5( 9) | 1( 1) |
| Koeleria cristata | 9( 7) | 7( 8) | 7( 6) | 3( 3) | - - | - - | 6( 9) | 7( 8) | 3( 4) | 5( 7) |
| Poa pratensis | - - | - - | - - | - - | 6( 7) | - - | - - | - - | - - | p( p) |
| Poa sandbergii | - - | - - | - - | - - | - - | - - | - - | - - | - - | p( p) |
| Stipa occidentalis | p( p) | 1( 1) | - - | 1( 1) | 8( 8) | - - | - - | - - | - - | - - |
| FORBS | | | | | | | | | | |
| Achillea millefolium | 3( 1) | 6( 2) | 6( 2) | 1( 1) | 2( 1) | 5( 2) | 8( 3) | 8( 3) | 5( 2) | 2( 1) |
| Agoseris glauca | - - | - - | p( p) | - - | - - | - - | - - | - - | - - | - - |
| Allium cernuum | - - | - - | - - | - - | - - | p( p) | p( p) | - - | 2( 1) | p( p) |
| Alyssum alyssoides | - - | - - | - - | p( p) | - - | - - | - - | - - | - - | - - |
| Anemone multifida | - - | - - | - - | - - | - - | 1( 1) | - - | - - | - - | - - |
| Antennaria microphylla | 2( 1) | 5( 3) | 2( 1) | - - | - - | - - | 2( 2) | 3( 2) | - - | 15( 9) |
| Arnica fulgens | 3( 1) | p( p) | 2( 1) | - - | - - | - - | 4( 2) | - - | - - | - - |
| Arenaria congesta | 5( 3) | 2( 2) | - - | 1( 1) | - - | 2( 2) | p( p) | 12( 7) | 3( 3) | 12( 8) |
| Artemisia ludoviciana | - - | - - | - - | - - | - - | 1( 1) | - - | - - | - - | - - |
| Balsamorhiza sagittata | - - | - - | - - | - - | - - | 9( 9) | - - | - - | - - | - - |
| Calochortus apiculatus | - - | - - | - - | - - | - - | - - | 1( p) | - - | 1( 1) | - - |
| Campanula rotundifolia | p( p) | - - | - - | - - | - - | - - | - - | - - | - - | - - |
| Cerastium arvense | 2( 2) | - - | - - | - - | - - | - - | - - | - - | - - | 1( 1) |
| Clematis hirsutissima | 4( 3) | - - | - - | - - | - - | - - | - - | - - | - - | - - |
| Collomia linearis | - - | p( p) | p( p) | p( p) | p( p) | - - | - - | - - | - - | - - |
| Collinsia parviflora | - - | 1( p) | 1( p) | - - | - - | - - | - - | - - | - - | - - |
| Crepis sp. | - - | - - | - - | 1( 1) | - - | - - | - - | - - | - - | - - |
| Draba sp. | - - | - - | - - | 1( p) | p( p) | - - | - - | - - | - - | - - |
| Erigeron compositus | - - | - - | - - | - - | - - | - - | - - | - - | 3( 5) | - - |
| Erigeron spp. | 10(10) | - - | p( p) | 1( 1) | - - | - - | - - | - - | - - | - - |
| Eriogonum flavum | - - | - - | - - | 4( 3) | - - | - - | 6( 5) | 4( 3) | p( p) | - - |
| Eriogonum umbellatum | 3( 2) | 1( 2) | 2( 1) | 1( 1) | 1( p) | - - | - - | 1( 1) | - - | p( 1) |
| Eriogonum sp. | - - | - - | - - | - - | - - | p( 1) | - - | - - | - - | - - |
| Filago arvensis | - - | - - | - - | - - | 1( p) | - - | - - | - - | - - | - - |
| Fragaria virginiana | - - | - - | - - | - - | - - | 17(13) | p( p) | - - | - - | - - |
| Gaillardia aristata | 1( 1) | - - | - - | - - | - - | - - | - - | - - | 2( 3) | - - |
| Galium boreale | - - | - - | - - | - - | - - | - - | - - | - - | 1( 1) | - - |
