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Plant Community Classification for Alpine Vegetation on the Beaverhead National Forest, Montana

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Contents

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Introduction

Much of what is generally considered the Northern Rocky Mountains floristic province is in Montana (McLaughlin 1989). Numerous mountain ranges occur in the western half of the State, many reaching elevations above treeline. The vegetation of grasslands, shrublands, forests, woodlands, and riparian areas of western Montana have been described and classified (Hansen and others 1995; Mueggler and Stewart 1980; Pfister and others 1977). However, due to inaccessibility and relatively low economic importance, few studies have described the alpine vegetation of the Northern Rocky Mountains. Existing studies include Glacier National Park (Bamberg and Major 1968; Choate and Habeck 1967), the Big Snowy Mountains and Flint Creek Mountains (Bamberg and Major 1968), and the Beartooth Plateau (Johnson and Billings 1962); these studies were conducted at fewer than a half-dozen sites. Recently, studies have been completed for alpine areas of east and east-central Idaho (Brunsfeld 1981; Caicco 1983; Henderson 1992; Moseley 1985; Urbanczyk and Henderson 1994).

Twenty-seven mountain ranges in Montana support significant alpine terrain. More than half of these ranges are in the southwestern portion of the State, and nine are on Beaverhead National Forest. Southwestern Montana is also the most floristically diverse region of the State (Lesica and others 1984). Knowledge of alpine plant communities in this area would allow a more comprehensive portrayal of Northern Rocky Mountain alpine ecosystems. Our study had the following objectives:

1. Develop a classification system for alpine communities on the Beaverhead National Forest.
2. Relate abiotic environmental factors such as climate, soils, and landforms to the occurrence of these communities.
3. Compare the alpine vegetation communities on the Beaverhead National Forest to those described from other areas of Western North America.
4. Consider management implications for alpine vegetation systems.

Study Area

Vegetation

Our study area encompassed eight alpine mountain ranges that occur, at least in part, on the Beaverhead National Forest: Anaconda (color plate 1), Beaverhead, Gravelly, Madison, Pioneer, Snowcrest, Tendoy, and Tobacco Root (fig. 1a,b). The sampled portions of these ranges are all east of the Continental Divide. The area is semiarid, and both upper and lower treelines occur in all ranges. Intermountain valleys are high (4,800 to 6,600 ft), and the cold, frost-prone climate is unsuitable for the establishment of tree species that are not cold-adapted. Thus, *Pseudotsuga menziesii* and *Pinus flexilis*, not *Pinus ponderosa*, are climax dominants of lower treeline and extend through the montane to the middle of the subalpine zone. *Pinus flexilis* extends onto sites drier and warmer than can be tolerated by *Pseudotsuga*; it also shows a preference for the calcareous substrates of this area (Pfister and others 1977).

The upper subalpine is composed of *Abies lasiocarpa*, *Picea engelmanii*, *Pinus contorta*, *P. albicaulis*, and occasionally *P. flexilis*; relative proportions of these trees depend primarily on successional status, aspect, and to a lesser degree, substrate (Pfister and others 1977). Above approximately 8,500 ft, the forest canopy becomes progressively more open and dominated by *Pinus albicaulis*. Near treeline, the belt of mostly continuous forest gives way to atolls of stunted and flagged trees interspersed among nonforest vegetation. The extent of true krummholz, trees not reaching much more than waist height due to ice particle abrasion of

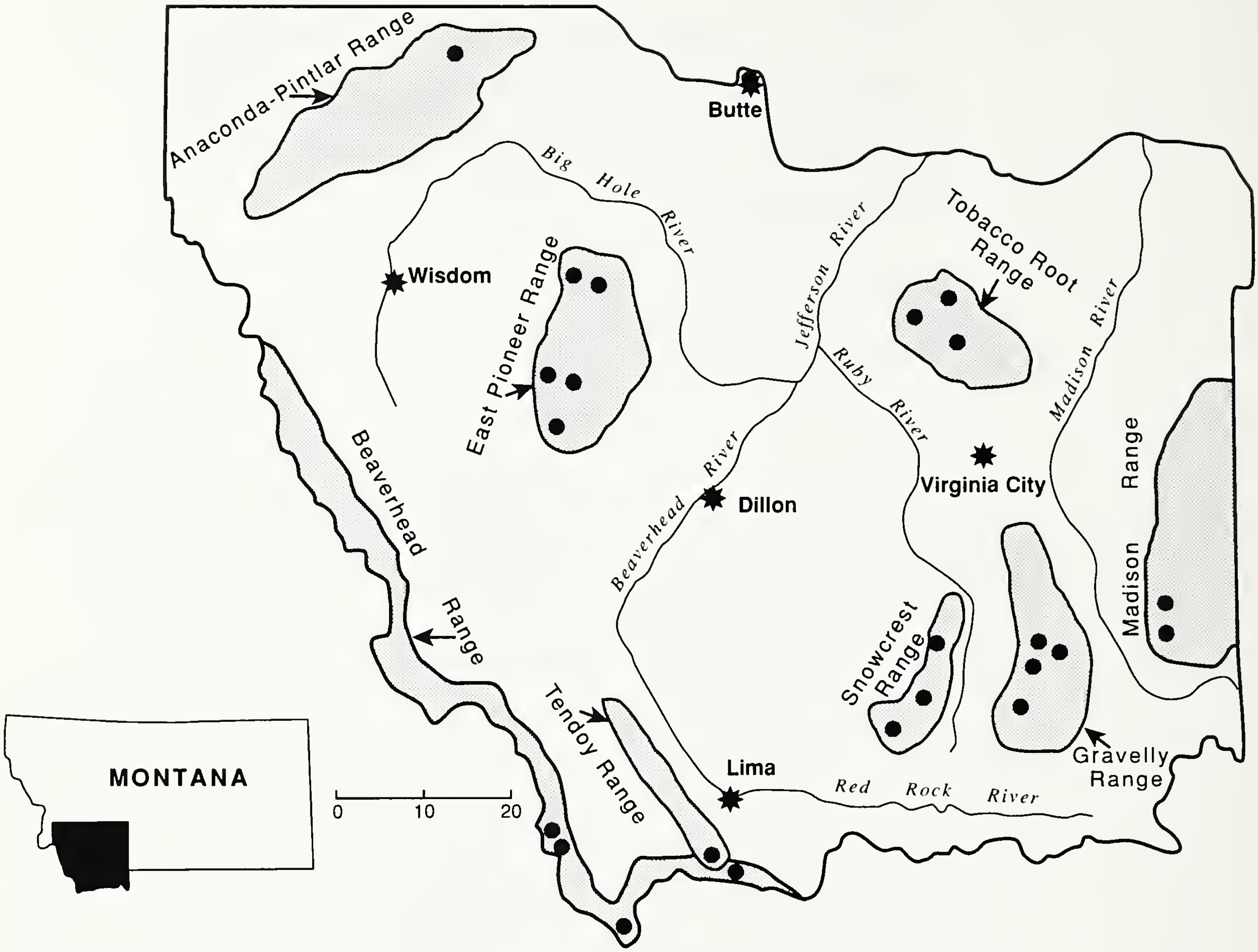


Figure 1a—Study area mountain ranges in southwestern Montana. ● indicates location of sample plots.

exposed surfaces, is very limited. Forest communities for this area are detailed by Pfister and others (1977).

The nonforest communities at or just below treeline are shrub-steppe dominated by *Artemisia tridentata* ssp. *vaseyana*, grasslands dominated by *Festuca idahoensis* and *Deschampsia cespitosa*, and subalpine forb fields on the moister sites. Many of the plant associations comprising these high-elevation steppes have been described by Mueggler and Stewart (1980).

Subalpine cirque basins often contain areas in which soil moisture is above that of the surrounding uplands for at least part of the year. These areas support wetland vegetation dominated by species of *Salix*, especially *S. planifolia* and *S. wolfii*, or by herbaceous species such as *Carex scopulorum*, *Eleocharis pauciflora*, *Juncus balticus,* and *Caltha leptosepala*. Many of these subalpine wetlands are described by Hansen and others (1995).

Climate

There are no long-term weather records for high-elevation sites in our study area. Walter-type climate diagrams (Walter and others 1975) for Virginia City and Lima, MT, are presented in figure 2. Although these stations are located at 5,776 and 6,275 ft (fig. 1), they illustrate the seasonal march of temperature and precipitation for the area. Precipitation in the alpine zone is undoubtedly higher, and temperatures are lower than at these valley stations. Clearly, the seasonal patterns of precipitation and temperature are very similar for both stations. Compared to Billing's (1988) diagrams for typical alpine areas in New Hampshire, California, and Colorado, our study area pattern is closest to that of Niwot Ridge, CO, with the notable exception of having a distinct precipitation bulge in May and June. This spring maximum also sets our study area apart from Sierra Nevada

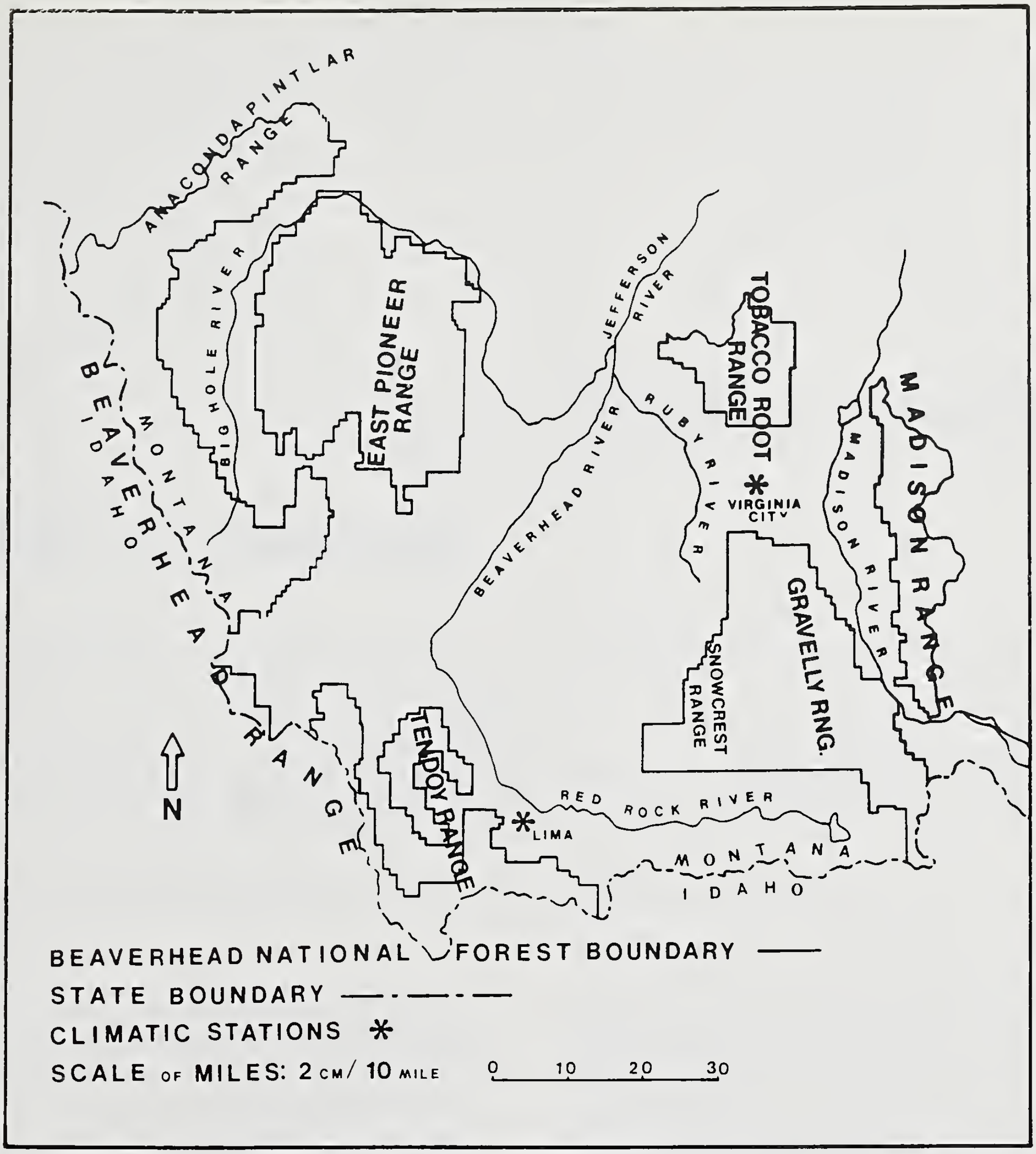


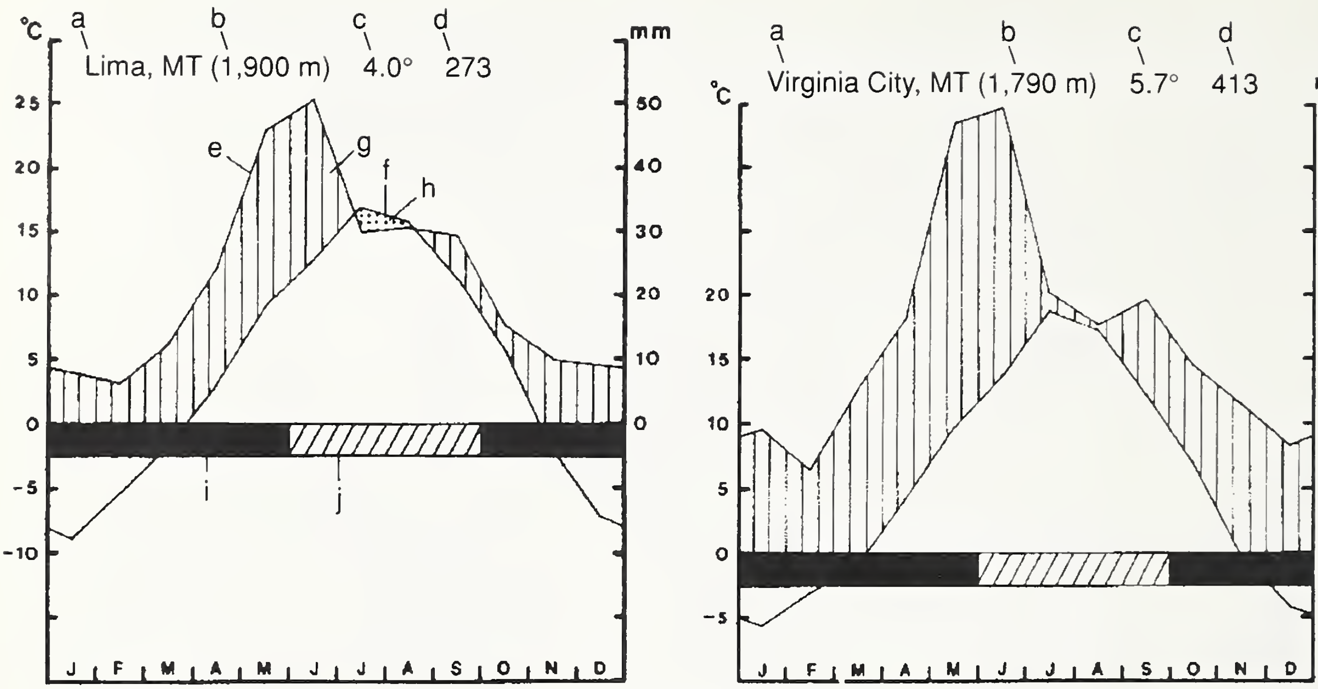
Figure 1b—Study area showing boundaries of the Beaverhead National Forest.

and Appalachian alpine. The relatively droughty conditions portrayed by our valley stations would not obtain in the alpine where precipitation increases and the temperatures would be depressed by about 5.7 to 6.8 °F (3.2 to 3.8 °C). Such a depression would result in a total of 6 months with average temperatures below freezing. Some authors characterize the alpine zone as having a climate where the monthly average temperature never exceeds 50 °F (10 °C) (Billings 1988). However, the Sierra Nevadan alpine has at least 3 months that exceed this figure, and our lowest elevation sites exceed it in July and August.

Ross and Hunter (1976) present precipitation isopleth maps for Montana based on a large number of snow-depth recording stations. These maps indicate that precipitation increases from west to east in the southwestern part of the State. The crests of Beaverhead, Snowcrest, and Tendoy ranges receive approximately 30 inches of precipitation annually. The Gravelly Range receives 30 to 40 inches, and the Anaconda, Pioneer, and Tobacco Root ranges receive 40 to 60 inches. The Madison Range at the west edge of our study area receives 50 to 70 inches.

Geology and Soils

Representative exposures from the three major groups of parent materials—sedimentary, metamorphic,



a = station name
b = station elevation (m)
c = mean annual temperature (°C)
d = mean annual precipitation (mm)
e = monthly march of precipitation
f = monthly march of temperature
g = relatively humid season (vertical hatching, note axes explicitly scaled so the 10° = 20 mm precipitation)
h = period of relative drought
i = period of mean daily minimum below 0 °C (blackened)
j = months with absolute minimum below 0 °C

Figure 2—Walter-type climatic diagrams for two stations in the study area, Virginia City and Lima, Montana.

and igneous—are found in mountain ranges of southwestern Montana. Sedimentary and metamorphosed sedimentary rocks predominate in the south and west portions of the study area, while intrusive and metamorphic basement rocks become more common to the east and north (Ross and others 1955). The crests of the southern Beaverhead, Gravelly, Snowcrest, and Tendoy Mountains are composed of Mesozoic and upper Paleozoic limestones, sandstones and quartzites. The southern end of the Beaverhead Mountains is composed of calcareous Beaverhead Conglomerate. The highest point in the Gravelly Mountains, Black Butte, is a remnant stock of Quaternary basalt. The high country of the Tobacco Root Mountains is composed of granite of the Tobacco Root Batholith. Most of the alpine terrain in the Pioneer Mountains is underlain by granite of the Pioneer Batholith; however, the high peaks at the very north end of the range form a contact between the intrusive igneous and Paleozoic limestones and dolomites. Although the main mass of the Anaconda Mountains is granitic, the east end where we sampled is underlain by Precambrian quartzites and limestones. The southern end of the Madison Mountains is composed primarily of Precambrian gneiss and schist with some areas on the east flank underlain by Mesozoic limestone (Ross and others 1955). Table 1 summarizes the number of plots established in each mountain range by parent material.

Soils supporting alpine vegetation have been described for the Northern Rocky Mountains by Bamberg and Major (1968), Johnson and Billings (1962), Nimlos and McConnell (1962), and Thilenius and Smith (1985). Soils from our study sites on sedimentary parent material resembled those described by Bamberg and Major (1968), while sites with crystalline parent material had soils similar to those described by Johnson and Billings (1962) and Nimlos and McConnell (1962). In general, turf and meadow soils developed from sandstones, limestones, and shales were finer textured than those derived from granite, quartzite, or metamorphic basement rocks.

Indications of cryopedogenic processes were evident in all of the mountain ranges. Solifluction lobes and terraces were common on steep, moist north slopes. Frost boils, rock polygons, and stone stripes were often apparent, especially in the Anaconda-Pintlar, Madison, East Pioneer, Tendoy, and Tobacco Root Mountains.

Table 1—Distribution of sample plots by mountain range and parent material type.

	Range								Total
	Beaver-head	Tendoy	Snowcrest	Gravelly	East Pioneer	Anaconda-Pintlar	Tobacco Root	Madison	parent material
Calcareous types									
Limestone/dolomite	16	01	04	08	05	02	00	03	39
Sandstone	00	00	12	05	00	00	00	00	17
Conglomerate	00	04	02	00	00	00	00	00	06
Mixed	00	01	01	00	02	00	00	00	04
Alluvium	01	00	00	00	00	00	00	00	01
Calcareous subtotal	17	06	19	13	07	02	00	03	67
Noncalcareous types									
Sandstone	00	00	00	02	00	00	00	00	02
Quartzite	00	02	00	02	05	05	00	00	14
Siltite	00	00	00	00	00	01	00	00	01
Extrusive volcanics	00	00	00	08	00	00	00	00	08
Intrusive volcanics	00	00	00	00	11	00	05	03	19
Metamorphosed volcanic	00	00	00	00	00	00	12	09	21
Mixed	00	01	00	00	00	00	00	01	02
Alluvium	00	00	00	02	00	00	00	01	03
Noncalcareous subtotal	00	03	00	14	16	06	17	14	70
Total by mountain range	17	09	19	27	23	08	17	17	137

Development of these features has been described by Billings and Mooney (1959), Johnson and Billings (1962), Lewis (1970), and Washburn (1956).

Methods and Discussion

Stand Selection

We examined U.S. Geological Survey topographical maps and aerial photography to ascertain the upper elevational limit of trees. For most of the study area, treeline occurs at approximately 9,500 ft, often higher on warm slopes and lower on north slopes. On the north side of the Anaconda Mountains at the northern end of our study area, treeline occurs at approximately 9,200 ft. All of our sample plots were near or above these limits and above nearly all of the high elevation *Artemisia tridentata* ssp. *vaseyana*-dominated shrub steppe and the majority of the scattered treeline stands. Other researchers have consistently not considered *A. tridentata*- and *A. arbuscula*-dominated vegetation as alpine community types, even where this type occurred much above treeline. We did not sample *Artemisia*-dominated communities. Most alpine terrain in our study area is far from any roads, and ease of access to an extensive alpine area was an important consideration in selecting sampling locations.

We sampled stands that appeared homogeneous in vegetation composition and structure (Mueller-Dombois and Ellenberg 1974). Efforts were made to avoid areas where site variables were not constant (for example, change in slope or exposed rock) or where vascular plant cover was less than 10 percent. Generally, stands were representative of large areas of vegetation; however, wetlands were usually limited in extent.

Vegetation Sampling

Sample plots were 30 x 30 m with a 30 m tape placed in the middle of the plot perpendicular to the slope. In some cases, we had to modify the shape of our macroplot to accommodate the shape of the stands. We employed Daubenmire's (1959) concept of canopy cover in estimating species abundance. Canopy cover of bare soil, rock, litter, moss and lichens, total shrubs, total graminoids, total forbs, and all vascular plant species in the plot was assigned to one of the following cover classes:

Code	Class range	Midpoint
	Percent	
0	0	0.0
T	>0 to <1	0.5
P	= or >1 to <5	3.0
1	= or >5 to <15	10.0
2	= or >15 to <25	20.0
3	= or >25 to <35	30.0
4	= or >35 to <45	40.0
5	= or >45 to <55	50.0
6	= or >55 to <65	60.0
7	= or >65 to <75	70.0
8	= or >75 to <85	80.0
9	= or >85 to <95	90.0
F	= or >95 to 100	97.5

At the start of field work, we verified the accuracy of whole-plot estimates of canopy cover by first estimating cover by species across the macroplot. We then estimated cover in 25 to 50 randomly placed 50 x 20 cm microplots and used these data to obtain a second estimate of canopy cover for the macroplot. We conducted this test for three plots in alpine grassland and meadow vegetation. Canopy cover estimates for macroplots, based on microplot averages, never differed by more than one cover class from the ocular estimates. In fact, class estimates matched for more than 80 percent of the species. Cover estimates for surface features were also within one cover class of measured values. Thus, we concluded that whole-plot ocular estimation of species cover would be appropriate and considerably more efficient than using microplots. Estimates of canopy cover were always made by the same investigator to minimize variation.

We sampled stands in the Beaverhead, Gravelly, Snowcrest, and Tendoy Mountains on July 18 to 30 and August 10 to 12, 1989. We sampled stands in the Anaconda, Madison, Pioneer, and Tobacco Root Mountains from July 21 to August 2, 1991. Weather was drier than average in southwestern Montana during the winter and spring of 1989, while precipitation in 1991 was above average.

Taxonomic Considerations

Vascular plant nomenclature generally follows Hitchcock and Cronquist (1973). Nomenclature for willows (*Salix* spp.) follows Dorn (1984).

The genus *Poa* is very difficult taxonomically, and a number of different treatments have been proposed for Western North America. We followed the treatment proposed by Arnow (1987). *Poa incurva* is combined under *P. secunda*; *P. cusickii* is combined under *P. fendleriana*; *P. rupicola* and *P. interior* are combined under *P. glauca*; *P. grayana* is considered synonymous with *P. arctica*.

Koeleria cristata is considered an illegitimate name. We call it *Koeleria macrantha* (Ledeb.) J. A. Shultes, following Wilken (1993).

There has been a good deal of discussion on the taxonomy of the grass tribe Triticeae (for example, the genera *Agropyron*, *Elymus*, *Sitanion*, *Pseudoroegneria*). The issue is far from settled. We have chosen to follow the conservative treatment employed in Hitchcock and Cronquist (1973).

Distinctions between *Oxytropis campestris* and *O. sericea* break down at higher elevations (Barneby, personal communication, as cited in Brunsfeld 1981); we have used the name *O. campestris* for this species complex.

Productivity

To estimate primary productivity, we clipped the current year's aboveground growth in three 20 x 50 cm microplots placed at 5, 15, and 25 m along the upper side of the transect line. Clippings were pooled into three life-form classes (shrub, graminoid, forb) for each plot, air-dried, and then weighed to the nearest gram. Due to the appreciable difference in precipitation between the 2 sampling years, productivity estimates were probably lower than average for 1989 and higher for 1991.

Soils

For each plot we collected three 1 liter soil samples from along the lower side of the transect line at the 5, 15, and 25 m marks. Each sample was collected from below the litter and organic layers to a depth of 6 inches. Reported means of soil variables refer only to the surface 6 inches. Percent of coarse fragments was determined in the field by sieving through a 2 mm screen and measuring volumetric displacement of the rock fragments remaining on the screen. Soil pH was determined by preparing 2:1 aqueous suspensions of sieved soil from each sample, allowing the suspension to equilibrate for 10 minutes and then measuring pH with a portable digital temperature-compensated meter. Means of the three measurements from each plot were used to develop the classification sections. Duff (the fermentation and humus sections of the organic layer) and litter (the surface layer of freshly fallen leaves and twigs) were measured to the nearest 0.1 inch.

Soil samples were dried at 60 °C for 24 hours and passed through a 2 mm sieve before analysis. Organic matter was determined by weight loss after combustion at 375 °C for 16 hours (Davies 1974). It was assumed that loss of structural water from clay minerals and loss of CO_2 was not significant. Particle size distribution was determined using the hydrometer method (Gee and Bauder 1986). Soil totals of nitrogen and carbon were analyzed by a medium-temperature resistance furnace (Nelson and Sommers 1982).

Data Analysis

Data were summarized using STRATA, the U.S. Department of Agriculture, Forest Service Region One's ECODATA data reduction program. Constancy and coverage tables (appendix C) were compiled using a 1 percent minimum cover criterion. We used Two-way Indicator Species Analysis (TWINSPAN), a polythetic, divisive, hierarchical clustering technique, to group stands into community types (Gauch 1982). This classification was refined by tabular comparison (Becking 1957; Mueller-Dombois and Ellenberg 1974). The two methods agreed closely regarding the placement of stands within types. One stand could not be classified and was removed from further analysis. Detrended correspondence analysis (DCA) is a revised version of reciprocal averaging or correspondence analysis (Gauch 1982). We used DECORANA, the Cornell Ecology Program version of DCA (Hill 1979), as an indirect method of determining important environmental gradients controlling vegetative composition.

Results

The results of our study are delineations of 23 alpine vegetation community types. The key to the community types, and brief descriptions of these plant communities and their habitats are presented in the next sections. Appendix A lists vascular plant species by family. Means for site variables and their standard deviations are presented in appendix B, and constancy and average canopy cover for vascular plant species are presented in appendix C.

Key to Alpine Communities

Caveats and Conventions

1. This key is generally structured to identify, within life-form groups, the wettest sites first and then progresses to successively drier sites (habitats).

2. Alpine vegetation, due to climatic extremes, is in a constant state of flux—more so than that of lower elevation environments. Therefore, the recognized classificatory units are community types, implying no particular seral status. We consider all identified c.t.'s to be stable for timeframes relevant to land management considerations. The existence of climax or long-term stable alpine communities is widely disputed (Billings 1973). Certainly at the largest scales (within stands of particular c.t.'s) there is continual disturbance due to both physical (for example, congeliturbation) and biological factors (pocket gophers, *Thomomys talpoides*).

3. The following conventions are followed when estimating and referencing canopy cover. Daubenmire's concept (1959) of canopy cover, a vertical projection about the outermost perimeter of a plant's canopy expressed as a fraction of the area sampled, was employed. Cover classes are those of the ECODATA manual: T = trace, 0 to <1%; P = 1 to <5%; 1 = 5 to <15%; 2 = 15 to <25%; 3 = 25 to <35%; 4 = 35 to <45%; 5 = 45 to <55%; 6 = 55 to <65%; 7 = 65 to <75%; 8 = 75 to <85%; 9 = 85 to <95%; F = full coverage, 95 to 100%.

Canopy Cover Terms and Their Complements Employed in the Key

Absent: 0% c.c. (canopy cover) versus .... Present: trace to 100%
Scarce: <1% c.c. versus .... Common: 1 to 100%
Poorly represented: <5% c.c. versus .... Well represented: 5 to 100%
Not abundant: <25% c.c. versus .... Abundant: 25 to 100%

4. Keep in mind, when reading key leads, that breaks and information presented are based on sample data and observations. Sites and vegetation exist that are not consonant with this classification. To increase the key's applicability, we have incorporated leads that key to c.t.'s of adjacent regions—c.t.'s that may well occur in our study area.

5. The dichotomous key is only a convenience for identifying community types; **it is not the classification!** Validate your determination of c.t. by comparing plot vegetation and site characteristics with parameters of c.t. descriptions.

Instructions

1. Homogeneity of environment and vegetation are primary considerations in plot selection. The plot being classified should be representative of the stand as a whole; if not, then relocate plot and re-estimate coverages.

   a. Note that environmental gradients are often steep in the alpine, and the size of relatively homogeneous vegetation types may be extremely small (<10 m^2). One can identify c.t.'s, but they could only be mapped as components of a complex mosaic.
   b. Homogeneity is most easily appraised as an area supporting a particular suite of dominant species and then by examining the subordinate species for indicator significance.

2. Accurately identify and estimate canopy cover (see 4) for all indicator species used in the key.

3. On sites where the vegetation is obviously depauperate (unusually sparse) due to heavy grazing or browsing, adjust the key downward to reflect the reduced canopy cover (for example, "well represented" [>5% c.c.] would become "common" [>1% c.c.]).

