VEGETATION ON QUARTZ DIORITE IN THE BEAR LAKES AREA,
TRINITY COUNTY, CALIFORNIA

by

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ABSTRACT

Previous vegetation studies on granitic soils in the Klamath Region of Northern California suggest the area is typically floristically rich and vegetationally complex. My initial reconnaissance suggested the Bear Lakes area is much simpler in both respects.

A descriptive and comparative study of this apparently different area was designed. Some 318 vascular plants were inventoried. The vegetation was then sampled following the Braun-Blanquet releve method. There were 198 releves taken. Vegetative and habitat data were analyzed by tabular comparison. Twelve vegetation types resulted; three herb-dominated, three shrub-dominated and six tree-dominated.

Detailed comparison of the results with several previous works from nearby granitic areas shows the study area to be relatively floristically depauperate and xerophytic. This is reflected in the simplicity of its vegetation pattern. Dry herbaceous and chaparral types are extensive and are elevationally independent as compared to the less extensive, elevationally zoned forests.

Forest zonation at Bear Lakes is similar to other areas in the region. Some forest type descriptions suggest appreciable similarities which become greatest at higher elevations.

The relatively small orographic mass of the study area is principally responsible for differences seen there. It
results in steep terrains which support few, extensive, xerophytic communities. More gentle and mesic environments, supporting species-rich vegetation elsewhere, are scarce. The physiography of the study area also results in relatively little snowpack and reduced local climatic gradients. A regional climatic gradient makes the area drier as well.

Extensive disturbance by fire promotes simplicity of pattern in the study area. Disturbance in nearby areas, with more complex vegetation patterns, enhances habitat diversity.

Differences between Bear Lakes and other areas in the Klamath Region are in both degree and kind. This illustrates the complexity of the Klamath Region vegetation and suggests that regional descriptions need to be flexible.
ACKNOWLEDGMENTS

It pleases me very much to have the opportunity to thank the people who have helped me, either directly or indirectly, in the many stages of this project. I would like to express particular appreciation to the following persons:

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INTRODUCTION

The Klamath Mountains of northern California are customarily introduced in botanical works as a relatively unstudied region of high vegetational and floristic diversity (Whittaker, 1960; Lewis, 1966; Sawyer and Thornburgh, 1971, 1974; Mize, 1973). As is probably true with any region where little research has been done, the localities first studied are those unique and interesting. Since much of the vegetational work done in the Klamath Region is of this initial type, its representation of the entire province may be suspect.

Comparative reconnaissance of several locations in the Klamath Mountains suggested to me that some undescribed areas are rather different from those already studied. Since much previous work is from areas with granitic parent materials, I have selected for study one of these discernibly different undescribed areas which has soils of granitic origin.

The study area is within twelve miles of two of the previously studied granite areas, Russian Peak (Sawyer and Thornburgh, 1974, 1977) and the Trinity Alps (Ferlatte, 1974). It is thirty miles from English Peak (Oettinger, 1975) and sixty miles from the Siskiyou Mountains (Whittaker, 1960).

Since there are no major topographic discontinuities between my study area and the closer comparable areas, it
can be assumed, based upon this proximity, that these eastern Klamath Region locations have basically the same climate. The granitic parent material of the study area is quite similar to that of all the other areas as are the general elevational limits of the granitic soils. While not all of these described areas are surrounded by ultramafic parent materials, as is mine, several are adjacent to this parent material. Except that elevations in other areas extend somewhat higher, the general glaciated and montane nature of all these granitic terrains is similar.

There are, however, some perceptible differences between mine and comparable areas. Here montane chaparral is more extensive than forests, and the chaparral is, for the most part, not limited to south and west facing slopes. Instead it occurs widely on east and north facing slopes as well. The scarcity of mesic meadows, either valley bottom types or steeper hillside herbaceous communities contribute to an overall more xeric impression of the study area. Both of these meadow types are common in many montane areas of the Klamath Region. Likewise, wet to mesic habitats are almost exclusively restricted to localized areas around lakes, occasional seeps and immediate streamside environments. Topography in the study area is somewhat more severe than the other areas. Slopes are generally no steeper, but flats and gentle slopes are in comparatively short supply. There seems to be a greater amount of exposed bedrock as well.
Initial reconnaissance also suggests a reduced number of plant species and comparatively simple communities. It raises the question as to whether or not the vegetation in this area forms substantially different patterns than that described for other areas with granitic soils in the Klamath Mountains.

These apparent dissimilarities led me to design a descriptive study of the vegetation of the Bear Lakes area which allows detailed comparisons among areas in the Klamath Mountains. My objectives, then, are to inventory the plants and create a vegetation classification of the area. This will allow for comparisons to appropriate areas, and in this way expand the knowledge of the Klamath Region vegetation.
THE STUDY AREA

Location

The basis for confining the study to the vegetation of granitic soils is that prior work (Whittaker, 1960) has shown parent material to be the primary controlling factor of vegetation patterns. This at once reduces the scope of comparisons with other areas to a reasonable level and provides a natural boundary to the area to be studied.

The study area is defined by the limits of a roundish, more or less isolated granitic pluton approximately four miles in diameter (Figure 3). The surrounding parent material is ultramafic rock which provides a distinctly different soil and vegetative pattern. This boundary is immediately obvious from soil color and rock fragments. It occurs at elevations from about 3500' to around 6000' with most of it occurring near 4000'. The upper limit of the approximately ten square mile area is an unnamed peak at 7190'.

The study area lies adjacent to the Scott Mountains of the east central portion of the Klamath Region of northwestern California as defined by Diller (1902), Fenneman (1931) and Irwin (1960). It is in Trinity County and is owned in a "checkerboard" pattern of alternating sections by the Southern Pacific Land Company and Shasta-Trinity National Forest. The U.S. Geological Survey has the area
mapped on the northwest quarter of the Bonanza King quadrangle, mostly in T38, 39N, R7W. The area has been a part of the Salmon-Trinity Alps Primitive Area but its wilderness status is currently pending. The area is completely roadless with no prior impact aside from trails. There has been no mining activity here as there has been throughout much of the Klamath Region. The area is located about 35 miles north northeast of Weaverville, and may be reached by trails up Tangle Blue, Horse, and Bear Creeks with trailheads along State Highway 3 (Figure 1).

Three glacial lakes, Bear (5800'), Little Bear (6200') and Log (6050'), are in the area (Figure 2). The largest of these is Bear Lake which is 28 acres and 73' deep (California Department of Fish and Game, 1969). The area is drained by Bear Creek, Log Creek and Horse Creek. Parts of the watersheds of Eagle Creek and Tangle Blue Creek are also included. These are all tributaries of the Trinity River.

Climate

Steep climatic gradients occur across the Klamath Region (Whittaker, 1960). In addition to the maritime versus more continental climates near the ends of this gradient, the elevations generally increase from the coastal area eastward (Table 1). In the eastern Klamath Region these two factors result in less fog, decreased average humidities, warmer summer temperatures, colder
Figure 1. Map showing location of the Bear Lakes study area in relation to the major features of the surrounding Klamath region.
Figure 2. Topographic map of the study area.
Table 1. Climate records for selected stations across the Klamath Region. Stations are ordered from western to eastern locations. U.S. Dept. Commerce Annual Summ. 1973. Climatological Data 77(13).