| Gayophytum ramosissimum | - - | - - | - - | 2( 1) | - - | - - | - - | - - | - - | - - |
| Geranium viscosissimum | 1( 1) | - - | - - | - - | 1( p) | - - | - - | 2( 2) | - - | - - |
| Geum triflorum | 1( p) | 5( 3) | 1( 1) | - - | - - | - - | 5( 4) | - - | - - | - - |
| Hedysarum occidentale | - - | - - | - - | - - | - - | 1( 1) | - - | - - | - - | - - |
| Hieracium cynoglossoides | - - | 7( 5) | 6( 4) | - - | - - | 2( 3) | 5( 3) | 1( p) | - - | - - |
| Linanthus septentrionalis | - - | - - | - - | - - | 6( 2) | - - | - - | - - | - - | - - |
| Linum perenne | - - | - - | - - | p( p) | - - | 2( 1) | - - | - - | - - | p( p) |
| Lithospermum ruderale | - - | - - | - - | - - | - - | 1( 2) | - - | - - | - - | - - |
| Lomatium macrocarpum | - - | - - | - - | - - | - - | - - | 1( 1) | - - | 2( 1) | 7( 5) |
| Lomatium triternatum | - - | - - | - - | - - | - - | - - | p( p) | - - | - - | - - |
| Lupinus sericeus | 1( 1) | 12(12) | 15(18) | 4( 6) | 1( 1) | - - | 7( 7) | 9(14) | - - | - - |
| Microsteris gracilis | - - | - - | - - | - - | - - | - - | - - | - - | - - | 1( p) |
| Oxytropis sericea | - - | - - | - - | - - | - - | - - | - - | - - | 3( 3) | - - |
| Pedicularis contorta | - - | - - | - - | - - | - - | p( 1) | - - | - - | - - | - - |
| Polygonum douglasii | 3( 2) | 1( 1) | 2( 1) | 4( 3) | 10( 8) | - - | p( p) | 3( 2) | 1( p) | 2( 1) |
| Potentilla glandulosa | 2( 1) | 1( 1) | 7( 1) | 4( 2) | - - | - - | - - | 4( 3) | - - | p( p) |
| Potentilla gracilis | p( p) | - - | - - | - - | - - | - - | - - | - - | - - | p( p) |
| Sedum stenopetalum | p( p) | 2( 1) | p( p) | - - | 1( 2) | 1( 1) | 1( 1) | 6( 4) | 3( 3) | - - |
| Senecio spp. | - - | 2( 2) | - - | - - | - - | - - | p( 1) | - - | 6(10) | 3( 3) |
| Taraxacum officinale | - - | 2( 1) | p( p) | p( p) | - - | - - | p( p) | 1( p) | p( p) | p( p) |
| Tragapogon dubius | 1( 1) | - - | - - | - - | - - | - - | - - | - - | p( 1) | p( 1) |
| Zigadenus venenosus | 1( 1) | - - | - - | - - | - - | - - | - - | - - | - - | - - |
| SHRUBS | | | | | | | | | | |
| Amelanchier alnifolia | - - | - - | - - | - - | 7( 7) | - - | - - | - - | - - | - - |
| Arctostaphylos uva-ursi | - - | 6( 6) | 3( 3) | - - | - - | - - | - - | - - | - - | - - |
| Berberis repens | - - | 1( 1) | - - | - - | 1( 2) | - - | 3( 2) | - - | 1( 1) | - - |
| Prunus virginiana | - - | - - | - - | - - | 1( 2) | - - | - - | - - | - - | - - |
| Rosa arkansana | - - | - - | - - | - - | - - | - - | 1( p) | - - | 2( 3) | - - |
| Spiraea betulifolia | - - | - - | - - | - - | 7( 7) | - - | - - | - - | - - | - - |
| Symphoricarpos albus | - - | - - | - - | - - | 3( 5) | - - | - - | - - | - - | - - |

TABLE 13. SPECIES CANOPY COVERAGE AND COMPOSITION BY WEIGHT FOR STIPA OCCIDENTALIS-KOELERIA CRISTATA COMMUNITY TYPE.