Key to Community Types

1. Communities with shrubs dominant or having shrubby aspect, though shrub canopy coverage may not exceed 5% 2
1. Shrubs poorly represented (less than 5% c.c.), widely scattered individuals 11

2. Shrub communities of wetland areas with any of the following *Salix* spp. (*S. arctica*, *S. reticulata*, *S. planifolia*) dominating the shrub layer; these species generally abundant, though occasionally only well represented 3
2. Shrub communities lacking attributes of wetlands (regarding soils, hydrology, or floristic composition); *S. reticulata*, *S. arctica*, or *S. planifolia* absent or confined to microsites 5

3. *Salix planifolia* dominating the shrub layer with *Carex scopulorum* well represented and usually dominant, though *Deschampsia cespitosa* also achieves this status .... ***Salix planifolia/Carex scopulorum* c.t.**[3]
3. *S. planifolia* not the shrub layer dominant 4

4. *Salix reticulata* the dominant shrub with *Caltha leptosepala* present to abundant but not necessarily dominating the diverse herbaceous layer. .... ***Salix reticulata/Caltha leptosepala* c.t.**
4. *Salix arctica* the dominant shrub with *Polygonum bistortoides* well represented in the herbaceous layer .... ***Salix arctica/Polygonum bistortoides* c.t.**

5. *Salix glauca* dominating the shrub layer, undergrowth variable .... ***Salix glauca* c.t.**
5. Shrub layer dominant not *S. glauca* 6

6. *Salix* spp. other than *S. glauca*, dominant .... Undefined *Salix* spp. c.t.
6. Shrub species other than *Salix* dominating canopy 7

7. Environments with late-persisting snowpack (snowbed communities) or stands on moderate to steep, predominantly north-facing slopes 8
7. Environments lacking late-persisting snowpack and not occupying steep, predominantly north-facing slopes; not snowbed communities 9

8. *Phyllodoce empetriformis* or *P. glandulifera* dominating the shrub layer with canopy cover ranging upward from abundant; *Antennaria lanata* diagnostic of herbaceous layer with coverages highly variable .... ***Phyllodoce empetriformis/Antennaria lanata* c.t.**
8. Not as above, *Cassiope mertensiana* dominating the shrub layer; *Carex paysonis* present as graminoid diagnostic species .... ***Cassiope mertensiana/Carex paysonis* c.t.**

9. Sites with *Dryas octopetala* as the shrub-layer dominant 10
9. *D. octopetala* not the shrub-layer dominant .... Undefined shrub type

10. Relatively mesic sites of protected slopes giving the impression of nearly total vegetation coverage (turf sites) with *Dryas octopetala* abundant and *Salix reticulata* may be well represented but not abundant; *Polygonum viviparum*, *P. bistortoides*, *Zigadenus elegans*, and *Oxytropis viscida* are diagnostic (common) in forb layer; graminoids are poorly represented .... ***Dryas octopetala/Polygonum viviparum* c.t.**
10. Not as above, sparsely vegetated sites of exposed positions (ridgetops, shoulders, saddles, etc.) with *Dryas octopetala* in distinct clumps of highly variable coverage, usually surrounded by bare ground or rock; common forb layer components include *Phlox pulvinata*, *Oxytropis campestris*, *Arenaria obtusiloba*, and *Douglasia montana*; *Carex rupestris* and *C. elynoides* dominate the sparse graminoid layer .... ***Dryas octopetala/Carex rupestris* c.t.**

11. Stands dominated by graminoids (grasses, sedges, rushes, etc.) 12
11. Stands dominated not by graminoids, but rather by forbs 29

12. Wetland sites with floristic composition and/or soils/hydrology meeting wetland criteria[3] 13
12. Sites not wetlands, not meeting wetland criteria 14

13. Wetland sites dominated by *Carex scopulorum* and/or *C. lenticularis* and *Caltha leptosepala* or *Senecio cymbalarioides*, singly or combined, well represented and diagnostic forbs .... ***Carex scopulorum/Caltha leptosepala* c.t.**
13. Wetland sites with *Carex scopulorum* and *C. lenticularis* poorly represented .... Undefined graminoid-dominated wetland type(s)

14. Snowbed communities (sites with greater accumulations of snow than other landscape positions and/or later snow meltoff) 15
14. Not snowbed sites, not characterized by above average snow deposition or late meltoff 18

15. Sites where snow is long-persisting (longer than any other vegetated position) and *Carex nigricans* is dominant and usually abundant .... ***Carex nigricans* c.t.**
15. *C. nigricans* scarce, not the canopy dominant 16

16. Snowbed sites often with depauperate herb cover; with *Juncus drummondii*, *Antennaria lanata* and/or *Sibbaldia procumbens* present and dominant .... ***Juncus drummondii/Antennaria lanata* c.t.**
16. Snowbed sites, but not as above 17

17. *Juncus parryii* the dominant graminoid with *Erigeron ursinus* the dominant forb, though only common, cover generally not exceeding 5% .... ***Juncus parryii/Erigeron ursinus* c.t.**
17. *J. parryii* not the dominant graminoid and *E. ursinus* not dominant forb .... Undefined snowbed c.t.'s

18. Stands dominated by one or by combinations of the following six graminoids: *Deschampsia cespitosa*, *Festuca idahoensis*, *Hesperochloa kingii*, *Bromus pumpellianus*, *Juncus balticus,* or *Carex obtusata* 19
18. Stands not dominated by any one or by any combination of the above six graminoid species 25

19. Graminoid component dominated by *Deschampsia cespitosa*, moist to wet meadows 20
19. Graminoid component not dominated by *D. cespitosa* 22

20. *Caltha leptosepala* and/or *Senecio cymbalalrioides* dominate forb layer of wet meadows .... ***Deschampsia cespitosa/Caltha leptosepala* c.t.**
20. Forbs other than *C. leptosepala* or *S. cymbalarioides* dominant 21

21. *Potentilla diversifolia* common in the forb layer .... ***Deschampsia cespitosa/Potentilla diversifolia* c.t.**
21. *P. diversifolia* scarce .... Undefined *Deschampsia*-dominated c.t.

22. Graminoid component dominated by *Festuca idahoensis*, *Carex obtusata*, *Bromus pumpellianus*, or any combination of these three .... ***Festuca idahoensis/Potentilla diversifolia* c.t.**
22. Neither *F. idahoensis*, *C. obtusata,* or *B. pumpellianus,* or any combination of these three dominating the graminoid component 23

23. *Hesperochloa kingii* the graminoid with greatest coverage in rather depauperate communities 24
23. *H. kingii* not the indicated dominant .... Undefined or elsewhere described graminoid-dominated c.t.'s[2]

24. *Oxytropis campestris* present and characteristic forb .... ***Hesperochloa kingii/Oxytropis campestris* c.t.**
24. *O. campestris* not present, not diagnostic .... ***Hesperochloa kingii***[2]

25. Turf communities (commonly characterized by an abundance of dwarf, fibrous-rooted graminoids, usually *Carex* spp., but forbs may dominate some stands); dominant graminoids with individual or combined cover exceeding 15% including *Carex elynoides*, *C. rupestris*, *C. scirpoidea*, *C. phaeocephala*, *C. albonigra*, *C. atrata,* and *Festuca ovina* 26
25. Not graminoid-dominated or having reduced total (<50%) canopy coverage turf communities as described before 29

26. Moist turf sites with one or some combination of the following: *Carex* spp. dominant; *C. scirpoidea*, *C. phaeocephala*, *C. albonigra*, *C. atrata* 27
26. Dry turf sites with one or some combination of the following species dominant; *Carex rupestris*, *C. elynoides*, *Festuca ovina* .... ***Carex elynoides* c.t.**

27. *Geum rossii* common (usually well represented and the dominant forb); substrates noncalcareous .... ***Carex scirpoidea/Geum rossii* c.t.**
27. *Geum rossii* scarce, other forbs dominant 28

28. *Potentilla diversifolia* and/or *Phlox pulvinata* dominant and common .... ***Carex scirpoidea/Potentilla diversifolia* c.t.**
28. Not as above, *P. diversifolia* and *P. pulvinata* not dominant and scarce .... Undefined turf c.t.'s

29. Forb-dominated turf communities ranging from dense generally continuous plant cover to somewhat open plant cover characterized by well-distributed clumps of erect forbs, though cushion plants may be dominant 30
29. More like cushion plant than turf communities, with erect forbs sparse and cushion plants dominant and/or much exposed substrate 34

30. *Geum rossii* as erect forb, dominant or codominant 31
30. *G. rossii* present, not dominant, cespitose and reduced in size 34

31. Erect forb *Trifolium parryi* dominant or codominant in forb layer..... ***Geum rossii/Trifolium parryi* c.t.**[1]
31. *T. parryi* absent or not dominant/codominant 32

32. Cushion plant *Trifolium nanum* dominant/codominant in forb layer .... ***Geum rossii/Trifolium nanum* c.t.**[1]
32. *T. nanum* not dominant/codominant 33

33. Cushion plant *Trifolium dasyphyllum* dominant/ codominant .... ***Trifolium dasyphyllum/Geum rossii* c.t.**[1]
33. *T. dasyphyllum* not dominant/codominant .... Undefined turf c.t.'s

34. Fellfield (high degree of exposed rock) or cushion plant environments (exposed, wind-blasted positions, usually ridge crests, slope shoulders, and saddles); cushion plants range from a dominant aspect of community to slightly subordinate to erect forbs 35
34. Sites not fellfields nor cushion plant communities, rather they include steep dry or wet slopes with a high degree of exposed substrate (> approximately 50%) 39

35. Cushion plant communities wherein *Geum rossii* and/or *Arenaria obtusiloba* are common or dominants of the forb layer (which is often depauperate with scattered plants) .... ***Geum rossii-Arenaria obtusiloba* c.t.**
35. Neither *G. rossii* nor *A. obtusiloba* common nor forb layer dominants 36

36. Moderately dense, single-tier plant cover of prostrate and cespitose forbs, graminoid component depauperate, with *Phlox pulvinata* and *Trifolium dasyphyllum* providing more canopy cover than other forbs .... ***Phlox pulvinata/Trifolium dasyphyllum* c.t.**[1]
36. Not as above, neither *P. pulvinata* nor *T. dasyphyllum* the most important cushion plants 37

37. Scattered mixture of erect and cushion plants and graminoids with *Antennaria microphylla* and/or *Artemisia scopulorum* most important forbs .... ***Antennaria microphylla/Artemisia scopulorum* c.t.**[1]
37. Cushion plant communities with neither *A. microphylla* nor *A. scopulorum* nor combinations of the two dominate the forb layer 38

38. Cushion plants dominant aspect of communities with varying combinations of the three species *Phlox multiflora*, *Trifolium nanum,* and *Eritrichium nanum* providing majority of canopy cover .... ***Phlox multiflora/Trifolium nanum* c.t.**[1]
38. None of the above three species providing the dominant aspect of vegetation cover .... Undefined cushion plant type(s)

39. Sites with predominantly northerly exposures, moderate to steep slopes with a high degree (at least 75%) of exposed substrate of which more than 80% is soil or gravel; soils moist to saturated throughout growing season; vegetative canopy cover is much reduced, not exceeding 40% but with no characteristic species assemblage .... **Moist slope communities**
39. Sites not as above 40

40. Sites with uniformly steep (>40%), often unstable slopes of southeast- through west-facing exposures; of the large amount of exposed substrate (> approximately 50%) about 50% is gravel; *Agropyron scribneri* is usually the one species with higher coverage and constancy in this "type" than other c.t.'s .... **Dry slope communities**
40. Sites not as described above .... Undefined community type(s)

[1]Thelenius and Smith (1985).
[2]Various studies from east-central Idaho; Urbanczyk and Henderson 1994; Moseley 1985; Caicco 1983.
[3]Hansen and others (1995); see pp. 66-68 for wetland criteria.

Grassland Communities

Grassland communities occurred on gentle to steep slopes at the lower reaches of the alpine zone. They often continue downslope to subalpine elevations or merge into high-elevation sagebrush steppe. The deep soils and relatively warm climate make these some of the most productive sites in our study area. They are similar in graminoid composition to previously described high-elevation grasslands (Mueggler and Stewart 1980), but often contain alpine forb species, such as *Polemonium viscosum* and *Trifolium haydenii*, not commonly found in the subalpine zone. Alpine grasslands often grade into turf communities at higher elevations. Grassland communities are dominated by relatively robust grasses, while alpine turf associations are usually dominated by sedges and forbs of shorter stature. Grassland sites are often less wind-exposed than turf communities.

Festuca idahoensis/Potentilla diversifolia c.t. (FESIDA/POTDIV; Idaho Fescue/Diverse-Leaved Cinquefoil)

Environment—FESIDA/POTDIV was common below 9,900 ft in the Beaverhead, Gravelly, Snowcrest, and Tendoy Mountains in the western portion of our study area. It was most common on warm slopes at the low limit of alpine vegetation (about 9,500 ft) where moderate to light snow cover melts early in the growing season. It abutted subalpine forest dominated by *Picea engelmannii*, *Pinus albicaulis,* and *Pseudotsuga menziesii*, or graded into shrublands dominated by *Artemisia tridentata* ssp. *vaseyana* below treeline. FESIDA/POTDIV merged with DESCES/POTDIV grassland on moister slopes and with CARELY turf at higher elevations on warm, dry, wind-impacted slopes. Dominance of *Bromus pumpellianus* defines a phase that was locally abundant on cool slopes in the Snowcrest Range.

Vegetation—Mean graminoid cover in FESIDA/POTDIV was 55 percent (color plate 2). *Festuca idahoensis* was the dominant graminoid with *Agropyron caninum* ranking second in abundance. *Carex obtusata*, *Poa secunda*, *C. scirpoidea,* and *P. arctica* were locally common, the first two on warm aspects and the last two on cooler slopes or level areas with deeper soils. Mean forb cover was 34 percent. Common forbs were *Potentilla diversifolia*, *Phlox pulvinata,* and *Polemonium viscosum*. *Polygonum bistortoides*, *Myosotis sylvatica,* and *Cerastium arvense* were frequent; *Geum triflorum* and *Trifolium haydenii* were locally common. Mean cover of lichens and mosses was only 2 percent.

Two stands from cool slopes in the Snowcrest range were dominated by *Bromus pumpellianus* (BROPUM) instead of *Festuca idahoensis*. *Carex obtusata* was abundant in one. These stands were otherwise compositionally similar to typical FESIDA/POTDIV.

Soils—Parent material was generally sedimentary with limestones and calcareous sandstones predominating. Quartzite, calcareous conglomerate, and volcanic andesite were also represented. Mean litter depth was 0.6 inch, and mean duff depth was 0.3 inch. Bare ground and gravel covered 11 percent of the surface. Coarse fragment content varied from 2 to 51 percent with a mean of 20 percent. Texture of the fine fraction ranged from fine clay to sandy clay-loam; the mean textural class was sandy clay. Reaction of the soil was near-neutral (pH = 6.7 to 7.5) with a mean pH of 7.2. Mean organic matter content was 19 percent, mean total nitrogen was 0.66 percent, and C:N ratio was 14:1.

Productivity—Graminoid productivity varied between 180 and 1,130 lbs per acre with a mean of 726 lbs per acre. Forb productivity varied between 160 and 1,270 lbs per acre with a mean of 778 lbs per acre. Mean total productivity for FESIDA/POTDIV was 1,504 lbs per acre. Productivity was highest on deep soils.

Other Studies—FESIDA/POTDIV could be considered a high-elevation phase of Mueggler and Stewart's (1980) *Festuca idahoensis/Agropyron caninum* habitat type. Although the dominant graminoids in the two types are similar, the important forbs are different. *Potentilla gracilis*, *Geum triflorum,* and *Achillea millefolium* are the most abundant forbs in the lower elevation type. Alpine grasslands similar to FESIDA/POTDIV were described for east-central Idaho (Caicco 1983; Moseley 1985) where they were characterized by having the highest snow deposition of all alpine communities (Moseley 1985). Alpine meadows dominated by *Festuca thurberi*, an ecological analogue of *F. idahoensis*, have been described for New Mexico (Baker 1983).

Deschampsia cespitosa/Potentilla diversifolia c.t. (DESCES/POTDIV; Tufted Hairgrass/Divers-Leaved Cinquefoil)

Environment—This community type occurred from treeline to over 10,000 ft in the Gravelly, Madison, and Snowcrest Mountains; but small examples can probably be found in all of the wetter ranges in our study area (color plate 3). It was confined to cool slopes, valley bottoms, and depressions where soils were deep and remained moist until at least mid-summer. This community type occupied the most mesic situations in the lower alpine zone. Snow cover during winter protects the plants, and although snow release comes moderately early in the season, the sites are often fed by meltwater from upslope snowfields. DESCES/POTDIV was abundant on the old erosion terraces of the Gravelly Mountains and was often associated with slopes showing evidence of solifluction. This community type generally occurred in a matrix of drier grassland and moist or dry turf vegetation. It also graded into wetland communities, especially DESCES/CALLEP. In the Gravelly Mountains, it sometimes occurred above shrublands dominated by *Artemisia tridentata* ssp. *vaseyana* or subalpine forests dominated by *Picea engelmannii*.

Vegetation—Graminoid cover in DESCES/POTDIV was high, averaging 78 percent, and was exceeded only by the CARSCO/CALLEP marsh community. *Deschampsia cespitosa* was the dominant graminoid, often forming large tussocks. *Carex atrata* and *Phleum alpinum* were also important graminoids. *Festuca idahoensis* was common in stands at lower elevations, and *Carex phaeocephala* and *Juncus balticus* were locally common. The latter may have increased under the influence of livestock grazing (Hansen and others 1995). Mean forb cover was 37 percent. *Potentilla diversifolia*, *Polygonum bistortoides,* and *Senecio crassulus* were the most abundant forbs. *Cerastium arvense*, *Ranunculus eschscholtzii,* and *Saxifraga oregana* were also common. *Mertensia ciliata* was abundant in one stand. Mean cover of lichens and mosses was 3 percent.

Soils—Parent materials for these stands were sandstone, limestone, quartzite and gneiss. Mean depths of litter and duff were 0.4 and 0.8 inch. Generally, soils supporting this community type were deep with dark, mollic-appearing epipedons and high moisture content throughout much of the growing season. Bare ground and gravel covered 6 percent of the surface. This type had the lowest coarse fragment content of all nonwetland types, ranging from 0 to 19 percent with a mean of 8 percent. Texture of the fine fraction ranged from fine clay to loamy sand with a modal textural class of clay loam. Soil reaction varied from a low of 6.0 pH on soils derived from gneiss to 7.0 pH on soils derived from limestone and calcareous sandstone. Mean pH for the type was 6.5. Mean organic matter content was 18 percent, mean total nitrogen was 0.65 percent, and C:N ratio was 14:1.

Productivity—Graminoid productivity varied between 850 and 2,350 lbs per acre with a mean of 938 lbs per acre. Forb productivity ranged from 180 to 875 lbs per acre with a mean of 729 lbs per acre. Mean total productivity was 1,667 lbs per acre and was highest on warmer aspects.

Other Studies—DESCES/POTDIV at lower elevations is very similar in environment and composition to Mueggler and Stewart's (1980) *Festuca idahoensis/Deschampsia cespitosa* habitat type. Mueggler and Stewart's FESIDA/DESCES probably also encompasses our moist turf community type CARSCI/POTDIV. These authors state that productivity of their type probably ranges between 1,200 and 1,500 lbs per acre, somewhat lower than the upper range measured in our study. Johnson and Billings (1962) described wet meadows dominated by *D. cespitosa* and *Carex scopulorum* in the Beartooth Mountains of south-central Montana, and Lesica (1991) reported that drier communities dominated by *D. cespitosa* and *Geum rossii* also occur in this range. In North America, similar associations are best developed in the Rocky Mountains from southern Montana south to New Mexico where Baker (1983) reported communities similar in dominant vegetation and landscape position. Lewis (1970) described alpine meadow communities from the Uinta Mountains of Utah dominated by *D. cespitosa*, *Polygonum bistortoides*, and *Geum rossii*. These types differ by having *G. rossii* dominant instead of *P. diversifolia* and by the greater prominence of *Trifolium* spp. Bonham and Ward (1970) and Komarkova and Webber (1978) described similar communities in Colorado with *G. rossii* and *Trifolium parryi*. This community type in the Rocky Mountain National Park, CO, did not have an abundance of *T. parryi*; and Willard (1979) believes that this species has increased under the influence of livestock grazing in unprotected areas outside the park. Meadows dominated by *D. cespitosa* are reported for the Cascade Mountains of Washington (Hamann 1972 as cited in Willard 1979).

Hesperochloa kingii/*Oxytropis campestris* c.t. (HESKIN/OXYCAM; Spike Fescue/Field Crazyweed)

Environment—HESKIN/OXYCAM is a minor type occurring at 9,500 to 9,800 ft on moderate to steep slopes, generally with warm aspects (color plate 4). Extensive stands of this type occurred only in the Beaverhead and Tendoy Mountains, the westernmost and driest part of our study area. Although not particularly windswept, these areas receive little precipitation, and snowmelt occurs early. HESKIN/OXYCAM most often occurred in a mosaic of FESIDA/POTDIV grassland and CARELY turf communities. It occurred in stonier soils other than grassland types and at lower elevations than turf communities. Subalpine grasslands and shrublands dominated by *Artemisia tridentata* ssp. *vaseyana* generally occurred at lower elevations.

Vegetation—Mean graminoid cover was 37 percent. *Hesperochloa kingii* (=*Leucopoa kingii*, *Festuca kingii*) was the dominant grass. *Agropyron spicatum* and *Poa fendleriana* were present in all three stands. Mean forb cover was 23 percent. Common forbs included *Oxytropis campestris*, *Phlox hoodii*, *Erigeron compositus*, and *Cymopterus bipinnatus*. The subshrub *Artemisia frigida* was a minor component of all three stands, and the shrubs *A. tridentata* and *Chrysothamnus viscidiflorus* were minor components in the lowest elevation stand that bordered subalpine shrublands. Mean cover of lichens and mosses was less than 1 percent.

Soils—HESKIN/OXYCAM occurred only on soils derived from calcareous parent material, either limestone or Beaverhead conglomerate. Mean depths of litter and duff were 0.3 and 0.2 inch. Bare ground and gravel covered 21 percent of the surface, and rock cover averaged 9 percent. Coarse fragments ranged from 33 to 65 percent with a mean of 51 percent. The modal texture of the fine fraction was sandy clay-loam. Soil reaction varied from 7.3 to 7.5 pH, with a mean pH of 7.4. Mean organic matter content was 11 percent, mean total nitrogen was 0.35 percent, and C:N ratio was 21:1. This community occurred on the shallowest, stoniest, and sandiest soils of any grassland type; and organic matter and nitrogen levels are only half of that in the other two grassland community types.

Productivity—Graminoid productivity varied between 275 and 875 lbs per acre with a mean of 613 lbs per acre. Forb productivity ranged from 250 to 600 lbs per acre with a mean of 399 lbs per acre. Shrub productivity in the lowest elevation stand was 253 lbs per acre. Mean total productivity was 1,096 lbs per acre, appreciably less than that of the other two grassland types.

Other Studies—Although *Hesperochloa kingii* occurs throughout much of the Western United States, similar alpine grassland associations have only been described for the calcareous ranges of east-central Idaho (Caicco 1983; Moseley 1985; Urbanczyk and Henderson 1994) and northwestern Utah (Preece 1950; Ream 1964). In Idaho where this association is more common, two variants based on differences in soil stability are recognized (Moseley 1985).

Turf Communities

We define turf as vegetation dominated by dwarf, fibrous-rooted graminoids, usually *Carex* spp. (Eddleman and Ward 1984; Johnson and Billings 1962). May and Webber (1982) have referred to these sites as dry meadow, which seems a contradiction in terms because meadows have traditionally been conceived of as relatively moist (Daubenmire 1968). Forb-dominated sites have also been characterized as turf (Thilenius and Smith 1985). Turf communities are consistently associated with wind-scouring of winter snow, gentle terrain (ridgetops and slope shoulders), a dense, generally continuous plant cover, and appreciable soil development. As wind exposure increases and soil becomes more stony and shallow, turf vegetation grades into cushion plant communities.

Carex elynoides c.t. (CARELY; Blackroot Sedge)

Environment—CARELY was the most frequently sampled c.t. It was found in all eight mountain ranges and is undoubtedly the most extensive alpine vegetation type in our study area (color plate 5). It was most extensive in the drier Tendoy, Beaverhead, and Snowcrest ranges. CARELY spanned a considerable range in elevation, 9,360 to 10,360 ft. All sites, because of topographic position and orientation, were inferred to be highly wind-impacted and blown free of winter snow. More than half of the stands occurred on ridge crests or shoulders with less than 20 percent slope. Most of the remainder were on moderate to steep southwest- to west-facing slopes. This type often graded to grassland c.t.'s or CARSCI/POTDIV c.t. of more protected, moister sites and cushion plant-dominated sites with yet greater wind impact. Mean exposed bare soil, gravel, and rock (23 percent) was slightly greater than for grassland types; however, sites grading to cushion plant communities had as much as 70 percent substrate exposure.

Vegetation—The CARELY community type was characterized by a short (<4 inches), usually dense ground cover of fibrous-rooted graminoids (average canopy cover 46 percent) and forbs. *Carex elynoides* was strongly dominant (100 percent constancy, 27 percent canopy cover) followed in decreasing order by the "turf-formers" *Carex rupestris* and *Festuca ovina*. Other common graminoids were *Calamagrostis purpurascens*, *Poa glauca*, and *Hesperochloa kingii*. Average forb cover was 31 percent, only slightly less than that of grassland types. The dominance of *Phlox pulvinata* and *Selaginella densa* and the presence and occasional dominance of cushion plants set this type apart from grasslands. Forbs with high (>50 percent) constancy included *Cymopterus bipinnatus*, *Besseya wyomingensis*, *Hymenoxys grandiflora*, *Oxytropis campestris*, *Potentilla diversifolia*, and *P. ovina*.

Soils—Parent materials were predominantly limestones and calcareous sandstones, but quartzites and gneiss were also represented. Mean litter and duff depths were, respectively, 0.4 and 0.3 inch. Percent of coarse fragments ranged from 8 to 75 percent with a mean of 33 percent, a figure intermediate between the grassland and cushion plant c.t.'s. Texture of the fine fraction ranged from clay to sandy clay-loam, and the modal textural class was sandy clay. Soil reactions were slightly more basic than those of grasslands with an average pH of 7.5 for calcareous materials and 6.4 for noncalcareous substrates. Mean organic matter content was 16 percent, mean total nitrogen was 0.57 percent, and C:N ratio was 15:1.

Productivity—A nearly 10-fold range in productivity was recorded for both graminoids (80 to 682 lbs per acre) and forbs (115 to 977 lbs per acre). Average productivities for graminoids, forbs, and community total were, respectively, 398, 398, and 796 lbs per acre. A cline of decreasing productivity occurred from solid turf conditions to near cushion plant conditions.

Other Studies—*Carex elynoides* turf communities are reported from similar environments in neighboring ranges in Idaho (Caicco 1983; Moseley 1985), other calcareous ranges in Montana (Bamberg and Major 1968), the Beartooth Plateau of Wyoming and Montana (Johnson and Billings 1962), throughout Colorado (Eddleman and Ward 1984; Komarkova and Webber 1978; Willard 1979), the Uinta Mountains of Utah (Lewis 1970), the Great Basin ranges of Nevada (Loope 1969), and as far south as New Mexico (Baker 1983). Johnson and Billings (1962) consider *C. elynoides*- and *G. rossii*-dominated turf to be the climax vegetation type of their study area. Similar vegetation is not reported for the moister ranges to the north and west of our study area.

Carex scirpoidea/*Potentilla diversifolia* c.t. (CARSCI/POTDIV; Northern Single-Spike Sedge/Diverse-Leaved Cinquefoil)

Environment—CARSCI/POTDIV is a moist turf type that was found in ranges with higher precipitation (Gravelly, Snowcrest, Anaconda-Pintlar, and Madison). It occurred from 9,300 to 10,320 ft associated with gentle, not nearly so wind-impacted slopes as those of the CARELY c.t. Most of the sites had evidence of frost-sorting or solifluction lobes (slopes >20 percent). We hypothesize these sites are turf because they occur in windswept positions (little winter snow accumulation); but the sites are also moist because they are in runoff collecting positions or on slopes with low solar insolation (north-facing). CARSCI/POTDIV grades to CARELY on upper slopes and to wet meadows or snowbed communities on wetter sites. With the exception of wet meadow c.t.'s, CARSCI/POTDIV had less exposed soil and rock (4 percent) than any other graminoid-dominated c.t.

Vegetation—Dominance of *Carex scirpoidea*, *C. atrata*, *C. phaeocephala*, *C. obtusata*, or a combination of these sedges is diagnostic for this c.t. Graminoid canopy cover averaged 66 percent, of which 35 percent was *C. scirpoidea*. *Carex elynoides*, *C. rupestris*, *Festuca ovina*, and *Calamagrostis purpurascens* were strongly represented. *Agropyron caninum*, *Luzula spicata*, and *Poa alpina* had high constancy and low coverage. Average forb cover (47 percent) was high, reflecting the favorable moisture status of these sites. Forbs with high constancy (>50 percent) included those more typical of moist sites such as *Lloydia serotina*, *Erigeron simplex*, *Polygonum bistortoides*, *P. viviparum*, and *Zigadenus elegans*. Other high-constancy forbs included *Cerastium arvense*, *Hymenoxys grandiflora*, *Lupinus argenteus*, *Pedicularis parryi*, *Solidago multiradiata*, and most characteristically *Potentilla diversifolia*. Forbs more typical of dry turf or cushion plant communities included *Arenaria obtusiloba*, *Oxytropis campestris*, and *Phlox pulvinata*.

Soils—Samples were about evenly divided between calcareous (limestone and conglomerate) and noncalcareous (basalt, granite, and quartzite) substrates.

Average litter and duff depths 0.6 and 0.4 inch. Coarse fragment content ranged from 0 to 31 percent and averaged 9 percent. Texture of the fine fraction ranged from fine clay to sandy clay, and modal texture was sandy clay. Soil reaction was strongly conditioned by substrate type, averaging 7.2 pH for calcareous and 5.8 pH for noncalcareous types; both values were distinctly lower than for the drier turf types. Mean organic matter content was 20 percent, mean total nitrogen was 0.73 percent, and C:N ratio was 13:1.

Productivity—The range in total productivity was relatively narrow, 1,127 to 1,426 lbs per acre (average 1,283 lbs per acre), with graminoids averaging 743 and forbs 540 lbs per acre. These high values relative to the CARELY c.t. (average 796 lbs per acre) further substantiate the less stressful, higher moisture status of the CARSCI/POTDIV c.t.

Other Studies—Douglas and Bliss (1977) described a *Carex scirpoidea* var. *scirpoidea* c.t. from the eastern North Cascades of Washington that is vegetationally and physiognomically very similar to CARSCI/POTDIV. However, in the moister Cascadian climate, their *Carex scirpoidea* c.t. represents the dry, early snow-free end of an alpine continuum, occurring on well-drained slopes of all aspects. Stand tables from Bamberg and Major (1968) show plots for the Big Snowy Mountains of Montana that conform to our conception of this c.t.