<table>
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winter temperatures, greater diurnal temperature fluctuations and greater summer thunderstorm activity than in the western part.

Most of the precipitation is received during the winter. At the higher elevations this is usually snow and a considerable snowpack can develop. The reduced winter precipitation in the eastern Klamath combined with higher spring and summer temperatures causes the snowpack to disappear earlier in the season than in montane areas to the west. Within the study area there are no permanent snowfields and nearly all the snow is gone by July of most years.

Though summer thunderstorms do occur in the study area, they are generally less severe than in the higher mountains nearby.

The year to year weather can be characterized as undependable with some summers having no thundershowers and some winters developing little or no montane snowpack.

Though the Callahan Station (Table 1) is closest to the Bear Lakes area, the elevation is lower. Temperatures in the study area will be lower than those listed and precipitation may be somewhat greater.

Geology

The Klamath Mountains Geological Province has long been recognized for its complex lithic pattern (Diller,
1902; Fenneman, 1931; Irwin, 1960). The rocks are
distinctively different from and older than those of the
surrounding areas. These mountains are thought to be an
accumulation of slices of oceanic crust and island arc
that have accreted to the continental margin by the process
of seafloor spreading (Irwin, 1977). These slices are
generally arranged in arcuate bands opening to the east and
tending to be younger to the west (Irwin, 1966, 1977;
Oakeshott, 1971).

The Klamath Mountains Province is customarily divided
into four lithic belts, the eastern Klamath, central meta-
morphic, western Paleozoic and Triassic, and western
Jurassic (Irwin, 1960; Davis, 1966). These belts represent
thrust plates forming an imbricate sequence dipping to the
east (Irwin, 1966, 1977; Alt and Hyndman, 1975). These
subdivisions are also based on the distribution of ultra-
mafic rocks, previously thought to have been intruded as
cool plastic masses along plate boundaries (Davis, 1966;
Irwin, 1966, 1977; Alt and Hyndman, 1975). It seems now
that most ultramafic bodies represent dismembered sections
of former oceanic crust and upper mantle (Irwin, 1977).

Paleozoic rocks are present in the three easternmost
belts. In the eastern Klamath belt they are less tecton-
ically disturbed and lie in a relatively orderly sequence
from Ordovician to Permian. These strata lie on the
Trinity ultramafic sheet. This is extensively exposed and
consists of mainly peridotite, chiefly harzburgite and
Figure 3. Geologic map of vicinity of study area showing major formations.
dunite which is partly serpentinized and intruded by gabbro, pyroxenite, diabase and plagiogranite (Irwin, 1977).

Granitic plutons are rather sparse in the eastern Klamath belt. The study area occurs on one small pluton, more or less surrounded by the Trinity ultramafic sheet (Fig. 3). This Bear Lakes pluton is of quartz diorite (tonalite) as are most of the granitic rocks of the province (Norris and Webb, 1976; Irwin, 1966). The Russian Peak granitics are chemically similar granodiorite.

During the Paleozoic, the Klamath Mountains did not exist but were accreted to the continental margin by Mesozoic tectonics (Irwin, 1977). There were two major province-wide periods of regional folding, faulting, deformation and igneous intrusion (Norris and Webb, 1976; Davis, 1966). Isoclinal folding and igneous intrusion occurred in the Jurassic. In the Cenozoic, the region experienced normal and high angle reverse faulting which produced the rolling upland later eroded to the present topography (Norris and Webb, 1976). Crest and ridge lines suggest perhaps two or more cycles of uplift and erosion since the Miocene (Irwin, 1960).

During the Quarternary there were several episodes of glaciation in the nearby Trinity Alps. These glaciers extended as low as 2500' and were responsible for considerable erosion (Sharp, 1960). The study area, though lower than the Alps, shows evidence of extensive glaciation in
the north and northeast-trending drainages. Such indica-
tions include cirques, steep headwalls and glacial polish
on the rock at upper elevations. Moraines occur at lower
elevations.
METHODS

Plant Inventory

The bulk of vascular plant collections were made during the field seasons of 1973, 1974 and 1975 although some unfamiliar plants were collected during the principal vegetation sampling season of 1976. Identifications primarily relied on Munz (1959, 1968) and Ferlatte (1974), but Hitchcock (1955-1969), Hitchcock (1950), Abrams (1940, 1960), and McMinn (1939) were also used. Where possible, identifications were verified with specimens from the Humboldt State University Herbarium (HSC). My voucher specimens are deposited there. A list of taxa found in the study area may be found in Appendix A.

Floristic compilation resulted in a personal field key which was invaluable in the vegetation sampling phase.

Sampling

The Braun-Blanquet relevé method as detailed by Mueller-Dombois and Ellenberg (1974) and used by Sawyer and Thornburgh (1971, 1974, 1977) and Mize (1973) on granitic soils of the Klamath Region, was chosen. Some factors in this choice were the relative alacritity with which such plots may be taken, the demonstrated workability of the technique in the Klamath Region, and the increased facility of comparison.
Plots were taken within the most floristically homogeneous assemblages. Areas of transition were avoided. In many instances, however, there was some degree of transitionality along environmental gradients. In these situations, plots were taken in areas where homogeneity was greatest and the assemblage could be seen to have some degree of identity. Entitation (Mueller-Dombois and Ellenberg, 1974) was not attempted prior to sampling. It seemed wisest to let vegetational units be defined from the sampling data alone. Plot size was often equal to the entire stand as defined by the limits of the habitat. In those instances where the stand to be sampled was extensive, or where the species composition was transitional, the plot size was determined by increasing the area until very few additional species were encountered (10% increase in area yields only 5-10% increase in number of new species encountered) (Mueller-Dombois and Ellenberg, 1974). In practice, it was usually obvious when nearly all species were included. Those erratic and occasional species which may sometimes have been missed were felt not to be important in the analysis. Plots averaged approximately \( \frac{1}{4} \) to \( \frac{1}{2} \) acre.

For each plot, topographic position, elevation, slope, surface texture, character, depth of humus layer, aspect, pertinent historical observations, notes on unique plot characteristics and location of plot were first noted. The vegetation was broken down into herb, shrub and tree categories, the trees being subdivided into seedlings,
saplings, and canopy. Percent cover and height of canopy, sapling and shrub layers were noted while only percent cover of the herbs and seedlings were recorded. Cover classes (see sample plot sheet, Appendix B) for all species present were listed and any unknown species were collected.

Some 198 plots were taken during the field seasons of 1975 and 1976. Distribution of samples was uniform throughout the area with the exception of extensive chaparral, which was sampled mostly near trails and natural boundaries. Travel into these unbroken expanses was impractical at best.

Interpretation

Interpretation of the sampling data primarily involved grouping of relevés into vegetation categories on the basis of floristic characteristics. The method used was that of tabular comparison (Mueller-Dombois and Ellenberg, 1974). The process is to preliminarily group relevés into tentative types, make tabular comparisons, and redistribute relevés as necessary to produce the most cohesive categories.