| Stand Number | 1 | 2 | 3 | 4 | 5 | 10 | 23 | 35 | 38 |
|---|---|---|---|---|---|---|---|---|---|
| GRAMINOIDS | | | | | | | | | |
| Agropyron spicatum | 1( p) | p( p) | 3( 3) | 5( 6) | 1( 1) | 7(11) | 4( 8) | p( 1) | - - |
| Agrostis scabra | - - | - - | - - | - - | - - | - - | - - | 2( 1) | - - |
| Bromus inermis | - - | - - | - - | - - | - - | - - | - - | 2( 3) | - - |
| Bromus tectorum | - - | p( p) | - - | - - | - - | - - | - - | - - | - - |
| Carex spp. | - - | - - | - - | - - | 3( 3) | - - | p( p) | - - | - - |
| Danthonia intermedia | - - | - - | 8( 8) | 2( 2) | 9( 7) | p( p) | - - | 6( 7) | - - |
| Danthonia unispicata | p( p) | 2( 1) | - - | 5( 6) | 2( 1) | - - | - - | 2( 2) | p( 1) |
| Festuca idahoensis | 1( 1) | 3( 3) | 8(11) | 7( 7) | 8( 8) | 1( 3) | 2( 2) | 1( 1) | - - |
| Festuca scabrella | - - | - - | - - | 1( 1) | 5( 8) | - - | - - | 5( 9) | - - |
| Koeleria cristata | 4( 5) | 1( 1) | 5( 7) | 4( 7) | 9(10) | 4( 4) | 9(11) | 7( 9) | 2( 5) |
| Poa pratensis | - - | - - | - - | - - | - - | - - | - - | 1( 1) | - - |
| Poa sandbergii | 8( 7) | 1( 1) | 1( 1) | - - | 1( 1) | 3( 7) | 1( p) | - - | 15(21) |
| Poa spp. | - - | - - | - - | - - | - - | 2( 3) | - - | - - | - - |
| Stipa occidentalis | 33(39) | 15(16) | 25(25) | 22(25) | 17(17) | 11(18) | 18(30) | 34(42) | 18(34) |
| Stipa richardsonii | - - | - - | - - | - - | 7(10) | - - | - - | 1( 2) | - - |
| FORBS | | | | | | | | | |
| Achillea millefolium | - - | - - | 1( p) | p( p) | 4( 3) | 1( 1) | 4( 4) | 2( 1) | 1( 1) |
| Agoseris glauca | - - | - - | - - | - - | - - | 1( 1) | - - | - - | - - |
| Allium cernuum | - - | 1( 2) | - - | - - | - - | - - | - - | - - | 1( 1) |
| Alyssum alyssoides | - - | p( p) | - - | - - | - - | - - | - - | - - | - - |
| Antennaria microphylla | 13(19) | 3( 3) | 1( 1) | 9(10) | 4( 3) | 2( 2) | p( p) | 2( 1) | - - |
| Arenaria congesta | p( p) | p( p) | 2( 3) | - - | - - | - - | p( p) | p( p) | - - |
| Arenaria serpyllifolia | - - | 4( 4) | - - | - - | - - | - - | - - | - - | - - |
| Arnica fulgens | - - | - - | - - | p( p) | 1( p) | - - | - - | - - | - - |
| Calochortus apiculatus | - - | - - | - - | - - | - - | p( 1) | 1( 1) | - - | p( p) |
| Chrysopsis villosa | 6( 8) | 10(15) | - - | - - | - - | - - | 4( 6) | - - | 6(12) |
| Collinsia parviflora | - - | - - | - - | - - | - - | p( p) | - - | - - | - - |
| Collomia linearis | p( p) | 1( 1) | - - | - - | - - | 5( 7) | - - | - - | - - |
| Draba spp. | - - | - - | - - | - - | - - | - - | p( p) | - - | 1( 1) |
| Erigeron compositus | - - | - - | - - | - - | - - | 3( 6) | 4( 5) | - - | 12(14) |