Carex scirpoidea/Geum rossii c.t. (CARSCI/GEUROS; Northern Single-Spike Sedge/Ross' Avens)

Environment—We regard CARSCI/GEUROS as a geographic substrate variant of CARSCI/POTDIV. It was a common community type in those relatively moist mountain ranges (East Pioneer and Tobacco Root) that were dominated by granitic or metamorphosed intrusive volcanics (color plate 6). It was also found in the Madison Mountains exclusively on gneiss. It spanned the full range of alpine elevations, from 9,300 to 10,320 ft. Sample sites were about evenly divided between low gradient slopes and steeper slopes. All aspects were represented. Most characteristic was some degree of enhanced effective moisture through increased snowpack or delayed snowmelt. Often CARSCI/GEUROS turf occurred as patches scattered among boulders that act as snow fences, creating eddy currents, and increasing snowpack. CARSCI/GEUROS graded to drier turf types, usually CARELY, on more exposed positions and to DRY SLOPE or MOIST SLOPE c.t.'s on steeper, unstable slopes.

Vegetation—Graminoid canopy cover averaged only 37 percent, of which 24 percent was *Carex scirpoidea*. *Carex phaeocephala*, *C. atrata*, and *C. albonigra* were also dominant in at least one stand. Common turf graminoids *C. rupestris*, *C. elynoides*, and *Festuca ovina* had moderate coverages or high constancy but are much less important than in the CARSCI/POTDIV c.t. Other graminoids with high constancy were *Luzula spicata*, *Poa alpina*, *P. secunda*, and *Trisetum spicatum*. The moister sites supported *Deschampsia cespitosa*, but canopy cover did not exceed 5 percent. CARSCI/GEUROS forb cover averaged 51 percent, similar to that of CARSCI/POTDIV. With the exception of *Geum rossii*, which was 100 percent constant and averaged 37 percent canopy cover in this type, the two *C. scirpoidea*-dominated turf types had many forb species of high constancy or coverage in common, for example, *Arenaria obtusiloba*, *Potentilla diversifolia*, *Phlox pulvinata*, *Polygonum bistortoides*, *Erigeron simplex*, *Lloydia serotina*, and *Lupinus argenteus*. Nonetheless, fewer herbaceous species were held in common (55) between these two turf types than were found to occur uniquely in either one of the two community types (63 and 66 herbaceous species).

Soils—All soils were developed on intrusive igneous or metamorphosed substrates. CARSCI/GEUROS had roughly seven times more exposed soil, gravel, and rock than CARSCI/POTDIV. Both litter and duff depths were shallow (0.2 inch). Coarse fragment content ranged from 6 to 39 percent and averaged 19 percent—twice that of the CARSCI/POTDIV c.t. Texture of the fine fraction ranged from sandy clay to sandy loam, while the modal textural class was sandy clay-loam. The pH values were low, averaging 5.9 and ranging from 5.5 to 6.3. Mean organic matter content was 14 percent, mean total nitrogen was 0.45 percent, and C:N ratio was 18:1. Soils were more coarse-textured, and organic matter and nitrogen contents were lower than other turf communities.

Productivity—The high degree of variability in productivity appears to reflect the variability in exposed substrate. Total productivity ranged from 236 to 2,669 lbs per acre and averaged 964 lbs per acre. Productivity was 272 and 692 lbs per acre for graminoids and forbs.

Other Studies—The *Carex scirpoidea* var. *scirpoidea* c.t. described by Douglas and Bliss (1977) for the eastern North Cascades has a strong floristic similarity with our CARSCI/GEUROS c.t., except their type lacks *Geum rossii*. However, their CARSCI c.t. represents drier portions of moisture and snowmelt gradients from a much wetter climatic regime. Conversely, Thilenius and Smith (1985) described as the moistest of their Absaroka Mountains alpine sites a *Geum rossii-Trifolium parryi* c.t., with environmental parameters resembling those of CARSCI/GEUROS but with differing vegetation, having *C. scirpoidea* replaced by *C. ebenea*. In analogous fashion, the Sange de Cristo Mountains of New Mexico support a *Geum rossii* meadow type in which *C. heteroneura* (=*C. atrata*) and *Deschampsia cespitosa* are conspicuous components denoting the mesic nature and their similarity to our CARSCI/GEUROS c.t. (Baker 1983). Lewis (1970) described vegetation dominated by *Carex scirpoidea*, *Geum rossii*, and *Deschampsia cespitosa* from Utah's Uinta Mountains. Well-drained sites were dominated by *C. scirpoidea*, while *D. cespitosa* dominated areas of impeded drainage.

Dryas octopetala/*Polygonum viviparum* c.t. (DRYOCT/POLVIV; White Dryas/ Viviparous Bistort)

Environment—This minor type was found in both the wettest (Anaconda and Madison) and the driest (Tendoy) Mountains. Small occurrences of this type were noted but not sampled in other mountain ranges. This vegetation was generally found on northerly facing gentle to steep slopes. Evidence of disturbance, including solifluction, slumps, and earthflows, was also common. Only trace amounts of rock were exposed, but gravel ranged from 5 to 30 percent.

Vegetation—Mats of *Dryas octopetala*, ranging in cover from 30 to 80 percent, and *Salix reticulata* (5 to 20 percent canopy cover) provided the dominant aspect. Graminoid canopy cover was low, not exceeding 5 percent, and was composed of the common turf species *Carex elynoides*, *C. rupestris*, and *Festuca ovina* as well as *Poa alpina*. Average forb cover was also relatively low, 14 percent, with dominance shared among the diagnostic species (*Polygonum viviparum*, *P. bistortoides*, *Zigadenus elegans*, and *Oxytropis viscida*) for the type. Other forbs with high constancy, low coverage, and some degree of fidelity to this type were *Lloydia serotina*, *Senecio crassulus*, *Smelowskia calycina*, *Oxytropis campestris*, and *Pedicularis cystopteridifolia*. Two plots had moss and lichen coverages in excess of 50 percent, adding to the impression of a smooth blanket of vegetation.

Soils—Parent materials were limestone and quartzite. Average litter and duff depths were 0.4 and 0.5 inch. Coarse fragment content ranged from 8 to 45 percent and averaged 30 percent. Mean textural class of the fine fraction was sandy clay. Soil reaction for calcareous sites ranged from 7.4 to 7.6 pH; the lone quartzite sample was more than one pH unit lower at 6.2. Mean organic matter content was 25 percent, mean total nitrogen was 0.75 percent, and C:N ratio was 18:1. This type had the highest average organic matter and nitrogen content of any nonwetland community in our study.

Productivity—Of the two plots clipped, the one from the rocky site registered only 548 lbs per acre (46 percent shrub), whereas the one with only trace amounts of exposed rock and soil produced 1,229 lbs per acre (97 percent shrub).

Other Studies—Vegetation similar to DRYOCT/POLVIV is common in the Canadian Rockies (Achuff and Corns 1982; Hrapko and LaRoi 1978). Canadian types have a high diversity of lichens and mosses and are considered successionally mature. Concentrating on calcareous substrates of several Montana ranges, Bamberg and Major (1968) sampled many stands of what they termed "zonal alpine vegetation," but they did not explicitly group stands into community types. On the basis of their stand tables, it appears that DRYOCT/POLVIV is a major c.t. in Glacier National Park and Big Snowy Mountains. A similar turf type occurs in the Flint Creek Mountains. For the Colorado Rockies, Willard (1979) described moist fellfield communities dominated by *D. octopetala* with significant *P. viviparum* cover and lichens and mosses, but lacking dwarf *Salix* spp.; she described dwarf willow communities as being confined to snowbed environments.

McGraw (1985) found that *D. octopetala* consists of at least two distinct ecotypes in Alaska: one that occurs in cool, moist habitats and one that is found on dry, exposed sites. Similar ecotypic differentiation would explain the dominance of *D. octopetala* in the relatively cool, moist DRYOCT/POLVIV c.t. as well as in the drier DRYOCT/CARRUP c.t.

Salix arctica/*Polygonum bistortoides* c.t. (SALARC/POLBIS; Arctic Willow/American Bistort)

Environment—Though our definition of this c.t. is based on only two plots, the fact that this type is recognized elsewhere in the Rocky Mountains allows us to compare and interpret our data. Sites occurred in the East Pioneer and Anaconda-Pintlar Mountains ranges on lower to mid-slopes of gentle terrain. We interpret these sites as wetland and turf hybrids in terms of both environment and vegetation. Both sites were potentially in water-receiving positions; one community was intercalated between snowbeds upslope and drier turf c.t.'s downslope, while the other was developed on an ephemeral spring with spongy ground throughout. Landscape positions of SALARC/POLBIS were much like those supporting SALRET/CALLEP but with a higher probability of wind-scouring. Vegetation composition also indicated a drier environment than that of SALRET/CALLEP.

Vegetation—These stands were dominated by *Salix arctica* (50 percent canopy cover) with reduced amounts of *Dryas octopetala*. Moss cover in excess of 50 percent added to the visual impression of blanket vegetation. Graminoid cover averaged 15 percent, contributed mostly by *Poa alpina* and moist-site *Carex* spp., *C. albonigra*, *C. phaeocephala,* or *C. nova*. Forb cover averaged 30 percent. The diagnostic forb *Polygonum bistortoides* (10 percent canopy cover) was among several with relatively high coverages, including *P. viviparum*, *Geum rossii*, *Potentilla diversifolia*, *Aster alpigenus,* and *Claytonia lanceolata*.

Soils—Parent material included quartzite and granite-limestone mix from a contact zone. Average litter and duff depths were 0.1 and 0.4 inch. Coarse fragment content ranged from 19 to 33 percent. Texture of the fine fraction was clay. Soil reactions were slightly acid, averaging 6.50 pH. Mean organic matter content was 16 percent, mean total nitrogen was 0.43 percent, and C:N ratio was 25:1.

Productivity—Total productivity ranged from 798 to 1,095 lbs per acre with shrub productivity constituting 32 to 81 percent of the total; graminoid and forb cover was 148 and 295 lbs per acre.

Other Studies—*Salix arctica* dominates in some snowbed communities of the Canadian Rockies (Achuff and Corns 1982; Hrapko and LaRoi 1978). *Potentilla diversifolia* and *Polygonum viviparum* were common species in their type; however, snowbed indicator species such as *Antennaria lanata*, *Phyllodoce glanduliflora,* and *Cassiope mertensiana* were also common. Johnson and Billings (1962) discussed small disturbance sites within moist *Deschampsia* meadows with vegetation very similar to SALARC/POLBIS (see Other Studies section under SALRET/CALLEP for expanded discussion). For in the Colorado Rockies, Willard (1979) described snowbed vegetation dominated by *S. arctica*; this community type had high cover of *Geum rossii*, *Polygonum* spp., *Festuca ovina*, mosses, and lichens and was more similar to that of our study area. Baker (1983) described late snowbank communities dominated by *S. arctica* and *S. reticulata* for the Sangre de Cristo Mountains of New Mexico.

Cushion Plant Communities

Cushion plant communities occurred on extremely wind-exposed sites, often on ridgetops or saddles. Such sites have little winter snow cover and receive abundant direct insolation, and as a result, were the most xeric high-elevation sites and may be thought of as alpine deserts. Soils on these windy, unproductive sites were shallow, stony, low in organic matter, and poorly developed, strongly reflecting the composition of the parent material. Wind deflation often resulted in a gravelly pavement. Cushion plants, with their low, compact growth form, were favored in this dry, windy, cold environment. Unlike most other habitats including turf communities, graminoids were generally less abundant than forbs. *Dryas octopetala*, a low, mat-forming shrub, dominated one of the community types.

Carex rupestris/Potentilla ovina c.t. (CARRUP/POTOVI; Curly Sedge/Sheep Cinquefoil)

Environment—CARRUP/POTOVI occurred on exposed, windswept upper slopes, saddles, and ridgetops, nearly restricted to soils developed from calcareous parent materials in the Beaverhead, Madison, Pioneer, and Tendoy ranges. Elevations ranged from 9,500 to 10,400 ft. CARRUP/POTOVI generally graded into the CARELY or CARSCI/POTDIV turf communities of deeper soils on more protected slopes.

Vegetation—Mean graminoid cover was 11 percent. Important graminoids were *Carex rupestris*, *Festuca ovina*, and *Hesperochloa kingii*. *Carex elynoides* was common in some stands. Mean forb cover was 29 percent. Consistently present and often well-represented forbs included *Potentilla ovina*, *Arenaria obtusiloba*, *Oxytropis campestris,* and *Phlox pulvinata*. *Eritrichium nanum*, *Bupleurum americanum*, *Cymopterus bipinnatus*, *Erigeron compositus,* and *Senecio canus* occurred consistently but with low cover. *Trifolium haydenii*, *Selaginella densa,* and *Silene acaulis* were well represented in some stands. The shrub *Potentilla fruticosa* was present in one stand. Lichen and moss cover was less than 2 percent.

Soils—Parent material was quartzite in one stand and limestone in the remaining seven stands. Bare ground and gravel covered 67 percent of the surface. Mean depths of litter and duff were both 0.1 inch. Percent of coarse fragments ranged from 40 to 66 percent with a mean of 57 percent. Texture of the fine fraction varied from sandy clay to sandy clay-loam with a modal class of sandy clay-loam. Soil pH varied from 6.9 to 8.2 with a mean of 7.8; pH from the seven plots on limestone varied from 7.5 to 8.2 with a mean of 7.9; pH of the single plot on quartzite was 6.9. Mean organic matter content was 12 percent, mean total nitrogen was 0.34 percent, and C:N ratio was 32:1.

Productivity—Graminoid productivity varied from 35 to 253 lbs per acre with a mean of 112 lbs per acre. Forb productivity ranged from 89 to 759 lbs per acre with a mean of 277 lbs per acre. Mean total productivity was 389 lbs per acre. Cushion plant productivity is difficult to measure; thus, the forb estimates are only rough approximations. However, this community type was among the least productive in our study area.

Color plate 1—The crest of Storm Lake Pass in the Pintlar Range affords a panoramic view of the Goat Flats vicinity, an extensive, rolling, and deceptively homogeneous appearing alpine landscape. Eight different alpine c.t.'s were sampled within a half mile radius.

Color plate 2—1991, Plot 058: On calcareous sandstones at the lower limits of the alpine within the Madison Mountains, *Festuca idahoensis/Potentilla diversifolia* is an extensive and productive c.t. This late summer phenology emphasizes the graminoid component where *F. idahoensis* has 60 percent canopy cover and litter nearly completely blankets the interstices between basal clumps.

Color plate 3—1989, Plot 002: The *Deschampsia cespitosa/Potentilla diversifolia* c.t. is the most productive of upland graminoid-dominated vegetation types. The graminoid component is rather intact compared to lower elevation *Deschampsia*-dominated sites where cattle are the primary grazers, as opposed to sheep, in alpine habitats.

Color plate 4—1989, Plot L067: In the Lima Peaks vicinity of the Tendoy Mountains, alpine grasslands are extensive; on coarse-textured (excessively drained) and somewhat unstable substrates, the *Hesperochloa kingii/ Oxytropis campestris* c.t. (entire area of photo) is often the characteristic c.t. with *Festuca idahoensis/Potentilla diversifolia* occupying adjacent, less droughty habitats.

Color plate 5—1989, Plot L017: In the Gravelly (shown here), Beaverhead, and Tendoy Mountains, where large expanses of calcareous substrates obtain, turf types, especially the *Carex elynoides* c.t., are by far the most extensive of alpine habitats. The *C. elynoides* c.t. pictured stretches from the sampling point to the far horizon along the upper one-third of the ridge and is dominated by a fibrous rooted sward of *C. elynoides* and the cespitose *Festuca ovina*; the showy forb *Hymenoxys grandiflora* has less than 5 percent canopy cover.

Color plate 6—1991, Plot 004: In upper alpine habitats on the granitic substrates of the East Pioneer Range, *Carex scirpoidea/Geum rossii* is a common moist turf c.t. In this photograph, the early season phenology is emphasized by the lush deep green of the forb component, especially *G. rossii* in bloom.

Color plate 8—1991, Plot 21: This northwest exposure on limestone at 9,900 ft in the East Pioneer Range exemplifies the dry extreme of the *Dryas octopetala/Carex rupestris* cushion plant c.t. Small clones of *D. octopetala* have colonized the riser portion of a slope patterned at a microscale with treads and risers.

Color plate 7—1991, Plot 35: A typical cushion plant community (*Geum rossii-Arenaria obtusiloba*) on a ridge shoulder in the Tobacco Root Mountains. With its near ridge crest and southwestern exposure, this site is undoubtedly severely wind-impacted as evidenced by the diminutive growth form of the vegetation and by the high percentage (more than 75 percent) of exposed gravel and rock.

Color plate 9—1991, Plot 029: The *Carex nigricans* c.t. (tawny brown portion in mid-ground with clipboard) is typically associated with the longest persisting snow patches, such as occur in concavities. The grey-green vegetation at periphery of *C. nigrican* c.t. is the visually distinctive *Antennaria lanata* within a band of the *Juncus drummondii/A. lanata* c.t., typical of sites where snow ablation is earlier.

Color plate 10—1991, Plot 061: Lush, highly productive wetland (*Carex scopulorum/Caltha leptosepala* c.t.) dominated by *C. scopulorum*, *Deschampsia cespitosa*, and *Senecio cymbalarioides* surrounds alpine tarn in the Madison Mountains; soils are continuously saturated and gleyed to the surface.

Color plate 11—1991, Plot 060: This solifluction lobe at 10,200 ft in the Madison Mountains is carpeted with *Salix reticulata/Caltha leptosepala* c.t., typical of high-elevation snowbed sites. Water percolating through the solifluction lobe and from surrounding fellfields feeds the alpine wetland (*Carex scopulorum/Caltha leptosepala*) in the foreground.

Color plate 12—1991, Plot 047: *Salix planifolia/Carex scopulorum* c.t. is a common component of high subalpine to alpine wetland habitats. Though *Salix planifolia* height does not exceed 4 to 5 dm, even in the most favorable of environments, this is still the tallest alpine type.

Other Studies—*Carex rupestris* commonly dominates windswept fellfields in the Rocky Mountains. Lewis (1970) described cushion plant communities in the Uinta Mountains of Utah dominated by *C. rupestris*, *Festuca ovina*, and cushion plants such as *Silene acaulis* and *Trifolium nanum*. Willard (1979) described a dry turf association dominated by *C. rupestris*, *Potentilla nivalis*, and *Silene acaulis* for the Rocky Mountain National Park in Colorado. Komarkova and Webber (1978) reported a fellfield community dominated by *C. rupestris* and *Kobresia myosuroides* from Niwot Ridge, CO. Baker (1983) described a *C. rupestris*-cushion community for the Sangre de Cristo Mountains of New Mexico. Moseley (1985) described similar limestone fellfields dominated by *C. rupestris* and *Potentilla ovina* from east-central Idaho, while Urbancyzk and Henderson (1994) reported cushion plant communities dominated by *C. rupestris* in the Lemhi Mountains of Idaho, but *P. ovina* was uncommon (Henderson, personal communication).

In our study area, CARRUP/POTOVI is mainly confined to calcareous parent materials; and *Potentilla ovina*, one of the dominant forbs, is a calciphile at high elevations. In the limestone mountains to the north, most *C. rupestris* associations support *Dryas* spp. as an important component (Achuff and Corns 1982; Bamberg and Major 1968). To the east and south of our study area, *C. rupestris* fellfield communities on crystalline parent material are often codominated by *Geum rossii* or *Dryas octopetala* (Bliss 1956; Johnson and Billings 1962; Willard 1979) and are more similar to our GEUROS/AREOBT c.t. The CARRUP/POTOVI c.t. may be endemic to limestone ranges of southwestern Montana and adjacent east-central Idaho.

Geum rossii-Arenaria obtusiloba c.t. (GEUROS-AREOBT; Ross' Avens-Arctic Sandwort)

Environment—GEUROS-AREOBT was common on exposed, windswept upper slopes, saddles, and ridgetops between 9,800 and 10,400 ft in the Pioneer and Tobacco Root ranges (color plate 7). This type occurred only on soils developed from crystalline parent material. This sparsely vegetated association usually graded into the CARSCI/GEUROS turf community in deeper soils on more protected slopes.

Vegetation—Mean graminoid cover was only 4 percent. *Festuca ovina* was the only graminoid commonly present in appreciable amounts. *Luzula spicata* and *Carex elynoides* had low coverage but were frequent, and *Carex rupestris* and *Trisetum spicatum* were locally common. Mean cover of forbs was 30 percent. *Geum rossii* had the greatest constancy and cover of any forb. *Arenaria obtusiloba*, *Eritrichium nanum*, *Phlox pulvinata*, and *Silene acaulis* were common cushion plants. *Selaginella densa* and *S. watsonii* were locally abundant. Trace amounts of the shrubs *Ribes hendersonii* and *Dryas octopetala* occurred in one stand. Cover of mosses and lichens was less than 1 percent.

Soils—Parent materials were granite and quartzite. Bare ground and gravel covered 47 percent of the surface. Mean depths of litter and duff were both less than 0.1 inch. Percent of coarse fragments varied from 355 to 70 percent with a mean of 49 percent. Textural classes of the fine fraction ranged from sandy clay-loam to sand with a modal class of sandy loam. Soil pH ranged from 6.2 to 6.6 with a mean of 6.4. Mean organic matter content was only 8 percent, mean total nitrogen was 0.24 percent, and C:N ratio was 20:1. Soils had a sandier texture and lower levels of organic matter and nitrogen than most other community types sampled.

Productivity—Graminoid productivity ranged from 0 to 118 lbs per acre with a mean of 41 lbs per acre. Forb productivity varied from 192 to 651 lbs per acre with a mean of 453 lbs per acre. Mean total productivity was 494 lbs per acre. Cushion plant productivity is difficult to measure; thus, the forb estimates are only rough approximations. The low total productivity reflects the small graminoid contribution.

Other Studies—Fellfields and cushion plant communities similar to GEUROS/AREOBT are common in the Rocky Mountains of southern Montana south to Colorado. Bamberg and Major (1968) described a fellfield community from the Flint Creek Mountains of Montana dominated by *G. rossii*, *Carex elynoides*, *Lupinus argenteus*, and *Potentilla concinna*. Cushion plant communities in the Beartooth Mountains of Montana and Wyoming are dominated by *G. rossii*, *Carex rupestris*, *Arenaria obtusiloba*, *Silene acaulis*, and *Trifolium nanum* (Johnson and Billings 1962; Lesica 1991). Bliss (1956) described ridgetop vegetation in the Medicine Bow Mountains of Wyoming dominated by *Carex rupestris* and cushion plants such as *Paronychia pulvinata*, *Selaginella densa*, *Arenaria obtusiloba*, *Phlox caespitosa*, and *Trifolium dasyphyllum*. *Geum rossii* was present but of secondary importance. Similar plant associations with varying amounts of *Geum rossii* have been described from Wyoming's Absaroka Mountains (Thilenius and Smith 1985) and the Uinta Mountains in Utah (Lewis 1970). In the Rocky Mountains of Colorado, exposed ridges and fellfields are dominated by cushion plants such as *Trifolium dasyphyllum*, *Paronychia pulvinata*, *Silene acaulis*, and *Arenaria obtusiloba* as well as *Carex rupestris* and *Kobresia myosuroides* (Komarkova and Webber 1978; Willard 1979). *Geum rossii* is dominant in turf communities but is of secondary importance in cushion plant associations in these areas.

Dryas octopetala/*Carex rupestris* c.t. (DRYOCT/CARRUP; Mountain Avens/ Curly Sedge)

Environment—This sparsely vegetated community type occurred on broad ridgetops, shoulders, saddles, and upper slopes at 9,200 to 9,700 ft in the Pioneer and Anaconda ranges (color plate 8). Distinct patterning was apparent, with *Dryas octopetala* forming mats surrounded by bare ground or rock pavement. Mats were either evenly spaced or aligned along the edge of stepped terraces or windrows. Bamberg and Major (1968) report that *Dryas* mats in the Big Snowy Mountains of Montana demonstrated appreciable yearly downslope movement. However, windrows at Siyeh Pass in Glacier Park were relatively stable. DRYOCT/CARRUP usually occurred in a matrix of dry or moist turf communities such as CARELY or CARSCI/POTDIV. This community type is closely related to DRYOCT/POLVIV, and the two may intergrade. However, DRYOCT/POLVIV occurred on wetter sites, had higher total vegetal cover, and had more species such as *Salix reticulata*, *Polygonum* spp., and *Poa alpina*, indicative of more mesic conditions.

Vegetation—Mean cover of dwarf shrubs was 38 percent. *Dryas octopetala* was the only common shrub species; *Cassiope mertensiana*, *Potentilla fruticosa,* and *Salix arctica* each occurred in one stand. Mean graminoid cover was 13 percent. Common species included *Carex rupestris* and *C. elynoides*. *Calamagrostis purpurascens*, *Festuca ovina,* and *Poa secunda* were locally distributed. Mean forb cover was only 15 percent, the second lowest value among all community types. *Oxytropis campestris* and *Phlox pulvinata* were common species found in most stands. *Anemone drummondii*, *Arenaria obtusiloba*, *Douglasia montana*, *Geum rossii*, *Oxytropis viscida*, *Potentilla diversifolia*, *Zigadenus elegans,* and *Selaginella densa* were common in some stands. Cover of mosses and lichens was less than 1 percent.

Soils—Parent materials were limestone, granite, and quartzite, with limestone predominating. Bare ground and gravel covered 40 percent of the surface. Mean depths of litter and duff were both 0.1 inch. Percent of coarse fragments ranged from 33 to 54 percent with a mean of 42 percent. Texture of the fine fraction varied from sandy clay to sandy clay-loam, and modal texture was sandy clay. Soil pH ranged from 6.2 to 7.8 with a mean of 7.3. Mean organic matter content was 12 percent, mean total nitrogen was 0.34 percent, and C:N ratio was 36:1. Soils were erodible and often unstable. Sandy clay-loam soils that were derived from calcareous parent materials often showed evidence of frost churning.

Productivity—Our estimates are based on only three stands, and two of these stands were on barren soils derived from partially metamorphosed limestone. These soils likely have unusual physiochemical properties that deter plant establishment and growth. Consequently, our production estimates for this type are probably low. Shrub productivity varied from 44 to 651 lbs per acre with a mean of 157 lbs per acre. Graminoid productivity ranged from 15 to 89 lbs per acre with a mean of 33 lbs per acre. Forb productivity varied from 8 to 148 lbs per acre with a mean of 43 lbs per acre. Total productivity averaged 233 lbs per acre.

Other Studies—Achuff and Corns (1982) described an alpine type from the Canadian Rockies dominated by *Dryas octopetala* and *Kobresia myosuroides*, but this community has many mesic site indicators and is more similar to our DRYOCT/POLVIV. Douglas and Bliss (1977) described *Dryas* fellfields from the North Cascades Mountains of Washington. Only a handful of species, including *D. octopetala*, *Festuca ovina,* and *Arenaria obtusiloba*, were common. Associations dominated by *D. octopetala*, *Carex rupestris*, *C. elynoides,* and *C. scirpoidea* occur in the Big Snowy and Flint Creek Mountains of Montana (Bamberg and Major 1968). *Dryas* communities in Glacier National Park, MT, appear compositionally intermediate between those in the Flint Creek Mountains and those of the Canadian Rockies (Bamberg and Major 1968; Choate and Habeck 1967). Johnson and Billings (1962) stated that *D. octopetala* colonizes wind-eroded sites and is very limited on the Beartooth Plateau of south-central Montana and adjacent Wyoming. Urbanczyk and Henderson (1994) described vegetation dominated by *D. octopetala* and *C. rupestris* on steep north slopes below snowbanks in Idaho's Lemhi Mountains. Communities dominated by *D. octopetala* and *Carex rupestris* from the Rocky Mountains of Colorado are associated with high levels of calcium according to Komarkova and Webber (1978) and Willard (1979), but Eddleman and Ward (1984) found no such relationship. *Festuca ovina*, *Geum rossii*, *Silene acaulis,* and *Trifolium nanum* are also common in the Colorado types.

Our two *Dryas*-dominated types, DRYOCT/CARRUP and DRYOCT/POLVIV, appear to be at the drier and wetter ends of a moisture gradient. DRYOCT/CARRUP predominates in relatively dry mountain ranges of the Central and Northern Rockies and on the east side of the Cascades, while DRYOCT/POLVIV is more common in the Canadian Rockies and the wetter ranges of the Northern Rockies (see Other Studies section under DRYOCT/POLVIV).

Slope Communities

Two stand groupings, DRY SLOPES and MOIST SLOPES, are not named for dominant or diagnostic species. There were no species assemblages that characterized these sites; rather, composition was derived from the flora of adjacent communities. However, member stands occupied similar, relatively unstable environments. Frequent natural disturbances, such as avalanche-scouring, slumping, and erosion, prevent zonal vegetation types from establishing. Consequently, these sites were generally occupied by a sparse complement of species from adjacent vegetation types adapted to the particular local disturbance regimes. These sites were common and easily recognized by their sparse cover and usually steep topographic positions.

Dry Slopes

Environment—These species assemblages occurred in all ranges and were most abundant in the Tendoy and Tobacco Root Mountains. Elevations ranged from 9,580 to 10,530 ft. Slopes were almost uniformly steep, inclination averaging 50 percent, and their aspects, with but two exceptions, were southeast through west. None of the sites had less than 55 percent exposed soil, gravel, and rock. The dominant aspect was exposed gravel (39 percent mean) with lesser amounts of exposed soil (18 percent mean) and rock (25 percent mean).

Vegetation—Vegetative cover of these sites was usually low (<20 percent); however, a few stands with higher cover inflated the averages. Average cover by life form was shrubs 1 percent, graminoids 10 percent, and forbs 25 percent. *Agropyron scribneri* was the one species with both higher constancy and higher coverage in the DRY SLOPE type than in the other c.t.'s; this grass appeared to be associated with gravelly, unstable slopes, but can also be found in stable, calcareous habitats (Henderson, personal communication). Other graminoids with greater than 50 percent constancy were *Festuca ovina*, *Poa glauca*, *P. secunda,* and *Trisetum spicatum*. Forbs with at least 50 percent constancy were *Achillea millefolium*, *Hymenoxys grandiflora*, *Lomatium cous*, *Phlox pulvinata*, *Potentilla diversifolia*, *Sedum lanceolatum,* and *Smelowskia calycina*. If present at all, moss and lichen cover did not exceed trace amounts.

Soils—Parent materials included limestone, calcareous sandstone, quartzite, granite, basalt, and gneiss. The only litter and duff present were immediately under vegetation canopies. Coarse fragment content ranged from 31 to 79 percent, averaging 55 percent. Texture of the fine fraction ranged from sandy clay to loamy sand, and modal texture was sandy clay-loam. Relative lack of substrate weathering was reflected in high soil reactions for both calcareous and noncalcareous sites, 7.7 and 6.6 pH. Mean organic matter content was only 8 percent, mean total nitrogen was 0.27 percent, and C:N ratio was 20:1.

