VEGETATION MAPS AND FLORISTIC LIST

FOR THE

VERMILION PASS BURN: 1976

FINAL REPORT

by

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ABSTRACT

This is the final report on a study carried out in 1976, directed at describing the vegetation of the Vermilion Pass Burn, the fire having occurred in 1968. Emphasis was placed on the standardization of methods to maximize comparative ability. The bulk of the results are presented in the form of three maps; Lodgepole Pine Seedling Densities, Dominant Shrubs, and Dominant Herbs. The floristic list (Appendix I) includes 256 vascular plant species encountered this past year. Degree of seedling regeneration was, in most cases, related to the available supply of seeds. Exceptions occurred in areas of high water table and disturbed bed. Avalanche slopes which have appeared since the fire are, for the most part, regenerating normally. Average seedling density in the Burn has increased by over two times since 1972. Peak seedling emergence occurred in 1971. The number of shrub individuals per plot has increased by over four times since 1972, although *Menziesia glabella* has only somewhat more than doubled in numbers. *Sambucus melanocarpa* is a major successional shrub species. Percent bare ground has decreased from about 65% in 1972 to about 25% in 1976. The two major herb species in the Burn are *Elymus innovatus* and *Epilobium angustifolium*. *Arnica cordifolia* has largely fallen out of the "race".

INTRODUCTION

In 1972 Willard and Harris produced the first set of vegetation regeneration maps for the Vermilion Pass Burn. The following year Winterbottom (1973) carried out a detailed M.Sc. study on the vegetation of the avalanche slopes in the area and also mapped some of the major changes within the Kootenay National Park portion of the Burn proper. Previous to these two studies, Dube (1972) and Olthof (1972) performed detailed post-graduate work on specific aspects of the regeneration in some areas of the Burn.

This paper represents the results of a study done during the summer of 1976 directed at remapping the vegetation of the Burn; this is the second time (i.e., covering most of the study area in reasonable detail) since the fire of 1968. In 1972 Willard and Harris produced three maps: one concentrating on the densities and patterns of the lodgepole pine (*Pinus contorta* var. *latifolia*) seedlings; one depicting the zones of dominant shrubs; and one depicting the zones of dominant herbs. Similarly, three maps are presented this year. This task was expanded somewhat by including areas of Burn previously not investigated: those portions included within the avalanche complex, the far southwest corner of the Burn, and most of the northwest section. These comprise a large percentage of the Burn and are of special interest because of their complexity and somewhat different floristic nature. For a general description of the study area, the reader is referred to Guy (1976) and any of the other papers originating from the Vermilion Pass Burn Study.

METHODS

In 1972, a group of surveyors set out a 300 metre grid of pins which later formed the basis for the construction of the first base map.[1] In past years the procedure has been to set up sample plots or releves at or near each of these pins. Both within and without the Burn, there are some 245-plus possible sample sites thus defined (if one includes bench-marks). The surveyors had marked each pin location with two red or orange flags tied around a tree and in addition usually placed some flagging at intervals between each pin along the N.W.-S.E. grid lines. Unfortunately, in the four years that have passed since then, many of the flags have faded, been lost, or the trees have fallen down. Consequently, locating the pins (many of which have become grown over) was very difficult over much of the Burn. It was not unusual for us to spend several hours searching for a single pin. Hopefully, to alleviate this situation in future years each pin found was re-marked by painting two fluorescent orange rings around a reasonably stable trunk not more than five metres away. With the aid of only a compass, it was virtually impossible to find pins on many of the avalanche slopes (where most flagging had been swept away) and in the far southwest corner (where not a single pin on lines 18-SW, 19-SW, 20-SW, and 21-SW was located). In total, 159 pins were found, of which 152 were sampled. Seven were either deemed unsuitable or occurred in the unburnt forest. Thirty-six additional pins were sought for and not found, which precluded the finding of some

[1] Necessarily revised this year.

40 more pins or benchmarks. Around pins, then, 152 tree/shrub relevés and 146 herb relevés were set up. In addition, 18 extra tree/shrub relevés and seven extra herb relevés were used. Six of these were placed near the permanent weather stations for possible future application. Thus a total of 493 plots (i.e., trees, shrubs, and herbs all considered separately) were investigated this year.[1] Although this may seem to be a very substantial number, I firmly believe it to be totally inadequate as a basis for mapping an area as large as that covered by the Burn. To assume that each of the systematically postioned plots fairly represents a surrounding area corresponding to 90,000 m^2 would be a grave mistake. In fact, when a few herb sites were sampled twice, once with the standard 2 m radius and once with a 5 m radius, very different results were obtained. Many of the plots "landed" in places exhibiting characteristics of vegetation cover obviously atypical of that in the general vicinity, yet it is the "general vicinity" that one is interested in when mapping vegetation on such a large scale. To help alleviate this problem, detailed information was collected along transects between the sample sites (in most cases).[2] Changes in dominance, density, associations, topography, adjacent vegetation, etc. were recorded according to the number of paces walked. This information was later transcribed to maps for analysis. As a consequence, the final vegetation maps presented are

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[1] This compares with about 223 used in 1972 for compiling the maps and an additional 95 or so extra plots not used for that purpose.

[2] I would estimate that complete transect data was collected over a total linear distance of some 60-70 km or more.

largely based on the transect data (indeed, in many cases, such as for the far southwest corner, only on transect data). The primary purpose of the plot data, then, as it related to the mapping, was to provide a check on the observed and estimated patterns of vegetation encountered along the transects. The plots did, of course, provide an opportunity to investigate the vegetation in more detail and are (and will be) extremely useful in the objective documentation of successional changes at the many single separate locations. Such data, when pooled, can provide a basis for drawing generalized conclusions about the entire Burn or large portions thereof.

The tree and shrub relevés were constructed by laying out a 5 m radius circle (78.54 m^2) around each pin, or other object chosen in the case of extra plots, or grid points lacking any apparent pin. These circles were delineated by 12 stakes, a number which in most cases was suitable for the inclusion or exclusion of the shrubs or seedlings in question. All seedlings were measured for height and counted in the process. In many cases the number of internodes possessed by each individual was recorded. During the earlier months of the season the degree of candle elongation was also recorded. Shrubs of each species were counted and placed in height classes as follows:

(1) <25 cm; not included; considered part of the herb layer.

(2) 25-35 cm; small.

(3) 35-60 cm; moderate.

(4) >60 cm; large.

In addition, extremely massive individuals were also noted separately. This system was employed in order that the determination of the dominant shrub would not be based simply on numbers alone (as it was in 1972 and 1973). For example, it is obvious that a very large *Alnus* contributes

much more biomass than, say, three small spindly *Rubus* canes. This classification is by no means universally applicable as some consideration to shrub width should also be (and was) given.

Work on the herbs was commenced at the beginning of July. For this purpose, a 2 m radius (12.57 m^2) relevé was set up around each pin and marked off with stakes (as was done for the shrubs and tree seedlings). In previous years percent cover by each species was estimated by eye. Normally when this is done the observer uses a partitioned estimate scale of 6 or 7 classes. This method usually provides reproducible results among experienced workers. Total percent cover is allowed to exceed 100 (and often does). However, this has not been the case in this study where percent cover for each species was estimated (in previous years) to within 5% at any level and not allowed to exceed 100 when totalled for all species. As a result, a great deal of subjectivity and variability between workers could be expected. To help standardize the results to make them more objective and comparable in future years, and, at the same time, to try to maintain a reasonably high degree of comparability to previous years, I devised a new method of sampling. A small lightweight ring (~12 cm in diameter) attached to a string was thrown as randomly as possible (over the back) into the plot 25 times from each of four sides. The plant species (or "nothing") occupying the greatest area within the ring was recorded. If two plants overlaid each other, the same criterion was used. Where two or more species filled the ring more or less equally, the one closest to the middle was taken. Total values ("contacts") obtained were later rounded off to the nearest 5 percent. In effect, this system translates to a modified Point-Intercept Method which equates frequency with cover (see Mueller-Dombois and Ellenberg, 1974, page 84). Of course, there

are numerous drawbacks to this technique. For example, tall plants may tend to intercept the ring in "flight"; also it is impossible to insure complete randomness when throwing the ring. I feel, however, that the method is suitably accurate for our purposes. A number of plots were sampled twice in order to get some idea of the reproducibility. In almost every case values were within 5% of each other. Trampling of the herb plots was at all times kept to a minimum.

Standard information collected at all plot sites included: aspect, slope (steep, moderate, gentle, etc.), deadfall (low, moderate, high), presence of polycyclic tree seedlings, all other species in the immediate vicinity, and other notes (e.g., "boggy", "atypical", heavily browsed", "rocky", etc.). In addition, lodgepole pine seed source-tree supply was estimated on a scale based on the burnt trees surrounding as follows:

(1) 0% = none

(2) 0-5% = poor

(3) 5-25% = fair

(4) 25-75% = good

(5) 75-95% = very good

(6) 95-100% = excellent

Throughout the summer, voucher specimens were collected for identification, pressing, and mounting. A number of photographs were taken as well.