Preliminary grouping is necessary as it is impossible to compare all relevés without some initial breakdown. I formed these preliminary groupings mostly according to similarities in species composition and to a lesser extent, according to the habitat information.
These preliminary categories were tabulated in a raw table (Mueller-Dombois and Ellenberg, 1974), where species are listed by cover class and relevé. Plots were roughly arranged along a continuum of the most obvious gradient. Species constancy in the preliminary types was then determined. The raw tables were then revised to form constancy tables, where species are ranked according to constancy by types. My constancy tables included species with over 10% relative constancy. Relative constancy is the percentage of plots in a type which contain that species.

With the species so ordered, it became evident that some relevés were not comparable to most in a category and thus were relocated. Some, taken from several preliminary types, were regrouped into new categories. In other cases preliminary categories were split into new types. In still others, separation was not justified, instead, phases were distinguished.

Once relevés were adjusted according to the information in the constancy tables, final tabulation by type was done. In the final, summary table (Table 2), the twelve vegetation types, consisting of three herb-dominated types, three shrub-dominated types, and six tree-dominated types, were arranged. The species are listed by presence and modal cover class. The species are arranged to best illustrate the distinctiveness of each type. Because of the complexity involved in arranging all species differentially, I decided to arrange herbs to distinguish herb-dominated types,
shrubs to distinguish shrub-dominated types and trees to distinguish tree-dominated types.
RESULTS

Flora

The plant inventory and sampling phases resulted in a fairly comprehensive flora for the study area (Appendix A). Some 503 collections of vascular plants were made. These, including voucher specimens for most of the 318 taxa, representing 59 families, are deposited in the Humboldt State University Herbarium (HSC). Vouchers are not included for the tree species.

Nomenclature follows Munz (1959, 1968) except where otherwise noted in Appendix A.

Vegetation

The tabular method of classification of the vegetation, as sampled by the 198 relevés, resulted in twelve distinguishable vegetation types with three showing enough variation to recognize phases. The twelve types do not all group naturally into larger categories. A certain lack of cohesiveness is shown by any grouping according to either elevation, habitat or floristic criteria. I decided, rather, to form groupings by physiognomy, with floristics and habitat specifics detailed in the descriptions. The classification can be summarized as follows.
Herb-dominated types

*Dodecatheon jeffreyi-Juncus mertensianus*; herbaceous communities of perennially wet sites.

*Phlox diffusa-Sedum obtusatum*; herbaceous communities of vernally wet, thin rocky soils.

*Pteridium aquilinum-Stachys rigida*; herbaceous communities of vernally moist, deep sandy soils.

Shrub-dominated types

*Amelanchier pallida-Acer glabrum*; montane shrub communities of perennially wet to moist soils.

*Arctostaphylos patula-A. nevadensis*; montane shrub communities of dry slopes and ridges.

*Ceanothus integerrimus-Quercus vaccinifolia*; low elevation shrub communities of dry slopes and ridges.

Tree-dominated types

*Tsuga mertensiana* zone forests

*Tsuga mertensiana/Pyrola picta*; closed forests of upper slopes.

*Tsuga mertensiana/Arctostaphylos nevadensis*; open forests of upper slopes.

*Abies magnifica* zone forests

*Abies magnifica/Pyrola picta*; closed forests of mid to high-elevation terraces and slopes.

*Abies magnifica/Lithocarpus densiflora*; open to closed forests of mid to high-elevation slopes.

*Abies concolor* zone forests

*Abies concolor/Rosa pisocarpa*; closed forests of lower elevation slopes and alluvial terraces.

*Quercus kelloggii/Apocynum pumilum*; open forests of dry, lower elevation slopes.
By convention, components of type names are separated by a dash if they belong to the same vegetation layer, and by a slash if they belong to different layers. Subspecific and varietal names will not be used except as necessary when two or more are found in the study area. Complete names are given in Appendix A. Common names of trees may occasionally be used for brevity. When a number of species are listed in a description, they are ordered according to their diagnostic importance.

Herb-dominated types

Communities dominated by herbaceous plants cover a very minor proportion of the area compared to those dominated by shrubs or trees. They occur at the extremes of several environmental gradients, often being limited to either the driest sites with very thin soils or the wettest sites with deep soils, which are saturated for much of the growing season.

*Dodecatheon jeffreyi-Juncus mertensianus*. This type is found in cool, deep, soddy soils of lakesides, seeps, wet meadows, streamsides and some late snowmelt areas. Usually with a generally north aspect, these areas are often flat, or nearly so. Mostly boggy, especially early in the season, they remain perennially moist, if not saturated. The type is limited to the higher elevations, being found at an average elevation of 6000' and ranging from 5300 to 6300' (Table 4).
The ground is typically well vegetated with herbs which average 76% cover. Shrubs constitute most of the remaining cover. This type is the most diverse in herbaceous species. It has no herbaceous dominants except for Carex kelloggi (Table 2). In addition to Dodecatheon jeffreyi and Juncus mertensianus, Ligusticum californicum, Erigeron peregrinus, Carex integra and Veratrum californicum are common associates. They occur in other types as well, but usually with reduced abundance. Scirpus criniger, Polygonum bistortoides, Eleocharis sp., Juncus mertensianus, Carex kelloggi, Ligusticum californicum, Erigeron peregrinus, Carex integra and Veratrum californicum are common associates. They occur in other types as well, but usually with reduced abundance. Scirpus criniger, Polygonum bistortoides, Eleocharis sp., Juncus mertensianus, Carex kelloggi, Ligusticum californicum, Erigeron peregrinus, Carex integra and Veratrum californicum are common associates. They occur in other types as well, but usually with reduced abundance. Scirpus criniger, Polygonum bistortoides, Eleocharis sp., Juncus mertensianus, Carex kelloggi, Ligusticum californicum, Erigeron peregrinus, Carex integra and Veratrum californicum are common associates. They occur in other types as well, but usually with reduced abundance.

The 1.5' tall shrubs cover 26% here. These include: Phyllodoce empetriformis, Vaccinium arbuscula, Ledum glandulosum, Leucothoe davisiæ, Alnus tenuifolia, Amelancier pallida and Quercus vaccinifolia. The Phyllococe and Ledum are relatively important and are good type indicators (Table 2).

The tree species are most often of seedling and sapling size. They average about 4% coverage. Although they appear to be actively invading these soggy meadows, such saturated soils probably cannot maintain them past a certain size. Most common is Pinus monticola with fewer Tsuga mertensiana, Abies magnifica and Calocedrus decurrens.
A gradation of the type into Amelanchier pallida-Acer glabrum is often seen and illustrates the major floristic affinity. Also, clumps of Phyllodoce are characteristic of the slightly raised, better drained microhabitats within this wet herb type. Minor affinities are seen to Phlox diffusa-Sedum obtusatum, Tsuga mertensiana/Arctostaphylos nevadensis and Abies concolor/Rosa pisocarpa (Table 3).

Phlox diffusa-Sedum obtusatum. A typical habitat for this vegetation type is an open, north-facing, glaciated slope of exposed granite which contains small pockets of sandy or gravelly soil. The type is seen on slopes with aspects other than north, but the cooler aspects probably provide a prolonged snowmelt for a longer growing season. The type reaches its richest development on these sites. These soil pockets are typically wet early in the season with the shallow soils drying shortly after the disappearance of the snow by late June or July in most years. The type ranges from elevations of 5100 to 7030', averaging 6135' (Table 4).