Production—Total production ranged from 207 to 964 lbs per acre, averaging 657 lbs per acre, with forb production (494 lbs per acre) far outstripping that of graminoids (163 lbs per acre). It is instructive to note that grass and forb coverage values of dry slopes approximate those of cushion plant communities, but dry slope production is twice as great. Greater dry slope production is due to a predominance of upright growth forms as opposed to cushion plants.

Other Studies—Diverse plant assemblages occurring on sparsely vegetated slopes have been reported for Washington's Cascades (Douglas and Bliss 1977). They found high beta diversity in this group of stands and that clustering and ordination techniques did not yield meaningful insight into community structure and classification. They also found that composition of sparsely vegetated slopes was most dependent on species comprising immediately adjacent communities. We hypothesize that similar, open, early seral stands occur in most mountain ranges, but their fate is the "no-fit" category, and thus they go unreported in the literature.

Caicco (1983) and Moseley (1985) described an *Agropyron scribneri* c.t. of east- and south-central Idaho that is floristically and environmentally similar to about half of our stands. Their sites are also characterized by unstable surfaces but occupy a variety of landscape positions, including snowbeds. Moseley (1985) described a *Hesperochloa kingii* c.t., unstable phase, on gravelly soils that is similar to several of our plots from the Gravelly and Beaverhead Mountains. We speculate that the DRY SLOPES community type is environmentally similar to the "dry fellfield" of Colorado's Front Range, described as having discontinuous or no winter snow cover, a growing season exceeding 3 months, windswept exposures, and often severe soil erosion (Eddleman and Ward 1984; Isard 1986; May and Webber 1982). Because our sites were seldom cushion plant-dominated, we infer our dry slopes to be less windswept than those of Colorado.

Moist Slopes

Environment—This environmental type was observed in all study area ranges and sampled on the Gravelly, Snowcrest, Tendoy, Tobacco Root, and Madison Mountains. Sites were moderate to steep, straight slopes with predominantly northerly exposures. This type usually extended from mid-slope positions to the slope shoulder where it frequently graded into turf or cushion plant communities. Elevations ranged from 9,480 to 10,000 ft. Besides having cooler slope exposures, MOIST SLOPES differ from DRY SLOPES by having even more exposed substrate (90 percent average), a much reduced fraction of rock (8 percent average), and a much higher percent of exposed soil (53 percent) and gravel (29 percent). We speculate that these are snowbed sites of varying degree due to their upper lee slope positions, cooler exposures, and moist to wet soils. The steeper sites were abundantly rilled or gullied and also exhibited extensive sheet erosion; features which are to be expected with rapid snowmelt and consequent overland flow on these steep, sparsely vegetated sites.

Vegetation—Vegetative cover was reduced—canopy cover was only 12 percent for graminoids and 29 percent for forbs. Sites with the longest persisting snowpack had less than 10 percent total canopy cover. Like the DRY SLOPES, there were no characteristic species. Rather, the composition was apparently drawn from surrounding communities. Only four graminoids, *Deschampsia cespitosa*, *Agropyron caninum*, *Poa alpina*, and *P. fendleriana*, had more than 50 percent constancy, but coverage seldom exceeded 5 percent. Moist-site graminoids with relatively high coverage were *Carex paysonis*, *C. haydenii*, and *C. phaeocephala*. Forbs with at least 50 percent constancy were *Achillea millefolium*, *Agoseris glauca*, *Lupinus argenteus*, *Potentilla diversifolia*, *Senecio crassulus*, and *Solidago multiradiata*. In addition to *L. argenteus* and *P. diversifolia*, other forbs that dominated at least two stands were *Aster foliaceus*, *Erigeron ursinus*, *Ranunculus eschscholtzii*, and *Sibbaldia procumbens*; the last three species were also often associated with snowbed communities described for the study area. Only trace amounts of mosses and lichens were recorded.

Soils—Parent materials included gneiss, quartzite, sandstone, calcareous sandstone, and limestone. Trace amounts of litter and duff were found only under individual plants. Coarse fragment content ranged widely, from 5 to 71 percent, and averaged 31 percent. The two stands with the lowest coarse fragment content (5 and 6 percent) were probably snowbed areas and had extensive pocket gopher (*Thomomys talpoides*) workings and soil erosion. Texture of the fine fraction ranged from clay to sandy loam; the modal textural class was sandy clay-loam. Soil reaction for both calcareous (7.3 pH) and noncalcareous (6.5 pH) substrates tended to be lower than for DRY SLOPES. Mean organic matter content was only 9 percent, mean total nitrogen was 0.18 percent, and C:N ratio was 17:1. Levels of organic matter and nitrogen were lower than for most other community types sampled.

Productivity—Total production ranged from 391 to 1,104 lbs per acre; average production total was 646 lbs per acre; and component fractions averaged 479 lbs per acre for forbs, 167 lbs per acre for graminoids, and were very similar to DRY SLOPES values.

Other Studies—In terms of site parameters, vegetation coverage, and productivity values, WET SLOPES are like *Sibbaldia-Selaginella* snowbed communities described for Colorado's Front Range (Eddleman and Ward 1984; Isard 1986; May and Webber 1982) but they differ by lacking *Selaginella densa* and lichens, described as dominant ground cover in Colorado types (see DRY SLOPES section).

Snowbed Communities

Prevailing winds from the southwest and west interact with topography to cause snow to accumulate in consistent patterns behind small ridges, on upper lee slopes, and in depressions. Plants in these snow accumulation areas are well protected during the winter and generally receive more moisture than surrounding zonal vegetation. In addition, late snow release results in a shortened growing season and in soils that remain cold and often near saturation during much of the season. The depth of accumulated snow determines the interplay among these factors and results in a relatively large number of communities associated with this habitat, varying from sparsely vegetated forb-dominated communities to dense graminoid sods and moist dwarf shrub types. Different types may intergrade in an intricate mosaic related to broken topography or may form concentric patterns on more even terrain (Holway and Ward 1963; Johnson and Billings 1962). In extreme cases, late persisting snow precludes most vascular plant growth. We did not sample these "snow barrens."

Carex nigricans c.t. (CARNIG; Black Alpine Sedge)

Environment—CARNIG was found between 9,500 and 10,000 ft in the Anaconda, Madison, Pioneer, and Tobacco Root Mountains—the wettest ranges in our study area. This distinctive community occurred on nearly level sites at the base of slopes and in swale and valley bottoms where blowing snow is deposited and meltoff does not occur until well into the growing season. CARNIG occupied sites with perennially moist or saturated soil and with the shortest snow-free season of any snowbed c.t. In 1991, many of our stands had just begun to green-up in late July. CARNIG usually occurs in a matrix of small patches of wetland or other snowbed communities (color plate 9). DESCES/CALLEP, CARSCO/CALLEP, JUNDRU/ANTLAN, and PHYEMP/ANTLAN were often adjacent.

Vegetation—Mean graminoid cover was 83 percent. *Carex nigricans* was the absolute dominant with a mean cover of 76 percent. Other frequent but less abundant graminoids were *Juncus drummondii*, *Phleum alpinum*, and *Carex paysonis*. Forbs had a mean cover of 21 percent. The most common species were *Caltha leptosepala*, *Antennaria lanata*, and *Erigeron peregrinus*. No forb species occurred in all four stands, and only one, *A. lanata* occurred in three out of four stands. The dwarf shrubs *Phyllodoce empetriformis* and *P. glanduliflora* were present in small amounts in two stands, and *Salix arctica* was common in one stand. Mean cover of mosses and lichens was less than 1 percent.

Soils—Parent materials were limestone, granite, and gneiss. Bare ground and gravel covered only 2 percent of the surface. Mean depths of litter and duff were 0.4 and 0.2 inch. Percent of coarse fragments were always less than 10 percent with a mean of 3 percent. Modal texture of the fine fraction was sandy clay. Soil pH was 6.5 at the limestone site and varied between 5.8 and 6.2 when parent materials were crystalline. Mean pH was 6.2. Mean organic matter content was 15 percent, mean total nitrogen was 0.36 percent, and C:N ratio was 20:1. Soils in late July of 1992 were always wet and cold.

Productivity—Due to retarded phenology in 1991, we measured productivity in only two stands. Graminoid productivity had a mean of 375 lbs per acre, and forb productivity had a mean of 275 lbs per acre. Mean productivity of dwarf shrubs was 22 lbs per acre. Mean total productivity was 650 lbs per acre. *Carex nigricans* was not fully mature when we clipped plots in these stands; thus, our estimates of graminoid and total productivity are low.

Other Studies—Communities dominated by *Carex nigricans* have been described for Banff and Jasper National Parks in Alberta, Canada (Achuff and Corns 1982; Hrapko and LaRoi 1978). Composition is similar to our CARNIG c.t., although *Luzula wahlenbergii* (=*L. piperi*) was a common component of the Canadian types. *Carex nigricans* communities are more widely distributed in the Canadian Rockies, often occurring on slopes as well as level areas. Communities similar to CARNIG are also common in the North Cascades of Washington (Douglas 1972; Douglas and Bliss 1977). *Luetkea pectinata* and bryophytes were common in the North Cascades type. Rottman and Hartman (1985) reported an association dominated by *C. nigricans* occurring in the center of sorted stone polygons in the San Juan Mountains of Colorado. *Sibbaldia procumbens*, *Artemisia scopulorum*, and *Juncus drummondii* were other common species. *Carex nigricans* snowbed communities appeared to be most common to the north and west of our study area.

Juncus drummondii/*Antennaria lanata* c.t. (JUNDRU/ANTLAN; Drummond's Rush/ Woolly Pussytoes)

Environment—Small examples of JUNDRU/ ANTLAN were common in depressions in valleys and cirque basins between 9,600 and 10,000 ft in the Madison Mountains. This community was always associated with areas of late snowmelt; however, meltoff probably occurs earlier than in communities dominated by *Carex nigricans*. JUNDRU/ANTLAN was often part of a vegetation mosaic resulting from uneven snow deposition. Commonly associated communities were moist turf, wetland, and other snowbed associations such as CARSCI/GEUROS, CARSCO/ CALLEP, CARNIG, and PHYEMP/ANTLAN.

Vegetation—Mean graminoid cover was 30 percent. Dominant graminoids were *Juncus drummondii*, *Poa fendleriana*, and *Carex paysonis*. *Carex pyrenaica* was locally common. Mean cover of forbs was 37 percent, and common species included *Antennaria lanata*, *Sibbaldia procumbens*, and *Erigeron peregrinus*. *Arnica latifolia* was common in one stand. The shrub *Vaccinium scoparium* was also common in this same stand. Mean cover of mosses and lichens was 2 percent.

Soils—Parent materials were gneiss and granite. Bare ground and gravel covered 50 percent of the surface. Mean depths of litter and duff were both 0.1 inch. Percent of coarse fragments ranged from 6 to 17 percent with a mean of 13 percent. Modal texture of the fine fraction was sandy clay. Although they occurred in topographically low positions, these relatively barren and unproductive communities were apparently underlain by shallow and perhaps excessively well-drained soils. Soil pH ranged from 6.0 to 6.1 with a mean of 6.1. Mean organic matter content was 12 percent, mean total nitrogen was 0.21 percent, and C:N ratio was 24:1.

Productivity—Graminoid productivity varied between 200 and 270 lbs per acre with a mean of 237 lbs per acre. Forb productivity ranged from 150 to 860 lbs per acre with a mean of 460 lbs per acre. Productivity of dwarf shrubs in one stand was 30 lbs per acre. Mean total productivity was 726 lbs per acre. Highest productivity occurred on the deepest soils.

Other Studies—*Antennaria lanata* is a common component of snowbed communities in the North Cascades Mountains and Canadian Rockies, but codominant species are *Carex nigricans* or dwarf shrubs such as *Cassiope* or *Phyllodoce* spp. rather than *Juncus drummondii* (Achuff and Corns 1982; Douglas and Bliss 1977; Hrapko and LaRoi 1978). Snowbed communities dominated by *Juncus drummondii* with

Carex pyrenaica and *Sibbaldia procumbens* occur in the Rocky Mountains of Colorado (Komarkova and Webber 1978; Willard 1979); however, *Antennaria lanata* is not listed for the Colorado associations. Lesica (1991) reported communities very similar to JUNDRU/ANTLAN from the eastern edge of the Beartooth Mountains in south-central Montana. It appears that *Juncus drummondii* dominates snowbed communities in the central Rocky Mountains, while *Antennaria lanata* occupies a similar niche in the Canadian Rockies and the North Cascades. The two species codominate snowbed associations in the crystalline ranges of southern Montana.

Phyllodoce empetriformis/Antennaria lanata c.t. (PHYEMP/ANTLAN; Mountain-Heather/Woolly Pussytoes)

Environment—PHYEMP/ANTLAN was locally common on gentle to moderate protected slopes between 9,200 and 10,100 ft in the Anaconda, Madison, and Pioneer Mountains and is associated with crystalline parent materials in these wetter ranges of our study area. These sites are undoubtedly well covered by snow during the winter, and meltoff probably occurs relatively late in the season, although not as late as in the CARNIG c.t. In addition to other snowbed associations such as CARNIG and JUNDRU/ANTLAN, PHYEMP/ANTLAN often grades to moist turf communities such as SALARC/POLBIS and CARSCI/GEUROS. A typical toposequence on a lee slope might be CARSCI/GEUROS on the lower slope, PHYEMP/ANTLAN at the base of the slope, with CARNIG in the bottom.

Vegetation—Dwarf shrubs provide the dominant aspect with a mean cover of 55 percent. *Phyllodoce empetriformis* and *Vaccinium scoparium* were common in all four stands, while *P. glanduliflora* and *Cassiope mertensiana* were common in two of the stands. Mean graminoid cover was low (20 percent). *Carex paysonis*, *Juncus drummondii,* and *Poa fendleriana* were common graminoids occurring in all or most stands. Forb cover was 35 percent; *Antennaria lanata*, *Polygonum bistortoides,* and *Sibbaldia procumbens* were consistently present, though only *A. lanata* occurred with greater than 5 percent cover. Mean cover of mosses and lichens was less than 1 percent.

Soils—Parent materials were granite and quartzite. Cover of bare ground and gravel was 15 percent with 8 percent cover of rock. Mean depths of litter and duff were both 0.1 inch. Percent of coarse fragments varied from 0 to 14 percent with a mean of 7 percent. Modal texture of the fine fraction was sandy clay-loam. Soil reaction ranged from 6.0 to 6.4 pH with a mean pH of 6.1. Mean organic matter content was 14 percent, mean total nitrogen was 0.30 percent, and C:N ratio was 23:1. Soils underlying PHYEMP/ANTLAN were relatively deep and generally still moist in late July.

Productivity—We measured productivity in only two stands; the heather species proved difficult to clip accurately. Thus, our production estimates are only rough approximations. Mean shrub productivity was 166 lbs per acre. Graminoid productivity had a mean of 133 lbs per acre, and forb productivity had a mean of 104 lbs per acre. Mean total productivity was 403 lbs per acre.

Other Studies—Mountain-heather communities similar to PHYEMP/ANTLAN have been reported for Banff and Jasper National Parks in the Canadian Rockies by Achuff and Corns (1982) and Hrapko and LaRoi (1978). The Canadian types had similar composition, but *Phyllodoce glanduliflora* and *Cassiope mertensiana* were the dominant heather species. Mountain-heather communities from the North Cascades Mountains of Washington are more similar to our PHYEMP/ANTLAN (Douglas 1972; Douglas and Bliss 1977). Whereas Douglas (1972) combined all *Phyllodoce-* and *Cassiope*-dominated associations into one community type, Douglas and Bliss (1977) designated separate community types dominated by *P. empetriformis*, *P. glanduliflora,* and *C. mertensiana*. In the North Cascades Mountains where snowpack is much higher than most areas of the Northern Rockies, these communities are not confined to areas of late snow release. Apart from these studies, Choate and Habeck's (1967) mention of a similar type at Logan Pass in Glacier National Park in northwestern Montana appears to be the only other reference to heather-dominated communities. Thus, mountain-heather plant associations appear to be confined to the mountains north and west of our study area.

Cassiope mertensiana/Carex paysonis c.t. (CASMER/CARPAY; Merten's Moss-Heather/Payson's Sedge)

Environment—CASMER/CARPAY is uncommon in the study area, occurring at the base of gentle, north- or east-facing slopes at 9,400 to 9,600 ft in the Anaconda and Tobacco Root Mountains. This type probably also occurs in the Pioneer Mountains. These cool, protected sites have deep snow during the winter, and release comes somewhat late in the growing season. Sites often showed signs of frost-churning and solifluction, suggesting that they receive additional upslope moisture. CASMER/CARPAY forms a mosaic with other snowbed associations such as CARNIG and JUNDRU/ANTLAN and often occurs adjacent to moist turf communities such as SALARC/POLBIS and

CARSCI/GEUROS. CASMER/CARPAY probably experiences earlier snow release than the other mountain-heather community PHYEMP/ANTLAN.

Vegetation—Mean canopy cover of shrubs was 60 percent. *Cassiope mertensiana* and *Salix arctica* were the dominant shrubs. *Phyllodoce glanduliflora* was present in one stand. Mean graminoid cover was 23 percent, with *Carex paysonis* as the dominant. *Poa alpina* and *Carex scirpoidea* were common; *Poa fendleriana* and *Deschampsia cespitosa* were well represented in one stand. Mean forb cover was 30 percent. *Geum rossii* and *Potentilla diversifolia* were common species, and *Erigeron simplex* and *Polygonum bistortoides* were frequent. *Antennaria lanata* and *Juncus drummondii* were notable by their absence or low cover. Mean cover of lichens and mosses was less than 1 percent.

Soils—Parent materials were quartzite, gneiss, and granite. Bare ground and gravel covered 11 percent of the surface, while rock cover was 8 percent. Mean depth of litter was 0.2 inch, and mean depth of duff was 0.1 inch. Coarse fragment percent varied from 9 to 35 percent with a mean of 23 percent. Modal texture of the fine fraction was sandy clay. Soil pH ranged from 5.8 to 6.2 with a mean of 6.0. Mean organic matter content was 19 percent, mean total nitrogen was 0.52 percent, and C:N ratio was 19:1. Soils were moderately deep and moist to wet in late July.

Productivity—We measured productivity in only one stand; *Cassiope* was difficult to clip accurately. Thus, our production estimates are only rough approximations. Shrub productivity was 237 lbs per acre, graminoid productivity was 267 lbs per acre, and forb productivity was 712 lbs per acre. Total productivity was 1,216 lbs per acre.

Other Studies—Associations dominated by *Cassiope mertensiana* have been reported for the Canadian Rockies, the North Cascade Range, and northwestern Montana. *Phyllodoce* spp. were often codominants (see PHYEMP/ANTLAN section).

Juncus parryi/*Erigeron ursinus* c.t. (JUNPAR/ERIURS; Parry's Rush/Bear Fleabane)

Environment—Examples of JUNPAR/ERIURS were locally common near the base of gentle slopes with warm aspects. Both of our stands were between 9,500 and 9,800 ft in the Gravelly Mountains. Although snow is expected to accumulate on these sites, this type is perhaps least affected by late meltoff of all the snowbed communities. FESIDA/POTDIV grassland was the most common adjacent plant community. JUNPAR/ERIURS is similar in physiognomy and habitat to JUNDRU/ANTLAN.

Vegetation—Mean graminoid cover was 35 percent. Dominant graminoids were *Juncus parryi* and *Festuca idahoensis*, and *Poa glauca* was consistently present with low coverage. Mean cover of forbs was 25 percent. Common species included *Erigeron ursinus*, *E. peregrinus*, *E. simplex*, *Antennaria umbrinella*, and *Lewisia pygmaea*. Mean cover of mosses and lichens was 2 percent.

Soils—Parent materials in the two stands were andesite and quartzite. Bare ground and gravel covered 47 percent of the surface, making this the most barren of our snowbed communities. Mean depths of litter and duff were 0.3 and 0.1 inch. Mean coarse fragment content was 25 percent. Modal texture of the fine fraction was clay. Mean soil pH was 5.6. Mean organic matter content was 20 percent, mean total nitrogen content was 0.64 percent, and C:N ratio was 15:1. This sparsely vegetated community type is similar to JUNDRU/ANTLAN, but the soils were even more stony and acidic.

Productivity—Mean graminoid productivity was 439 lbs per acre, and mean forb productivity was 253 lbs per acre. Mean total productivity was 692 lbs per acre. Productivity is probably affected more by the shallow, poorly developed soils than late snow release.

Other Studies—Holway and Ward (1963) reported snow accumulation areas in the Colorado Rocky Mountains dominated by *Carex pyrenaica* and *Juncus parryi*. Willard (1979) states that *Juncus parryi* is ecologically similar to *J. drummondii* but generally occurs at lower elevations. In our study area, JUNPAR/ERIURS was associated with terrain supporting alpine grasslands, while JUNDRU/ANTLAN was associated with turf communities. Despite occupying similar topographic positions, we infer from the respective vegetation matrices that of these two community types the latter occupies cooler, drier habitats.

Salix glauca c.t. (SALGLA; Glaucus Willow)

Environment—The single stand of SALGLA occurred on a moderate to steep upper, north-facing slope, just in the lee of a divide ridge at 9,900 ft in the Snowcrest Range. We observed but did not sample other examples of this type in the Gravelly Mountains. This site was a definite snow catchment area. Adjacent associations were CARELY turf and MOIST SLOPES.

Vegetation—*Salix glauca* had canopy cover of 60 percent; no other shrubs were present. Trace amounts of *Poa alpina* and *Agropyron caninum* were present, but total graminoid cover was only 1 percent. Forb cover was 60 percent. Common species included *Aster alpigenus*, *Hedysarum sulphurescens*, *Senecio crassulus*, and *Synthyris pinnatifida*. Lichens and mosses covered 7 percent of the ground surface.

Soils—Parent material was calcareous sandstone. Exposed ground and gravel constituted 6 percent of the surface. Depths of litter and duff were 1.0 and 0.5 inch. The high surface organic matter probably reflects low rates of decomposition due to low insolation and late snowmelt. Percent of coarse fragments was very different for each microsite but averaged 30 percent for the stand. The texture of the fine fraction was sandy loam. Soil pH was 7.6. Organic matter content was 14 percent, mean total nitrogen was 0.31 percent, and C:N ratio was 28:1.

Productivity—Our estimates are based on only three clipped plots in one stand and should be considered only rough approximations. *Salix glauca* produced 759 lbs per acre. Graminoid productivity was 12 lbs per acre, and forb productivity was 759 lbs per acre. Total productivity was 1,530 lbs per acre.

Other Studies—Achuff and Corns (1982) described three community types dominated by *Salix glauca* from the Canadian Rockies. These associations contain other shrubs (for example, *Salix*, *Betula*, and *Potentilla*) and higher coverages of graminoids. *Salix glauca* associations were observed near treeline in the Lewis and Sawtooth Ranges of Montana, south of Glacier National Park (Cooper and Lesica, personal observation). Associations dominated by *Salix glauca* occur on gentle lee slopes on the east end of the Beartooth Range (Lesica 1991). Common understory species in these communities were *Carex paysonis*, *Deschampsia cespitosa*, *Geum rossii*, and *Lupinus argenteus*. In the Beartooth Mountains of Montana and the Rocky Mountains of Colorado, *Salix planifolia* and *S. glauca* dominated associations were found on cool moist slopes having late snow release (Johnson and Billings 1962; Komarkova and Webber 1978).

Wetland Communities

Community types described under this heading include bogs and fens that would be considered wetlands under Federal convention (Federal Interagency Committee for Wetland Delineation 1989). We also include those environments referred to as moist or mesic meadows, meltwater meadows, wet meadows, and *Deschampsia* meadows, the greater portion of which would probably not meet Federal criteria for wetland designation. Any assessment of site hydrological conditions is problematical. We assessed the degree of saturation or inundation using landscape position and soil moisture at the time of sampling. In environments where mottling or gleying might be expected, these features were not explicitly noticed. Where *Deschampsia cespitosa* was dominant, there were some consistent vegetational and environmental differences for distinguishing grasslands from moist meadow.

Deschampsia cespitosa/Caltha leptosepala c.t. (DESCES/CALLEP; Tufted Hairgrass/ Elkslip Marshmarigold)

Environment—This c.t. was well represented in the Gravelly Mountains and also sampled in the Beaverhead and Madison Mountains; it was noted, but not sampled, in four of the other five mountain ranges. It occurred at elevations as high as 10,100 ft, but was much more common at lower elevation collecting positions (either snow or percolating water). Sampled sites occupied flat to concave benches and slopes that did not exceed 15 percent slope and were north- through northeast-facing. Small patches of this c.t. were noted on steeper slopes below persistent snowbanks. At the time of sampling, all soil profiles were saturated to the surface. Solifluction lobes were prominent even on the most gentle slopes.

Vegetation—The high coverage of moss (72 percent mean) contributed dramatically to the lush appearance of this c.t. Only trace amounts of *Salix* spp. were found. Graminoid cover varied considerably, averaging 38 percent. *Deschampsia cespitosa* was clearly the dominant graminoid. Other moist site graminoids occurring with at least 5 percent coverage were *Carex atrata*, *C. nigricans*, *C. haydenii*, *Juncus drummondii*, and *J. balticus*. Though *D. cespitosa* clumps provided a recognition factor for this c.t., forb cover (68 percent average) far outstripped that of the graminoids. *Caltha leptosepala* dominated (48 percent canopy cover) the forb layer. Other forbs with high coverage but not necessarily high constancy were *Aster foliaceus*, *Claytonia lanceolata*, *Erigeron peregrinus*, *Pedicularis groenlandica*, *Polygonum bistortoides*, *P. viviparum*, *Senecio cymbalarioides*, and *Veronica wormskjoldii*.

Soils—Parent materials included alluvium, limestone, sandstone, basalt, and gneiss. Litter and duff depths averaged 0.6 and 0.4 inch. Coarse fragment content was consistently low, averaging only 3 percent, with traces of gravel and rock found on the surface. Bare soil exposure was as high as 20 percent, especially where pocket gopher (*Thomomys talpoides*) workings were extensive. Soil texture varied from clay to sandy clay with a sandy clay modal value. Soil reaction for calcareous substrates averaged 7.5 pH, while that for noncalcareous was only 5.8 pH. Mean organic matter content was 20 percent, mean total nitrogen was 0.57 percent, and C:N ratio was 15:1.

Productivity—Total productivity ranged widely, from 621 to 3,197 lbs per acre with a mean of 1,820 lbs per acre. Graminoid productivity accounted for only 13 to 42 percent of the total. These productivity figures are likely underestimates because at least two sites were sampled prior to culmination of growth.

Other Studies—Mueggler and Stewart (1980) described a *Deschampsia cespitosa/Carex* spp. c.t. for subalpine meadows of western Montana. It has high productivity but little contribution by forbs. Our DESCES/CALLEP c.t. can be interpreted as an alpine extension of the *Deschampsia* series. A more broadly defined *Deschampsia cespitosa* vegetation type (appreciable *Carex scopulorum*) has been described for the Beartooth Range of Montana and Wyoming by Johnson and Billings (1962). They state that increasing coverage of *Caltha leptosepala* indicates a transition to *C. scopulorum*-dominated bog conditions. *Deschampsia cespitosa*-dominated meadows extend southward to Colorado (Bonham and Ward 1970; Eddleman and Ward 1984; May and Webber 1982; Willard 1979), Utah (Lewis 1970), and northern New Mexico (Baker 1983), but apparently lack the mesic to hydric forbs that characterize the DESCES/CALLEP c.t. Their *D. cespitosa*-dominated types are apparently intermediate moisture status between our DESCES/POTDIV and DESCES/CALLEP c.t.'s.

Carex scopulorum/Caltha leptosepala c.t. (CARSCO/CALLEP; Holm's Rocky Mountain Sedge/Elkslip Marsh Marigold)

Environment—This c.t. was extensive in the Gravelly and Madison Mountains, sampled in the Tobacco Roots, noted in the East Pioneer, and is to be expected in the other ranges based on broad distribution of the dominant species (color plate 10). Saturated soil, often with standing water throughout the growing season, was the dominant feature. These sites span the range from wet meadow to fen and occur in shallow undrained depressions and low-gradient subirrigated positions, and are also adjacent to first-order streams or rivulets. Because of the high values for basal area (8 percent average) and abundant moss (60 percent average) and litter (30 percent average), there was seldom more than a trace amount of exposed soil and gravel or rock.

Vegetation—Only trace amounts of *Salix* spp. were present. Without exception, the graminoid component, dominated by the diagnostic species *Carex scopulorum* or *C. lenticularis*, was extremely dense (88 percent mean canopy cover), though not exceeding 8 to 12 inches in height. Other graminoids with high constancy or coverage were *C. haydenii*, *Deschampsia cespitosa*, *Juncus drummondii*, *J. mertensiana*, and *Poa alpina*. The forb component, notably lacking in diversity, was dominated by several wet-site species, most commonly *Caltha leptosepala* (35 percent mean canopy cover), *Pedicularis groenlandica*, *Polygonum bistortoides*, *Senecio cymbalarioides*, *Trollius laxus*, and *Veronica wormskjoldii*.

Soils—All parent materials were characterized as alluvium, mostly volcanic-derived. Four of the five sites had fibrous peat at least 6 inches deep. Litter depths averaged 0.7 inch; we did not discriminate duff from peat. No coarse fragments were found in any of the profiles. Soil texture ranged from clay to sandy clay-loam with a modal value of clay loam. Soil reaction for the one calcareous site (pH = 5.9) was the lowest of any calcareous site sampled; however, the soils derived from volcanic alluvium showed no trend of lower pH values (6.0 average) than other wet or moist sites. The only slightly acid values indicated minerotrophic sites having more in common with fens than bogs (as this c.t. has been termed in the literature). Mean organic matter content was 25 percent, mean total nitrogen content was 0.70 percent, and C:N ratio was 17:1. Organic matter and nitrogen content were higher than in other wetland types and were equaled only by the DRYOCT/POLVIV turf.

Productivity—Average productivity for this c.t. (2,277 lbs per acre) was higher, particularly in the graminoid component (1,720 lbs per acre), than that of any other study area c.t. However, the range (1,426 to 4,123 lbs per acre) overlaps with a number of moist or wet site types. We speculate that these values are underestimates, as sampling invariably occurred prior to phenological optima. A protected site at 10,230 ft in the Madison range had a total productivity of 4,123 lbs per acre, much higher than for comparable c.t.'s in the central Rockies (Briggs and MacMahon 1983; May and Webber 1982; Scott and Billings 1964).