RESULTS

A floristic list for the Burn was compiled and is presented in Appendix I. Excluding the avalanche slopes and roadway, 215 herb (including forbs, grasses, prostrate shrubs, and woody herbs), 32 shrub, and 9 tree species were encountered and identified this year. Not included in the list are the non-vascular plant species. Although not considered as much a part of the study as were the vascular plants (i.e., non-vasculars were not extensively collected nor do they appear in any of the zone descriptions[1]), they are rapidly assuming a major role in the regeneration of the Vermilion Pass Burn. Fungi are quite common, being, visually, best developed on the burnt logs and stumps. *Marchantia polymorpha* (a liverwort) is a major species frequently found near the bases of burnt trees, under roots, in moist hollows, or in continuous carpets near the Burn-edge. The two seemingly most important (and possibly extensively competing) mosses in the area are *Ceratodon purpureus* and *Polytrichum juniperum*. As yet, the lichen flora of the Burn is very poorly developed. In all likelihood this situation will reverse within the next 10-20 years. Only two small thalli were observed during the entire field season. One was a *Peltigera* sp. while the other appeared to be of the genus *Cetraria*.

The bulk of the results is presented in Maps 1, 2 and 3. Two types of line appear on the maps. A solid line indicates reasonable certainty of the position of that line. A dashed line indicates some uncertainty. The maps are described and discussed below.

MAP ONE: Lodgepole Pine Seedling Densities.

The isolines are in numbers of seedlings per 78.54 m^2 plot. As is

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[1] Although the presence of moss in significant (dominant or prominently sub-dominant) amounts is indicated on the herb map.

apparent from the map, the pattern of seedling regeneration is by no means simple. For the most part, the number of seedlings in any area could be correlated with the available seed supply at the time of the fire (as in many other studies). Very little of the regeneration can be ascribed to seed blown in from outside the Burn. Most lodgepole pine seed is disseminated by wind to distances within only 50-90 metres of standing trees (Lotan, 1973). Regions with low seedling densities (or none at all) almost invariably had a negligible supply of source trees. Exceptions to this rule occurred in areas of high water tables, often with *Calamagrostis canadensis* (marsh reed grass) as the predominant ground cover. Horton (1953, in Brown 1973) maintains that low intensity fires on moist sites are unable to reduce the duff layer, resulting in a poor seedbed and thus poor stocking. Alternatively, severe competition imposed by the grass may be responsible. Certainly the high moisture content of the soil is not directly responsible. Lodgepole pine seedlings can grow on even saturated soils and are quite tolerant of high water tables (Lapushinsky, 1973). Many workers have noted that seeding to grass may restrict regeneration (Basile, 1973). Burning prior to seeding increases the likelihood of a good stand of grass (Terwilliger, 1964 in Basile 1973). My hypothesis is that a large portion of the roots of the marsh reed grass survived the fire because of the higher water table. They were thus in a position to rapidly recover such areas, thereby severely limiting the chances of any lodgepole pine seedlings becoming established. It should be noted that seedlings are not usually completely non-existent in these locations.

The importance of seed supply, and thus stand history, as a factor determining seedling density was strikingly apparent on the northeast-

facing side of the valley in the Kootenay National Park portion of the Burn. After the maps were completed, it was noticed that the major isolines, separating large belts of relatively low or high density, closely followed a line separating two previous stands of different age. This line was still visible in the post-fire aerial photographs. On the upper slopes, the former forest was probably in the full-climax condition. The lower slopes were most likely covered by a near-climax forest.

Upon canopy closure, stands of 4,000 plus stems per acre reach a level of negligible herbage production (Basile, 1973). Such dense stands (known as "locked" or, in more extreme cases, "dog-hair" stands) tend to remain dense regardless of site quality (Smithers, 1961 in Johnstone 1973). Four thousand stems per acre is equivalent to 77.5 seedlings per 78.54 m^2 plot. Thus, those areas on May 1 surrounded by an isoline representing 75 seedlings per plot are prime candidates for such stands. In most cases these high density zones are confined to those locations dominated by reproductively mature lodgepole pine forest prior to the fire of 1968[1]. The highest single count in any plot recorded in the Vermilion Pass Burn in 1976 was 265. This is equivalent to 13,665 stems per acre! This, however, is not an incredible figure when one considers that stocking levels as high as 600,000 seedlings per acre have been recorded in other forested regions of North America (Johnstone, 1973).

On Map 1 the isolines may or may not cross avalanche slopes or streams. Avalanche slopes without isolines crossing (and within) them have no, or nearly no, seedlings. As a general rule those avalanche slopes

[1] Cat-cuts are also sometimes very densely covered under other conditions. See, for example, the high density zone near 21D and 21E-SW as shown on the map.

which have appeared since the fire have seedlings in numbers equal to or slightly less than adjacent wooded areas. Slight reductions may be due to excessive rubble or partial removal of the seed supply. Those avalanche slopes which were well established and of reasonable width before the fire have, for the most part, no or few lodgepole pine seedlings.

MAP 2: Dominant Shrubs; and MAP 3: Dominant Herbs

These maps break the Burn up into numerous zones of widely varying sizes, described by particular dominant species, or sets of co-dominants and/or sub-dominants. Each zone is numbered; the numbers corresponding to particular types as defined in the keys (Appendices II and III). The unusually large numbers of map units used present a very complicated picture of the extant vegetation. I have tried not to form any excessively arbitrary or unnatural groups, attempting to keep the maps as realistic and descriptive as possible. There are many advantages to such an approach, especially for a long term study such as the one this paper represents a segment of. Changes may be more easily followed and their origins traced. The continuum of vegetation change as a function of topography is more apparent. More emphasis is placed on the fact that rarely does one find a precise boundary between two or more vegetation complexes. To simplify matters somewhat, I have also outlined (in color) the inside of boundaries of similar zones which can be grouped together into larger zones defined by one major dominant (in most cases).

On both the shrub and herb maps, lines marking out a zone do not generally cross streams or avalanche slopes. Where a zone does straddle such a formation, designating numerals have been placed on either side. Avalanche slopes were not included in the mapping of the shrubs and herbs,

as in many cases data were insufficient. For the most part the results correspond reasonably well with those of Winterbottom (1974) who studied them in considerably greater detail.

VEGETATION CHANGE SINCE 1972

All changes noted are based on plot data only. Uneven representation of various areas and problems encountered in the collation of data from 1972 with that of 1976 require that many of the following conclusions be taken with a "grain of salt."

TREE SEEDLINGS: On the basis of 48 corresponding plots used in both years, lodgepole pine density has increased by an average of 2.14 times. Extremes are an increase from 2 to 120 per plot and a decrease from 50 to 5 per plot. The majority of seedlings in 1976 had 5 or 6 internodes, the peak being in the 6 internode interval. This would indicate that maximum seedling emergence took place in 1971 and has fallen rapidly since. Figure 1 on page 13 plots number of individuals (total = 460, from 36 plots sampled before noticeable candle elongation) against number of internodes. It was assumed that polycyclic individuals made up an insignificant segment of the population. Seedlings emerging since 1971 account for 38% of the total number of seedlings present at this time. Seedlings established in 1975 account for only 2% of the total seedling number. Figure 2, page 14 , plots average seedling height against number of internodes for the same individuals as used in the plotting of Figure 1. It would appear that most of the seedlings in the Burn are over 0.5 m tall, at least at the lower elevations. Some seedlings measured in at over 1.5 m in height. These tend to be polycyclic.

As in 1972, most of the spruce and fir seedlings were found near unburnt pockets or close to the Burn-edge. Although largely absent over the rest of the Burn in 1972, they are now fairly evenly and thinly distributed throughout almost the entire area; the spruce seedlings especially so. Aspen clones occur occasionally, but for the most part this species is represented by solitary scattered individuals. *Pinus albicaulis* (Whitebark Pine) seedlings were a relatively frequent occurrence, at elevations as low as 5,000' (~1800 m) A.S.L, though best developed at the higher elevations.

SHRUBS: On the basis of 33 corresponding plots used in 1972 and 1976, the number of shrub individuals per plot has increased by 4.40 times (from 9.61 to 42.24) and the number of species per plot has increased by 1.87 times (from 1.88 to 3.52). Average percentage[1] composition by species for these plots was, in 1972: *Menziesia* 65.7%, *Spiraea* 8.2%, *Rosa* 7.9%, *Ledum* 6.3%, *Sambucus* 3.8%, *Shepherdia* 3.5%, *Lonicera* 1.6%, *Ribes* 1.3%, *Rubus* 0.6%, *Vaccinium* 0.6%, *Potentilla* 0.3%.

In 1976: *Menziesia* 36.7%, *Ledum* 12.5%, *Spiraea* 12.2%, *Salix* 10.9%, *Rosa* 6.6%, *Potentilla* 5.8%, *Betula* 4.8%, *Shepherdia* 3.2%, *Rubus* 1.6%, *Sambucus* 1.3%, *Lonicera* 1.3%, *Rhododendron* 1.2%, *Ribes* 0.9%, *Sorbus* 0.9%, *Vaccinium* 0.1%, *Alnus* 0.1%.