Herbaceous cover averages 35%. In addition to Phlox and Sedum, the type is distinguished by Arenaria congesta, Juncus parryi, Erythronium grandiflorum, Stipa occidentalis, Streptanthus tortuosus, Eriogonum marifolium, Cheilanthes gracillima and the widely occurring Cryptogramma acrostichoides and Penstemon newberryi which reach their best
development here. Also present, but less common are Heuchera merriamii, Achillea lanulosa, Danthonia unispicata, Lewisia leana, Saxifraga ferruginea, Calamagrostis koeleroides, Aspidotus densa and Poa suksdorfii (Table 2).

Shrubs are usually those of the adjacent communities. They have an average coverage of 13%. The more important shrub species include Arctostaphylos nevadensis, Quercus vaccinifolia, Holodiscus microphyllus and Arctostaphylos patula.

Trees show some invasion of the type by saplings and seedlings, but only very occasionally can they find a suitable crevice to develop to maturity. Even then the form tends to be rather twisted and sculpted by the elements.

This type shows greatest affinities to Arctostaphylos patula-A. nevadensis and Amelanchier paliida-Acer glabrum. Minor affinities may be seen to Dodecatheon-Juncus, Abies magnifica/Lithocarpus and Tsuga/Arctostaphylos nevadensis (Table 3).

Pteridium aquilinum-Stachys rigida. Typically found as sandy meadows bordered by forest and chaparral, this type grows on deep, well-drained, sandy soils. Snow melts early from these and they become quite dry late in the season. The deep, early warmed soils, however, make for a lush, early season herb growth. With an average slope/aspect of 32% to the southeast, these lower slope
sites have typically thin, dry humus layers. They average 5510' in elevation, ranging from 5000 to 6500' (Table 4).

The herb stratum, averages 80% cover, and is dominated by *Pteridium aquilinum* with a sparse but consistent occurrence of *Stachys rigida*. *Phacelia mutabilis*, *Hackelia micrantha*, *Vicia americana*, and *Stellaria jamesiana* are important diagnostic species. *Veratrum californicum*, *Hydrophyllum occidentale*, *Calyptridium umbellatum*, *Bromus marginatus*, *Lupinus croceus*, *Achillea lanulosa* and *Epilobium paniculatum* are commonly found here. Toward the shaded edges are *Dicentra formosa*, *Osmorhiza chilensis*, *Galium triflorum* and *Carex subfusca*. Less common, but characteristic are *Sanicula tuberosa*, *Epilobium minutum*, *E. angustifolium*, *Allium validum*, *Cirsium calilepis*, *Arabis sparsiflorus*, *Plagiobothrys cognatus*, *Stipa columbiana*, *Carex presleyi*, *Elymus glaucus*, *Campanula prenanthoides*, *Collinsia torreyi*, *Silene campanulata* and *Artemisia douglasiana*.

The shrub layer, often found toward meadow edges or as isolated clumps, averages 16% cover and 3' in height. *Prunus emarginatus* and *Amelanchier pallida* are characteristic along with the less common *Ceanothus cordulatus*, *Rubus leucodermis* and *Haplopappus bloomeri*. Some of the more mesic areas may show *Acer glabrum*, *Salix commutata*, *Lonicera conjugialis* and *Spiraea douglasii*.

Tree species have an average coverage of only 5% and are represented by sparse seedlings and/or saplings of
Abies magnifica, Pinus monticola, Calocedrus decurrens and A. concolor. Occasionally, isolated individuals of mature Calocedrus and aggregations of mature Pseudotsuga and A. concolor are found within these meadows.

Only a minor affinity is seen here to the often surrounding Abies concolor/Rosa pisocarpa. A weak tie is seen with Quercus kelloggii/Apocynum pumilum (Table 3).

Shrub-dominated types

Communities dominated by shrubs are the most extensive in the area. Arctostaphylos patula-A. nevadensis and Ceanothus integerrimus-Quercus vaccinifolia together cover more than half the area. The shrub types also tend to occur toward the environmental gradient extremes, being found on dry, thin, sandy soils or perennially moist soils. The shrub-dominated types, however, do not occupy sites as extreme as those on which some of the herb-dominated types grow.

These chaparral types do not show recent evidence of extensive fire. About half of the plots show reproductive stages of tree species suggesting some stands may be successional to forests in a continuing absence of fire. The degree of vegetative stability, however, was not a criterion in determination of types.

Amelanchier pallida-Acer glabrum. This type is most often found toward the outrun of the higher montane slopes or in ravines, seeps, lakeside or streamside locations.
The variable slopes and aspects on which it grows average 45% and northerly, but range from level to 100% and may face any direction. These various situations have in common a generally moist to wet soil, often with a deep organic layer. These soils are often intermittent with large boulders and some sites have the common vernally wet and late season dry pattern. The type occurs at the middle high elevations, averaging 5943' and ranging from 5200 to 6600' (Table 4). Late snow areas are often included or contribute to the soil moisture.

The type as a whole is characterized by *Amelanchier pallida, Acer glabrum, Sorbus californica, Vaccinium arbuscula* and *Rhamnus purshiana* (Table 2). There are two obvious phases. The closed phase occupies the more mesic sites and has shrub coverage to 100%. Characteristic shrubs are *Leucothoe davisiæ, Alnus tenuifolia, Ledum glandulosum* and *Taxus brevifolia*. Characteristic shrubs of the more open phase are *Arctostaphylos nevadensis, A. patula* and *Spiraea densiflora*. The ubiquitous *Quercus vaccinifolia* is found throughout both phases as a major component.

The herbaceous layer best distinguishes the two phases. The closed phase has very few herbs, there being usually none or at most, sparse occurrences of *Smilacina racemosa var. glabrum* and/or *Pteridium aquilinum*. The open phase has an average of 20% herb cover. This phase typically includes *Penstemon newberryi, Ligusticum californicum,*
*Sedum obtusatum*, *Achillea lanulosa* and *Juncus parryi*. These together with the closed phase species are the characteristic herbs for the type.

Trees are sparse and there is a tendency for the closed phase to have more canopy and sapling-sized trees while the open phase has more seedlings. Most abundant in both phases are *Pinus monticola*, *Tsuga mertensiana*, *Abies magnifica* and *A. concolor*. *Calocedrus decurrens* and *Picea breweriana* are rarer.

Most important affinities are shown to *Arctostaphylos patula-* *A. nevadensis*, *Tsuga/A. nevadensis*, *Abies magnifica/ Lithocarpus* and *Phlox-Sedum*. Less important are affinities to *Dodecatheon-Juncus* and *Abies magnifica/Pyrola*. A minor affinity is seen to *Abies concolor/Rosa* (Table 3).

*Arctostaphylos patula-* *A. nevadensis*. This montane chaparral is found at the middle to high elevations in the study area ranging from 5400' to 7030' and averaging 6360'. The type has an average slope of 45% but ranges from 90% to level and occurs no more frequently on slopes with a generally south aspect than on slopes with a generally north aspect. Covering slopes and ridges with dry sandy or rocky soils, it normally has little or no humus layer (Table 4).