Other Studies—Virtually identical alpine marsh communities and environmental parameters are described for the Beartooth (Johnson and Billings 1962), Medicine Bow Mountains (Scott and Billings 1964), and Teton Ranges (Spence and Shaw 1981) of Wyoming and Colorado Front Range (May and Webber 1982; Willard 1979). *Caltha leptosepala* is the dominant forb in many alpine marshes of Utah's Uinta Mountains, but the dominant graminoids are *Carex aquatilis* or *C. saxatilis*, rather than *C. scopulorum* (Briggs and MacMahon 1983; Lewis 1970). Hansen and others (1995) described a similar type from subalpine and alpine areas of Montana, but subalpine stands have a different forb composition. Similar communities have not been described north and west of our study area.

Salix reticulata/Caltha leptosepala c.t. (SALRET/CALLEP; Snow Willow/ Marsh Marigold)

Environment—Sampled in only the Tendoy and Gravelly Mountains, SALRET/CALLEP appears to be a minor type, environmentally and floristically related to SALARC/POLBIS. The relative paucity of this c.t. can be explained, at least in part, by lack of appropriate habitat (for example, gentle to steep north-facing slopes). Slopes with this aspect and possessing a soil mantle are not common in the predominantly north-south trending ranges of the study area. Slopes with northerly aspects did occur as spur ridges, but often they were merely boulder fields. Both stands carpeted active solifluction slopes and were sub-irrigated from late-persisting snowfields lying above. Ostensibly, these sites could be as wet as CARSCO/CALLEP, differing by lacking stagnant water and possessing both unstable substrates and possibly long-persisting snowpacks (color plate 11).

Vegetation—The prevailing aspect of this c.t. was a lush green carpet of dwarf shrubs (average canopy cover 70 percent), among which *S. reticulata* (=*S. nivalis*) was dominant, but *S. rotundifolia* (=*S. dodgeana*) and *S. arctica* also figure prominently. The graminoid component was sparse, not exceeding 20 percent canopy cover with *Carex haydenii*, *C. nova*, *C. scirpoidea*, *Deschampsia cespitosa*, *Luzula spicata*, and *Poa alpina* having at least 5 percent canopy cover in one or more stands. Averaging 21 percent canopy cover, *Caltha leptosepala* was a diagnostic species (the only forb with 100 percent constancy), and along with *Silene acaulis*, they were the only forb with more than 10 percent coverage.

Soils—Both stands were developed on limestone but were notably low in coarse fragment content (<10 percent). Litter and duff depths were less than 0.5 inch. Modal soil texture was clay. Despite the wet conditions, soil reaction was typical for calcareous substrates (7.5 pH average). Mean organic matter content was 15 percent, mean total nitrogen was 0.40 percent, and C:N ratio was 24:1.

Productivity—The wide range in productivity, 517 to 1,670 lbs per acre, despite the similarity of site parameters, is partly explained by the fact that the low-productivity site had experienced snow release just prior to sampling. The higher figure would be more typical for the c.t. The shrub fraction of total production was 56 and 78 percent.

Other Studies—Stands dominated by *Caltha leptosepala* and *Trollius laxus* with a significant contribution by *Salix arctica* and *S. reticulata* are occasionally found in alpine seepage areas in the Canadian Rockies (Achuff and Corns 1982). For the Beartooth Mountains, Johnson and Billings (1962) described small areas of soil frost disturbance dominated by *Salix arctica* or *S. reticulata* and *Trifolium parryi*. They infer these sites to be in an early stage of recolonization and described no more extensive communities with dwarf *Salix* spp. dominant. Our sites are like those of the Beartooth Range, but disturbance (solifluction and congeliturbation) has apparently occurred on a much larger scale. Willard (1979) described alpine marshes in the Colorado Rockies dominated by *Carex scopulorum* and *Caltha leptosepala* with *Salix arctica* a common species (see CARSCO/CALLEP section). In her Colorado study area, *S. reticulata* is apparently rare.

Salix planifolia/Carex scopulorum c.t. (SALPLA/CARSCO; Planeleaf Willow/ Holm's Rocky Mountain Sedge)

Environment—Only a single stand of SALPLA/CARSCO was sampled in the Tobacco Root Mountains, though numerous small examples were noted in other ranges, mostly associated with the alpine-subalpine ecotone (color plate 12). This c.t. is associated with continuously saturated soils, frequently occurring as stringers on meandering first-order streams or in snow-collecting depressions. It occurs most characteristically as part of a wetland-snowbed mosaic of *Carex scopulorum*, *Deschampsia/Caltha leptosepala*, and *Carex nigricans* c.t.'s with SALPLA/CARSCO, by its microenvironmental setting, ostensibly being the wettest of these types. The sampled stand had a deep (>30 cm) peat layer, and reconnaissance indicated peat accumulation is a common condition.

Vegetation—*Salix planifolia* (var. *monica*) occurred in dense patches with a canopy cover of 70 percent; no other shrubs occurred in the sampled stand. Herbaceous cover was at least as great as that of the *S. planifolia* with *Carex scopulorum*, *Deschampsia cespitosa*, and *Trollius laxus* about equally represented at 20 percent canopy cover. Other typical wetland forbs present were *Senecio cymbalarioides*, *Veronica wormskjoldii*, and *Epilobium alpinum*. Mosses formed a nearly continuous layer.

Soils—Parent material for the single sampled stand was gneiss-derived alluvium in which there were no coarse fragments. With the high moss and litter cover there was no exposed bare ground. The pH was 6.3. Cold, saturated substrates were associated with the accumulation of peat as exemplified by this stand.

Productivity—Total productivity was 2,373 lbs per acre: 860, 178, and 1,335 lbs per acre, for graminoids, forbs, and shrubs, respectively.

Other Studies—Johnson and Billings (1962) briefly described a "Salix thicket" vegetation type similar in landscape position and vegetation to SALPLA/CARSCO, wherein *S. planifolia* is the dominant shrub, and the undergrowth is typical of associated "bogs" or subalpine zone vegetation. Potkin and Munn [n.d.] name but do not describe a SALSCO/CARSCO type found exclusively in alpine zone wet sites of the Wyoming's Wind River Range. This type apparently extends as far south as the Front Range of Colorado where it is described for the Indian Peaks vicinity (Komarkova 1976) and the Arapaho and Roosevelt National Forests (Hess 1981).

Ordinations and Environmental Gradients

Beta diversity of the data set was high because a broad diversity of environments, parent materials, and mountain ranges was represented. We reduced the unacceptably high beta diversity by compartmentalizing the data set into dry and moist portions prior to DECORANA runs (Gauch 1982). Assignment of plots to dry and moist groups was based on analysis of abiotic variables and precedents set by previous alpine vegetation studies. Grassland, turf, cushion plant, and slope communities formed the dry portion, and snowbed and wetland communities formed the wet portion.

Wet Sites

The best separation of types in ordination space was obtained with Axes 1 and 3 (fig. 3). There was a moderate degree of correspondence between Axis 1 and site moisture. *Carex scopulorum*-dominated sites, subjectively assessed as the wettest, clustered at the left end (fig. 3). Immediately adjacent to *C. scopulorum* sites on Axis 1 were *Deschampsia cespitosa*- and *Caltha leptosepala*-dominated sites. These positions corresponded well with their respective places on moisture gradients in the field. Snowbed communities ordinated to the right of these wetland types. CARNIG, the wettest snowbed type, was closest to the wet end of Axis 1, while the three drier types dominated by *Juncus* spp. and *Antennaria lanata* ordinated at the dry end of Axis 1.

We were unable to determine a correspondence between Axis 2 and any known environmental gradient. The distinctive composition of *Juncus parryi*- and *Erigeron ursinus*-dominated plots (assessed as snowbed sites) set them apart on Axis 2 and compressed the

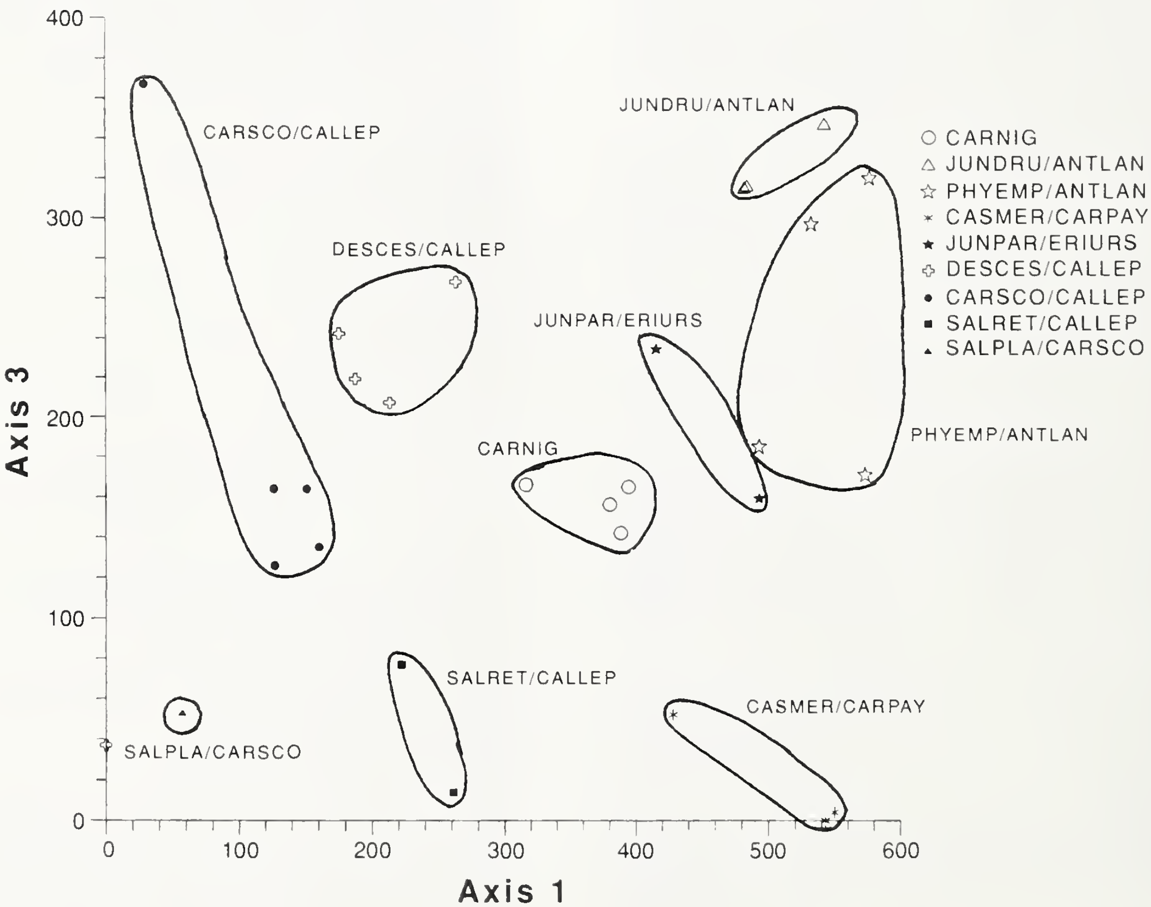


Figure 3—Detrended correspondence analysis ordination of wet-site alpine communities. Axis scales are in units of average standard deviations of species turnover x 100. Community abbreviations are defined in the text.

remaining variability. The merely wet sites are clustered near the center of Axis 2, whereas the snowbed sites (with exception of JUNPAR/ERIURS c.t.) are clustered near the axis origin. The various snowbed c.t.'s did not segregate on Axis 2. The ordination did not even recover the fact that *Carex nigricans*-dominated snowbed sites clearly were the last to become snow-free, though they were positioned as the wettest of snowbed sites on Axis 1. There was a tendency for communities dominated by shrubs to have lower values on Axis 3, but otherwise this axis does not seem to correspond to known environmental gradients.

Dry Sites

The best separation of types was obtained using Axis 1 and Axis 3. Axis 1 roughly corresponds to a gradient of wind-exposure and soil depth, with shallow stony soils of exposed sites on the left end and deep soils with less exposure on the right (fig. 4). Axis 3 appears to correspond to a moisture gradient. Dry grassland communities occur near the bottom, while moister turf communities are found near the top (fig. 4). Moist dwarf shrub-dominated types occur in the upper left corner, while grassland communities are found in the lower right (fig. 4). Cushion plant and turf communities are found in the center of the ordination space, and there is a considerable amount of overlap among them. Plots of slope communities are scattered throughout much of the ordination space rather than clustering together or with any other types. This result is expected because these "communities" are only assemblages of species on disturbed sites drawn from adjacent vegetation types. Axis 2 did not appear to correspond to any known environmental gradient.

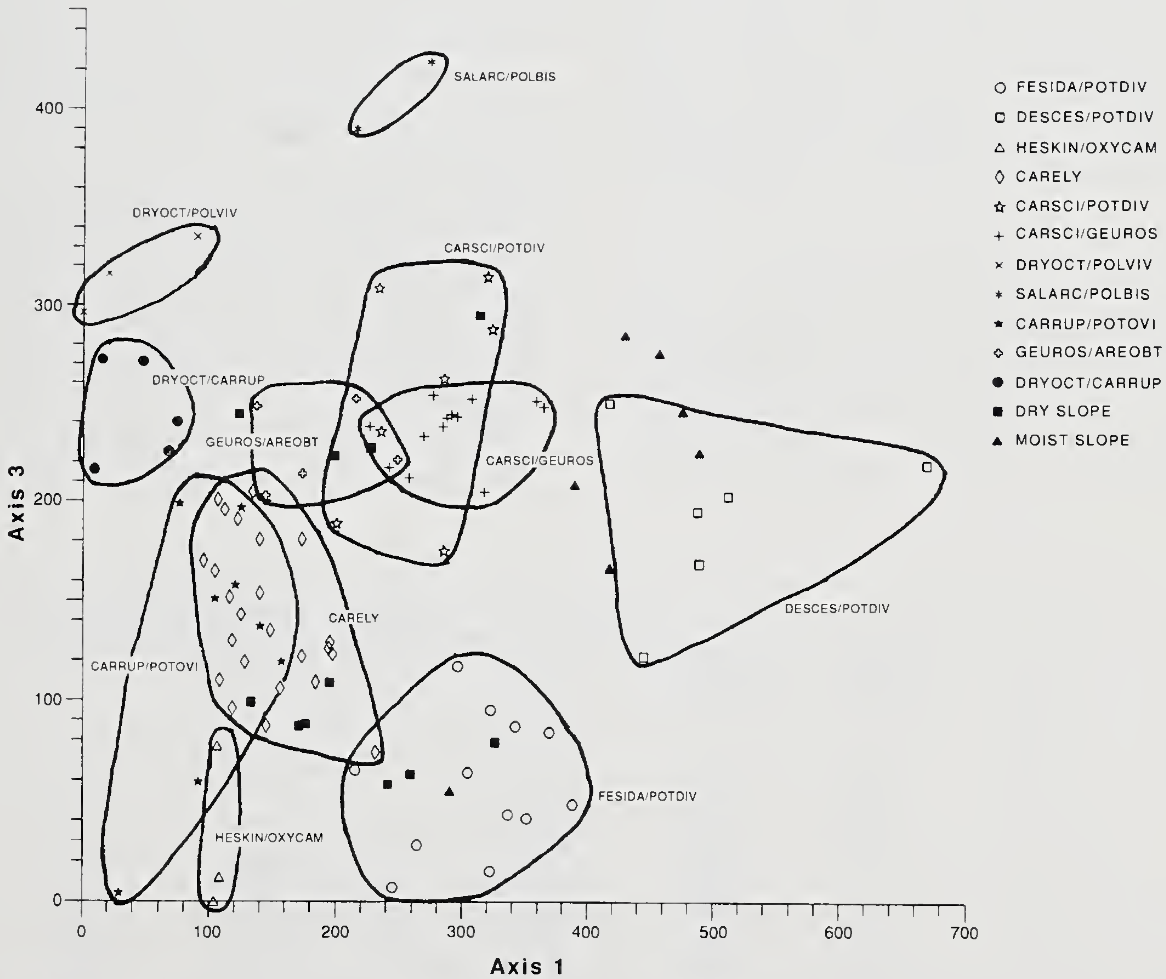


Figure 4—Detrended correspondence analysis ordination of dry-site alpine communities. Axis scales are in units of average standard deviations of species turnover x 100. Community abbreviations are defined in the text. DRY SLOPE and MOIST SLOPE community types are not encircled due to extreme spread in points plotted.

The results of the DECORANA analysis suggest that moisture and soil depths are important environmental factors determining vegetation of the drier communities. These two variables are often correlated when the entire range of environments is considered because wind exposure results in soil deflation as well as removal of snow. When only dry sites are considered, this covariation becomes less pronounced. In general, moist sites with stony soil support dwarf willow or mountain avens communities; moist sites with deep soil support sedge-dominated turf; dry sites with deep soil support grasslands; and dry stony sites are dominated by cushion plants. For wetland and snowbed sites, moisture and timing of snow release are the overriding important environmental gradient because these sites are not wind-exposed, and soils are generally deep. Wind exposure, moisture, and timing of snow release have generally been considered the most important environmental factors determining vegetation above treeline (Billings 1988; Bliss 1963; Eddleman and Ward 1984; Isard 1986; Johnson and Billings 1962; Willard 1979). May and Webber (1982) also identified disturbance as an important environmental gradient in the Colorado alpine. Our slope communities are structured by disturbance, and the commonness of these communities suggests that disturbance is also important in our study area.

Soils

There was a strong positive correlation among proportion of clay, organic matter, nitrogen, carbon, and litter (litter + duff) depths, and a strong negative correlation between these factors and the proportion of sand (table 2). A principal components analysis of these soil factors generated two axes that explained 71 percent of the variation. The first axis accounted for 53 percent of the variation, and the major components of the axis were proportions of sand, clay, organic matter, nitrogen, carbon, and litter depths (table 2). Net mineralization of soil organic matter and decomposition of plant material is more rapid in sandy soils than in clay soils (Verberne and others 1990). Lower mineralization in clay soils is caused by a greater physical protection of soil organic matter, which may explain the positive correlations between clay, organic matter, and total nitrogen. In a study of grassland soil texture in the Netherlands, Hassink (1992) found that sandy soils had organic matter contents of 3 to 8 percent, while clay soils ranged from 9 to 10.5 percent. Total nitrogen followed these same trends with 0.11 to 0.30 percent in sandy soils but 0.51 to 0.66 percent in clay soils.

Total nitrogen content of these alpine soils is similar to *Picea mariana-Salix* spp.-*Equisetum* spp. plant associations found on poorly drained sites in Alberta, Canada (total N = 0.64 percent) (Kojima 1982). In the Sierra Nevada Range at 5,300 to 6,500 ft, total nitrogen content of the mineral soil was 1.1 percent and carbon was 23.4 percent (Schlesinger and others 1989). Higher total nitrogen at these sites reflects a higher net production and input to soil organic pools under forest vegetation.

There was also a strong positive correlation between pH and the amount of coarse fragments (table 2). The second principal components axis accounted for 18 percent of the variation and was dominated by these two variables (table 2). This correlation probably reflects the fact that moist sites generally have lower pH and little or no coarse fragments in the surface horizons.

Soil pH for both dry and wet sites are much higher than those reported for mineral soil in alpine and

Table 2—Values of Pearson correlation coefficient for soil characteristics:[a] correlations in which the two variables explain >15 percent of their variation are in bold. Results of principal components analysis of soil characteristics.

	Sand	Clay	OM	N	pH	CF	Lit	C
Sand	1.00							
Clay	**–0.92**	1.00						
OM	**–0.55**	**0.59**	1.00					
N	**–0.47**	**0.57**	**0.93**	1.00				
pH	–0.10	0.10	–0.15	–0.03	1.00			
CF	0.32	–0.26	**–0.43**	–0.31	**0.42**	1.00		
Lit	**–0.39**	0.37	**0.57**	**0.54**	–0.16	**–0.46**	1.00	
C	**–0.41**	**0.51**	**0.82**	**0.84**	**0.63**	–0.22	**0.42**	1.00
Factor 1	–0.75	0.79	0.93	0.89	–0.09	–0.51	0.68	0.81
(53 percent of variance explained)								
Factor 2	–0.29	0.33	–0.06	0.05	0.86	0.63	–0.29	0.16
(18 percent of variance explained)								

[a]Sand = percent sand; Clay = percent clay; OM = percent organic matter; N = percent of total nitrogen; pH = hydrogen ion concentration; CF = percent coarse fragments; Lit = depth of litter (litter + duff); C = percent carbon.

subalpine zones in Alberta (Kojima 1982), likely due to the greater leaching caused by the much higher precipitation occurring in the Canadian Rocky Mountains. Moist, low-elevation *Abies grandis* forests of northern Idaho have a mineral soil pH between 5.4 and 6.0 (Page-Dumroese and others 1989), similar to high-elevation *Pinus contorta* stands in Alberta (Florence and Dancik 1988). Lower pH values of forests are the result of greater inputs of organic matter and faster decomposition rates.

Soils supporting turf and cushion plant communities differed in a number of characteristics when derived from calcareous compared to crystalline parent materials (table 3). Calcareous soils had a mean pH of 7.5, while those developed from crystalline materials had a pH of 6.2. The proportion of sand was higher in soils derived from crystalline rock, while calcareous soils were higher in clay, carbon, and nitrogen.

Many common alpine plant associations were restricted to soils derived from either calcareous or crystalline parent materials. *Carex scirpoidea/Geum rossii* turf and *Geum rossii/Arenaria obtusiloba* cushion plant communities occurred only in areas dominated by crystalline geology, while all but one example of *Carex rupestris/Potentilla ovina* cushion plant association occurred on limestone. Although *Hesperochloa kingii* is a common grass found farther south in the Rocky Mountains, in southwestern Montana high-elevation grasslands dominated by this species, occur only on calcareous soils. The *Juncus drummondii/Antennaria lanata*, *Phyllodoce empetriformis/Antennaria lanata,* and *Cassiope mertensiana/Carex paysonis* snowbed associations were found only on soils derived from crystalline parent material. These same patterns have been observed in east-central Idaho (Henderson, personal communication).

Management Considerations

Alpine environments are among the most severe on earth. Low temperatures, nearly constant high winds, and high insolation are among the factors that shape the alpine environment and limit plant growth (Billings 1988; Bliss 1985; Brown and others 1978). The alpine growing season is short, often only 8 to 12 weeks. Temperatures during the growing season are cool, and frost can occur on any night. As a result, plants are limited in the amount of photosynthate they can store. Furthermore, the frequent freeze-thaw cycles make frost-churning a common phenomenon, especially in moist sites. Frost-churning and needle ice damage vegetation and limit recruitment. High windspeeds can damage plants through desiccation. Wind-driven soil and ice particles can destroy plant tissue, especially when young. Wind redistributes snow cover. Ridgetops and upper windward slopes are dry and exposed to severe winter temperatures, while lee slopes and depressions are cold and wet with a reduced growing season. Wind diminishes the formation of a boundary layer around plant parts, further exacerbating low summer temperatures. Solar radiation at high elevations is intense. Intense radiation coupled with high winds promote summer drought and high levels of evaporation. High levels of ultraviolet radiation can damage plant tissues.

The harsh environmental conditions above treeline make growth and the accumulation of biomass a slow process. Furthermore, soil formation takes much longer at high elevations because of the retarded pace of biological processes. As a result, recovery from disturbance is generally slow (Billings 1973; Willard and Marr 1971).

Table 3—Mean soil characteristics (±SE) for turf and cushion plant communities:[a] Characteristics in bold are significantly different ($P \leq 0.05$) by *t*-test.

	Calcareous	Crystalline	Number of observations	*t*-test value	Probability
Sand	**57.41** (1.98)	**64.47** (2.61)	31,29	2.17	0.034
Silt	5.78 (0.64)	4.96 (0.52)	31,29	1.00	0.324
Clay	**36.81** (1.96)	**30.57** (2.42)	31,29	2.01	0.049
OM	15.74 (1.39)	14.16 (0.99)	32,30	0.91	0.365
C	**10.23** (0.63)	**7.65** (0.59)	32,30	2.97	0.004
N	**0.57** (0.06)	**0.42** (0.04)	32,30	2.00	0.050
pH	**7.48** (0.06)	**6.21** (0.08)	34,31	13.2	<0.001
CF	33.2 (3.5)	29.0 (3.2)	34,31	0.89	0.379
Litter	0.56 (0.08)	0.54 (0.08)	34,31	0.20	0.839
C:N	26.46 (6.09)	33.78 (7.77)	31,30	0.30	0.765

[a]Sand = percent sand; Silt = percent silt; Clay = percent clay; OM = percent organic matter; C = percent carbon; N = percent of total nitrogen; pH = hydrogen ion concentration; CF = percent coarse fragments; Litter = depth of litter (litter + duff); C:N = carbon to nitrogen ratio.

Alpine tundra ecosystems evolved almost completely without the disruptive effects of humans. Only in the past 150 years have these systems been exposed to such large-scale disturbances as livestock grazing, mining, and road-building. Unfortunately, few controlled studies have been done on the effects of these encroachments in alpine landscapes.

Livestock Grazing

Grazing has two primary effects on plant communities—removal of plant biomass and trampling. By selecting certain plants over others, grazers alter the competitive balance among species and eventually alter the composition of communities. Although both sheep and cattle graze above treeline in our study area, in most areas of the Rocky Mountains sheep are the principle domestic animal in the alpine zone (Johnson 1962; Thilenius 1975). Consequently, most observations relating to the effects of livestock on alpine ranges refer to sheep. In general, cushion plants such as *Arenaria obtusiloba* and *Silene acaulis*, and low sedges such as *Carex rupestris* and *C. elynoides* tend to increase with grazing pressure; but robust graminoids such as *Deschampsia cespitosa* and *Poa glauca*, and forbs such as *Agoseris* spp. and *Potentilla diversifolia* tend to decrease (Johnson 1962; Lewis 1970). At low elevations, grazing tends to have the same effect as drought, decreasing mesic site indicators and increasing xeric site species (Weaver 1954). The same appears to be true in the alpine. Henderson (personal communication) reported that toxic forb species (for example, *Lupinus argenteus*, *Oxytropis campestris*) appear to have increased in turf communities that are subject to long-term sheep grazing. Unfortunately, there have been no controlled quantitative studies to verify the scarce anecdotal evidence available.

Sheep grazing was common on the gentle alpine terrain of the Gravelly Range. We commonly observed cattle or evidence of cattle above treeline in the Snowcrest, Beaverhead, and Pioneer ranges. We were surprised to find evidence of heavy livestock use near 11,000 ft in the Beaverhead Mountains.

There were no exclosures above treeline in our study area, so we have little knowledge of the effects of livestock grazing on plant species composition. Cushion plants were more common in some turf communities than others, but these differences could be due to soils or moisture regime rather than overgrazing. *Poa pratensis*, an introduced grass considered an indicator of present or past disturbance, occurred in some grassland, turf, and wetland stands, mainly in ranges that had been subject to long-term livestock grazing (for example, Gravelly and Snowcrest ranges) and in moist or wet community types. *Juncus balticus* was codominant with *Deschampsia cespitosa* in one wetland site in the Snowcrest Mountains. *Juncus balticus* is native but is thought to increase under grazing pressure in wet meadows (Hansen and others 1995). These observations suggest that the moist and wet sites are most susceptible to alteration of species composition from grazing.

In drier portions of our study area, such as the Beaverhead and Snowcrest Mountains, surface water is uncommon above treeline. As a result, cattle use tends to be concentrated in areas near water. We observed the effects of livestock trampling mainly in wetland communities. Streams where use had been heavy had increased turbidity, and banks had been compacted and eroded.

Trampling can destroy plants and result in the loss of soil. Plant communities occupying wet habitats are more easily damaged than mesic communities (Willard and Marr 1970), and continued disturbance often results in significant erosion (Billings 1973). Plants in wet sites are more succulent and susceptible to being broken, and the soil is more prone to compaction (Willard and Marr 1970). Turf communities are not as easily disturbed; but repeated trampling will result in the loss of soil, and recovery may take hundreds of years (Willard and Marr 1971). Wind erosion and frost action enlarge areas that have been denuded by trampling (Willard and Marr 1971). In general, wet communities are more susceptible to adverse effects of trampling, but drier areas will take longer to recover once damage has occurred.

Thilenius (1975, 1979) has written guidelines for livestock grazing in the alpine zone; the following synopsis is taken from his report. Cattle tend to aggregate in lower portions of cirque basins where water and lush vegetation are concentrated. These sites suffer damage under untended cattle grazing. Wet sites (including snowbed communities), dry sites, and steep slopes (40°+) should not be grazed. Livestock should not be allowed to remain in any area for very long. Thus, intensive range-riding or herding is needed for nondestructive use of alpine ranges by livestock. Grazing and trampling by horses used for recreation can also cause damage when use is concentrated.

Vehicle Use

There are fewer roads above treeline in Montana than in other Rocky Mountain States. Nonetheless, vehicle use, including motorcycles and all-terrain vehicles, was apparent in the alpine zone of the Beaverhead, Snowcrest, Gravelly, Pioneer, and Tobacco Root ranges. Road construction and vehicle use are among the most damaging activities in alpine environments (Brown and others 1978; Thilenius 1975). Repeated vehicle use destroys plants and causes soil erosion and compaction. Damage is generally proportional to (1) wetness of the site, (2) frequency of use, and (3) weight of the vehicles (Thilenius 1975).

Four-wheel drive vehicles are banned from the alpine zone in some states (Thilenius 1975).

At the north end of the Pioneer Range, some areas have soils derived from highly metamorphosed limestone that are relatively barren and easily erodible. These areas are also the sites of mining activity, and roads have been built to the mines, providing access to fragile alpine landscapes for four-wheel drive and all-terrain vehicles. Some of these roads remain open, while others have been closed. However, we observed a three-wheel all-terrain vehicle driving on a steep, barren, eroding trail behind a locked gate. We also observed unauthorized all-terrain vehicles in the Italian Peaks area of the Beaverhead Mountains, an area closed to all motor vehicles. Use of vehicles for recreation in the alpine zone is causing damage that will take tens or perhaps hundreds of years to recover (Willard and Marr 1971).

Mining

Mines damage alpine communities, causing destruction of vegetation, soil erosion, and water pollution (Brown and others 1978; Thilenius 1975). Evidence of mining activity is common in the Pioneer and Tobacco Root Mountains. Mine shafts, building sites, tailings heaps, dumps, and roads scar the landscape in many areas. In most cases, activity ceased decades ago; nonetheless, the damage is still apparent and revegetation negligible at the majority of these sites.

Geographic Affinities of Alpine Plant Communities

With the possible exception of JUNPAR/ERIURS, none of the plant communities we described are endemic to our study area. Rather, the mountain ranges of southwestern Montana appear to be a meeting ground for associations that are best developed in the mountains to the south, west, and northwest. Many of these plant associations are apparently at the edge of their range in southwestern Montana and east-central Idaho. The unique geographical position of these ranges and the presence of calcareous and crystalline parent materials result in the great diversity of plant communities.