Significant changes in dominance were not apparent at all but three of these pins. It would appear that in the vicinities of 10B-NE, 8B-NE,

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[1] I again stress that the validity of these figures is very tenuous and they by no means represent an equable cross section of the entire Burn. Their inclusion is merely for purposes of illustrating some general concepts.

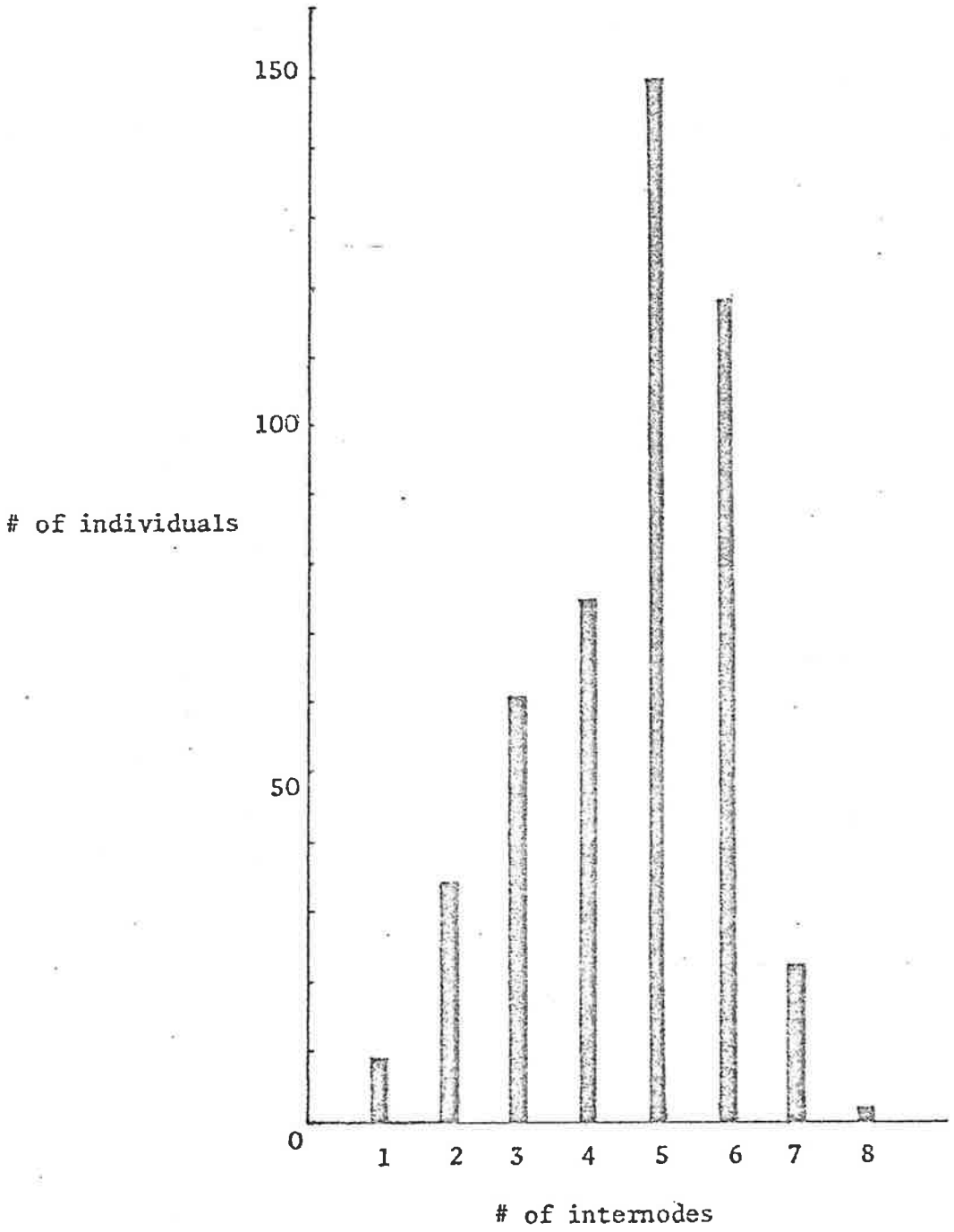

Figure 1. Number of *Pinus contorta* var. *latifolia* (Lodgepole Pine) seedlings in each internode class. Based on 460 seedlings from 36 plots sampled before noticeable candle elongation.

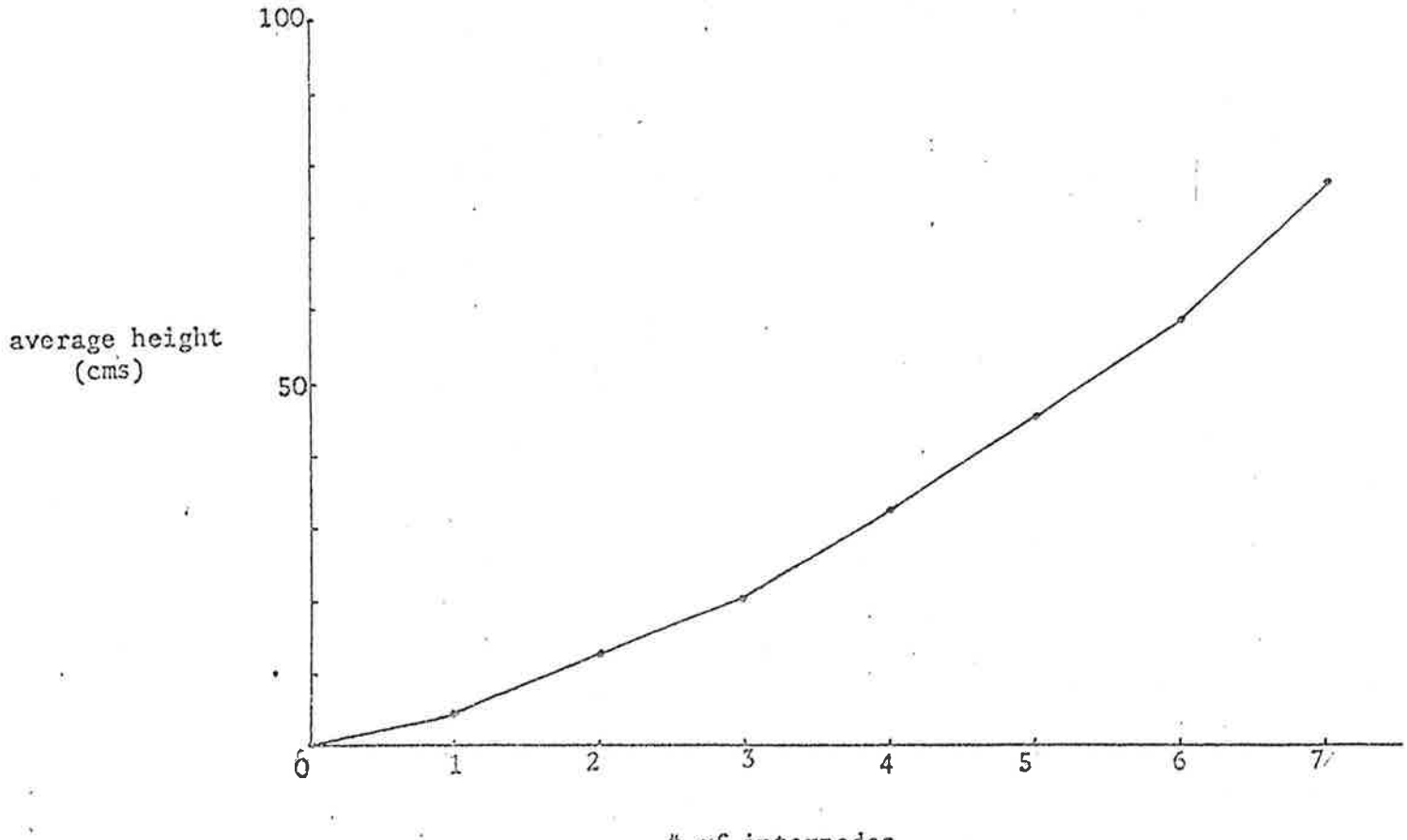

Figure 2. Average heights in centimetres of *Pinus contorta* var. *latifolia* (Lodgepole Pine) seedlings in each internode class. Based on measurements of 460 seedlings from 36 plots sampled before noticeable candle elongation.

and 12C-SW. *Menziesia glabella* (False Huckleberry) has lost its role as the dominant shrub. Whether or not a loss in numbers has occurred cannot be definitely ascertained, although this does not appear to be the case. Rather, these areas have experienced rapid regrowth of *Spiraea lucida* (White Meadowsweet) and *Rosa acicularis* (Prickly Rose). *Shepherdia canadensis* (Canada Buffalo-berry) has also become somewhat prominent. This rapid growth had apparently not occurred up until 1972. This, in fact, would seem to be the trend exhibited by most of the species and probably accounts for the decrease in the amount of percentage composition (by numbers) formally held by *Menziesia glabella*. Although the total shrub number has increased by over fourfold, the number of *Menziesia glabella* individuals has only somewhat more than doubled.