Like *Amelanchier-Acer*, this type has two phases distinguished not so much by species presence as by openness and height of the shrub layer and presence or
absence of an herb layer. Most common is the closed phase which often has 100% cover consisting of *Arctostaphylos patula*, *Quercus vaccinifolia*, *Arctostaphylos nevadensis*, *Holodiscus microphyllus* and *Ceanothus velutinus* with lesser amounts of *Lithocarpus densiflora*, *Chrysolepis sempervirens* and *Prunus emarginata*. These shrubs are often in extensive unbroken stands 4-7' in height. They are characteristic of south-facing slopes. The open phase is characterized by the same species, but tends to be less than 3' in height, occupies the more north-facing aspects, and has less shrub and more herb cover.

The herbaceous layer of the closed phase is characterized by sparse occurrences of *Penstemon newberryi* with even lesser amounts of *Sedum obtusatum*, *Cryptogramma acrostichoides*, *Cheilanthes gracillima*, *Stipa columbiana* and *Penstemon deustus*. That of the open phase is far richer in species and greater in coverage. In addition to those above are *Senecio integerrimus*, *Phlox diffusa*, *Juncus parryi*, *Calyptridium umbellatum*, *Arabis platysperma*, *Penstemon procerus* and *Arenaria congesta* (Table 2).

The tree species are consistent in both phases but the closed phase tends to have more coverage and sizes while the open phase has mostly seedlings. *Pinus monticola* and *Abies magnifica* are most important, with lesser amounts of *Tsuga mertensiana*, *A. concolor*, *Pinus jeffreyi* and *Calocedrus decurrens*. 
A pronounced affinity exists between the open phase of this type and *Phlox*-*Sedum*. Other important affinities are seen to *Amelanchier*-*Acer*, *Abies magnifica*/*Pyrola*, *A. magnifica*/*Lithocarpus* and *Tsuga*/*Arctostaphylos nevadensis*. A minor affinity exists to *Tsuga*/*Pyrola* (Table 3).

*Ceanothus integerrimus-Quercus vaccinifolia*. Found at the lower elevations and extending downward often to the periphery of the study area, this type occupies lower slopes of medium steepness and averaging 4316' in elevation (Table 4). Aspects are usually southerly. Being free early of slow and receiving less summer precipitation than higher elevations, this type has very dry rocky and sandy soils with only a thin humus layer which may be absent.

The shrub layer is 3-6' high and usually dense, often with 90% or greater coverage. Characterized by *Ceanothus integerrimus*, *Garrya fremontii* and *Lithocarpus densiflora*, it contains large amounts of the more widely occurring *Quercus vaccinifolia* and *Arctostaphylos patula*.

The herb layer is consistently sparse with an average cover of only 2%. Characteristic species include *Apocynum pumilum*, *Polystichum munitum*, *Epilobium paniculatum*, *Keckiella lemmonii*, and *Pedicularis densiflorus*. Lesser amounts of *Hieracium cynoglossoides*, *Kelloggia galioides* and *Campanula prenanthoides* are seen, but may be considered characteristic as well.
Trees have an average coverage of 27%, most of this accounted for by the scattered individuals or clumps. There is consistent sapling and seedling presence, probably indicating community instability. Diagnostic here are *Quercus chrysolepis* and *Pinus attenuata* with greater amounts of *Quercus kelloggii, Calocedrus decurrens, Pseudotsuga menziesii, Pinus jeffreyi, Abies concolor* and *P. lambertiana* (Table 2).

Only one major affinity is seen, and is to the often adjacent *Quercus kelloggii/Apocynum*. A minor affinity, surprisingly, occurs to *Abies magnifica/Pyrola* (Table 3).

**Tree-dominated types**

Although not as diverse as the herb-dominated communities and not as extensive as the montane chaparrals, the forests are an important component of the area's vegetation.

While, in general, the herb and shrub types tend to occupy the extremes of environmental gradients, the forests are usually found on the most intermediate, mesic sites. On these sites the forests show strong elevational zonation patterns. This long recognized zonation (Whittaker, 1960; Franklin and Dyrness, 1973; Sawyer and Thornburgh, 1971, 1974) has been commonly used to describe western forests. It is useful here and I will follow roughly those of Sawyer and Thornburgh (1976) which apply to the area. My three zones are characterized by *Tsuga mertensiana, Abies*
magnifica and A. concolor, each the dominant canopy tree of the mesic site, from high to low elevation, respectively.

Tsuga mertensiana zone forests

Forests in this zone are characterized by a dominance of Tsuga mertensiana with few other canopy species and a lack of the lower elevation trees. They occur almost entirely on the generally north or east-facing slopes, descending here to about 6400'. On south and west-facing slopes they occur only at the highest elevations short of the ridges and summits. High elevations and northeasterly aspects have cooler temperatures and late season snowmelt providing some soil moisture through much of the summer season. These generally upper slope sites often have a deep soil matrix of boulders and fine soils topped with duff, a situation conducive to moisture retention.

Tsuga mertensiana/Pyrola picta. This type is found on high north-facing upper slope sites (Table 4). The soil surface is covered with a deep layer of duff between large boulders. Snow patches are commonly found in these closed forests into July and even August. As soon as the snow melts, the top portion of the duff dries to form an insulating and moisture retaining layer, keeping the soil cool and moist.
The closed canopy averages 72' in height and is dominated by *Tsuga mertensiana*. *Abies magnifica* and *Pinus monticola* are the other canopy species of occasional occurrence. All are reproducing well throughout.

The shrub layer is scant, averaging only 5% cover with a height of 1'. It is characterized by scattered clumps of *Arctostaphylos nevadensis* and *Quercus vaccini-folia* (in small canopy openings) with an occasional individual of *Ribes nevadensis*.

The herb layer is even more sparse with an average coverage of only 2% with the ubiquitous *Penstemon new-berryi* most common, occurring only occasionally on drier microsites in somewhat more open portions of the forest. Also sparsely common are *Pyrola picta*, *Chimaphila umbellata*, *Erigeron inornatus* and *Lupinus croceus*. The last two occur mostly in canopy openings. *Juncus parryi* and *Carex multicaulis* are typically quite sparse (Table 2).

The closest affinity is to *Abies magnifica/Pyrola* with a less important similarity to *Tsuga/Arctostaphylos nevadensis*. Minor affinities occur to *Arctostaphylos patula-A. nevadensis* and *Abies magnifica/Lithocarpus* (Table 3).

*Tsuga mertensiana/Arctostaphylos nevadensis*. Drier sites within the zone typically support an open forest. The rocky soils are similar to those of *Tsuga/Pyrola*
except that moist microsites are somewhat sparse and the duff layer is often thin or intermittent. Late season snowmelt is not as common a feature due to a more open canopy. Elevations average slightly lower within the zone than those for the previous type. The lowest sites tend to have late snowpacks, thick duff, and be most north-easterly of aspect (Table 4).

The canopy is quite open with an average coverage of 31% and an average height of 69'. The dominant *Tsuga* is found with sparse, but consistent amounts of *Abies magnifica* and *Pinus monticola*. *Abies concolor* is found in a minority of the releves and *Picea breweriana*, though it occurs with only a 6% constancy, is codominant where it does occur in small scattered stands. Reproduction of the canopy species is occurring. No major successional change is indicated.