Alpine grasslands dominated by *Hesperochloa kingii* (HESKIN/OXYCAM) have been reported in the Rocky Mountains only from east-central Idaho and northwestern Utah (Brunsfeld 1981; Caicco 1983; Moseley 1985; Preece 1950; Ream 1964; Urbanczyk and Henderson 1994). Alpine associations dominated by *F. idahoensis* (FESIDA/POTDIV) are common only in Idaho and southwestern Montana. These communities may be considered forms of high-elevation grasslands that persist in the alpine zone on well-developed soils derived from calcareous sedimentary parent materials.

Moist turf communities in our study area show affinities with both the Southern Rockies and east-central Idaho. *Carex scirpoidea* and *Geum rossii* are common associates in the Southern Rocky Mountains and in the eastern portion of our study area (CARSCI/GEUROS). In the warmer and drier western ranges of our area and adjacent Idaho, *G. rossii* is replaced by *Potentilla diversifolia* (CARSCI/POTDIV).

Plant associations dominated by *Carex elynoides*, *Deschampsia cespitosa*, *Geum rossii*, and *Carex scopulorum* occur in the Rocky Mountains from southern Montana south at least to Colorado (Johnson and Billings 1962; Komarkova and Webber 1978; Lewis 1970; Willard 1979). All of these community types in our study area with the exception of CARELY turf (for example, DESCES/POTDIV, CARSCI/GEUROS, GEUROS/AREOBT, DESCES/CALLEP, CARSCO/CALLEP, SALPLA/CARSCO) are most common on or confined to soils derived from crystalline parent materials, which predominate in the Southern Rocky Mountains. All of the vegetation studies from this area have been done in ranges formed by intrusives, therefore, it is not possible to determine if the range of these communities is determined climatically or edaphically or both.

Communities similar to the JUNDRU/ANTLAN c.t. are found throughout much of the Rocky Mountains and the Cascade Range. All of the other common snowbed communities found in our study area (CARNIG, PHYEMP/ANTLAN, CASMER/CARPAY) are best developed or confined to the wetter mountains to the north and west (Achuff and Corns 1982; Douglas 1972; Douglas and Bliss 1977; Hrapko and LaRoi 1978). Rottman and Hartman (1985) reported an association dominated by *Carex nigricans* from the San Juan Mountains, one of the more mesic ranges in Colorado. Otherwise, this snowbed association has not been reported from the Southern Rockies. In our study area, these communities were found only in the wetter ranges. Clearly, these mesic to hydric snowbed associations are dependent on reliable, late-persisting snow cover found principally in the Cascades, the Northern Rockies, and the Canadian Rockies.

Dryas spp. are a common, often dominant, component of alpine vegetation throughout the Western Cordillera. In the Canadian Rockies and the Cascade Range, *D. octopetala* generally forms communities with wet- or mesic-site indicators such as *Salix reticulata*, *Polygonum viviparum*, and *Lupinus lepidus* (Achuff and Corns 1982; Douglas and Bliss 1977). In the Southern Rockies, *D. octopetala* occurs in more xeric communities with *Carex rupestris* and cushion plants such as *Silene acaulis*, *Trifolium nanum*, and *Arenaria obtusiloba* (Willard 1979). Our study area occupies an intermediate position in this continuum, and both xeric and mesic *Dryas* associations were present. DRYOCT/POLVIV was found on moist terraces and mesic slopes, while DRYOCT/CARRUP occurred in shallower soils of exposed ridges and upper slopes.

Carex rupestris is a common component of fellfields and dry turf throughout much of the Rocky Mountains. The common *D. octopetala*/*C. rupestris* type has already been mentioned. In the Southern Rockies, *C. rupestris* also commonly occurs with *Geum rossii* on soils derived from crystalline parent material. On calcareous soils in our study area and adjacent Idaho, a similar community occurs (CARRUP/POTOVI), but *Potentilla ovina* replaces *G. rossii*.

This geographic analysis indicates that the suite of plant communities found above treeline in southwestern Montana has been formed by an interplay of geography, climate, soil parent material, and floristic sources. Plant associations gradually change character over the length of the Western Cordillera as individual species wax and wane in importance. In general, communities adapted to cool, wet climates, and calcareous soils predominate in the Canadian Rockies and northern Montana. Communities adapted to more xeric, less snowy environments are common in the Central and Southern Rocky Mountains. Our study area in southwestern Montana occurs in the tension zone between these two distinct phytogeographic zones.

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Appendix A—Vascular Plant Species Encountered in Macroplots During the Course of the Study in 1989 and 1991

This list is arranged alphabetically by and within plant families. Nomenclature generally follows Hitchcock and Cronquist (1973). Nomenclature for *Salix* follows Dorn (1984), and *Poa* nomenclature follows Arnow (1987).

Apiaceae

Angelica roseana
Bupleurum americanum
Cymopterus bipinnatus
Lesquerella pulchella
Ligusticum tenuifolium
Lomatium cous
Lomatium cusickii

Asteraceae

Achillea millefolium
Agoseris glauca
Antennaria alpina
Antennaria anaphaloides
Antennaria aromatica
Antennaria corymbosa
Antennaria lanata
Antennaria microphylla
Antennaria umbrinella
Arnica alpina
Arnica diversifolia
Arnica fulgens
Arnica latifolia
Arnica longifolia
Arnica mollis
Arnica rydbergii
Artemisia dracunculus
Artemisia frigida
Artemisia tridentata
Artemisia scopulorum
Aster alpigenus
Aster foliaceus
Aster integrifolius
Chaenactis alpina
Chrysothamnus viscidiflorus
Cirsium scariosum
Erigeron asperugineus
Erigeron caespitosus
Erigeron compositus
Erigeron humilis
Erigeron leiomerus
Erigeron peregrinus
Erigeron radicatus
Erigeron rydbergii
Erigeron simplex
Erigeron tweedyi
Erigeron ursinus
Haplopappus acaulis
Haplopappus lanuginosus
Haplopappus lyallii
Haplopappus suffruticosus
Haplopappus uniflorus
Hieracium gracile
Hymenoxys acaulis
Hymenoxys grandiflora
Microseris nigricans
Saussurea weberi
Senecio canus
Senecio crassulus
Senecio cymbalarioides
Senecio fremontii
Senecio hydrophyllus
Senecio streptanthifolius
Senecio triangularis
Solidago multiradiata
Taraxacum ceratophorum
Taraxacum lyratum
Taraxacum officinale
Townsendia condensata
Townsendia montana
Townsendia parryi

Boraginaceae

Cryptantha sp.
Eritrichium nanum
Mertensia alpina
Mertensia ciliata
Mertensia oblongifolia
Mertensia perplexa
Myosotis sylvatica

Brassicaceae

Arabis drummondii
Arabis lemmonii
Arabis lyallii
Arabis nuttallii
Braya humilis
Draba apiculata
Draba crassifolia
Draba incerta
Draba lanceolata
Draba lonchocarpa
Draba nemorosa
Draba oligosperma
Draba ventosa
Draba sp.
Lesquerella alpina
Lesquerella sp.
Physaria saximontana
Smelowskia calycina
Thlaspi parviflorum

(con.)

Appendix A (Con.)

Campanulaceae

Campanula rotundifolia
Campanula scabrella
Campanula uniflora

Caryophyllaceae

Arenaria capillaris
Arenaria congesta
Arenaria nuttallii
Arenaria obtusiloba
Arenaria rossii
Arenaria rubella
Cerastium arvense
Cerastium beeringianum
Lychnis apetala
Silene acaulis
Silene parryi
Silene repens
Stellaria calycantha
Stellaria longipes
Stellaria umbellata

Crassulaceae

Sedum lanceolatum
Sedum rosea

Cyperaceae

Carex albonigra
Carex atrata
Carex elynoides
Carex haydenii
Carex illota
Carex lenticularis
Carex leporinella
Carex microptera
Carex nardina
Carex nigracans
Carex nova
Carex obtusata
Carex pachystachya
Carex paysonis
Carex petasata
Carex phaeocephala
Carex pyrenaica
Carex rossii
Carex rupestris
Carex scirpoidea
Carex scopulorum

Ericaceae

Cassiope mertensiana
Phyllodoce empetriformis
Phyllodoce glanduliflora
Phyllodoce intermedia
Vaccinium scoparium

Fabaceae

Astragalus aboriginum
Astragalus adsurgens
Astragalus alpinus
Astragalus bourgovii
Astragalus kentrophyta
Astragalus miser
Hedysarum sulphurescens
Lupinus argenteus
Lupinus lepidus
Oxytropis campestris
Oxytropis deflexa
Oxytropis viscida
Trifolium haydenii
Trifolium longipes
Trifolium nanum
Trifolium parryi

Gentiaceae

Frasera speciosa
Gentiana affinis
Gentiana algida
Gentiana amarella
Gentiana calycosa
Gentiana prostrata

Grossulariaceae

Ribes hendersonii
Ribes lacustre

Hydrophyllaceae

Phacelia hastata
Phacelia sericea

Hypericaceae

Hypericum formosum

Juncaceae

Juncus balticus
Juncus drummondii
Juncus mertensianus
Juncus parryi
Luzula campestris
Luzula hitchcockii
Luzula spicata

Liliaceae

Allium brevistylum
Allium cernuum
Allium schoenoprasum
Erythronium grandiflorum
Lloydia serotina
Zigadenus elegans

Linaceae

Linum perenne

(con.)

Appendix A (Con.)

Onagraceae

Epilobium alpinum
Epilobium latifolium

Pinaceae

Abies lasiocarpa
Larix lyallii
Picea engelmannii
Pinus albicaulis

Plantaginaceae

Plantago tweedyi

Poaceae

Agropyron caninum
Agropyron scribneri
Agropyron spicatum
Agrostis humilis
Agrostis variabilis
Alopecurus alpinus
Bromus pumpellianus
Calamagrostis purpurascens
Deschampsia cespitosa
Danthonia intermedia
Festuca idahoensis
Festuca ovina
Hepserocloa kingii
Koeleria macrantha
Phleum alpinum
Poa alpina
Poa arctica
Poa fendleriana
Poa glauca
Poa leptocoma
Poa nervosa
Poa pratensis
Poa reflexa
Poa secunda
Stipa occidentalis
Trisetum spicatum

Polemoniaceae

Collomia debilis
Gilia spicata
Phlox hoodii
Phlox multiflora
Phlox pulvinata
Polemonium viscosum

Polygonaceae

Eriogonum flavum
Eriogonum ovalifolium
Eriogonum umbellatum
Oxyria digyna
Polygonum bistortoides
Polygonum viviparum
Polygonum watsonii
Rumex pauciflorus

Portulacaceae

Claytonia lanceolata
Lewisia pygmaea
Montia chamissoi

Primulaceae

Androsaceae filiformis
Androsaceae septentrionalis
Dodecatheon pulchellum
Douglasia montana

Ranunculaceae

Anemone drummondii
Anemone multifida
Anemone parviflora
Caltha leptosepala
Delphinium occidentale
Ranunculus eschscholtzii
Ranunculus pygmaeus
Thalictrum sp.
Trollius laxus

Rosaceae

Dryas octopetala
Geum rossii
Geum triflorum
Ivesia gordonii
Potentilla breviflora
Potentilla concinna
Potentilla diversifolia
Potentilla fruticosa
Potentilla glandulosa
Potentilla hippiana
Potentilla nivea
Potentilla ovina
Potentilla quinquefolia
Sibbaldia procumbens

Salicaceae

Salix arctica
Salix brachycarpa
Salix glauca
Salix planifolia
Salix reticulata
Salix rotundifolia

Saxifragaceae

Heuchera cylindrica
Heuchera parvifolia
Lithophragma bulbifera
Saxifraga adsurgens
Saxifraga arguta
Saxifraga bronchialis
Saxifraga caespitosa
Saxifraga flagellaris
Saxifraga occidentalis

(con.)

Appendix A (Con.)

Saxifragaceae
Saxifraga oppositifolia
Saxifraga oregana
Saxifraga rhomboidea
Saxifraga tempestiva

Selaginellaceae
Selaginella densa
Selaginella watsonii

Scrophulariaceae
Besseya wyomingensis
Castilleja crista-galli
Castilleja cusickii
Castilleja miniata
Castilleja nivea
Castilleja pallescens
Castilleja pulchella
Castilleja rhexifolia

Scrophulariaceae
Chionophila tweedyi
Pedicularis contorta
Pedicularis cystopteridifolia

Scrophulariaceae
Pedicularis groenlandica
Pedicularis parryi
Penstemon attenuatus
Penstemon montanus
Penstemon procerus
Synthyris pinnatifida
Veronica cusickii
Veronica wormskjoldii

Valerianaceae
Valeriana edulis

Violaceae
Viola adunca
Viola nuttallii

Appendix B—Mean Site Variables (±SD) for 23 Plant Community Types in the Study Area

COMMUNITY TYPE NAMES

Site Variables	FESIDA/POTDIV N = 12	DESCES/POTDIV N = 6	HESKIN/OXYCAM N = 3	CARELY N = 24	CARSCI/POTDIV N = 7	CARSCI/GEUROS N = 13	DRYOCT/POLVIV N = 3
Elevation (ft MSL)	9640.8(161.7)	9666.7(329.8)	9650.0(183.8)	9839.0(256.2)	9785.7(363.3)	9880.0(224.0)	9560.0(330.4)
Aspect (azimuths)	180.4(129.6)	257.5(132.0)	163.3(97.5)	162.7(101.4)	126.4(103.3)	212.7(107.2)	233.3(197.9)
Slope (%)	35.5(21.6)	20.2(21.1)	42.0(13.2)	24.0(16.9)	19.6(12.9)	28.2(15.5)	29.3(18.4)
Bare ground cover (	6.5(8.2)	5.7(7.9)	7.7(4.0)	4.7(5.7)	2.4(3.5)	3.8(3.6)	2.3(1.2)
Gravel ground cover	4.4(11.2)	.5(.5)	13.3(5.8)	8.3(10.5)	1.3(.8)	10.8(12.7)	13.7(14.8)
Rock ground cover (	1.9(2.7)	.3(.5)	8.7(9.8)	10.0(17.6)	1.4(1.1)	21.2(18.5)	1.0(.0)
Litter ground cover	63.6(31.5)	58.3(34.3)	56.7(23.1)	53.8(28.2)	62.9(26.3)	50.0(23.5)	43.3(40.4)
Bryophyte ground co	15.3(25.1)	27.0(37.5)	.3(.6)	8.7(14.5)	26.1(25.9)	1.5(2.9)	40.0(36.1)
Basal veg cover (%)	7.1(3.6)	6.5(3.8)	5.3(4.0)	6.2(6.0)	8.0(3.4)	9.9(5.4)	5.3(4.0)
Water cover (%)	2.5(8.7)	.2(.4)	.0(.0)	3.4(9.2)	.0(.0)	3.2(5.8)	.3(.6)
pH	7.2(0.3)	6.6(0.4)	7.4(0.1)	7.2(0.5)	6.4(0.8)	6.0(0.3)	7.1(0.8)
Coarse fragment (%)	20(18)	6(7)	51(16)	33(16)	9(11)	19(9)	30(19)
	N=11	N=5	N=3	N=22	N=6	N=13	N=3
Sand (%)	49.8(8.1)	48.7(17.7)	59.6(2.7)	56.4(13.4)	50.8(9.6)	71.3(8.5)	51.9(5.1)
Silt (%)	10.5(8.4)	11.8(4.5)	6.8(4.9)	6.0(3.0)	4.0(1.9)	4.0(2.5)	6.3(3.2)
Clay (%)	39.7(10.2)	39.5(17.0)	33.6(4.9)	37.6(12.7)	45.2(10.9)	24.7(8.0)	41.8(5.3)
Organic matter (%)	19.1(6.0)	18.4(3.1)	10.7(4.0)	16.0(5.5)	19.9(4.0)	14.4(4.4)	25.1(15.0)
Total carbon (%)	9.1(3.0)	9.0(1.5)	7.3(0.8)	8.4(3.4)	9.8(2.7)	8.0(2.6)	13.6(7.3)
Total nitrogen (%)	0.66(0.27)	0.65(0.13)	0.35(0.23)	0.57(0.30)	0.73(0.25)	0.45(0.21)	0.75(0.59)

COMMUNITY TYPE NAMES

Site Variables	SALARC/POLBIS N = 2	CARRUP/POTOVI N = 8	GEUROS/AREOBT N = 5	DRYOCT/CARRUP N = 5	DRY SLOPE N = 11	MOIST SLOPE N = 7	CARNIG N = 4
Elevation (ft MSL)	9540.0(254.6)	9875.0(309.0)	******(225.0)	9504.0(181.9)	9824.5(326.0)	9740.0(193.1)	9585.0(280.0)
Aspect (azimuths)	205.0(198.0)	128.8(75.7)	197.0(105.9)	127.0(95.0)	179.1(83.2)	164.3(108.2)	228.8(122.9)
Slope (%)	9.0(1.4)	17.0(13.4)	15.6(16.6)	24.8(15.3)	49.7(12.8)	44.0(18.3)	7.8(4.6)
Bare ground cover (	1.0(.0)	3.8(4.1)	3.2(3.9)	11.8(16.1)	17.6(10.4)	52.9(27.5)	.8(.5)
Gravel ground cover	11.5(12.0)	62.9(26.1)	44.0(11.4)	35.0(26.5)	39.1(21.2)	29.1(24.0)	1.0(.0)
Rock ground cover (	6.5(4.9)	15.6(20.2)	26.0(15.2)	12.2(10.7)	24.6(18.5)	8.3(8.6)	8.8(14.2)
Litter ground cover	21.5(26.2)	5.9(6.9)	16.6(10.4)	32.8(31.7)	7.3(8.6)	4.0(7.1)	75.0(12.9)
Bryophyte ground co	55.0(21.2)	.0(.0)	.0(.0)	.6(1.3)	.3(.5)	.0(.0)	7.8(14.8)
Basal veg cover (%)	3.0(.0)	2.5(.9)	4.0(3.5)	4.4(3.1)	2.9(2.5)	1.9(1.1)	10.0(.0)
Water cover (%)	.5(.7)	1.6(3.5)	2.0(4.5)	.6(1.3)	.1(.3)	.0(.0)	.0(.0)
pH	6.5( )	7.8(0.4)	6.4(0.2)	7.3(0.7)	7.2(0.7)	6.9(0.7)	6.2(0.3)
Coarse fragment (%)	26( )	57(10)	49(13)	49(13)	55(15)	33(27)	3(4)
	N=1	N=6	N=5	N=5	N=9	N=7	N=2
Sand (%)	40.6( )	58.2(7.7)	75.4(7.9)	60.0(8.5)	69.9(17.2)	55.7(15.7)	47.9(2.5)
Silt (%)	6.7( )	7.9(5.8)	4.8(2.3)	4.6(2.4)	5.8(3.4)	15.8(7.1)	10.8(0.1)
Clay (%)	52.7( )	34.0(5.2)	19.7(9.0)	35.4(7.8)	24.3(15.6)	28.4(11.7)	41.4(2.3)
Organic matter (%)	16.1( )	9.2(2.9)	8.4(3.9)	12.2(9.3)	8.3(3.3)	9.3(4.7)	15.4(6.6)
Total carbon (%)	10.7( )	9.9(1.7)	4.8(3.0)	12.2(3.6)	5.3(2.7)	3.1(2.3)	7.0(4.0)
Total nitrogen (%)	0.43( )	0.53(0.15)	0.24(0.17)	0.34(0.29)	0.27(0.15)	0.18(0.16)	0.36(0.20)

(con.)

Appendix B (Con.)

COMMUNITY TYPE NAMES

Site Variables	*JUNDRU/ANTLAN * N = 3	*PHYEMP/ANTLAN * N = 4	*CASMER/CARPAY * N = 3	*JUNPAR/ERIURS * N = 2	*SALGLA * N = 1	*DESCES/CALLEP * N = 5	*CARSCO/CALLEP * N = 5 *
Elevation (ft MSL)	9793.3(195.0)	9570.0(347.7)	9513.3(100.6)	9680.0(183.8)	9910.0(.0)	9772.0(246.2)	9594.0(390.4)
Aspect (azimuths)	173.3(152.7)	106.2(73.6)	63.3(53.0)	202.5(38.9)	360.0(.0)	111.2(161.8)	162.5(188.0)
Slope (%)	13.0(8.9)	27.0(11.5)	14.3(9.5)	16.0(7.1)	33.0(.0)	11.7(7.4)	1.8(1.0)
Bare ground cover (	30.0(10.0)	6.8(8.9)	4.0(5.2)	35.0(35.4)	3.0(.0)	4.8(8.5)	.2(.4)
Gravel ground cover	20.0(10.0)	8.5(8.6)	7.0(5.2)	11.5(12.0)	3.0(.0)	.4(.5)	.0(.0)
Rock ground cover (	4.0(5.2)	7.8(4.5)	8.0(10.4)	2.0(1.4)	10.0(.0)	.8(1.3)	.2(.4)
Litter ground cover	30.0(10.0)	55.0(31.1)	66.7(15.3)	30.0(28.3)	3.0(.0)	13.2(15.4)	30.0(29.2)
Bryophyte ground co	20.0(20.0)	5.5(9.7)	7.0(11.3)	15.0(21.2)	70.0(.0)	72.0(29.5)	60.0(23.5)
Basal veg cover (%)	5.3(4.0)	6.5(4.0)	7.7(4.0)	3.0(.0)	3.0(.0)	4.4(3.1)	8.6(3.1)
Water cover (%)	.3(.6)	15.2(23.6)	3.3(5.8)	.0(.0)	.0(.0)	.0(.0)	2.0(4.5)
pH	6.1(1.0)	6.1(0.2)	6.0(0.2)	5.6( )	------	6.5(1.1)	6.0(0.3)
Coarse fragment (%)	10(6)	7(6)	23(13)	25( )	------	3(2)	0(0)
	N=3	N=4	N=3	N=1	N=1	N=4	N=3
Sand (%)	52.3(4.4)	67.3(26.4)	51.0(13.1)	35.3( )	63.1( )	48.7(4.3)	41.8(20.1)
Silt (%)	11.3(3.2)	4.6(1.9)	6.1(4.5)	4.7( )	24.9( )	11.5(3.2)	15.3(12.2)
Clay (%)	36.4(1.4)	28.2(25.1)	42.9(13.0)	60.0( )	12.0( )	39.8(5.9)	42.8(17.2)
Organic matter (%)	12.2(1.5)	13.5(8.3)	19.0(4.9)	19.8( )	13.7( )	19.8(7.5)	25.2(7.8)
Total carbon (%)	5.0(0.5)	6.8(3.2)	9.9(2.0)	9.9( )	8.5( )	8.4(4.4)	11.9(4.6)
Total nitrogen (%)	0.21(0.09)	0.30(0.28)	0.52(0.22)	0.64( )	0.31( )	0.57(0.34)	0.70(0.40)

COMMUNITY TYPE NAMES

Site Variables	*SALNIV/CALLEP * N = 2	*SALPLA/CARSCO * N = 1 *
Elevation (ft MSL)	9905.0(219.1)	9320.0(.0)
Aspect (azimuths)	357.5(3.5)	10.0(.0)
Slope (%)	28.0(9.9)	1.0(.0)
Bare ground cover (	2.0(1.4)	.0(.0)
Gravel ground cover	1.0(.0)	.0(.0)
Rock ground cover (	5.5(6.4)	.0(.0)
Litter ground cover	35.0(35.4)	10.0(.0)
Bryophyte ground co	50.0(28.3)	80.0(.0)
Basal veg cover (%)	10.0(.0)	10.0(.0)
Water cover (%)	.0(.0)	.0(.0)
pH	7.5( )	6.3( )
Coarse fragment (%)	7( )	.0(.0)
	N=1	N=1
Sand (%)	27.3( )	----
Silt (%)	13.7( )	----
Clay (%)	59.0( )	----
Organic matter (%)	14.7( )	68.7( )
Total carbon (%)	9.4( )	39.1( )
Total nitrogen (%)	0.40( )	2.5( )

Appendix C—Vascular Plant Constancy and Coverage (Mean and Range) by Community Type

Species Abbreviations	*FESIDA/POTDIV * N = 12	*DESCES/POTDIV * N = 6	*HESKIN/OXYCAM * N = 3	*CARELY * N = 24	*CARSCI/POTDIV * N = 7	*CARSCI/GEUROS * N = 13	*DRYOCT/POLVIV * N = 3
***** Trees *****							
PINALBVT	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	4 (1)[1- 1]	0 (0)[0- 0]	31 (2)[1- 3]	0 (0)[0- 0]
***** Shrubs *****							
ARTFRIVS	0 (0)[0- 0]	0 (0)[0- 0]	100 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ARTTSVVS	0 (0)[0- 0]	0 (0)[0- 0]	33 (10)[10-10]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CASMERVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
DRYOCTVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	4 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]	100 (60)[30-80]
HAPSUFVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	8 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
PHYEMPVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	8 (1)[1- 1]	0 (0)[0- 0]
PHYGLAVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
POTFRUVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	4 (3)[3- 3]	29 (7)[3-10]	0 (0)[0- 0]	0 (0)[0- 0]
SALARCVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SALDODVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SALGLAVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SALNIVVS	8 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	14 (1)[1- 1]	0 (0)[0- 0]	100 (11)[3-20]
SALPLAVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
VACSCOVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
***** Graminoids *****							
AGRCANVG	58 (5)[1-10]	0 (0)[0- 0]	33 (1)[1- 1]	29 (5)[1-20]	86 (1)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]
AGRSCRVG	0 (0)[0- 0]	0 (0)[0- 0]	33 (1)[1- 1]	17 (4)[1-10]	0 (0)[0- 0]	8 (3)[3- 3]	0 (0)[0- 0]
AGRSPIVG	0 (0)[0- 0]	0 (0)[0- 0]	100 (3)[3- 3]	4 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ALOALPVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
BROPUMVG	33 (16)[3-30]	0 (0)[0- 0]	0 (0)[0- 0]	13 (1)[1- 1]	29 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]
CALPURVG	0 (0)[0- 0]	0 (0)[0- 0]	33 (3)[3- 3]	46 (9)[1-50]	43 (8)[1-20]	15 (1)[1- 1]	33 (1)[1- 1]
CARALBVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	14 (1)[1- 1]	15 (7)[3-10]	33 (1)[1- 1]
CARATRVG	25 (1)[1- 1]	67 (13)[1-30]	0 (0)[0- 0]	0 (0)[0- 0]	14 (1)[1- 1]	8 (20)[20-20]	0 (0)[0- 0]
CARELYVG	50 (4)[1-10]	0 (0)[0- 0]	33 (3)[3- 3]	100 (27)[1-60]	71 (31)[3-70]	46 (3)[1- 3]	100 (2)[1- 3]
CARHAYVG	8 (1)[1- 1]	50 (8)[1-20]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARILLVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARLENVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARLEPVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARNIGVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARNOVVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CAROBTVG	33 (40)[30-50]	0 (0)[0- 0]	0 (0)[0- 0]	8 (2)[1- 3]	29 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]
CARPACVG	8 (1)[1- 1]	17 (40)[40-40]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARPAYVG	0 (0)[0- 0]	17 (20)[20-20]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	15 (1)[1- 1]	0 (0)[0- 0]
CARPETVG	25 (4)[1-10]	17 (1)[1- 1]	0 (0)[0- 0]	8 (1)[1- 1]	14 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
CARPHAVG	0 (0)[0- 0]	17 (10)[10-10]	0 (0)[0- 0]	0 (0)[0- 0]	14 (1)[1- 1]	77 (6)[1-20]	33 (1)[1- 1]
CARPYRVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARROIVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARRUPVG	33 (2)[1- 3]	0 (0)[0- 0]	33 (1)[1- 1]	63 (16)[1-40]	29 (6)[1-10]	23 (14)[3-30]	33 (3)[3- 3]

(con.)

Appendix C (Con.)

Species Abbreviations	*FESIDA/POTDIV * N = 12	*DESCES/POTDIV * N = 6	*HESKIN/OXYCAM * N = 3	*CARELY * N = 24	*CARSCI/POTDIV * N = 7	*CARSCI/GEUROS * N = 13	*DRYOCT/POLVIV * N = 3
***** Graminoids Continued *****							
CARSCIVG	8 (40)[40-40]	0 (0)[0- 0]	0 (0)[0- 0]	21 (2)[1- 3]	86 (36)[3-60]	85 (24)[1-30]	0 (0)[0- 0]
CARSCOVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
DANINTVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	29 (12)[3-20]	15 (1)[1- 1]	0 (0)[0- 0]
DESCESVG	42 (1)[1- 1]	100 (29)[1-50]	0 (0)[0- 0]	0 (0)[0- 0]	29 (2)[1- 3]	23 (14)[3-30]	0 (0)[0- 0]
FESIDAVG	92 (28)[3-50]	33 (30)[10-50]	67 (2)[1- 3]	21 (5)[1-10]	43 (3)[3- 3]	8 (10)[10-10]	33 (1)[1- 1]
FESOVIVG	8 (3)[3- 3]	33 (2)[1- 3]	0 (0)[0- 0]	58 (10)[1-50]	100 (9)[1-50]	85 (5)[1-10]	67 (1)[1- 1]
HESKINVG	25 (7)[1-20]	0 (0)[0- 0]	100 (27)[20-30]	54 (5)[1-20]	0 (0)[0- 0]	0 (0)[0- 0]	33 (1)[1- 1]
JUNBALVG	0 (0)[0- 0]	17 (50)[50-50]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
JUNDRUVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
JUNMERVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
JUNPARVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
LUZHITVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
LUZPARVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
LUZSPIVG	17 (1)[1- 1]	50 (2)[1- 3]	0 (0)[0- 0]	8 (1)[1- 1]	57 (1)[1- 1]	92 (2)[1- 3]	0 (0)[0- 0]
PHLALPVG	0 (0)[0- 0]	67 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]	14 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
POAALPVG	42 (1)[1- 3]	33 (7)[3-10]	0 (0)[0- 0]	21 (2)[1- 3]	71 (3)[1-10]	46 (4)[1-10]	100 (3)[3- 3]
POAARCVG	8 (20)[20-20]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	33 (1)[1- 1]
POAFENVG	25 (2)[1- 3]	33 (2)[1- 3]	100 (2)[1- 3]	21 (1)[1- 1]	29 (1)[1- 1]	8 (3)[3- 3]	0 (0)[0- 0]
POAGLAVG	25 (5)[1-10]	17 (1)[1- 1]	33 (3)[3- 3]	67 (2)[1-10]	29 (1)[1- 1]	15 (2)[1- 3]	33 (1)[1- 1]
POAPRAVG	17 (3)[3- 3]	17 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	14 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
POAREFVG	0 (0)[0- 0]	17 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
POASECVG	8 (10)[10-10]	0 (0)[0- 0]	100 (5)[1-10]	13 (1)[1- 1]	0 (0)[0- 0]	54 (1)[1- 3]	0 (0)[0- 0]
STIOCCVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
TRISPIVG	8 (1)[1- 1]	33 (1)[1- 1]	0 (0)[0- 0]	13 (1)[1- 1]	29 (1)[1- 1]	85 (1)[1- 3]	33 (1)[1- 1]
***** Forbs *****							
ACHMILVF	83 (3)[1-10]	67 (2)[1- 3]	33 (1)[1- 1]	33 (3)[1-10]	57 (6)[1-20]	15 (2)[1- 3]	0 (0)[0- 0]
AGOGLAVF	50 (2)[1- 3]	17 (3)[3- 3]	67 (1)[1- 1]	46 (2)[1- 3]	43 (1)[1- 1]	31 (2)[1- 3]	33 (1)[1- 1]
ANEDRUVF	8 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	4 (1)[1- 1]	29 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
ANTALPVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	14 (3)[3- 3]	31 (1)[1- 1]	33 (1)[1- 1]
ANTAROVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	4 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ANTLANVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	15 (1)[1- 1]	0 (0)[0- 0]
ANTMICVF	17 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	8 (2)[1- 3]	14 (1)[1- 1]	15 (1)[1- 1]	0 (0)[0- 0]
ANTUMBVF	8 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	4 (20)[20-20]	14 (1)[1- 1]	15 (1)[1- 1]	0 (0)[0- 0]
ARECAPVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	4 (3)[3- 3]	0 (0)[0- 0]	23 (1)[1- 1]	0 (0)[0- 0]
ARECONVF	33 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	29 (1)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ARENUTVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	4 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	33 (1)[1- 1]
AREOBTVF	0 (0)[0- 0]	0 (0)[0- 0]	33 (10)[10-10]	33 (4)[1-10]	43 (5)[1-10]	77 (5)[1-10]	33 (3)[3- 3]
ARNLATVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ARNLONVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ARTDRAVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ARTSCOVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	8 (10)[10-10]	0 (0)[0- 0]
ASTABOVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	8 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ASTALGVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	23 (2)[1- 3]	0 (0)[0- 0]
ASTALPVF	17 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	4 (1)[1- 1]	43 (2)[1- 3]	15 (3)[3- 3]	33 (1)[1- 1]
ASTBOUVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]

(con.)