As pointed out by Willard and Harris (1972), most of the shrubs appear to originate from partially burnt roots which managed to survive the fire. However, this was not always the case. Of 10 shrub species investigated this past year, two appeared not to arise (for the most part) from pre-fire roots. These were *Salix glauca* (Blue-green Willow) and *Sambucus melanocarpa* (Black Elderberry). *Sambucus melanocarpa* is a major dominant over much of the Burn. It is shade tolerant and seems to prefer high water tables. It was observed that usually in such areas *Menziesia glabella* was apparently the sole dominant previous to the fire. Thus it would seem that *Sambucus melanocarpa* is a truly successional species. We did not investigate the roots of many of the major shrubs (e.g., *Spiraea lucida*, *Rosa acicularis*, *Potentilla fruticosa*, *Ribes lacustre*, and *Rubus strigosus*) and it would be advisable that these be looked at in future years (if it is not too late).

Generally speaking, the shrubs probably do not on the whole exhibit a profound successional pattern, tending to be relatively more static over time regardless of fire. This property may be useful as a means for helping to attempt the prediction of post-fire herbaceous covering in areas that could possibly be subject to controlled burning. A great deal more research would be necessary, however, merely to establish the feasibility of this proposal.

HERBS: On the basis of 38 corresponding plots representing (in some respects) a reasonable cross-section of the Burn, per cent ground cover has increased by about 1 3/4 times since 1972 when approximately 65% of the ground surface was bare. In 1976 only about 25% of the ground surface lacked herbaceous cover. Without any doubt, the herbaceous vegetation of the Burn has become much more complex. Major changes in dominance have occurred over much of the area. Unfortunately, these changes cannot be satisfactorily plotted on a map. To do so would be folly with the amount of information available. Certain generalizations can, however, be made. In general, the biomass attributable to each of the major plant species has increased considerably, with the exception of *Arnica cordifolia* (Heart-leaved Arnica). In 1972, this was one of the two major dominant species, the other being *Epilobium angustifolium* (Fireweed). In 1976, although still a major species, *Arnica cordifolia* was the sole dominant in only two relatively small areas. This species suffered a loss in numbers in almost all of the 1972/1976 corresponding plots it occupied. In most cases, it would appear to have been out-competed by *Epilobium angustifolium*, although in the vicinity of 12C-SW *Elymus innovatus* (Hairy Wild Rye) is now dominant, while at B.M. 14-SE,

Calamagrostis canadensis has taken over. Both of these, particularly *Elymus innovatus*, are now major dominants over much of the Burn. Still, *Epilobium angustifolium* is the most widespread and abundant element. In many areas, however, it has lost territory to *Elymus innovatus*. Another species which seems to have suffered a loss in dominance (and possibly a reduction in numbers) is *Cornus canadensis* (Bunchberry). It was a major co-dominant in 1972 but is now of relatively little significance in terms of biomass. A number of species have consistently, and sometimes dramatically, increased their numbers (occasionally to the point of assuming the dominant role). These include: *Aster ciliolatus* (Lindley's Aster), *Aster conspicuus* (Showy Aster), *Carex* spp. (Sedges), *Equisetum scirpoides* (a horsetail), *Hieracium albiflorum* (White Hawkweed), *Linnaea borealis* (Twin-Flower), *Vaccinium myrtillus* (Low Bilberry), *V. scoparium* (Grouseberry), mosses, and, no doubt, many others. I expect that these elements will continue to increase in importance over the next several years. Some data in support of this belief comes from the present vegetation of the small previously burned area on the northwest-facing slope. This area seems to have caught fire sometime in the early sixties and consequently did not burn in 1968. Although completely surrounded by an *Epilobium angustifolium*- dominated zone, the previous burn is now dominated by *Vaccinium* spp. with large pockets of *Hieracium albiflorum*. Paradoxically, *Arnica cordifolia* is also somewhat well developed.

SUGGESTIONS FOR FURTHER RESEARCH

1. It might be wise to do some detailed qualitative work on the biomass (standing crops and productivities) of the three major strata (herb, shrub, and tree). Comparative studies should be performed, at the same

time, within older successional and climax forest stands. If coupled with nutrient analyses on the major species, valuable information of importance to large mammal management would be obtained. Although Taylor (1967, in Lotan 1973), working in Yellowstone National Park, found that the percentage frequency of 33 successional vascular plants reached a maximum in a 25 year old burn, Basile (1973) states that total understorey peaks 11 years after cutting and burning in Montana. Thus if such a study were to be undertaken in the Vermilion Pass, it should commence within the next two or three years.

2. Very little work has been done on the role and pattern of lichen (and moss) growth following fire in subalpine coniferous forests. Lichens are a strikingly significant element of successional lodgepole pine forests. As the lichens are as yet poorly developed in the Burn, an excellent opportunity to study their successional status still exists. They should not be overlooked.

3. It would be interesting to re-examine in detail, in a few years' time, those sites studied by Dubé (1972) and Olthof (1972).

4. Certain portions of the Burn are in need of re-surveying; particularly the far southwest corner and the avalanche slope complex. The precise positions of the avalanche slopes are not known. If a survey crew could provide a base map showing all cliffs, ravines, ridges, seepage areas, etc., this would greatly facilitate the production of future vegetation maps.

5. All researchers should be required (in writing) to submit to the firm complete records of all data collected.

ACKNOWLEDGEMENTS

I would like to thank Dr. Stuart Harris and the Banff and Kootenay National Parks for allowing me to undertake this study. I gratefully acknowledge the help of my invaluable assistant, Peter Allen. Thanks to Dr. Bird (University of Calgary) for help with the moss identifications, and to Dr. Ogilvie (University of Calgary) for the identification of *Ceanothus velutinus*.

LITERATURE CITED

Basile, J. V., 1973; Forage Productivity in the Lodgepole Pine Type; in Baumgartner, D. M. (Ed.), 1975; Management of Lodgepole Pine Ecosystems, Symposium Proceedings, Washington State University Cooperative Extension Service.

Brown, J. K, 1973; Fire Cycles and Community Dynamics in Lodgepole Pine Forests; in Baumgartner, op. cit.

Dubé, D., 1972; Vermilion Pass Fire Project, Preliminary Report A; Unpublished report.

Guy, R. D., 1976; Small Mammals of the Vermilion Pass Burn, Annual Check: 1976; unpublished report.

Johnstone, W. D., 1973; Variable Stand Density Yields of Natural Lodgepole Pine Stands in Alberta; in Baumgartner, op. cit.

Lindsey, G. D., 1973; The Influence of Animals on Lodgepole Pine Regeneration; in Baumgartner, op. cit.

Lopushinsky, W., 1973; Water Relations and Photosynthesis in Lodgepole Pine; in Baumgartner, op. cit.

Lotan, J. E., 1973; Regeneration of Lodgepole Pine Forests in the Northern Rocky Mountains; in Baumgartner, op. cit.

Moss, E. H., 1959; Flora of Alberta; University of Toronto Press, Toronto.

Mueller-Dombois, D. and H. Ellenberg, 1974; Aims and Methods of Vegetation Ecology; John Wiley and Sons, Toronto.

Mulligan, G. A., 1976; The Genus *Draba* in Canada and Alaska: Key and Summary; Can. J. Bot. 54:1386-1393.

Olthof, P., 1972; A Series of Notes and Fieldwork Reports on the Regeneration and Vegetation of the Vermilion Pass Burn; Unpublished report.

Willard, T. and S.A. Harris, 1972; Vegetation Map of the Vermilion Burn; unpublished report.

Winterbottom, K. M., 1973; Vegetation Mapping of the Vermilion Burn; unpublished report.

Winterbottom, K. M., 1974; The Effects of Slope Angle, Aspect, and Fire on Snow Avalanching in the Field, Lake Louise, and Marble Canyon Region of the Canadian Rocky Mountains; unpublished M.Sc. thesis, University of Calgary.

APPENDIX I

Floristic List for the Vermilion Pass Burn, 1976.

The following list of vascular plant species occurring within the Burn in 1976 is by no means complete, although all the major entities are included. Undoubtedly, more work could be done, particularly on the grasses, sedges, and willows. Not all of the species listed herein can be considered fire successional. Many of the plants may have survived the fire as a function of their location (e.g., bogs, cliffs, etc.). Some of the plants were only observed near the Burn edge and thus may have escaped the full force of the fire (such cases are indicated under "Other Notes"). This list excludes the avalanche slopes, gravel pits, and roadways which, if included, would have contributed significantly to the overall number of taxonomic entities presented.

Blooming dates are not necessarily correct as they merely represent the first day I observed and recorded the flowering of any one species. Presence within one or both of the national parks (Kootenay National Park, Banff National Park) is indicated, as is the relative abundance of each species within the Burn as a whole (A = abundant, C = common, O = occasional, R = rare). Whether a plant was considered a member of the herb (H), shrub (S), or tree (T) layer is also specified. For the most part nomenclature is that of Moss (1959), with the exception of *Draba* spp. which follow Mulligan (1976).