| Erigeron spp. | - - | - - | - - | - - | - - | 4( 5) | 5( 6) | - - | - - |
| Eriogonum flavum | 1( 2) | 3( 3) | 9(10) | 5( 5) | - - | - - | 1( 1) | p( p) | 1( 1) |
| Eriogonum umbellatum | 1( 1) | - - | - - | - - | 3( 2) | 2( 2) | p( p) | p( p) | 2( 2) |
| Filago arvensis | - - | - - | - - | - - | - - | - - | - - | 3( 2) | - - |
| Fragaria virginiana | - - | - - | - - | 1( p) | - - | p( p) | p( p) | 2( 1) | - - |
| Gaillardia aristata | - - | 2( 2) | 2( 3) | 1( 1) | 2( 1) | - - | 2( 3) | - - | - - |
| Gayophytum ramosissimum | - - | - - | - - | - - | - - | - - | - - | 1( p) | - - |
| Geranium viscosissimum | - - | - - | - - | - - | 1( 1) | - - | - - | - - | - - |
| Geum triflorum | 1( p) | - - | 5( 5) | 5( 6) | 1( 1) | - - | 1( 1) | 1( 1) | - - |
| Heuchera cylindrica | - - | - - | - - | - - | 1( 2) | - - | - - | - - | - - |
| Hieracium cynoglossoides | - - | - - | 1( p) | - - | - - | - - | 1( 1) | - - | - - |
| Lithospermum ruderale | - - | - - | - - | - - | 1( 1) | - - | - - | - - | - - |
| Lomatium macrocarpum | - - | - - | - - | - - | - - | - - | 2( 2) | - - | - - |
| Lupinus sericeus | - - | - - | 8(14) | 2( 2) | 6( 8) | - - | - - | 2( 1) | - - |
| Microsteris gracilis | - - | - - | - - | - - | - - | - - | - - | - - | 3( 3) |
| Orthocarpus tenuifolius | - - | - - | - - | 2( 2) | p( p) | - - | - - | - - | - - |
| Penstemon confertus | 1( 1) | - - | - - | - - | - - | - - | - - | - - | - - |
| Polygonum douglasii | 2( 1) | 20(27) | 1( 1) | 9(10) | 5( 5) | 1( 2) | - - | 1( p) | 1( p) |
| Potentilla argentea | 2( 3) | 6( 7) | - - | - - | - - | - - | - - | - - | - - |
| Potentilla glandulosa | 1( p) | - - | - - | 2( 1) | 3( 2) | 2( 2) | - - | - - | - - |
| Sedum stenopetalum | 2( 3) | 8(12) | 4( 5) | 6( 8) | 4( 3) | 12(20) | 8( 7) | 3( 2) | 1( 1) |
| Senecio spp. | - - | 1( 2) | p( p) | - - | - - | p( p) | - - | - - | 1( 1) |
| Taraxacum officinale | 1( p) | p( p) | - - | - - | p( p) | p( p) | - - | 1( p) | - - |
| Tragopogon dubius | - - | - - | - - | - - | - - | p( 1) | p( 1) | - - | - - |
| Zigadenus venenosus | - - | - - | - - | - - | - - | - - | p( 1) | - - | - - |
| SHRUBS | | | | | | | | | |
| Arctostaphylos uva-ursi | - - | - - | - - | - - | 1( 1) | - - | 4( 5) | 1( 1) | - - |
| Berberis repens | 3( 3) | - - | - - | - - | - - | - - | 1( 1) | 8( 9) | 1( 1) |
| Rosa arkansana | 6( 5) | - - | p( p) | - - | - - | 4( 4) | 1( 2) | 1( p) | - - |

TABLE 14. SPECIES CANOPY COVERAGE AND COMPOSITION BY WEIGHT FOR DANTHONIA UNISPICATA, POA PRATENSIS AND PHLEUM PRATENSE PHASES.