Species Abbreviations	*FESIDA/POTDIV * N = 12	*DESCES/POTDIV * N = 6	*HESKIN/OXYCAM * N = 3	*CARELY * N = 24	*CARSCI/POTDIV * N = 7	*CARSCI/GEUROS * N = 13	*DRYOCT/POLVIV * N = 3
***** Forbs Continued *****							
ASTFOLVF	8 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	4 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
BESWYOVF	50 (2)[1- 3]	17 (1)[1- 1]	0 (0)[0- 0]	42 (2)[1- 3]	29 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
BUPAMEVF	42 (1)[1- 3]	0 (0)[0- 0]	33 (1)[1- 1]	54 (2)[1- 3]	43 (2)[1- 3]	15 (1)[1- 1]	67 (1)[1- 1]
CALLEPVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CASPULVF	0 (0)[0- 0]	17 (3)[3- 3]	0 (0)[0- 0]	8 (1)[1- 1]	43 (2)[1- 3]	8 (1)[1- 1]	33 (1)[1- 1]
CASRHEVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CERARVVF	75 (1)[1- 1]	67 (6)[1-20]	0 (0)[0- 0]	38 (1)[1- 3]	71 (1)[1- 3]	8 (1)[1- 1]	0 (0)[0- 0]
CHAALPVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CHITWEVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	15 (7)[3-10]	0 (0)[0- 0]
CLALANVF	8 (3)[3- 3]	17 (1)[1- 1]	0 (0)[0- 0]	13 (2)[1- 3]	29 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]
CYMBIPVF	17 (2)[1- 3]	0 (0)[0- 0]	100 (2)[1- 3]	54 (3)[1-10]	0 (0)[0- 0]	0 (0)[0- 0]	33 (1)[1- 1]
DELOCCVF	17 (1)[1- 1]	0 (0)[0- 0]	33 (1)[1- 1]	13 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
DODPULVF	0 (0)[0- 0]	33 (1)[1- 1]	0 (0)[0- 0]	13 (1)[1- 1]	43 (2)[1- 3]	46 (2)[1- 3]	33 (1)[1- 1]
DOUMONVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	8 (2)[1- 3]	29 (1)[1- 1]	8 (1)[1- 1]	0 (0)[0- 0]
EPIALPVF	0 (0)[0- 0]	17 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ERICAEVF	0 (0)[0- 0]	0 (0)[0- 0]	33 (1)[1- 1]	21 (3)[1-10]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ERICOMVF	17 (1)[1- 1]	0 (0)[0- 0]	67 (2)[1- 3]	46 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ERINANVF	0 (0)[0- 0]	0 (0)[0- 0]	67 (1)[1- 1]	33 (2)[1- 3]	14 (1)[1- 1]	15 (1)[1- 1]	0 (0)[0- 0]
ERIPERVF	0 (0)[0- 0]	17 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ERIRYDVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	17 (2)[1- 3]	14 (1)[1- 1]	31 (2)[1- 3]	33 (1)[1- 1]
ERISIMVF	25 (2)[1- 3]	33 (2)[1- 3]	0 (0)[0- 0]	13 (1)[1- 1]	86 (3)[1-10]	77 (4)[3-10]	33 (1)[1- 1]
ERIURSVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ERYGRAVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
FORBPEVF	0 (0)[0- 0]	17 (30)[30-30]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
FRASPEVF	50 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	33 (1)[1- 1]	29 (2)[1- 3]	0 (0)[0- 0]	33 (1)[1- 1]
GENALGVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	8 (3)[3- 3]	33 (1)[1- 1]
GENCALVF	8 (3)[3- 3]	17 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	57 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]
GEUROSVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	100 (37)[10-70]	33 (3)[3- 3]
GEUTRIVF	8 (10)[10-10]	0 (0)[0- 0]	33 (1)[1- 1]	8 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
HAPUNIVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	14 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]
HEDSULVF	8 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	13 (5)[3-10]	14 (1)[1- 1]	0 (0)[0- 0]	33 (3)[3- 3]
HIEGRAVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
HYMGRAVF	67 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	54 (2)[1-10]	71 (1)[1- 3]	15 (1)[1- 1]	0 (0)[0- 0]
LESQUEVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
LEWPYGVF	8 (1)[1- 1]	17 (1)[1- 1]	0 (0)[0- 0]	4 (1)[1- 1]	0 (0)[0- 0]	69 (1)[1- 3]	0 (0)[0- 0]
LIGTENVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
LLOSERVF	33 (2)[1- 3]	33 (1)[1- 1]	0 (0)[0- 0]	33 (2)[1- 3]	100 (3)[1-10]	62 (3)[1- 3]	100 (2)[1- 3]
LOMCOUVF	25 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]	38 (3)[1-10]	43 (3)[3- 3]	15 (1)[1- 1]	0 (0)[0- 0]
LUPARGVF	50 (1)[1- 1]	0 (0)[0- 0]	33 (1)[1- 1]	46 (2)[1- 3]	71 (9)[1-20]	85 (7)[1-20]	0 (0)[0- 0]
MERALPVF	0 (0)[0- 0]	17 (3)[3- 3]	0 (0)[0- 0]	4 (1)[1- 1]	14 (3)[3- 3]	54 (2)[1- 3]	0 (0)[0- 0]
MERCILVF	0 (0)[0- 0]	17 (30)[30-30]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
MICNIGVF	0 (0)[0- 0]	17 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
MONCHAVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
MYOSYLVF	75 (1)[1- 3]	50 (1)[1- 1]	0 (0)[0- 0]	21 (1)[1- 1]	29 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]
OXYCAMVF	42 (3)[1- 3]	0 (0)[0- 0]	100 (2)[1- 3]	79 (4)[1-20]	57 (4)[1-10]	8 (1)[1- 1]	67 (2)[1- 3]

(con.)

Appendix C (Con.)

Species Abbreviations	FESIDA/POTDIV N = 12	DESCES/POTDIV N = 6	HESKIN/OXYCAM N = 3	CARELY N = 24	CARSCI/POTDIV N = 7	CARSCI/GEUROS N = 13	DRYOCT/POLVIV N = 3
***** Forbs Continued *****							
OXYVISVF	8 (1)[1- 1]	0 (0)[0- 0]	33 (1)[1- 1]	25 (3)[1-10]	29 (1)[1- 1]	0 (0)[0- 0]	67 (6)[1-10]
PEDCONVF	8 (1)[1- 1]	0 (0)[0- 0]	33 (1)[1- 1]	0 (0)[0- 0]	14 (1)[1- 1]	8 (1)[1- 1]	0 (0)[0- 0]
PEDCYSVF	33 (1)[1- 1]	33 (2)[1- 3]	0 (0)[0- 0]	4 (3)[3- 3]	43 (4)[1-10]	0 (0)[0- 0]	67 (2)[1- 3]
PEDGROVF	0 (0)[0- 0]	17 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
PEDPARVF	50 (2)[1- 3]	33 (1)[1- 1]	0 (0)[0- 0]	25 (2)[1- 3]	57 (3)[1-10]	8 (1)[1- 1]	0 (0)[0- 0]
PENATTVF	8 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]	4 (1)[1- 1]	0 (0)[0- 0]	8 (1)[1- 1]	0 (0)[0- 0]
PENPROVF	42 (2)[1- 3]	33 (6)[1-10]	33 (1)[1- 1]	4 (1)[1- 1]	43 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]
PHLHOOVF	8 (3)[3- 3]	0 (0)[0- 0]	67 (10)[10-10]	13 (4)[1-10]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
PHLMULVF	25 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]	8 (6)[1-10]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
PHLPULVF	67 (11)[1-50]	17 (1)[1- 1]	67 (1)[1- 1]	88 (12)[1-60]	71 (9)[1-20]	92 (7)[1-50]	67 (1)[1- 1]
POLBISVF	58 (7)[1-20]	100 (8)[3-10]	0 (0)[0- 0]	25 (2)[1- 3]	100 (6)[1-20]	69 (5)[1-20]	67 (6)[1-10]
POLVISVF	92 (10)[1-20]	17 (1)[1- 1]	0 (0)[0- 0]	29 (7)[1-20]	14 (20)[20-20]	0 (0)[0- 0]	0 (0)[0- 0]
POLVIVVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	4 (10)[10-10]	43 (2)[1- 3]	0 (0)[0- 0]	100 (17)[1-30]
POLWATVF	0 (0)[0- 0]	17 (10)[10-10]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
POTDIVVF	83 (14)[1-30]	100 (11)[1-30]	0 (0)[0- 0]	63 (4)[1-20]	86 (14)[3-30]	85 (5)[1-20]	100 (1)[1- 1]
POTOVIVF	17 (1)[1- 1]	0 (0)[0- 0]	67 (2)[1- 3]	58 (3)[1-20]	14 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
RANESCVF	8 (1)[1- 1]	67 (4)[1-10]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
RUMPAUVF	0 (0)[0- 0]	33 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SAXOPPVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	4 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	33 (1)[1- 1]
SAXOREVF	8 (3)[3- 3]	50 (5)[3-10]	0 (0)[0- 0]	0 (0)[0- 0]	14 (1)[1- 1]	8 (3)[3- 3]	0 (0)[0- 0]
SAXRHOVF	67 (1)[1- 3]	33 (1)[1- 1]	0 (0)[0- 0]	42 (1)[1- 1]	43 (1)[1- 1]	23 (1)[1- 1]	0 (0)[0- 0]
SEDLANVF	17 (1)[1- 1]	17 (1)[1- 1]	100 (1)[1- 1]	42 (2)[1- 3]	29 (1)[1- 1]	54 (2)[1- 3]	33 (1)[1- 1]
SENCRAVF	17 (2)[1- 3]	67 (9)[1-30]	0 (0)[0- 0]	0 (0)[0- 0]	29 (2)[1- 3]	0 (0)[0- 0]	67 (1)[1- 1]
SENCYMVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SENECIVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SIBPROVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	14 (3)[3- 3]	31 (1)[1- 1]	0 (0)[0- 0]
SILACAVF	8 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	17 (2)[1- 3]	29 (1)[1- 1]	46 (1)[1- 3]	0 (0)[0- 0]
SILPARVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	17 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SILREPVF	8 (1)[1- 1]	0 (0)[0- 0]	33 (1)[1- 1]	17 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SMECALVF	8 (1)[1- 1]	0 (0)[0- 0]	33 (1)[1- 1]	33 (2)[1-10]	14 (3)[3- 3]	31 (1)[1- 1]	67 (1)[1- 1]
SOLIDAVF	8 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SOLMULVF	42 (2)[1- 3]	17 (3)[3- 3]	0 (0)[0- 0]	25 (2)[1- 3]	86 (11)[1-50]	8 (3)[3- 3]	33 (3)[3- 3]
STECALVF	0 (0)[0- 0]	17 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
STELONVF	8 (1)[1- 1]	17 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	8 (1)[1- 1]	0 (0)[0- 0]
SYNPINVF	33 (2)[1- 3]	17 (1)[1- 1]	0 (0)[0- 0]	29 (1)[1- 3]	14 (10)[10-10]	39 (2)[1- 3]	33 (1)[1- 1]
SYNPLAVF	8 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
TAROFFVF	0 (0)[0- 0]	33 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
TRIHAYVF	25 (11)[3-20]	17 (1)[1- 1]	0 (0)[0- 0]	13 (5)[1-10]	0 (0)[0- 0]	0 (0)[0- 0]	33 (1)[1- 1]
TRILONVF	8 (3)[3- 3]	33 (6)[1-10]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
TRINANVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	8 (1)[1- 1]	0 (0)[0- 0]
TRIPARVF	0 (0)[0- 0]	33 (10)[10-10]	0 (0)[0- 0]	0 (0)[0- 0]	14 (10)[10-10]	8 (1)[1- 1]	0 (0)[0- 0]
TROLAXVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
VALEDUVF	17 (2)[1- 3]	17 (1)[1- 1]	0 (0)[0- 0]	8 (2)[1- 3]	14 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
VERWORVF	0 (0)[0- 0]	17 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ZIGELEVF	25 (5)[1-10]	0 (0)[0- 0]	0 (0)[0- 0]	29 (4)[1-10]	71 (5)[1-10]	0 (0)[0- 0]	67 (3)[3- 3]
***** Ferns and Allied Taxa *****							
SELDENVE	8 (1)[1- 1]	0 (0)[0- 0]	33 (1)[1- 1]	71 (9)[1-30]	14 (1)[1- 1]	31 (4)[1-10]	0 (0)[0- 0]
SELWATVE	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	54 (15)[3-30]	0 (0)[0- 0]

(con.)

Appendix C (Con.)

Species Abbreviations	*SALARC/POLBIS * N = 2	*CARRUP/POTOVI * N = 8	*GEUROS/AREOBT * N = 5	*DRYOCT/CARRUP * N = 5	*DRY SLOPE * N = 11	*MOIST SLOPE * N = 7	*CARNIG * N = 4
***** Trees *****							
PINALBVT	50 (1)[1- 1]	0 (0)[0- 0]	20 (1)[1- 1]	0 (0)[0- 0]	18 (1)[1- 1]	14 (1)[1- 1]	0 (0)[0- 0]
***** Shrubs *****							
ARTFRIVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ARTTSVVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CASMERVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (10)[10-10]	0 (0)[0- 0]	0 (0)[0- 0]	50 (1)[1- 1]
DRYOCTVS	50 (10)[10-10]	0 (0)[0- 0]	20 (1)[1- 1]	100 (36)[10-60]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
HAPSUFVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	36 (3)[1-10]	0 (0)[0- 0]	0 (0)[0- 0]
PHYEMPVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	50 (1)[1- 1]
PHYGLAVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
POTFRUVS	0 (0)[0- 0]	13 (1)[1- 1]	0 (0)[0- 0]	20 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SALARCVS	100 (50)[30-70]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	25 (10)[10-10]
SALDODVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SALGLAVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SALNIVVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SALPLAVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
VACSCOVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
***** Graminoids *****							
AGRCANVG	50 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]	36 (2)[1- 3]	57 (4)[1-10]	0 (0)[0- 0]
AGRSCRVG	0 (0)[0- 0]	50 (1)[1- 1]	20 (3)[3- 3]	20 (1)[1- 1]	64 (4)[1-10]	29 (2)[1- 3]	0 (0)[0- 0]
AGRSPIVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ALOALPVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
BROPUMVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CALPURVG	0 (0)[0- 0]	38 (2)[1- 3]	0 (0)[0- 0]	40 (3)[3- 3]	9 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
CARALBVG	50 (3)[3- 3]	0 (0)[0- 0]	20 (1)[1- 1]	0 (0)[0- 0]	9 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
CARATRVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	25 (20)[20-20]
CARELYVG	100 (1)[1- 1]	38 (4)[1-10]	40 (2)[1- 3]	60 (5)[3-10]	27 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
CARHAYVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	43 (5)[1-10]	0 (0)[0- 0]
CARILLVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARLENVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARLEPVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARNIGVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	100 (78)[70-90]
CARNOVVG	50 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CAROBTVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARPACVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARPAYVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	9 (1)[1- 1]	14 (3)[3- 3]	50 (7)[3-10]
CARPETVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	29 (1)[1- 1]	0 (0)[0- 0]
CARPHAVG	50 (1)[1- 1]	0 (0)[0- 0]	20 (1)[1- 1]	0 (0)[0- 0]	9 (1)[1- 1]	14 (1)[1- 1]	25 (1)[1- 1]
CARPYRVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARROIVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARRUPVG	50 (1)[1- 1]	63 (9)[3-20]	20 (20)[20-20]	100 (4)[1-10]	9 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]
CARSCIVG	50 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	60 (1)[1- 1]	18 (6)[1-10]	0 (0)[0- 0]	0 (0)[0- 0]
CARSCOVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
DANINTVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	9 (1)[1- 1]	14 (3)[3- 3]	0 (0)[0- 0]
DESCESVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	57 (7)[1-20]	50 (2)[1- 3]

(con.)

Appendix C (Con.)

Species Abbreviations	*SALARC/POLBIS * N = 2	*CARRUP/POTOVI * N = 8	*GEUROS/AREOBT * N = 5	*DRYOCT/CARRUP * N = 5	*DRY SLOPE * N = 11	*MOIST SLOPE * N = 7	*CARNIG * N = 4
***** Graminoids Continued *****							
FESIDAVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	27 (8)[3-10]	43 (1)[1- 1]	0 (0)[0- 0]
FESOVIVG	100 (1)[1- 1]	50 (2)[1- 3]	60 (4)[1-10]	40 (2)[1- 3]	55 (2)[1- 3]	14 (1)[1- 1]	0 (0)[0- 0]
HESKINVG	0 (0)[0- 0]	50 (4)[1-10]	0 (0)[0- 0]	0 (0)[0- 0]	36 (2)[1- 3]	14 (1)[1- 1]	0 (0)[0- 0]
JUNBALVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
JUNDRUVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	14 (1)[1- 1]	100 (4)[1-10]
JUNMERVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
JUNPARVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
LUZHITVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
LUZPARVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
LUZSPIVG	100 (1)[1- 1]	0 (0)[0- 0]	80 (1)[1- 1]	40 (1)[1- 1]	36 (1)[1- 1]	14 (1)[1- 1]	0 (0)[0- 0]
PHLALPVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	14 (1)[1- 1]	75 (4)[1-10]
POAALPVG	100 (6)[1-10]	0 (0)[0- 0]	0 (0)[0- 0]	60 (1)[1- 1]	46 (2)[1- 3]	57 (1)[1- 1]	25 (1)[1- 1]
POAARCVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	14 (1)[1- 1]	0 (0)[0- 0]
POAFENVG	0 (0)[0- 0]	13 (1)[1- 1]	0 (0)[0- 0]	20 (1)[1- 1]	0 (0)[0- 0]	43 (2)[1- 3]	50 (2)[1- 3]
POAGLAVG	0 (0)[0- 0]	38 (2)[1- 3]	40 (2)[1- 3]	0 (0)[0- 0]	55 (1)[1- 3]	14 (3)[3- 3]	0 (0)[0- 0]
POAPRAVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
POAREFVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	14 (1)[1- 1]	0 (0)[0- 0]
POASECVG	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]	20 (3)[3- 3]	55 (3)[1-10]	0 (0)[0- 0]	0 (0)[0- 0]
STIOCCVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	14 (20)[20-20]	0 (0)[0- 0]
TRISPIVG	50 (1)[1- 1]	0 (0)[0- 0]	20 (3)[3- 3]	0 (0)[0- 0]	64 (1)[1- 1]	43 (4)[1-10]	0 (0)[0- 0]
***** Forbs *****							
ACHMILVF	50 (1)[1- 1]	38 (2)[1- 3]	0 (0)[0- 0]	20 (1)[1- 1]	73 (2)[1- 3]	71 (3)[1-10]	0 (0)[0- 0]
AGOGLAVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]	36 (2)[1- 3]	57 (2)[1- 3]	0 (0)[0- 0]
ANEDRUVF	0 (0)[0- 0]	25 (1)[1- 1]	0 (0)[0- 0]	40 (6)[1-10]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ANTALPVF	50 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	9 (1)[1- 1]	14 (1)[1- 1]	50 (1)[1- 1]
ANTAROVF	0 (0)[0- 0]	25 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ANTLANVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	75 (2)[1- 3]
ANTMICVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	9 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
ANTUMBVF	0 (0)[0- 0]	0 (0)[0- 0]	20 (3)[3- 3]	20 (1)[1- 1]	27 (2)[1- 3]	43 (1)[1- 1]	0 (0)[0- 0]
ARECAPVF	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]	0 (0)[0- 0]	9 (1)[1- 1]	14 (1)[1- 1]	0 (0)[0- 0]
ARECONVF	0 (0)[0- 0]	0 (0)[0- 0]	20 (3)[3- 3]	0 (0)[0- 0]	36 (1)[1- 1]	29 (1)[1- 1]	0 (0)[0- 0]
ARENUTVF	0 (0)[0- 0]	13 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	9 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]
AREOBTVF	100 (1)[1- 1]	88 (4)[1-10]	100 (9)[3-20]	40 (3)[3- 3]	18 (2)[1- 3]	14 (1)[1- 1]	0 (0)[0- 0]
ARNLATVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	14 (3)[3- 3]	25 (1)[1- 1]
ARNLONVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	14 (3)[3- 3]	0 (0)[0- 0]
ARTDRAVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	14 (3)[3- 3]	0 (0)[0- 0]
ARTSCOVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ASTABOVF	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]	40 (1)[1- 1]	9 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]
ASTALGVF	50 (10)[10-10]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	9 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
ASTALPVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	40 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ASTBOUVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	9 (20)[20-20]	0 (0)[0- 0]	0 (0)[0- 0]
ASTFOLVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	18 (1)[1- 1]	29 (7)[3-10]	0 (0)[0- 0]
BESWYOVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	36 (1)[1- 1]	29 (1)[1- 1]	0 (0)[0- 0]
BUPAMEVF	0 (0)[0- 0]	75 (1)[1- 1]	40 (1)[1- 1]	40 (1)[1- 1]	36 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
CALLEPVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	50 (16)[1-30]

(con.)

Appendix C (Con.)

Species Abbreviations	*SALARC/POLBIS * N = 2	*CARRUP/POTOVI * N = 8	*GEUROS/AREOBT * N = 5	*DRYOCT/CARRUP * N = 5	*DRY SLOPE * N = 11	*MOIST SLOPE * N = 7	*CARNIG * N = 4
***** Forbs Continued *****							
CASPULVF	50 (1)[1- 1]	25 (1)[1- 1]	20 (1)[1- 1]	100 (1)[1- 1]	18 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
CASRHEVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	14 (3)[3- 3]	0 (0)[0- 0]
CERARVVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	55 (1)[1- 3]	14 (1)[1- 1]	0 (0)[0- 0]
CHAALPVF	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]	0 (0)[0- 0]	18 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]
CHITWEVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	25 (1)[1- 1]
CLALANVF	50 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	25 (20)[20-20]
CYMBIPVF	0 (0)[0- 0]	63 (1)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]	18 (1)[1- 1]	14 (1)[1- 1]	0 (0)[0- 0]
DELOCCVF	0 (0)[0- 0]	13 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	18 (2)[1- 3]	14 (1)[1- 1]	0 (0)[0- 0]
DODPULVF	50 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	40 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	25 (1)[1- 1]
DOUMONVF	50 (1)[1- 1]	13 (1)[1- 1]	60 (2)[1- 3]	20 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
EPIALPVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	14 (1)[1- 1]	0 (0)[0- 0]
ERICAEVF	0 (0)[0- 0]	25 (1)[1- 1]	20 (10)[10-10]	0 (0)[0- 0]	9 (1)[1- 1]	14 (1)[1- 1]	0 (0)[0- 0]
ERICOMVF	0 (0)[0- 0]	88 (1)[1- 1]	20 (1)[1- 1]	20 (1)[1- 1]	82 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
ERINANVF	50 (1)[1- 1]	75 (1)[1- 3]	80 (2)[1- 3]	40 (1)[1- 1]	18 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
ERIPERVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	50 (1)[1- 1]
ERIRYDVF	0 (0)[0- 0]	13 (1)[1- 1]	40 (1)[1- 1]	0 (0)[0- 0]	18 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
ERISIMVF	100 (1)[1- 1]	0 (0)[0- 0]	20 (1)[1- 1]	40 (1)[1- 1]	18 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]
ERIURSVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	18 (2)[1- 3]	43 (14)[3-30]	0 (0)[0- 0]
ERYGRAVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
FORBPEVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
FRASPEVF	0 (0)[0- 0]	50 (2)[1- 3]	0 (0)[0- 0]	20 (1)[1- 1]	18 (1)[1- 1]	14 (1)[1- 1]	0 (0)[0- 0]
GENALGVF	50 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
GENCALVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	25 (3)[3- 3]
GEUROSVF	100 (10)[10-10]	0 (0)[0- 0]	100 (11)[3-20]	40 (3)[3- 3]	9 (10)[10-10]	0 (0)[0- 0]	0 (0)[0- 0]
GEUTRIVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
HAPUNIVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
HEDSULVF	50 (1)[1- 1]	13 (1)[1- 1]	0 (0)[0- 0]	60 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
HIEGRAVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	29 (1)[1- 1]	25 (3)[3- 3]
HYMGRAVF	50 (1)[1- 1]	25 (1)[1- 1]	40 (1)[1- 1]	0 (0)[0- 0]	55 (1)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]
LESQUEVF	0 (0)[0- 0]	13 (10)[10-10]	0 (0)[0- 0]	20 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
LEWPYGVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]	9 (1)[1- 1]	29 (1)[1- 1]	0 (0)[0- 0]
LIGTENVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
LLOSERVF	100 (2)[1- 3]	13 (1)[1- 1]	0 (0)[0- 0]	100 (1)[1- 1]	9 (3)[3- 3]	14 (1)[1- 1]	0 (0)[0- 0]
LOMCOUVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]	64 (2)[1-10]	29 (1)[1- 1]	0 (0)[0- 0]
LUPARGVF	0 (0)[0- 0]	13 (1)[1- 1]	40 (3)[3- 3]	0 (0)[0- 0]	36 (1)[1- 1]	71 (7)[1-20]	0 (0)[0- 0]
MERALPVF	0 (0)[0- 0]	0 (0)[0- 0]	40 (1)[1- 1]	20 (1)[1- 1]	27 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
MERCILVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
MICNIGVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
MONCHAVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
MYOSYLVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	9 (1)[1- 1]	14 (1)[1- 1]	0 (0)[0- 0]
OXYCAMVF	50 (3)[3- 3]	63 (4)[1-10]	20 (1)[1- 1]	100 (5)[1-10]	36 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]
OXYVISVF	0 (0)[0- 0]	25 (2)[1- 3]	0 (0)[0- 0]	20 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
PEDCONVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	9 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]
PEDCYSVF	50 (1)[1- 1]	13 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	9 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
PEDGROVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]

(con.)

Appendix C (Con.)

Species Abbreviations	*SALARC/POLBIS * N = 2	*CARRUP/POTOVI * N = 8	*GEUROS/AREOBT * N = 5	*DRYOCT/CARRUP * N = 5	*DRY SLOPE * N = 11	*MOIST SLOPE * N = 7	*CARNIG * N = 4
***** Forbs Continued *****							
PEDPARVF	0 (0)[0- 0]	25 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	27 (1)[1- 1]	14 (1)[1- 1]	0 (0)[0- 0]
PENATTVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	18 (2)[1- 3]	14 (1)[1- 1]	0 (0)[0- 0]
PENPROVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	27 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
PHLHOOVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
PHLMULVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	27 (3)[3- 3]	29 (1)[1- 1]	0 (0)[0- 0]
PHLPULVF	0 (0)[0- 0]	75 (9)[3-20]	100 (4)[1-10]	80 (6)[1-10]	64 (3)[1-10]	0 (0)[0- 0]	0 (0)[0- 0]
POLBISVF	100 (10)[10-10]	0 (0)[0- 0]	0 (0)[0- 0]	40 (2)[1- 3]	27 (2)[1- 3]	29 (1)[1- 1]	50 (3)[3- 3]
POLVISVF	0 (0)[0- 0]	13 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	18 (2)[1- 3]	29 (2)[1- 3]	0 (0)[0- 0]
POLVIVVF	100 (6)[1-10]	0 (0)[0- 0]	0 (0)[0- 0]	40 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
POLWATVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
POTDIVVF	50 (3)[3- 3]	38 (2)[1- 3]	60 (2)[1- 3]	60 (5)[1-10]	55 (3)[1-10]	71 (4)[1-10]	50 (2)[1- 3]
POTOVIVF	0 (0)[0- 0]	100 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]	27 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]
RANESCVF	50 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	43 (8)[1-20]	75 (2)[1- 3]
RUMPAUVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SAXOPPVF	50 (1)[1- 1]	13 (3)[3- 3]	0 (0)[0- 0]	60 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SAXOREVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SAXRHOVF	50 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]	9 (1)[1- 1]	14 (1)[1- 1]	0 (0)[0- 0]
SEDLANVF	100 (1)[1- 1]	13 (1)[1- 1]	60 (1)[1- 1]	40 (1)[1- 1]	64 (2)[1- 3]	14 (1)[1- 1]	0 (0)[0- 0]
SENCRAVF	50 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]	0 (0)[0- 0]	57 (2)[1- 3]	0 (0)[0- 0]
SENCYMVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	25 (3)[3- 3]
SENECIVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	14 (1)[1- 1]	0 (0)[0- 0]
SIBPROVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]	9 (1)[1- 1]	29 (12)[3-20]	50 (2)[1- 3]
SILACAVF	100 (1)[1- 1]	13 (3)[3- 3]	80 (5)[3-10]	40 (2)[1- 3]	18 (12)[3-20]	0 (0)[0- 0]	0 (0)[0- 0]
SILPARVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	18 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
SILREPVF	0 (0)[0- 0]	25 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	27 (1)[1- 1]	14 (1)[1- 1]	0 (0)[0- 0]
SMECALVF	50 (1)[1- 1]	25 (1)[1- 1]	60 (2)[1- 3]	40 (1)[1- 1]	55 (1)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]
SOLIDAVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SOLMULVF	0 (0)[0- 0]	50 (1)[1- 1]	0 (0)[0- 0]	40 (2)[1- 3]	27 (1)[1- 1]	57 (2)[1- 3]	0 (0)[0- 0]
STECALVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
STELONVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	18 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
SYNPINVF	50 (3)[3- 3]	0 (0)[0- 0]	40 (1)[1- 1]	20 (1)[1- 1]	36 (2)[1- 3]	14 (3)[3- 3]	0 (0)[0- 0]
SYNPLAVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
TAROFFVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	9 (1)[1- 1]	14 (1)[1- 1]	0 (0)[0- 0]
TRIHAYVF	0 (0)[0- 0]	13 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]	9 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
TRILONVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	14 (1)[1- 1]	0 (0)[0- 0]
TRINANVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	9 (30)[30-30]	0 (0)[0- 0]	0 (0)[0- 0]
TRIPARVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
TROLAXVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
VALEDUVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	14 (1)[1- 1]	0 (0)[0- 0]
VERWORVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	50 (6)[1-10]
ZIGELEVF	50 (1)[1- 1]	38 (2)[1- 3]	0 (0)[0- 0]	20 (3)[3- 3]	9 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
***** Ferns and Allied Taxa *****							
SELDENVE	0 (0)[0- 0]	25 (12)[3-20]	40 (10)[10-10]	20 (10)[10-10]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SELWATVE	0 (0)[0- 0]	0 (0)[0- 0]	40 (17)[3-30]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]

(con.)