Family / Species	Layer	Park: B.N.P. (Banff National Park)	Park: K.N.P. (Kootenay National Park)	Abundance	Blooming Date	Other Notes
OPHIOGLOSSACEAE						
Botrychium lunaria	H	✓	✓	R		
POLYPODIACEAE						
Athyrium Felix-femina	H		✓	R		On rocky slope above 3B-SE.
Cryptogramma stelleri	H		✓	R		Cliffs near 7D-SW.
Cystopteris Fragilis	H		✓	O		Cliffs.
Dryopteris dilatata	H	✓		R		3B-NE.
Gymnocarpium dryopteris	H	✓	✓	C		Beside brooks.
Polystichum lonchitis	H		✓	R		Brook near 1H-SE, Burn edge.
Woodsia scopulina	H	✓	✓	C		Cliffs and rocks.
EQUISETACEAE						
Equisetum arvense	H	✓	✓	C		Moist areas.
E. fluviatile	H		✓	R		Pond beside Stanley Trail.
E. hyemale	H	✓		R		Wet areas.
E. scirpoides	H	✓	✓	A		
E. sylvaticum	H		✓	C		Well developed north of B.M. 14-SE.
E. variegatum	H		✓	R		Near weather Station #1.
LYCOPODIACEAE						
Lycopodium annotinum	H	✓	✓	O		Burn edge.
L. clavatum	H	✓		R		South of 8E-NE.
L. complanatum	H	✓		R		South of 8E-NE.

Family / Species	Layer	Park: B.N.P.	Park: K.N.P.	Abundance	Blooming Date	Other Notes
PINACEAE						
Abies lasiocarpa	T	✓	✓	C		
Juniperus communis	S	✓	✓	O		Expected to increase.
Picea glauca X *engelmannii*	T	✓	✓	A		
Pinus albicaulis	T	✓	✓	O		At all elevations, but be developed higher up.
Pinus contorta var. *latifolia*	T	✓	✓	A		
Pseudotsuga menziesii	T		✓	R		Near 21H-SW
GRAMINEAE						
Agropyron repens	H		✓	O		
Agropyron trachycaulum	H	✓	✓	C		
Bromus pumpellianus	H	✓	✓	C	Aug.11	
Calamagrostis canadensis	H	✓	✓	A		Moist areas.
Calamagrostis rubescens	H		✓	R		May be more common.
Dactylis glomerata	H		✓	R		C.P.R. cutline.
Elymus innovatus	H	✓	✓	A	July 15	
Festuca brachyphylla	H		✓	O	Aug.1	High altitudes.
Koeleria cristata	H	✓	✓	O		
Hordeum jubatum	H		✓	O		Near highway.
Phleum alpinum	H	✓		O		High altitudes.
Phleum pratense	H	✓	✓	C	July 12	

Family / Species	Layer	Park B.N.P.	Park K.N.P.	Abundance	Flowering Date	Other Notes
Poa alpina	H	✓	✓	C		
P. glauca	H		✓	O		
P. leptocoma	H	✓		R		Near 9F-NE, close to Burn edge.
P. palustris	H	✓	✓	R		
P. pratensis	H	✓	✓	O		On trails and near 14D-NE.
Sitanion hystrix	H		✓	R		Near 15E-SW
Trisetum spicatum	H	✓	✓	C	Jul.17	
CYPERACEAE						
Carex aquatilis	H	✓		O		Bog at 8A-NE; also 48-NE.
C. atrosquama	H		✓	C		Moist areas.
C. aurea	H		✓	R		Near Weather Station #1.
C. capillaris	H		✓	O		Boggy areas.
C. deflexa	H	✓	✓	A		May be less abundant.
C. flava	H	✓		R	Aug.5	Boggy area near 13A-NE near Burn edge.
C. heliophila	H	✓	✓	A		Mostly south-facing slopes.
C. interior	H		✓	R		Bog between 12D-SE and 11D-SE.
C. physocarpa	H		✓	R		Pond beside Stanley Trail.
C. platylepis	H	✓	✓	A		
C. rossii	H	✓	✓	A		May be less abundant.
C. rostrata	H	✓		O		Bogs at 8A-NE and where Boom Ck. joins Altrude Ck
C. scirpoidea	H	✓	✓	O		May be more abundant.

Family / Species	Layer	Park: B.N.P.	Park: K.N.P.	Abundance	Flowering Date	Other Notes
Eriophorum viridi carinatum	H	✓	✓	O	Aug. 5	Boggy areas.
Scirpus caespitosus var. *callosus*	H		✓	R	Aug.15	Boggy areas.
JUNCACEAE						
Juncus albescens	H		✓	R	Aug.15	Wet areas.
J. balticus	H	✓	✓	C	July 19	Wet areas.
J. castaneus	H	✓	✓	R		Wet areas.
J. drummondii	H	✓	✓	C	July 22	Wet areas.
J. mertensianus	H	✓		R	July 22	Arnica Lake Trail.
J. nodosus	H		✓	R	July 29	Near 3B-SW
Luzula parviflora	H	✓	✓	A	July 8	
LILIACEAE						
Allium cernuum	H	✓	✓	C		
Disporum trachycaulum	H		✓	R		
Erythronium grandiflorum	H		✓	O	June 17	Higher altitudes.
Smilacina racemosa var. *amplexicaulis*	H		✓	R	July 4	Wet areas.
S. stellata	H		✓	O	July 4	
Stenanthium occidentale	H	✓	✓	C	July 5	
Tofieldia glutinosa	H	✓	✓	R		Wet areas.
T. pusilla	H	✓	✓	R		Wet areas.
Veratrum eschscholtzii	H		✓	R		Near Weather Stn. #1.
Zygadenus elegans	H	✓	✓	C	July 15	

Family / Species	Layer	Park B.N.P.	Park K.N.P.	Abundance	Flowering Date	Other Notes
ORCHIDACEAE						
Calypso bulbosa	H	✓	✓	O	May 19	
Habenaria dilatata	H	✓	✓	C	July 12	Wet areas.
H. hyperborea	H	✓	✓	O	Aug. 5	Wet areas.
Listera cordata	H		✓	R	June 20	Beside brook near 12B-SE.
Orchis rotundifolia	H	✓		R	July 18	Wet area near Burn edge.
SALICACEAE						
Populus balsamifera	T	✓	✓	C		Lower elevations.
P. tremuloides	T	✓	✓	C		Absent only in the very uppermost areas.
Salix arctica	H		✓	O	May 22	Near bog near 3B-SW
S. barklayi	S	✓	✓	C		
S. barrattiana	S	✓	✓	C	May 18	
S. brachycarpa	S		✓	R		
S. discolor	S	✓		R	June 15	Near Burn edge.
S. glauca	S	✓	✓	A	May 18	
S. nivalis	H		✓	O		High elevations.
S. vestita	S	✓	✓	C	May 18	
BETULACEAE						
Alnus crispa spp. *sinuata*	S	✓	✓	C	June 15	
Betula glandulosa	S	✓	✓	C	June 17	Wet areas usually.
B. occidentalis	T		✓	O	July 5	These two species seem to hybridize freely.
B. papyrifera	T		✓	O		

Family / Species	Layer	Park: B.N.P.	Park: K.N.P.	Abundance	Flowering Date	Other Notes
URTICACEAE						
Urtica lyallii	H	✓		R	July 13	3B-NE.
POLYGONACEAE						
Oxyria digyna	H	✓	✓	C	July 11	Higher altitudes.
Polygonum amphibium var. *stipulaccum forma fluitans*	H		✓	R		Pond beside Stanley Trail.
P. viviparum	H		✓	O	Aug.15	Wet areas.
Rumex acetosella	H	✓		R	Aug.18	Cat.-cut near Burn edge.
PORTULACACEAE						
Claytonia lanceolata	H		✓	R	June 23	Higher altitudes.
CARYOPHYLLACEAE						
Arenaria capillaris var. *americana*	H		✓	O	July 5	
A. rubella	H		✓	O	Aug. 1	High on Storm Mountain.
Cerastium arvense	H	✓	✓	O		
Silene parryi	H		✓	R	Aug. 1	Between OEE and OEF
Stellaria americana	H		✓	R	Aug. 9	Cliffs near 7D-SW.
S. longipes	H	✓	✓	O	July 11	
S. umbellata	H	✓		R	July 13	3B-NE.
RANUNCULACEAE						
Anemone drummondii	H	✓	✓	O	Aug. 1	Rocky slopes.
A. multifida	H	✓	✓	R	June 14	

Family / Species	Layer	Park B.N.P.	Park K.N.P.	Abundance	Flowering Date	Other Notes
RANUNCULACEAE (cont'd)						
Anemone parviflora	H	✓	✓	O	Aug. 1	Rocky slopes.
Aquilegia flavescens	H	✓	✓	A	July 4	
Clematis verticellaris var. *columbiana*	H	✓	✓	C	May 29	South facing slopes.
Ranunculus acris	H	✓		R	July 18	
Thalictrum occidentale	H	✓	✓	A	June 13	
Trollius albiflorus	H	✓	✓	C	May 21	
BERBERIDACEAE						
Berberis repens	S		✓	R		See Map 2.
FUMARIACEAE						
Corydalis aurea	H	✓		R	July 17	Vista Lake Trail.
CRUCIFERAE						
Arabis drummondii	H	✓	✓	O	May 26	
A. holboellii vars. *pinetorum* and *retrofracta*	H		✓	R	Aug. 5	
Draba aurea	H		✓	O	Aug. 1	High on Storm Mountain.
D. borealis	H	✓	✓	O	May 24	
D. incerta	H		✓	R	June 25	14D-SE
D. porsildii	H		✓	O	June 27	Beside brooks; Determination uncertain.
Erysimum inconspicuum	H		✓	R	Aug. 5	4D-SW.