| | Dain phase | | Popr phase | | Phpr phase |
|---|---|---|---|---|---|
| Stand Number | 28 | 31 | 24 | 37 | 13 |
| GRAMINOIDS | | | | | |
| Agropyron caninum | - - | - - | - - | - - | p( p) |
| Agropyron cristatum | - - | - - | - - | 6( 9) | - - |
| Agropyron spicatum | - - | - - | - - | 1( 1) | - - |
| Agrostis interrupta | p( p) | - - | - - | - - | - - |
| Agrostis scabra | - - | p( p) | - - | - - | - - |
| Bromus carinatus | - - | - - | p( p) | - - | 2( 2) |
| Calamagrostis rubescens | - - | - - | 2( 2) | - - | - - |
| Carex spp. | - - | - - | 4( 3) | - - | 13(11) |
| Danthonia intermedia | - - | - - | - - | 4( 3) | 5( 4) |
| Danthonia unispicata | 29(39) | 18(28) | - - | - - | - - |
| Festuca idahoensis | 3( 3) | 7( 8) | - - | 1( 1) | - - |
| Festuca scabrella | - - | 2( 2) | - - | 4( 5) | - - |
| Koeleria cristata | 2( 3) | 6( 8) | 13(16) | 3( 2) | - - |
| Phleum pratense | - - | - - | 4( 5) | - - | 14(19) |
| Poa pratensis | - - | - - | 16(17) | 14(17) | 1( 1) |
| Poa sandbergii | 6( 7) | 3( 3) | - - | p( p) | - - |
| Poa spp. | - - | - - | - - | - - | 19(16) |
| Stipa occidentalis | 2( 2) | 20(24) | 27(25) | 38(38) | 16(21) |
| Stipa richardsonii | - - | - - | p( p) | - - | - - |
| FORBS | | | | | |
| Achillea millefolium | p( p) | - - | 2( 1) | 8( 2) | 14( 4) |
| Agoseris glauca | - - | p( p) | - - | - - | 4( 1) |
| Anemone multifida | - - | - - | p( p) | - - | - - |
| Antennaria microphylla | 3( 4) | 3( 1) | p( p) | 2( 1) | - - |
| Arenaria congesta | 7( 7) | 8( 5) | - - | - - | - - |
| Arnica fulgens | p( p) | - - | - - | - - | - - |
| Collinsia parviflora | - - | p( p) | p( p) | - - | - - |
| Epilobium paniculatum | p( p) | - - | - - | - - | - - |
| Erigeron compositus | 4( 3) | 2( 2) | - - | - - | - - |
| Eriogonum flavum | - - | 5( 3) | - - | 1( 1) | - - |
| Eriogonum umbellatum | 1( 1) | - - | 2( 2) | 4( 2) | - - |
| Fragaria virginiana | - - | - - | 1( p) | 1( p) | 1( p) |
| Filago arvensis | p( p) | - - | - - | - - | - - |
| Galium boreale | - - | - - | 2( 2) | 2( 1) | 9( 4) |
| Gayophytum ramosissimum | 3( 1) | - - | p( p) | - - | - - |
| Geranium viscosissimum | - - | - - | 2( 1) | p( p) | - - |
| Geum triflorum | - - | p( p) | - - | - - | - - |
| Hieracium cynoglossoides | - - | - - | 1( 1) | - - | - - |
| Lomatium triternatum | p( p) | 1( p) | - - | - - | - - |
| Lupinus sericeus | 8(10) | 10(11) | 5( 5) | 3( 4) | - - |
| Microsteris gracilis | 4( 2) | - - | - - | - - | - - |
| Penstemon confertus | - - | - - | 10( 9) | - - | 14( 6) |
| Perideridia gairdneri | - - | - - | - - | - - | p( p) |
| Polygonum douglasii | 5( 3) | 2( 1) | p( p) | 1( p) | - - |
| Potentilla gracilis | - - | - - | - - | - - | 4( 1) |
| Sedum stenopetalum | 4( 5) | 1( 1) | - - | 3( 2) | - - |
| Senecio serra | - - | - - | - - | - - | 5( 5) |
| Senecio spp. | p( p) | 2( 2) | - - | 1( 1) | - - |
| Taraxacum officinale | 2( 1) | 2( p) | p( p) | p( p) | 10( 3) |
| Viola sp. | - - | - - | - - | - - | 1( p) |
| SHRUBS | | | | | |
| Arctostaphylos uva-ursi | - - | - - | - - | 8( 8) | - - |
| Berberis repens | - - | - - | 5( 3) | 2( 1) | - - |
| Rosa arkansana | 13(10) | 1( p) | 2( 1) | - - | - - |
| Symphoricarpos albus | - - | - - | 5( 5) | - - | - - |

TABLE 15. SPECIES CANOPY COVERAGE AND COMPOSITION BY WEIGHT FOR SYMPHORICARPOS ALBUS-AMELANCHIER ALNIFOLIA, POA PRATENSIS AND PINUS CONTORTA-CALAMAGROSTIS RUBESCENS COMMUNITY TYPES.