Appendix C (Con.)

Species Abbreviations	*JUNDRU/ANTLAN * N = 3	*PHYEMP/ANTLAN * N = 4	*CASMER/CARPAY * N = 3	*JUNPAR/ERIURS * N = 2	*SALGLA * N = 1	*DESCES/CALLEP * N = 5	*CARSCO/CALLEP * N = 5
***** Trees *****							
PINALBVT	33 (1)[1- 1]	50 (1)[1- 1]	67 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
***** Shrubs *****							
ARTFRIVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ARTTSVVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CASMERVS	0 (0)[0- 0]	50 (21)[1-40]	100 (47)[20-80]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
DRYOCTVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
HAPSUFVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
PHYEMPVS	0 (0)[0- 0]	100 (30)[10-60]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
PHYGLAVS	0 (0)[0- 0]	50 (40)[30-50]	33 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
POTFRUVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SALARCVS	0 (0)[0- 0]	25 (3)[3- 3]	67 (35)[20-50]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]
SALDODVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SALGLAVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	100 (60)[60-60]	0 (0)[0- 0]	0 (0)[0- 0]
SALNIVVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]	0 (0)[0- 0]
SALPLAVS	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (10)[10-10]
VACSCOVS	33 (10)[10-10]	100 (8)[1-20]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
***** Grasses *****							
AGRCANVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	50 (1)[1- 1]	100 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
AGRSCRVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
AGRSPIVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ALOALPVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (3)[3- 3]
BROPUMVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CALPURVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARALBVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARATRVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	60 (5)[1-10]	0 (0)[0- 0]
CARELYVG	0 (0)[0- 0]	0 (0)[0- 0]	33 (1)[1- 1]	50 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARHAYVG	67 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]	50 (1)[1- 1]	0 (0)[0- 0]	20 (10)[10-10]	60 (3)[3- 3]
CARILLVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (10)[10-10]
CARLENVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (90)[90-90]
CARLEPVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARNIGVG	33 (3)[3- 3]	25 (10)[10-10]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (3)[3- 3]	20 (1)[1- 1]
CARNOVVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CAROBTVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARPACVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARPAYVG	100 (2)[1- 3]	100 (11)[1-30]	100 (10)[1-20]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]	0 (0)[0- 0]
CARPETVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	50 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARPHAVG	67 (1)[1- 1]	25 (1)[1- 1]	33 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARPYRVG	33 (10)[10-10]	25 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARROIVG	0 (0)[0- 0]	25 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARRUPVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CARSCIVG	0 (0)[0- 0]	0 (0)[0- 0]	67 (12)[3-20]	50 (3)[3- 3]	0 (0)[0- 0]	20 (1)[1- 1]	20 (1)[1- 1]
CARSCOVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	40 (1)[1- 1]	80 (68)[50-80]
DANINTVG	0 (0)[0- 0]	25 (1)[1- 1]	0 (0)[0- 0]	50 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]

(con.)

Appendix C (Con.)

Species Abbreviations	*JUNDRU/ANTLAN * N = 3	*PHYEMP/ANTLAN * N = 4	*CASMER/CARPAY * N = 3	*JUNPAR/ERIURS * N = 2	*SALGLA * N = 1	*DESCES/CALLEP * N = 5	*CARSCO/CALLEP * N = 5
***** Graminoids Continued *****							
DESCESVG	33 (1)[1- 1]	25 (1)[1- 1]	33 (10)[10-10]	0 (0)[0- 0]	0 (0)[0- 0]	100 (18)[1-40]	100 (29)[3-60]
FESIDAVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	50 (20)[20-20]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
FESOVIVG	0 (0)[0- 0]	25 (1)[1- 1]	67 (1)[1- 1]	50 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
HESKINVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
JUNBALVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (50)[50-50]	0 (0)[0- 0]
JUNDRUVG	100 (18)[3-30]	100 (10)[1-20]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	40 (20)[10-30]	60 (2)[1- 3]
JUNMERVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	40 (1)[1- 1]	60 (2)[1- 3]
JUNPARVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	100 (25)[20-30]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
LUZHITVG	0 (0)[0- 0]	25 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
LUZPARVG	0 (0)[0- 0]	25 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]
LUZSPIVG	33 (1)[1- 1]	75 (2)[1- 3]	33 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
PHLALPVG	33 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	80 (2)[1- 3]	40 (7)[3-10]
POAALPVG	67 (1)[1- 1]	25 (1)[1- 1]	100 (2)[1- 3]	0 (0)[0- 0]	100 (1)[1- 1]	60 (2)[1- 3]	60 (4)[1-10]
POAARCVG	0 (0)[0- 0]	25 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
POAFENVG	100 (3)[3- 3]	75 (3)[3- 3]	33 (10)[10-10]	50 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
POAGLAVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	100 (1)[1- 1]	0 (0)[0- 0]	20 (1)[1- 1]	0 (0)[0- 0]
POAPRAVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	100 (1)[1- 1]	40 (1)[1- 1]	0 (0)[0- 0]
POAREFVG	33 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	40 (1)[1- 1]	0 (0)[0- 0]
POASECVG	33 (1)[1- 1]	0 (0)[0- 0]	33 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
STIOCCVG	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
TRISPIVG	0 (0)[0- 0]	75 (1)[1- 1]	33 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]	0 (0)[0- 0]
***** Forbs *****							
ACHMILVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	50 (1)[1- 1]	100 (1)[1- 1]	20 (1)[1- 1]	0 (0)[0- 0]
AGOGLAVF	33 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	100 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ANEDRUVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ANTALPVF	33 (1)[1- 1]	25 (3)[3- 3]	33 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ANTAROVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ANTLANVF	100 (27)[10-40]	100 (21)[1-60]	67 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ANTMICVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	50 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ANTUMBVF	67 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	100 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ARECAPVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ARECONVF	0 (0)[0- 0]	0 (0)[0- 0]	33 (1)[1- 1]	100 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ARENUTVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
AREOBTVF	67 (2)[1- 3]	25 (1)[1- 1]	100 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ARNLATVF	33 (10)[10-10]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ARNLONVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ARTDRAVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ARTSCOVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ASTABOVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ASTALGVF	33 (1)[1- 1]	25 (3)[3- 3]	67 (6)[1-10]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ASTALPVF	0 (0)[0- 0]	25 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]	100 (10)[10-10]	0 (0)[0- 0]	0 (0)[0- 0]
ASTBOUVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ASTFOLVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (60)[60-60]	20 (30)[30-30]
BESWYOVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
BUPAMEVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	100 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]

(con.)

Species Abbreviations	*JUNDRU/ANTLAN * N = 3	*PHYEMP/ANTLAN * N = 4	*CASMER/CARPAY * N = 3	*JUNPAR/ERIURS * N = 2	*SALGLA * N = 1	*DESCES/CALLEP * N = 5	*CARSCO/CALLEP * N = 5
***** Forbs Continued *****							
CALLEPVF	0 (0)[0- 0]	25 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	100 (48)[20-70]	100 (35)[1-70]
CASPULVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]
CASRHEVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CERARVVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	100 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
CHAALPVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CHITWEVF	0 (0)[0- 0]	50 (2)[1- 3]	33 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
CLALANVF	0 (0)[0- 0]	50 (6)[1-10]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	60 (10)[1-20]	0 (0)[0- 0]
CYMBIPVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
DELOCCVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
DODPULVF	0 (0)[0- 0]	50 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	100 (1)[1- 1]	20 (1)[1- 1]	40 (2)[1- 3]
DOUMONVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
EPIALPVF	0 (0)[0- 0]	25 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	40 (2)[1- 3]	0 (0)[0- 0]
ERICAEVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ERICOMVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ERINANVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ERIPERVF	100 (4)[1-10]	50 (1)[1- 1]	0 (0)[0- 0]	50 (20)[20-20]	0 (0)[0- 0]	40 (20)[10-30]	20 (30)[30-30]
ERIRYDVF	0 (0)[0- 0]	25 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ERISIMVF	0 (0)[0- 0]	50 (1)[1- 1]	100 (2)[1- 3]	0 (0)[0- 0]	100 (3)[3- 3]	20 (3)[3- 3]	20 (1)[1- 1]
ERIURSVF	33 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	100 (15)[10-20]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
ERYGRAVF	67 (7)[3-10]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
FORBPEVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
FRASPEVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	100 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
GENALGVF	0 (0)[0- 0]	25 (1)[1- 1]	67 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
GENCALVF	0 (0)[0- 0]	25 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]
GEUROSVF	0 (0)[0- 0]	0 (0)[0- 0]	100 (24)[1-60]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
GEUTRIVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
HAPUNIVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
HEDSULVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	100 (10)[10-10]	0 (0)[0- 0]	0 (0)[0- 0]
HIEGRAVF	100 (2)[1- 3]	50 (1)[1- 1]	33 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
HYMGRAVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	100 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
LESQUEVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
LEWPYGVF	33 (1)[1- 1]	75 (1)[1- 1]	67 (1)[1- 1]	100 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
LIGTENVF	0 (0)[0- 0]	25 (20)[20-20]	0 (0)[0- 0]	50 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
LLOSERVF	33 (1)[1- 1]	25 (1)[1- 1]	67 (2)[1- 3]	0 (0)[0- 0]	100 (1)[1- 1]	20 (1)[1- 1]	20 (1)[1- 1]
LOMCOUVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
LUPARGVF	0 (0)[0- 0]	25 (1)[1- 1]	33 (1)[1- 1]	50 (1)[1- 1]	100 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]
MERALPVF	0 (0)[0- 0]	0 (0)[0- 0]	33 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
MERCILVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
MICNIGVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (3)[3- 3]
MONCHAVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (20)[20-20]	20 (1)[1- 1]
MYOSYLVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	100 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]
OXYCAMVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
OXYVISVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
PEDCONVF	0 (0)[0- 0]	25 (1)[1- 1]	33 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
PEDCYSVF	0 (0)[0- 0]	0 (0)[0- 0]	33 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	40 (1)[1- 1]	0 (0)[0- 0]

(con.)

Appendix C (Con.)

Species Abbreviations	*JUNDRU/ANTLAN * N = 3	*PHYEMP/ANTLAN * N = 4	*CASMER/CARPAY * N = 3	*JUNPAR/ERIURS * N = 2	*SALGLA * N = 1	*DESCES/CALLEP * N = 5	*CARSCO/CALLEP * N = 5
***** Forbs Continued *****							
PEDGROVF	0 (0)[0- 0]	25 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	80 (3)[1- 3]	80 (7)[1-20]
PEDPARVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	50 (1)[1- 1]	100 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]
PENATTVF	0 (0)[0- 0]	25 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
PENPROVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	100 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
PHLHOOVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
PHLMULVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	50 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
PHLPULVF	0 (0)[0- 0]	0 (0)[0- 0]	33 (1)[1- 1]	50 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
POLBISVF	100 (2)[1- 3]	100 (3)[1- 3]	100 (2)[1- 3]	100 (2)[1- 3]	0 (0)[0- 0]	80 (8)[3-10]	100 (3)[1-10]
POLVISVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
POLVIVVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	100 (1)[1- 1]	20 (3)[3- 3]	20 (1)[1- 1]
POLWATVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
POTDIVVF	100 (1)[1- 1]	25 (3)[3- 3]	100 (8)[1-20]	50 (3)[3- 3]	100 (3)[3- 3]	60 (2)[1- 3]	60 (14)[3-30]
POTOVIVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
RANESCVF	33 (1)[1- 1]	25 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	100 (1)[1- 1]	0 (0)[0- 0]	20 (1)[1- 1]
RUMPAUVF	33 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SAXOPPVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SAXOREVF	0 (0)[0- 0]	25 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	60 (3)[3- 3]	60 (5)[1-10]
SAXRHOVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	50 (1)[1- 1]	100 (3)[3- 3]	0 (0)[0- 0]	0 (0)[0- 0]
SEDLANVF	33 (1)[1- 1]	0 (0)[0- 0]	67 (1)[1- 1]	50 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SENCRAVF	0 (0)[0- 0]	25 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	100 (10)[10-10]	20 (1)[1- 1]	20 (1)[1- 1]
SENCYMVF	0 (0)[0- 0]	25 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (40)[40-40]	60 (18)[3-30]
SENECIVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (3)[3- 3]
SIBPROVF	100 (8)[3-10]	75 (2)[1- 3]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]	20 (1)[1- 1]
SILACAVF	0 (0)[0- 0]	0 (0)[0- 0]	33 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SILPARVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	50 (1)[1- 1]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SILREPVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SMECALVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SOLIDAVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SOLMULVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
STECALVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]	40 (2)[1- 3]
STELONVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	80 (1)[1- 1]	20 (3)[3- 3]
SYNPINVF	0 (0)[0- 0]	0 (0)[0- 0]	67 (1)[1- 1]	0 (0)[0- 0]	100 (10)[10-10]	0 (0)[0- 0]	0 (0)[0- 0]
SYNPLAVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
TAROFFVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]	0 (0)[0- 0]
TRIHAYVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
TRILONVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]	40 (1)[1- 1]
TRINANVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
TRIPARVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (1)[1- 1]
TROLAXVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	20 (10)[10-10]
VALEDUVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
VERWORVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	40 (6)[1-10]	80 (6)[1-10]
ZIGELEVF	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	100 (1)[1- 1]	20 (1)[1- 1]	0 (0)[0- 0]
***** Ferns and Allied Taxa *****							
SELDENVE	0 (0)[0- 0]	0 (0)[0- 0]	33 (10)[10-10]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]
SELWATVE	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]	0 (0)[0- 0]

(con.)

Species Abbreviations	SALNIV/CALLEP N = 2	SALPLA/CARSCO N = 1
***** Trees *****		
PINALBVT	0 (0)[0- 0]	0 (0)[0- 0]
***** Shrubs *****		
ARTFRIVS	0 (0)[0- 0]	0 (0)[0- 0]
ARTTSVVS	0 (0)[0- 0]	0 (0)[0- 0]
CASMERVS	0 (0)[0- 0]	0 (0)[0- 0]
DRYOCTVS	50 (3)[3- 3]	0 (0)[0- 0]
HAPSUFVS	0 (0)[0- 0]	0 (0)[0- 0]
PHYEMPVS	0 (0)[0- 0]	0 (0)[0- 0]
PHYGLAVS	0 (0)[0- 0]	0 (0)[0- 0]
POTFRUVS	0 (0)[0- 0]	0 (0)[0- 0]
SALARCVS	50 (10)[10-10]	0 (0)[0- 0]
SALDODVS	50 (3)[3- 3]	0 (0)[0- 0]
SALGLAVS	0 (0)[0- 0]	0 (0)[0- 0]
SALNIVVS	100 (70)[70-70]	0 (0)[0- 0]
SALPLAVS	0 (0)[0- 0]	100 (70)[70-70]
VACSCOVS	0 (0)[0- 0]	0 (0)[0- 0]
***** Grasinoids *****		
AGRCANVG	0 (0)[0- 0]	0 (0)[0- 0]
AGRSCRVG	0 (0)[0- 0]	0 (0)[0- 0]
AGRSPIVG	0 (0)[0- 0]	0 (0)[0- 0]
ALOALPVG	0 (0)[0- 0]	0 (0)[0- 0]
BROPUMVG	0 (0)[0- 0]	0 (0)[0- 0]
CALPURVG	0 (0)[0- 0]	0 (0)[0- 0]
CARALBVG	0 (0)[0- 0]	0 (0)[0- 0]
CARATRVG	50 (1)[1- 1]	0 (0)[0- 0]
CARELYVG	0 (0)[0- 0]	0 (0)[0- 0]
CARHAYVG	100 (6)[1-10]	0 (0)[0- 0]
CARILLVG	0 (0)[0- 0]	0 (0)[0- 0]
CARLENVG	0 (0)[0- 0]	0 (0)[0- 0]
CARLEPVG	50 (3)[3- 3]	0 (0)[0- 0]
CARNIGVG	0 (0)[0- 0]	100 (1)[1- 1]
CARNOVVG	50 (10)[10-10]	0 (0)[0- 0]
CAROBTVG	0 (0)[0- 0]	0 (0)[0- 0]
CARPACVG	0 (0)[0- 0]	0 (0)[0- 0]
CARPAYVG	0 (0)[0- 0]	0 (0)[0- 0]
CARPETVG	0 (0)[0- 0]	0 (0)[0- 0]
CARPHAVG	0 (0)[0- 0]	0 (0)[0- 0]
CARPYRVG	0 (0)[0- 0]	0 (0)[0- 0]
CARROIVG	0 (0)[0- 0]	0 (0)[0- 0]
CARRUPVG	0 (0)[0- 0]	0 (0)[0- 0]
CARSCIVG	50 (3)[3- 3]	0 (0)[0- 0]
CARSCOVG	0 (0)[0- 0]	100 (30)[30-30]
DANINTVG	0 (0)[0- 0]	0 (0)[0- 0]
DESCESVG	50 (3)[3- 3]	100 (20)[20-20]

(con.)

Appendix C (Con.)

Species Abbreviations	SALNIV/CALLEP N = 2	SALPLA/CARSCO N = 1
***** Graminoids Continued *****		
FESIDAVG	0 (0)[0- 0]	0 (0)[0- 0]
FESOVIVG	0 (0)[0- 0]	0 (0)[0- 0]
HESKINVG	0 (0)[0- 0]	0 (0)[0- 0]
JUNBALVG	0 (0)[0- 0]	0 (0)[0- 0]
JUNDRUVG	0 (0)[0- 0]	0 (0)[0- 0]
JUNMERVG	0 (0)[0- 0]	100 (1)[1- 1]
JUNPARVG	0 (0)[0- 0]	0 (0)[0- 0]
LUZHITVG	0 (0)[0- 0]	0 (0)[0- 0]
LUZPARVG	0 (0)[0- 0]	100 (3)[3- 3]
LUZSPIVG	50 (10)[10-10]	0 (0)[0- 0]
PHLALPVG	0 (0)[0- 0]	0 (0)[0- 0]
POAALPVG	100 (6)[1-10]	0 (0)[0- 0]
POAARCVG	0 (0)[0- 0]	0 (0)[0- 0]
POAFENVG	0 (0)[0- 0]	0 (0)[0- 0]
POAGLAVG	0 (0)[0- 0]	0 (0)[0- 0]
POAPRAVG	0 (0)[0- 0]	0 (0)[0- 0]
POAREFVG	0 (0)[0- 0]	100 (3)[3- 3]
POASECVG	0 (0)[0- 0]	0 (0)[0- 0]
STIOCCVG	0 (0)[0- 0]	0 (0)[0- 0]
TRISPIVG	0 (0)[0- 0]	0 (0)[0- 0]
***** Forbs *****		
ACHMILVF	0 (0)[0- 0]	0 (0)[0- 0]
AGOGLAVF	0 (0)[0- 0]	0 (0)[0- 0]
ANEDRUVF	0 (0)[0- 0]	0 (0)[0- 0]
ANTALPVF	50 (1)[1- 1]	0 (0)[0- 0]
ANTAROVF	0 (0)[0- 0]	0 (0)[0- 0]
ANTLANVF	0 (0)[0- 0]	0 (0)[0- 0]
ANTMICVF	0 (0)[0- 0]	0 (0)[0- 0]
ANTUMBVF	0 (0)[0- 0]	0 (0)[0- 0]
ARECAPVF	0 (0)[0- 0]	0 (0)[0- 0]
ARECONVF	0 (0)[0- 0]	0 (0)[0- 0]
ARENUTVF	0 (0)[0- 0]	0 (0)[0- 0]
AREOBTVF	0 (0)[0- 0]	0 (0)[0- 0]
ARNLATVF	0 (0)[0- 0]	0 (0)[0- 0]
ARNLONVF	0 (0)[0- 0]	0 (0)[0- 0]
ARTDRAVF	0 (0)[0- 0]	0 (0)[0- 0]
ARTSCOVF	0 (0)[0- 0]	0 (0)[0- 0]
ASTABOVF	0 (0)[0- 0]	0 (0)[0- 0]
ASTALGVF	0 (0)[0- 0]	0 (0)[0- 0]
ASTALPVF	0 (0)[0- 0]	0 (0)[0- 0]
ASTBOUVF	0 (0)[0- 0]	0 (0)[0- 0]
ASTFOLVF	50 (1)[1- 1]	100 (10)[10-10]
BESWYOVF	0 (0)[0- 0]	0 (0)[0- 0]
BUPAMEVF	0 (0)[0- 0]	0 (0)[0- 0]
CALLEPVF	100 (22)[3-40]	0 (0)[0- 0]

(con.)

Species Abbreviations	SALNIV/CALLEP N = 2	SALPLA/CARSCO N = 1
***** Forbs Continued *****		
CASPULVF	0 (0)[0- 0]	0 (0)[0- 0]
CASRHEVF	0 (0)[0- 0]	0 (0)[0- 0]
CERARVVF	100 (2)[1- 3]	0 (0)[0- 0]
CHAALPVF	0 (0)[0- 0]	0 (0)[0- 0]
CHITWEVF	0 (0)[0- 0]	0 (0)[0- 0]
CLALANVF	0 (0)[0- 0]	0 (0)[0- 0]
CYMBIPVF	0 (0)[0- 0]	0 (0)[0- 0]
DELOCCVF	0 (0)[0- 0]	0 (0)[0- 0]
DODPULVF	0 (0)[0- 0]	0 (0)[0- 0]
DOUMONVF	0 (0)[0- 0]	0 (0)[0- 0]
EPIALPVF	0 (0)[0- 0]	100 (10)[10-10]
ERICAEVF	0 (0)[0- 0]	0 (0)[0- 0]
ERICOMVF	0 (0)[0- 0]	0 (0)[0- 0]
ERINANVF	0 (0)[0- 0]	0 (0)[0- 0]
ERIPERVF	0 (0)[0- 0]	0 (0)[0- 0]
ERIRYDVF	0 (0)[0- 0]	0 (0)[0- 0]
ERISIMVF	50 (1)[1- 1]	0 (0)[0- 0]
ERIURSVF	0 (0)[0- 0]	0 (0)[0- 0]
ERYGRAVF	0 (0)[0- 0]	0 (0)[0- 0]
FORBPEVF	0 (0)[0- 0]	0 (0)[0- 0]
FRASPEVF	0 (0)[0- 0]	0 (0)[0- 0]
GENALGVF	0 (0)[0- 0]	0 (0)[0- 0]
GENCALVF	0 (0)[0- 0]	100 (1)[1- 1]
GEUROSVF	50 (3)[3- 3]	0 (0)[0- 0]
GEUTRIVF	0 (0)[0- 0]	0 (0)[0- 0]
HAPUNIVF	0 (0)[0- 0]	0 (0)[0- 0]
HEDSULVF	0 (0)[0- 0]	0 (0)[0- 0]
HIEGRAVF	0 (0)[0- 0]	0 (0)[0- 0]
HYMGRAVF	0 (0)[0- 0]	0 (0)[0- 0]
LESQUEVF	0 (0)[0- 0]	0 (0)[0- 0]
LEWPYGVF	0 (0)[0- 0]	0 (0)[0- 0]
LIGTENVF	0 (0)[0- 0]	0 (0)[0- 0]
LLOSERVF	50 (1)[1- 1]	0 (0)[0- 0]
LOMCOUVF	0 (0)[0- 0]	0 (0)[0- 0]
LUPARGVF	0 (0)[0- 0]	0 (0)[0- 0]
MERALPVF	0 (0)[0- 0]	0 (0)[0- 0]
MERCILVF	0 (0)[0- 0]	0 (0)[0- 0]
MICNIGVF	0 (0)[0- 0]	0 (0)[0- 0]
MONCHAVF	0 (0)[0- 0]	0 (0)[0- 0]
MYOSYLVF	50 (1)[1- 1]	0 (0)[0- 0]
OXYCAMVF	0 (0)[0- 0]	0 (0)[0- 0]
OXYVISVF	0 (0)[0- 0]	0 (0)[0- 0]
PEDCONVF	0 (0)[0- 0]	0 (0)[0- 0]
PEDCYSVF	0 (0)[0- 0]	0 (0)[0- 0]
PEDGROVF	50 (1)[1- 1]	100 (3)[3- 3]

(con.)

Appendix C (Con.)

Species Abbreviations	SALNIV/CALLEP N = 2	SALPLA/CARSCO N = 1
***** Forbs Continued *****		
PEDPARVF	0 (0)[0- 0]	0 (0)[0- 0]
PENATTVF	0 (0)[0- 0]	0 (0)[0- 0]
PENPROVF	0 (0)[0- 0]	0 (0)[0- 0]
PHLHOOVF	0 (0)[0- 0]	0 (0)[0- 0]
PHLMULVF	0 (0)[0- 0]	0 (0)[0- 0]
PHLPULVF	0 (0)[0- 0]	0 (0)[0- 0]
POLBISVF	50 (1)[1- 1]	100 (3)[3- 3]
POLVISVF	0 (0)[0- 0]	0 (0)[0- 0]
POLVIVVF	50 (1)[1- 1]	0 (0)[0- 0]
POLWATVF	0 (0)[0- 0]	0 (0)[0- 0]
POTDIVVF	50 (1)[1- 1]	100 (3)[3- 3]
POTOVIVF	50 (1)[1- 1]	0 (0)[0- 0]
RANESCVF	50 (1)[1- 1]	0 (0)[0- 0]
RUMPAUVF	0 (0)[0- 0]	0 (0)[0- 0]
SAXOPPVF	50 (1)[1- 1]	0 (0)[0- 0]
SAXOREVF	50 (1)[1- 1]	0 (0)[0- 0]
SAXRHOVF	50 (1)[1- 1]	0 (0)[0- 0]
SEDLANVF	0 (0)[0- 0]	0 (0)[0- 0]
SENCRAVF	50 (1)[1- 1]	0 (0)[0- 0]
SENCYMVF	0 (0)[0- 0]	100 (3)[3- 3]
SENECIVF	0 (0)[0- 0]	0 (0)[0- 0]
SIBPROVF	0 (0)[0- 0]	0 (0)[0- 0]
SILACAVF	50 (10)[10-10]	0 (0)[0- 0]
SILPARVF	0 (0)[0- 0]	0 (0)[0- 0]
SILREPVF	0 (0)[0- 0]	0 (0)[0- 0]
SMECALVF	0 (0)[0- 0]	0 (0)[0- 0]
SOLIDAVF	0 (0)[0- 0]	0 (0)[0- 0]
SOLMULVF	50 (1)[1- 1]	0 (0)[0- 0]
STECALVF	0 (0)[0- 0]	100 (1)[1- 1]
STELONVF	50 (1)[1- 1]	0 (0)[0- 0]
SYNPINVF	50 (1)[1- 1]	0 (0)[0- 0]
SYNPLAVF	0 (0)[0- 0]	0 (0)[0- 0]
TAROFFVF	0 (0)[0- 0]	0 (0)[0- 0]
TRIHAYVF	50 (3)[3- 3]	0 (0)[0- 0]
TRILONVF	0 (0)[0- 0]	0 (0)[0- 0]
TRINANVF	0 (0)[0- 0]	0 (0)[0- 0]
TRIPARVF	0 (0)[0- 0]	0 (0)[0- 0]
TROLAXVF	0 (0)[0- 0]	100 (20)[20-20]
VALEDUVF	0 (0)[0- 0]	0 (0)[0- 0]
VERWORVF	0 (0)[0- 0]	100 (3)[3- 3]
ZIGELEVF	50 (1)[1- 1]	0 (0)[0- 0]
***** Ferns and Allied Taxa *****		
SELDENVE	0 (0)[0- 0]	0 (0)[0- 0]
SELWATVE	0 (0)[0- 0]	0 (0)[0- 0]

Cooper, Stephen V.; Lesica, Peter; Page-Dumroese, Deborah. 1997. Plant community classification for alpine vegetation on the Beaverhead National Forest, Montana. Gen. Tech. Rep. INT-GTR-362. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 61.

Vegetation of the alpine zone of eight mountain ranges in southwestern Montana was classified using TWINSPAN, DECORAN, and STRATA—algorithms embedded within the U.S. Forest Service Northern Region's ECADS (ecological classification and description system) program. Quantitative estimates of vegetation and soil attributes were sampled from 138 plots. Vegetation composition, structure, productivity, associated soil features, and landscape positions are described for the 23 recognized community types that include wetland, snowbed, cushion plant, turf, and grassland physiognomic types. Field identification of community types is facilitated through the inclusion of a diagnostic indicator species-based dichotomous key. Management related observations are posited for this regional alpine zone and for particular vegetation types.

Keywords: alpine habitats, vegetation classification, key to classification, parent materials, soil variables, southwestern Montana

INTERMOUNTAIN RESEARCH STATION

The Intermountain Research Station provides scientific knowledge and technology to improve management, protection, and use of the forests and rangelands of the Intermountain West. Research is designed to meet the needs of National Forest managers, Federal and State agencies, industry, academic institutions, public and private organizations, and individuals. Results of research are made available through publications, symposia, workshops, training sessions, and personal contacts.

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