Family / Species	Layer	Park: B.N.P.	Park: K.N.P.	Abundance	Flowering Date	Other Notes
CRASSULACEAE						
Sedum stonepetalum	H		✓	O	Aug. 1	Higher altitudes.
SAXIFRAGACEAE						
Heuchera cylindrica	H	✓	✓	O	July 17	
Leptarrhena pyrolifolia	H	✓	✓	O	June 15	Gt. Divide parking lot & at higher elevations.
Mitella pentandra	H	✓	✓	R	July 13	Wet areas.
Parnassia fimbriata	H	✓	✓	C		Wet areas.
P. kotzebueii	H	✓		R	July 22	Arnica Lake trail.
Ribeo lacustre	S	✓	✓	C	June 15	
R. laxiflorum	S	✓		O		
Saxifraga adscendens	H		✓	R	Sept. 4	Cliffs near 12D-SE.
S. aizoides	H		✓	R	June 25	Gravel banks.
S. bronchialis	H	✓	✓	C	July 10	
S. caespitosa	H		✓	O	Aug. 10	Cliffs.
S. cernua	H		✓	R	Aug. 10	4F-SE.
S. lyalli	H		✓	O	July 11	Higher elevations.
Tiarella unifoliata	H	✓	✓	O	July 13	Boggy areas.
ROSACEAE						
Amelanchies alnifolia	S	✓	✓	C	June 17	
Dryas drummondii	H		✓	O	June 13	Near highway & higher elevations.
D. hookeriana	H		✓	O	June 12	Near highway & higher elevations.

Family / Species	Layer	Park B.N.P.	Park K.N.P.	Abundance	Flowering Date	Other Notes
ROSACEAE						
Fragaria virginiana	H	✓	✓	A	May 18	
Potentilla diversifolia	H		✓	R	Aug. 1	High on Storm Mountain.
P. fruticosa	S	✓	✓	A	June 28	
Rosa acicularis	S	✓	✓	A	July 6	Dry slopes.
Rubus acaulis	H	✓	✓	R	July 3	Moist situations.
R. parviflorus	S		✓	O	Aug. 12	
R. strigosus	S	✓	✓	A	July 7	
Sorbus sitchensis	S	✓	✓	C	June 28	
Spiraea lucida	S	✓	✓	A	July 17	
LUGININOSAE						
Astragalus alpinus	H	✓	✓	O	June 23	
A. occidentalis	H	✓		R	July 31	14D-NE.
Hedysarum sulphurescens	H	✓	✓	C	June 23	
H. mackenzii	H		✓	R	June 12	Near highway.
Trifolium repens	H		✓	R		Near highway.
EMPETRACEAE						
Empetrum nigrum	H	✓		R		Near 8C-NE
ACERACEAE						
Acer glabrum	S	✓	✓	C	May 23	Best developed in southernmost corner of the Burn.

Family / Species	Layer	Park B.N.P.	Park K.N.P.	Abundance	Flowering Date	Other Notes
RHAMNACEAE						
Ceanothus velutinus	S		✓	R		See Map 2.
VIOLACEAE						
Viola adunca	H	✓	✓	O	May 21	Ledges and dry slopes.
V. orbiculata	H	✓	✓	C	May 29	
V. renifolia	H		✓	R	June 18	Beside brook near 12B-SE.
ELAEAGNACEAE						
Shepherdia canadensis	S	✓	✓	A	May 19	Dry slopes and ridge crests.
ONAGRACEAE						
Epilobium alpinum	H	✓	✓	O	July 4	
E. angustifolium	H	✓	✓	A	July 15	
E. hornemannii	H	✓	✓	O		
E. latifolium	H	✓	✓	O	July 15	Gravel banks; occasionally in the Burn proper.
UMBELLIFERAE						
Heracleum lanatum	H	✓	✓	O	July 15	Wet areas.
Osmorhiza depauperata	H		✓	R	June 27	4E-SE
CORNACEAE						
Cornus canadensis	H	✓	✓	A	June 17	
PYROLACEAE						
Moneses uniflora	H	✓	✓	O	July 18	
Pyrola bracteata	H	✓	✓	C	July 15	

Family / Species	Layer	Park B.N.P.	Park K.N.P.	Abundance	Flowering Date	Other Notes
PYROLACEAE						
Pyrola elliptica	H	✓	✓	O	July 18	
P. secunda	H	✓	✓	O	July 15	7D-NE
ERICACEAE						
Arctostaphylos rubra	H	✓	✓	R		7D-NE & Weather Stn.#3.
A. uva-ursi	H	✓	✓	O	May 19	
Kalmia polifolia var. *microphylla*	H		✓	R	June 18	Moist areas.
Ledum glandulosum	S	✓	✓	A	June 22	
L. groenlandicum	S	✓	✓	O		
Menziesia glabella	S	✓	✓	A	June 22	
Phyllodoce empetriformis	H	✓	✓	O	July 22	Higher altitudes.
Rhododendron albiflorum	S	✓	✓	C	July 11	Higher altitudes.
Vaccinium caespitosum	H		✓	O		
V. membranaceum	S		✓	O		
V. myrtillus	H	✓	✓	A	June 5	
V. scoparium	H	✓	✓	C	June 5	
V. vitis-idaea var. *minus*	H	✓		R		13C-NE; expected to increase.
PRIMULACEAE						
Dodecatheon radicatum	H	✓	✓	R	May 29	N.W. section
Primula mistassinica	H	✓	✓	O	May 21	

Family / Species	Level	Park B.N.P.	Park K.N.P.	Abundance	Flowering Date	Other Notes
GENTIANACEAE						
Gentianella amarella spp. *acuta*	H	✓	✓	C	July 24	
G. propinqua	H	✓	✓	O	July 17	Open areas.
Menyanthes trifoliata	H	✓		R	July 13	Pond near 4A-NE.
SCROPHULARIACEAE						
Castilleja miniata	H	✓	✓	C	May 25	
C. septentrionalis	H	✓	✓	O	June 22	
Pedicularis contorta	H		✓	O	Aug. 1	OEG and vicinity.
P. groenlandica	H	✓	✓	C	July 18	Moist areas.
P. bracteosa	H	✓		R		
Penstemon confertus	H	✓		R	July 18	
P. ellipticus	H	✓	✓	O	July 10	Rocky slopes.
Veronica alpina var. *unalaschensis*	H	✓	✓	O	July 3	
LENTIBULARIACEAE						
Pinguicula vulgaris	H	✓	✓	O	June 28	Boggy areas.
RUBIACEAE						
Galium boreale	H	✓	✓	C	July 15	
G. trifolium	H	✓		O		

Family / Species	Layer	Park B.N.P.	Park K.N.P.	Abundance	Flowering Date	Other Notes
CAPRIFOLIACEAE						
Linnaea borealis var. *americana*	H	✓	✓	A	July 9	
Lonicera involucrata	S	✓	✓	C	June 15	
L. utahensis	S		✓	O	June 26	Best developed in the far S.W. corner.
Sambucus melanocarpa	S	✓	✓	A	June 28	
Symphoricarpos albus	S		✓	R		Southernmost corner of Burn.
Viburnum edule	S	✓	✓	O	June 12	
VALERIANACEAE						
Valeriana sitchensis	H	✓	✓	O	July 10	
CAMPANULACEAE						
Campanula rotundifolia	H	✓	✓	O	July 24	
COMPOSITAE						
Achillea millefolium	H	✓	✓	C		
Agoseris aurantiaca	H	✓	✓	C	July 24	
A. glauca	H		✓	R	Aug. 8	
Anaphalis margaritacea	H	✓	✓	O		Particularly near the highway.
Antennaria alpina	H	✓	✓	?	June 15	Relative abundance unknown.
Antennaria racemosa	H	✓	✓	C	June 15	
A. rosea	H	✓	✓	O		
A. umbrinella	H	✓	✓	C	Aug. 13	
Arnica alpina	H		✓	R		High on Storm Mountain.
A. cordifolia	H	✓	✓	A	May 24.	