| | Syal-Amal c.t. | | | Popr c.t. | | | Pico-Caru c. t. |
|---|---|---|---|---|---|---|---|
| Stand Number | 18 | 19 | 20 | 22 | 29 | 40 | 12 |
| GRAMINOIDS | | | | | | | |
| Agropyron caninum | - - | - - | - - | - - | 1( 2) | - - | - - |
| Agropyron spicatum | 5( 3) | 4( 3) | 11( 6) | 2( 2) | - - | 4( 5) | - - |
| Agrostis scabra | - - | - - | - - | - - | 2( 1) | - - | - - |
| Bromus carinatus | 10( 4) | 5( 4) | 5( 2) | 1( 2) | - - | - - | - - |
| Calamagrostis rubescens | - - | 1( 1) | p( p) | - - | - - | - - | 47(46) |
| Carex geyeri | 6( 4) | 15(10) | 2( 1) | 1( 1) | - - | 1( 1) | - - |
| Carex spp. | - - | - - | - - | - - | 18(14) | 3( 2) | 5( 4) |
| Danthonia intermedia | - - | - - | - - | - - | 1( p) | 2( 2) | - - |
| Festuca idahoensis | - - | - - | - - | - - | - - | 1( 1) | - - |
| Festuca scabrella | - - | - - | - - | - - | - - | 2( 2) | - - |
| Juncus sp. | - - | - - | - - | - - | 1( p) | - - | - - |
| Koeleria cristata | - - | - - | - - | - - | - - | 3( 3) | - - |
| Melica spectabilis | p( p) | - - | 4( 1) | - - | - - | - - | - - |
| Phleum pratense | - - | 1( p) | - - | - - | - - | - - | - - |
| Poa pratensis | - - | 2( 2) | 3( 2) | 42(44) | 35(22) | 52(55) | - - |
| Stipa occidentalis | - - | - - | - - | - - | - - | 2( 2) | - - |
| FORBS | | | | | | | |
| Achillea millefolium | 1( p) | 9( 3) | 15( 5) | 3( 1) | 1( p) | 5( 3) | 1( p) |
| Agastache urticifolia | 1( 1) | - - | - - | - - | - - | - - | - - |
| Allium cernuum | - - | p( p) | 4( 2) | 1( 1) | - - | - - | - - |
| Arenaria congesta | - - | - - | - - | - - | - - | p( p) | - - |
| Arenaria serpyllifolia | - - | - - | - - | 5( 2) | - - | - - | - - |
| Antennaria microphylla | - - | 1( 1) | - - | - - | p( p) | 1( 1) | - - |
| Antennaria sp. | - - | - - | - - | - - | - - | - - | 1( p) |
| Arnica cordifolia | - - | - - | - - | - - | - - | - - | p( p) |
| Aster laevis | - - | - - | - - | - - | - - | - - | 2( 2) |
| Aster sp. | 1( p) | 9( 8) | 5( 6) | - - | - - | - - | - - |
| Castilleja mineata | - - | p( p) | - - | - - | - - | - - | - - |
| Draba sp. | - - | - - | - - | 1( 1) | - - | - - | - - |
| Epilobium angustifolium | - - | 4( 6) | - - | - - | - - | - - | - - |
| Epilobium paniculatum | - - | - - | - - | 21(15) | - - | - - | - - |
| Eriogonum flavum | - - | - - | 4( 6) | - - | - - | 4( 2) | - - |
| Eriogonum umbellatum | 5( 3) | 3( 3) | 5( 6) | - - | - - | p( p) | - - |