The shrub layer averages 58% cover with a height usually under 3'. It occurs in clumps, mostly of *Arctostaphylos nevadensis* and *Quercus vaccinifolia* with scattered amounts of *Lithocarpus*. It is by the shrub layer, and to some extent the herb layer, that a more mesic phase of the type may be distinguished. The somewhat less open canopies of this phase often cover, in addition to the typical shrubs, continuous expanses of *Leucothoe davisiae* with less abundant *Amelanchier pallida*, *Vaccinium arbuscula*, *Acer glabrum*, *Salix commutata*, *Taxus brevifolia* and *Alnus tenuifolia*. 
The herb layer is scant throughout, at an average coverage of 1%, characterized by *Penstemon newberryi* and *Carex multicaulis* with only the mesic phase having *Chimaphila umbellata* (Table 2).

The most pronounced affinity for the type is seen to *Abies magnifica/Pyrola*, as might be expected. Important affinities occur to *Amelanchier-Acer*, *Abies magnifica/Lithocarpus*, *Tsuga/Pyrola* and *Arctostaphylos patula-A. nevadensis*. Minor affinities are seen to *Dodecatheon-Juncus*, *Phlox-Sedum* and *Abies concolor/Rosa* (Table 3).

*Abies magnifica* zone forests

Occurring below *Tsuga mertensiana* zone forests, but not having a sharply defined boundary with them, these closed to open forests dominated by *Abies magnifica* are usually found on warmer, relatively drier sites. They occupy a wider variety of aspects than those of the zone, being often found on the southerly and westerly slopes between 6500 and 6800'. On the cooler aspects the zone ranges from 5000 to 6500'. *Abies concolor* characterizes the middle to low elevations within the zone while *Pinus monticola* occurs throughout, usually in the more open stands.

*Abies magnifica/Pyrola picta*. This type most often occupies higher elevations and sites with deep continuous soils, tending to be of a cooler aspect than *Abies*
Typically closed forests shelter late season snowpacks on northerly slopes. Soils here are also a matrix of boulders and fine soil covered with thick duff. They hold water well into the summer season, but dry somewhat more than those of higher elevations due to earlier snowmelt and warmer temperatures.

The canopy averages 56% coverage and 69' in height (Table 4). It is dominated by *Abies magnifica* with only occasional sparse occurrences of *Tsuga mertensiana*, *Pinus monticola* and *Abies concolor*, the latter two in the more open and the middle to lower elevations within the zone, respectively. Reproduction of *Abies magnifica* is abundant with sparser saplings and especially seedlings of other canopy species. One closed, nearly pure stand of *Pinus contorta* was found within the zone and is included here because it is a closed forest within the zone.

The shrub layer is characterized by occasional low patches of *Arctostaphylos nevadensis* and *Quercus vaccinifolia* in canopy openings. These, plus very few other shrubs contribute to an average cover of only 11% (Table 4).

The herb layer typically is lacking, with a coverage averaging less than one percent. Occasional *Pyrola picta* is characteristic. Other herbs, rarely present, are *Chimaphila umbellata*, *Apocynum pumilum* and *Penstemon newberryi* (Table 2).
Most significant affinities are to *Tsuga/Arctostaphylos nevadensis*, *Tsuga/Pyrola*, *Abies magnifica/Lithocarpus*, *Arctostaphylos patula-A. nevadensis* and *Amelanchier Acer*. A minor affinity is seen to *Ceanothus integerrimus-Quercus vaccinifolia* (Table 3).

*Abies magnifica/Lithocarpus densiflora*. This type is open forest of lower to upper slopes of any aspect. It occurs on warmer, drier southerly and westerly upper slopes and higher elevations within the zone (Table 4). Most often the soil surface is dry and sandy with a thin humus layer between rocks.

With an average cover of 32% and an average height of 79', the canopy is dominated by *Abies magnifica*. *Pinus monticola* is important as a secondary canopy species. *Tsuga mertensiana* and *Abies concolor* are characteristic, but only sparsely represented. *Picea breweriana* and *Pinus jeffreyi* are occasional. Reproduction of the canopy species is dominated by *Abies magnifica* and *Pinus monticola*, with less consistent reproduction of *A. concolor* and especially *Tsuga* (Table 2).

The shrub layer is most prominent in these open stands, covering, on the average 54% with heights between 2 and 4'. Occurring in dense clumps and thickets, interspersed with openings, the mosaic of shrubs is dominated by *Quercus vaccinifolia, Arctostaphylos nevadensis* and *Lithocarpus densiflora*. Less consistent are *Arctostaphylos patula* and
Holodiscus microphyllus. Leucothoe davisiæ and Amelanchier pallida characterize more mesic sites.

The herb layer is poorly represented by an average coverage of only 3%. It consists mainly of Pyrola picta, Goodyera oblongifolia and Chimaphila umbellata on the deeper organic soils of the more canopied sites. Apocynum pumilum, Carex multicaulis and Calyptridium umbellatum characterize the sparse herbs of more open areas with sandy soils.

Major affinities are to Abies magnifica/Pyrola, Amelanchier-Acer, Tsuga/Arctostaphylos nevadensis Arctostaphylos patula-A. nevadensis. Minor affinities are seen to Abies concolor/Rosa, Phlox-Sedum and Tsuga/Pyrola (Table 3).

The affinities to zones above and below this type plus the presence of some heterogeneous habitats, should have resulted, according to Sawyer and Thornburgh (1976) in coniferous forests with a rather high number of tree species. Tree species diversity, however, is not especially great for any mid-elevation forests here.

Abies concolor zone forests

This zone extends upward to around 5200' where it interfingers with the Abies magnifica zone. Below the study area boundary the forests are seen to grade into an open forest of Pseudotsuga menziesii and Calocedrus
decurrens. The zone is distinguished by a lack of the important higher elevation *Tsuga mertensiana* and *Abies magnifica*. Instead a more important role is played by *Abies concolor*, *Pinus jeffreyi*, *Calocedrus decurrens*, *Pseudotsuga menziesii* and *Pinus lambertiana*. *Acer macrophyllum* and *Quercus kelloggii* occur exclusively on special sites within the zone. To some extent, the zone is common ground for some higher and still lower elevation species.

*Abies concolor/Rosa pisocarpa.* These generally closed forests of lower slopes and alluvial terraces are found on deep, usually moist soils topped with thick humus and duff layers. Slopes are moderate, averaging 19%, and aspect varies. The elevations for this type average 5125'. They might range lower but for a lack of proper topography. Trees may grow to 170' heights but canopy height averages 110' and cover averages 61% (Table 4). Canopies are dominated by *Abies concolor* with *Pinus monticola*, *Calocedrus decurrens*, *Pseudotsuga menziesii* and *Pinus jeffreyi* sharing dominance in various combinations on some sites. *Acer macrophyllum* occurs less frequently, but with some importance in ravines and other moist situations. With the exception of *Pinus jeffreyi*, all canopy species are reproducing commonly in nearly all sampled stands.

Shrub cover averages only 19%, with heights to about 6'. The most characteristic shrub species are *Rosa*
pisocarpa, Amelanchier pallida, Rubus leucodermis and a form of Lithocarpus densiflora which is somewhat taller (to ten feet) than that found in the chaparral (but still var. echinoides). Alnus tenuifolia is important on the wetter sites where Salix commutata, Acer glabrum, Cornus stolonifera and Leucothoe davisiae may also be less consistently found. Prunus emarginata, Ribes nevadensis, Quercus vaccinifolia and Symphoricarpos mollis are occasional throughout the type.