Family / Species	Layer	Park B.N.P.	Park K.N.P.	Abundance	Flowering Date	Other Notes
COMPOSITAE						
A. latifolia	H		✓	O	Aug. 13	Higher altitudes
A. lonchophylla	H		✓	R	Aug. 12	
A. rydbergii	H		✓	R	Aug. 1	Rocky slope between OEE & OEF.
Artemisia michauxiana	H		✓	R		
Aster ciliolatus	H	✓	✓	A	Aug. 5	
A. conspicuus	H	✓	✓	A	Aug. 12	
A. foliaceus	H		✓	R	Aug. 13	Near 15E-SW.
A. sibiricus	H	✓	✓	C	July 18	Rocky slopes & exposed areas.
Chrysanthemum leucanthemum	H		✓	R	July 18	Near highway and trails.
Circium arvense	H	✓	✓	R		Disturbed soil.
C. hookerianum	H	✓	✓	O	July 18	
Crepis elegans	H		✓	R		
Erigeron acris vars. *debilus* & *asteroides*	H	✓	✓	A		
E. aureus	H	✓	✓	O	June 22	
E. compositus	H	✓	✓	R	June 4	
E. glabellus var. *pubescens*	H		✓	O	Aug. 5	
E. humilis	H		✓	R		4F-SE.
E. peregrinus	H	✓	✓	C	July 7	
Gaillardia aristata	H	✓	✓	O	Aug. 5	
Hieracium albertinum	H		✓	R	Aug. 5	
H. albiflorum	H	✓	✓	C	July 18	

Family / Species	Layer	Park B.N.P.	Park K.N.P.	Abundance	Flowering Date	Other Notes
COMPOSITAE						
Hieracium gracile	H	✓	✓	R	July 11	
Petasites palmatus	H	✓	✓	O	May 19	Wet areas.
P. sagittatus	H	✓		R		Vista Lake.
Saussurea densa	H		✓	O		High altitudes.
Senecio canus	H		✓	O	Aug. 5	Dry slopes and ridges.
S. cymbalaroides	H		✓	R		
S. fremontii	H		✓	O	July 13	
S. indecorus	H		✓	O	July 29	
S. lugens	H	✓	✓	C	June 28	
S. pauciflorus	H		✓	R	July 15	
S. pseudaureus	H	✓	✓	A	July 29	
S. triangularis	H	✓	✓	O	July 12	Wet areas.
Solidago multiradiata	H	✓	✓	O	June 24	
Taraxacum ceratophorum	H		✓	R	Aug. 13	High, rocky situations.
T. officinale	H	✓	✓	C	May 18	

Additional species collected in 1972 but not encountered in 1976 include:

Cicuta
Delphinium glaucum
Hackelia floribunda
Melilotus officinalis
Vicia americana

APPENDIX II

KEY TO MAP 2 (SHRUB VEGETATION)

(/) indicates co-dominance (either well-mixed or as a mosaic)

ZONE #

(1) *Shepherdia canadensis* dominated.

(2) *Shepherdia canadensis* dominated with *Rosa acicularis* prominently subdominant.

(3) *Menziesia glabella* dominated.

(4) *Menziesia glabella* dominated with *Sambucus melanocarpa* prominently sub-dominant.

(5) *Menziesia glabella* dominated with *Sambucus melanocarpa* and *Rhododendron albiflorum* prominently sub-dominant (one of the latter two may or may not be as well developed as the other).

(6) *Menziesia glabella* dominated with *Salix* spp. prominently sub-dominant.

(7) *Menziesia glabella* dominated with *Shepherdia canadensis* prominently sub-dominant.

(8) *Menziesia glabella* dominated with *Spiraea lucida* prominently sub-dominant.

(9) *Menziesia glabella* dominated with *Ledum* spp. prominently sub-dominant.

(10) *Menziesia glabella* dominated with *Salix* spp., *Spiraea lucida*, and *Rosa acicularis* prominently sub-dominant.

(11) *Salix* spp. dominated (*S. glauca*, *S. barrattiana*, or *S. vestita* in most cases).

(12) *Salix* spp. dominated with *Shepherdia canadensis* prominently subdominant.

(13) *Rosa acicularis* dominated.

(14) *Rubus strigosus* dominated.

(15) *Lonicera involucrata* dominated.

(16) *Ledum* spp. dominated (usually *L. glandulosum*).

(17) *Potentilla fruticosa* dominated (an interesting type found either at high elevations on dry rocky slopes or at lower elevations in wet boggy areas, in which case other species, particularly *Salix* spp., may also be well developed. Also very prominent on the higher avalanche slopes).

(18) *Sambucus melanocarpa* dominated.

(19) *Sambucus melanocarpa* dominated with *Menziesia glabella* prominently sub-dominant.

(20) *Alnus crispa* spp. *sinuata* dominated (*Menziesia glabella* may be prominently sub-dominant in some locations).

(21) *Spiraea lucida* dominated.

(22) *Spiraea lucida* dominated with *Shepherdia canadensis* prominently sub-dominant.

(23) *Ribes lacustre* dominated.

(24) *Rhododendron albiflorum* dominated.

(25) *Acer glabrum* dominated.

(26) *Viburnum edule* dominated.

(27) A small area dominated by *Berberis repens*.

(28) A small area dominated by *Rubus parviflorus*.

(29) A small area dominated by *Ceanothus relutinus* (on a ridge).

(30) *Shepherdia canadensis/Spiraea lucida/Rosa acicularis* co-dominated.

(31) *Rosa acicularis/Spiraea lucida* co-dominated.

(32) *Spiraea lucida/Shepherdia canadensis* co-dominated.

(33) *Spiraea lucida/Shepherdia canadensis/Salix* co-dominated.

(34) *Spiraea lucida/Shepherdia canadensis/Potentilla fruticosa* co-dominated (typically in more or less well defined bands following the contour in areas of successive small dry cliffs. Some *Rosa acicularis* may also be present).

(35) *Spiraea lucida/Rubus strigosus* co-dominated.

(36) *Spiraea lucida/Salix* co-dominated.

(37) *Potentilla fruticosa/Spiraea lucida/Rosa acicularis* co-dominated.

(38) *Rubus strigosus/Salix* spp./*Shepherdia canadensis/Spiraea lucida* co-dominated.

(39) *Potentilla fruticosa/Ledum* spp./*Shepherdia canadensis/Salix* spp. co-dominated.

(40) *Menziesia glabella/Shepherdia canadensis* co-dominated.

(41) *Lonicera involucrata/Shepherdia canadensis/Menziesia glabella* co-dominated.

(42) *Potentilla fruticosa/Shepherdia canadensis* co-dominated.

(43) *Menziesia glabella/Salix* co-dominated.

(44) *Menziesia glabella/Ledum* co-dominated.

(45) *Menziesia glabella/Sambucus melanocarpa* co-dominated.

(46) *Menziesia glabella/Sambucus melanocarpa/Ledum* spp. co-dominated.

(47) *Menziesia glabella/Salix vestita/Ledum* spp. co-dominated.

(48) *Menziesia glabella/Ribes lacustre* co-dominated.

(49) *Salix* spp./*Ledum* spp. co-dominated (one may be sub-dominant to the other rather than actually co-dominant).

(50) *Ledum* spp./*Salix* spp./*Betula glandulosa/Potentilla fruticosa* co-dominated areas (typically very dense growth in wet boggy areas; bordering streams, etc. The *Ledum* may or may not be well developed and some *Lonicera involucrata* is often present).

(51) *Betula glandulosa/Salix* spp. co-dominated.

(52) *Salix* spp./*Potentilla fruticosa* co-dominated.

(53) *Salix* spp./*Potentilla fruticosa/Ribes lacustre* co-dominated.

(54) *Sambucus melanocarpa/Rubus strigosus/Ribes lacustre* co-dominated (occasionally one of these members may not be as well developed as the others or *Menziesia glabella* may also be present in significant numbers. In the vicinity of pin 3B-NE, *Ribes laxiflorum* partly "replaces" *R. lacustre*. This type is generally confined to relatively steep slopes with a high water table).

(55) *Rubus strigosus/Ribes lacustre* co-dominated (nearer streams *Ribes lacustre* is generally the more apparent member).

(56) *Alnus crispa* spp. *sinuata/Salix* spp. co-dominated.

(57) *Potentilla fruticosa/Rosa acicularis/Acer glabrum* co-dominated (with small inclusions of many other species).

(58) Relatively complex areas of undetermined dominance with *Ledum* spp., *Menziesia glabella*, *Sambucus melanocarpa*, *Rubus strigosus*, and *Salix* spp. as the major members (*Shepherdia canadensis* and/or *Ribes lacustre* may also be prominent).

(59) A large, complex zone in the far S.W. corner with *Menziesia glabella*, *Spiraea lucida*, *Shepherdia canadensis*, and *Rosa acicularis* as the major components. Also locally well developed and sometimes dominant are *Amelanchier alnifolia*, *Lonicera involucrata*, *L. utahensis*, and *Salix* spp.

(60) Complex areas with many shrub species present (up to 10 or more) in more or less equal amounts. Usually, but not always, of relatively low density.

(61) Sparse shrubs (thus dominance undetermined). Very similar to zone (60) except that density and species diversity are lower.

(62) Complex areas of undetermined dominance, composed for the most part of those species in directly adjacent zones.

(63) No shrubs.

(64) Insufficient data.

(65) *Ribes lacustre/Rubus strigosus/Alnus crispa* ssp. *sinuata* co-dominated

APPENDIX III

KEY TO MAP 3, (HERBACEOUS VEGETATION 1976)

(/) indicates co-dominance (either well-mixed or as a mosaic). Prostrate shrubs (i.e., < 25 cm tall) and woody-herbs are included.