| Fragaria virginiana | 6( 2) | 7( 3) | 2( 1) | 3( 1) | 23( 8) | p( p) | 7( 3) |
| Gayophytum ramosissimum | - - | - - | - - | p( p) | 1( p) | - - | - - |
| Geranium viscosissimum | - - | - - | - - | - - | - - | - - | 1( p) |
| Heuchera cylindrica | - - | - - | - - | P( p) | - - | - - | - - |
| Hieracium albiflorum | - - | - - | - - | - - | - - | - - | 1( p) |
| Hieracium cynoglossoides | - - | - - | 1( p) | - - | - - | p( p) | - - |
| Lomatium macrocarpum | - - | - - | - - | p( p) | - - | - - | - - |
| Lupinus sericeus | - - | - - | - - | - - | - - | 14(14) | - - |
| Lupinus sp. | - - | - - | - - | - - | - - | - - | p( p) |
| Medicago lupulina | - - | - - | - - | 1( 1) | - - | - - | - - |
| Microsteris gracilis | - - | - - | - - | p( p) | - - | - - | - - |
| Penstemon albertinus | - - | - - | - - | 1( 1) | - - | - - | - - |
| Penstemon confertus | 10(12) | 7( 9) | - - | - - | 26(24) | p( p) | 1( 1) |
| Phacelia sp. | - - | 1( 1) | - - | - - | - - | - - | - - |
| Polygonum douglasii | 4( 3) | 4( 4) | 6( 3) | - - | p( p) | 2( 1) | - - |
| Potentilla argentea | - - | - - | - - | 1( p) | - - | - - | - - |
| Potentilla glandulosa | - - | - - | - - | - - | - - | 4( 1) | - - |
| Potentilla gracilis | - - | - - | - - | - - | 39(28) | p( p) | - - |
| Sedum stenopetalum | - - | 1( 1) | 1( 1) | 4( 3) | p( p) | 7( 3) | - - |
| Smilacina stellata | - - | - - | - - | - - | 1( p) | - - | - - |
| Taraxacum officinale | - - | - - | - - | - - | p( p) | p( p) | - - |
| Tragapogon dubius | - - | - - | - - | p( p) | - - | - - | - - |
| SHRUBS | | | | | | | |
| Acer glabrum | - - | 4( 3) | - - | - - | - - | - - | - - |
| Amelanchier alnifolia | 15(17) | 11(10) | 10(12) | - - | - - | - - | - - |
| Arctostaphylos uva-ursi | - - | - - | p( p) | - - | - - | - - | 12(21) |
| Berberis repens | 6( 5) | 7( 7) | 12(11) | 12(11) | - - | - - | 2( 2) |
| Ceanothus velutinus | - - | 2( 1) | - - | - - | - - | - - | - - |
| Pachistima myrsinites | - - | p( p) | - - | - - | - - | - - | - - |
| Prunus virginiana | 5( 4) | 1( 1) | 3( 4) | - - | - - | - - | - - |
| Rosa sp. | - - | - - | - - | - - | - - | - - | 1( 1) |
| Spirea betulifolia | - - | 7( 6) | - - | 13( 9) | - - | - - | - - |
| Symphoricarpos albus | 38(41) | 8(12) | 27(30) | 4( 5) | - - | - - | - - |
| Vaccinium caespitosum | - - | - - | - - | - - | - - | - - | 18(19) |

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