The herbs average 34% cover but range to 95%. Typically Pteridium aquilinum, Veratrum californicum, Senecio triangularis, Achillea lanulosa, Vicia americana, Fragaria vesca and Cirsium calilepis are found in the more open areas. In more mesic to wet openings are apt to be, additionally, Aqualegia formosa and less commonly, Lilium kellyanum. Most characteristic of the more closed areas are consistent occurrences of Adenocaulon bicolor, Galium triflorum, Apocynum pumilum, Osmorhiza chilensis and the diagnostic Viola glabella. Less common here are Pyrola picta, Goodyera oblongifolia, Stellaria jamesiana, Smilacina racemosa var. glabrum and Dicentra formosa. Too numerous to mention, many other characteristic herbs are inconsistently seen in the type (Table 2).

Based on species commonality the only major affinity is to Quercus kelloggii/Apocynum pumilum (Table 4). A number of minor affinities occur, the most notable of
these being to *Abies magnifica*/*Lithocarpus* and *Pteridium/Stachys*.

*Quercus kelloggii/Apocynum pumilum*. This type is generally found lower within the *Abies concolor* zone, averaging 4280' elevation, than is *Abies concolor/Rosa*. It is characteristic of lower slopes and warmer aspects. From these elevations it extends up the slopes higher than could be sampled due to limited access, so my upper elevational limit may well be an artifact. These forests most often have dry sandy soils with only a thin humus layer (Table 4). Occurring at the lower limits of the area, these forests are formed by a comingling of species largely from the type above and just below the study area boundary. To some extend, they may be considered an extension of low elevation xerophytic communities of ultramafic parent materials. At the higher elevations they grade into *Arctostaphylos patula-A. nevadensis*. Such ecotonal areas were not sampled due to inaccessibility.

The canopy averages 62% cover and 56' in height and is dominated by *Quercus kelloggii*. Occurring consistently, and often abundantly are large amounts of *Pseudotsuga* which occasionally overtop the *Quercus*. *Pinus jeffreyi, Calocedrus decurrens, P. lambertiana, Abies concolor* and *P. monticola* are present in minor amounts. These often occur as both emergents and canopy or sub-canopy individuals. This situation, along with often abundant conifer
reproduction suggest that *Quercus kelloggii* dominance is, in at least some cases, seral to a coniferous forest (Table 2).

The shrub layer averages 19% cover at about 4' in height and is characterized by fairly consistent presence of *Lithocarpus densiflora*. Other xerophytic species as *Quercus vaccinifolia*, *Arctostaphylos patula*, *Ceanothus integerrimus* and *Garrya fremontii* are less consistently found.

The herbs average only 7% coverage with *Apocynum pumilum* common, but sparse. Other common herbs are *Galium bolanderi*, *Pteridium aquilinum*, *Adenocaulon bicolor*, *Hieracium cynoglossoides*, *Keckiella lemmontii*, *Festuca arundinacea* and *Iris tenuissima* (Table 2).

Affinities are strongest to *Ceanothus integerrimus-Quercus vaccinifolia* and *Abies concolor/Rosa*, both of which are often adjacent. Several less important affinities also occur (Table 3).
Table 2. Percent presence (P) and modal cover/abundance (C)\textsuperscript{a} for species with greater than 10% presence, by vegetation type.

<table>
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<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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*1 = one individual, 2 = rare, 3 = <10%, 4 = 10-25%, 5 = 25-50%, 6 = 50-75%, 7 = >75%.*
Table 3. Percent species commonality\(^a\) between Bear Lakes vegetation types. These comparisons are the basis for type affinities\(^b\) described in the text and illustrated in Figure 5.

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<th>Vegetation Types</th>
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\(^a\) Percent species commonality = \(\frac{2c}{n_1 + n_2} \times 100\) where \(c\) is the number of species common to both types and \(n_1\) and \(n_2\) are the numbers of species in the two types being compared.

\(^b\) Percentages over 40% are considered major affinities. Minor affinities are generally between 30 and 39%.
Table 4. Mean and modal site factors\(^a\) for each Bear Lakes vegetation type.

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\(^a\) Numerical values are means, others are modal.

\(^b\) LS = lower slope, MS = mid-slope, US = upper slope
Patterns of vegetation within the study area

The vegetation patterning in the Bear Lakes area is dependent upon multiple factors, although for each physiognomic grouping of types, either elevation or edaphic factors are seen as principal controls. While forest types lend themselves to elevational zonation, shrub and herb types are not so well behaved. This variance may be due to differential competitive advantages in a more closed vegetation type (Sawyer and Thornburgh, 1977). The shrub types are primarily edaphically controlled, as in the wet site *Amelanchier-Acer* or the dry site chaparrals. On sites where forest climax is possible, periodic disturbances such as fire, avalanche, drought or inundation may allow shrub maintenance. The herb types occur at the extremes of wetness or dryness. These extremes are nearly absolute, minimizing the importance of elevation-dependent factors. Elevational limits of the shrub and herb dominated types appear to often be a function of habitat availability. The severe physiography reduces the number of types of habitats available. Only secondarily are these limitations due to the environmental factors associated with the elevational zone, such as length of growing season, diurnal and seasonal temperature patterns and amount and duration of winter snow cover.
The ranges of several types probably extend beyond the sampled elevations. *Amelanchier-Acer* along stream-sides at lower elevations and in isolated pockets above the apparent upper limit is an example. *Dodecatheon-Juncus* shows a rather limited elevational range for a non-forest type. It may occasionally extend still higher if suitable sites occur. *Pteridium-Stachys* apparent elevational limits may be an artifact of sampling as this type is rare in the study area. *Arctostaphylos patula-A. nevadensis*, which may be expected to grade into *Ceanothus integerrimus-Quercus vaccinifolia* at lower elevations, shows an elevational discontinuity. This apparent break may be the result of sampling only accessible trailside locations in valley bottoms. Here *Abies concolor* zone forests provide a physical discontinuity between the two chaparral types (Fig. 4).

Major floristic affinities are usually between geographically adjacent types that commonly grade into one another. There are, however, some significant affinities between elevationally separated types, due to a commonality of a specific contingent of species. An example is the wet site species common to both *Dodecatheon-Juncus* and *Abies concolor/Rosa* and resulting in a minor affinity (Table 3). Those types with the greatest number of important affinities tend to be centrally located along both elevational and soil moisture gradients. Surprising
Figure 4. Approximate distribution of Bear Lakes vegetation types along soil moisture and elevational gradients. Distribution along soil moisture gradient was subjectively generated from sampling data. Area enclosed by dotted line shows habitat absent from study area or unsampled.
Figure 5. Major affinities among Bear Lakes vegetation types showing percent species commonality\(^a\) for each relationship. Due to multidimensionality of the relationships, the position of each type reflects only illustrative convenience.

\(^a\) For an explanation of percent species commonality and a complete list of these values by vegetation type, see Table 3.
in this respect is the occurrence of only a few minor affinities between *Abies concolor/Rosa* and the forest types above (Table 3, Fig. 5).