ZONE #

(1) *Elymus innovatus* dominated (well developed on drier S.E.-S.W. slopes, particularly prominent on the avalanche slopes).

(2) *Elymus innovatus* dominated with *Linnaea borealis*, *Epilobium angustifolium*, *Aster conspicuus*, *Arnica cordifolia*, and *Vaccinium* spp. prominently sub-dominant.

(3) *Epilobium angustifolium* dominated.

(4) *Epilobium angustifolium* dominated with *Vaccinium* spp. prominently sub-dominant.

(5) *Epilobium angustifolium* dominated with *Aster ciliolatus* prominently sub-dominant.

(6) A wet, gravelly area where *Epilobium angustifolium* appeared dominant (for the most part) amidst a mosaic of *Senecio pseudaureus*, *Elymus innovatus*, *Fragaria virginiana*, *Calamagrostis canadensis*, and *Agropyron trachycaulum*.

(7) An area dominated by *Epilobium angustifolium* with *Linnaea borealis* and *Arnica cordifolia* as prominent sub-dominants (*Calamagrostis canadensis*, and *Cornus canadensis* also well developed over much of the zone).

(8) *Epilobium angustifolium* dominated with *Arnica cordifolia* prominently sub-dominant.

(9) *Epilobium angustifolium* dominated with *Elymus innovatus*, *Arnica cordifolia*, *Cornus canadensis*, and *Linnaea borealis* prominently sub-dominant.

(10) *Epilobium angustifolium* dominated with *Linnaea borealis*, *Aster conspicuus*, and *Arnica cordifolia* prominently sub-dominant.

(11) *Epilobium angustifolium* dominated with *Aster conspicuus* and *Senecio pseudaureus* prominently sub-dominant.

(12) *Epilobium angustifolium* dominated with *Senecio pseudaureus*, *Arnica cordifolia*, *Carex* spp., *Calamagrostis canadensis*, and *Elymus innovatus* prominently sub-dominant.

(13) *Epilobium angustifolium* dominated with *Anaphalis margaritacea* prominently sub-dominant.

(14) *Epilobium angustifolium* dominated with *Erythronium grandiflorum* prominently sub-dominant (in the latter part of the summer this relationship is not apparent because the *Erythronium* fades away).

(15) Complex; *Epilobium angustifolium* dominant with *Arnica cordifolia*, *Carex platylepis*, *Linnaea borealis*, and *Calamagrostis canadensis* prominently sub-dominant.

(16) *Calamagrostis canadensis* dominated.

(17) *Carex* spp. dominated (marshes, bogs, and otherwise).

(18) *Carex* spp. dominated with *Epilobium angustifolium* prominently sub-dominant.

(19) *Carex* Spp. dominated with *Aster conspicuus* and *Senecio pseudaureus* prominently sub-dominant.

(20) *Linnaea borealis* dominated.

(21) *Vaccinium* spp. (*Myrtillus* and/or *Scoparium*) dominated.

(22) *Arnica cordifolia* dominated.

(23) *Aster ciliolatus* dominated.

(24) *Elymus innovatus/Epilobium angustifolium* co-dominated.

(25) *Elymus innovatus/Epilobium angustifolium/Trisetum spicatum* co-dominated.

(26) *Elymus innovatus/Epilobium angustifolium/Aster ciliolatus* co-dominated.

(27) *Elymus innovatus/Epilobium angustifolium/Linnaea borealis* co-dominated.

(28) Reasonably complex with *Elymus innovatus/Epilobium angustifolium/Carex* spp./*Arnica cordifolia/Aster conspicuus* co-dominant.

(29) *Elymus innovatus/Epilobium angustifolium/Carex* spp. co-dominant.

(30) *Elymus innovatus/Epilobium angustifolium/Arnica cordifolia/Carex* spp. co-dominated.

(31) *Elymus innovatus/Epilobium angustifolium/Aster ciliolatus/Senecio pseudaureus* co-dominated.

(32) *Elymus innovatus/Epilobium angustifolium/Aster conspicuus* co-dominated.

(33)*Elymus innovatus/Epilobium angustifolium/Calamagrostis canadensis* co-dominated.

(34) *Elymus innovatus/Epilobium angustifolium/Aster conspicuus/Arnica cordifolia* co-dominant.

(35) *Aster conspicuus/Elymus innovatus* co-dominated.

(36) *Calamagrostic canadensis/Elymus innovatus* co-dominated.

(37) *Elymus innovatus/Aster ciliolatus* co-dominated.

(38) *Vaccinium* spp./*Elymus innovatus* co-dominated.

(39) *Elymus innovatus/Carex* spp. co-dominated.

(40) *Elymus innovatus/Carex* spp./*Senecio pseudaureus* co-dominated.

(41) *Aster ciliolatus/Elymus innovatus/Arnica cordifolia* co-dominated.

(42) *Epilobium angustifolium/Elymus innovatus/Arnica cordifolia/Linnaea borealis* co-dominated (*Linnaea borealis* may or may not be well developed).

(43) *Epilobium angustifolium /Arnica cordifolia* co-dominated.

(44) *Epilobium angustifolium/Vaccinium* spp. co-dominated.

(45) *Elymus innovatus/Phleum pratense/Calamagrostis canadensis* co-dominated.

(46) *Vaccinium* spp./*Epilobium angustifolium/Equisetum scirpoides* co-dominated.

(47) *Calamagrostis canadensis/Epilobium angustifolium* co-dominated.

(48) *Epilobium angustifolium/Carex* spp. co-dominated.

(49) *Epilobium angustifolium/Linnaea borealis* co-dominated.

(50) *Aster conspicuus/Epilobium angustifolium* co-dominated.

(51) *Epilobium angustifolium/Carex* spp./*Luzula parviflora* co-dominated.

(52) *Vaccinium* spp./*Epilobium angustifolium/Arnica cordifolia* co-dominated.

(53) *Vaccinium* spp./*Epilobium angustifolium/Arnica cordifolia/Carex* spp. co-dominated (with or without *Linnaea borealis* and *Cornus canadensis* also well-developed).

(54) *Arnica cordifolia/Epilobium angustifolium/Carex* spp. co-dominated.

(55) *Epilobium angustifolium/Calamagrostis canadensis/Carex platylepis* co-dominated.

(56) *Epilobium angustifolium/Arnica cordifolia/Linnaea borealis* co-dominated.

(57) *Aster conspicuus/Epilobium angustifolium/Vaccinium* spp./*Arnica cordifolia/Linnaea borealis* co-dominated.

(58) *Epilobium angustifolium/Vaccinium* spp./*Carex* spp./*Linnaea borealis* co-dominated.

(59) *Epilobium angustifolium/Linnaea borealis/Carex* spp./*Cornus canadensis* co-dominated.

(60) *Carex* spp./*Thalictrum occidentale/Aster conspicuus/Epilobium angustifolium* co-dominated.

(61) *Thalictrum occidentale/Aster conspicuus/Epilobium angustifolium* co-dominated.

(62) *Vaccinium* spp./*Arnica cordifolia* co-dominated.

(63) *Aster conspicuus* dominated with *Epilobium angustifolium, Linnaea borealis, Cornus canadensis,* and *Arnica cordifolia* prominently sub-dominant.

(64) *Aster conspicuus/Epilobium angustifolium/Arnica cordifolia/Cornus canadensis/Elymus innovatus/Linnaea borealis/Vaccinium* spp. co-dominated.

(65) A complex area with several small ravines and ridges. *Calamagrostis canadensis* is typically dominant in the ravines, while elsewhere the major dominants are *Epilobium angustifolium, Elymus innovatus, Arnica cordifolia, Linnaea borealis,* and *Aster conspicuus.*

(66) Reasonably complex with *Epilobium angustifolium, Arnica cordifolia, Aster conspicuus, Linnaea borealis, Elymus innovatus, Calamagrostis canadensis,* and *Carex* spp. dominant in various combinations and patterns.

(67) Complex herbaceous vegetation confined to wet boggy areas (e.g. seepage areas); numerous species present.

(68) Complex herbaceous vegetation usually confined to higher altitude, more or less rocky areas. Often as many as 30 or more species can be observed from any one point.

(69) *Aster ciliolatus/Fragaria virginiana* co-dominated (also the main cover type on the many ridge crests in the far S.W. corner of the Burn).

(70) *Carex* spp./*Thalictrum occidentale/Aster conspicuus* co-dominated.

(71) Rocky areas usually dominated by *Aster ciliolatus, Epilobium angustifolium, Thalictrum occidentale,* and *Linnaea borealis,* although *Senecio pseudaureus, Carex* spp., *Zygadenus elegans, Achillea millefolium,* or others may also be present in large numbers.

(72) A very complex area of ridges, rocky slopes, and intervening ravines. On the ridge crests type (69) predominates; on the rocky slopes type (71) predominates; in the ravines type (61) predominates.

(73) A complex transitional area with *Carex* spp., *Epilobium angustifolium, Aster ciliolatus, Senecio pseudaureus, Linnaea borealis, Arnica cordifolia,* and *Fragaria virginiana* as the major components.