Comparisons with other areas

Siskiyou Mountains

Descriptions of Klamath Region vegetation were pioneered by Whittaker's Siskiyou Mountain study (1960). The Siskiyous are approximately 60 miles west northwest of my area.

Whittaker classified vegetation substrates into three elevational zones. A subalpine zone (5700-7000') has open to closed forests of *Tsuga mertensiana* and *Abies procera* dominance. *Tsuga* tends toward the upper, more mesic sites, and the *Abies* toward the lower, drier sites. Montane forests (4000-6000') are dominated by *Abies concolor* at the higher elevations, *A. concolor-Pseudotsuga* in middle and *Pseudotsuga*-sclerophyll forests at lower elevations. Below 4000' he describes a mixed evergreen forest zone of principally sclerophyllous trees with *Pseudotsuga*. In ravines and other more moist sites his *Chamaecyparis-Pseudotsuga*-dominated forests occur from 1000 to 5000'.

Although his types are not equivalent to mine, the zonation pattern is comparable if *Abies procera* and *A. magnifica* var. *shastensis* are considered ecological equivalents. This has been suggested (Sawyer and Thornburgh, 1977).
Whittaker encountered some 255 species in sampling granitic substrates. I sampled 258 species. I probably included a greater proportion of the flora as a result of my sampling approach, as he did only a limited number of transects over a larger area. The Siskiyou mountains are probably considerably richer in species than my area.

Trinity Alps

Ferlatte's flora of the nearby Trinity Alps (1974), broadly defines five ecological zones above 5000'. He lists three forest zones (mixed conifer, red fir and subalpine) plus montane chaparral and alpine fell-fields. He includes minor habitats such as meadows, streamsides and lakesides within these larger zones. These zones, though, are not based upon sampling of the vegetation.

Two of his three forest zones are roughly equivalent to mine except that his elevational limits are consistently higher. His highest forest zone extends almost 1500' above peak elevations in my area. This upper zone is distinguished by Pinus balfouriana and P. albicaulis. Neither occur at Bear Lakes. His chaparral closely parallels Arctostaphylos patula-A. nevadensis, but he describes no equivalents to my extensive Phlox-Sedum or Amelanchier-Acer.

Ferlatte lists a flora of 571 taxa. I list some 318. Only 255 species are in common.

In addition to reasons I will discuss later, some of the comparative richness of the Trinity Alps flora and the
vegetational differences result from three important factors. 1.) The highest habitats in the Trinity Alps are about 2000' higher than any in my area. This results in an upward shift in the occurrence of many of the conifers. The higher elevation vegetation provides a different group of taxa to the flora, which may, additionally, enrich the mid-elevation vegetation by a comingling of high and mid-elevation taxa. The accumulation of snowpacks at high elevations provides lower zones with dry season moisture not available when these alpine terrains are absent. Such snow melt effects would allow the development of more mesic, species-rich sites. 2.) Ferlatte's study area is considerably larger than mine. 3.) His area includes parent materials besides granitic rock.

English Peak

There is a flora (Oettinger, 1975) of the high lake basin near English Peak in the Marble Mountain Wilderness, about 30 miles northwest of Bear Lakes. The substrate here is primarily granitic. The English Peak flora offers some extensive descriptions of vegetation patterns as well. Oettinger divides his area into three forest zones, white fir, red fir and mountain hemlock. He then discusses separately, montane chaparral, rocky ridges and slopes, mountain meadows (wet, dry and subalpine), plus several riparian and aquatic associations. His white fir, red fir and mountain hemlock zones are quite close to mine in
composition of important species with the exception of important occurrences of *Abies procera* and *A. amabilis* in his area. This might suggest a wetter climate there. His area is somewhat higher than mine. In contrast to the Trinity Alps, elevational limits of his zones agree with mine.

His montane chaparral is similar to, but richer in species than *Arctostaphylos patula-A. nevadensis*. Additionally, he restricts this type more to south-facing slopes. His "rocky ridges and slopes", "subalpine boreal meadows" and "dry meadows" are reasonably analogous to *Phlox-Sedum, Dodecatheon-Juncus* and *Pteridium-Stachys*, respectively. His associations are consistently richer in species. His flora consists of 452 (indigenous) species as compared to my 318. There are 205 taxa common to both areas.

Oettinger's subjective vegetation descriptions are quite extensive and obviously based upon a thorough familiarity. It is unfortunate that they are not complemented by some vegetational data affording better comparisons.

**Russian Peak and regional classifications**

Sawyer and Thornburgh (1971, 1974) describe elevational zones and forest types for the granodioritic Russian Peak area, about twelve miles northwest of Bear Lakes. Later they summarize vegetation patterns for the granitic
soils of the entire Klamath region (Sawyer and Thornburgh, 1977). Unlike previous works, their descriptions are based upon a sampling procedure nearly identical to mine, so their analyses are more comparable.

The 1977 regional descriptions including tabular summaries will be the basis for the following comparisons. Except where western subregional types are specified, the types mentioned are applicable to the Russian Peak area. Following Daubenmire and Daubenmire (1968), Sawyer and Thornburgh recognize elevational zones defined by the dominant vegetation of the mesic site (forests). They describe four zones, three closely corresponding to mine. Their highest, the whitebark pine zone, is not represented at Bear Lakes.

The most obvious difference between Russian Peak and Bear Lakes is the larger number of species in all layers of Russian Peak descriptions. Russian Peak has 447 taxa (Sawyer, pers. comm.) Bear Lakes shows only 318, with 213 common to both.

Their White Fir/Berberis nervosa bears some close habitat similarities to Abies concolor/Rosa pisocarpa. Floristically, however, the highest commonality (Table 5) is among Abies concolor/Rosa and their western subregional White Fir/Vicia and White Fir/Trillium. This is most pronounced in the herb layer. Quercus kelloggii/Apocynum shows a high commonality with their White Fir/Ceanothus. Ceanothus integerrimus-Quercus vaccinifolia is closely
related to their White Fir/Ceanothus, White Fir/Berberis and western subregional White Fir/Chimaphila (Table 5).

Sawyer and Thornburgh (1977) argue that regional differences diminish at higher elevations. This is borne out at Bear Lakes. The (Shasta) Red Fir and especially the Mountain Hemlock zones of my area and of both the Russian Peak and regional descriptions show greater floristic parallels than for lower zones. Bear Lakes tends toward a shortage of mesic and heterogeneous sites that are apparently more abundant at Russian Peak. These are conducive to somewhat richer species mixtures (Table 5).

Within the Red Fir zones, the greatest commonality is between *Abies magnifica/Pyrula* and Red Fir/*Pyrola*. Other high similarities are shown between Bear Lakes Red Fir forests and their Red Fir/*Quercus vaccinifolia* and the higher elevation Mountain Hemlock/*Pyrola* types (Table 5). Other comparisons to Mountain Hemlock zone types show less relationship.

The Russian Peak *Quercus vaccinifolia-Arctostaphylos patula* description is similar to *A. patula-A. nevadensis*, but floristically, more closely comparable to *Phlox-Sedum* (Table 5). Their Red Fir/*Quercus vaccinifolia*, Mountain Hemlock/*Q. vaccinifolia* and Mountain Hemlock/*Pyrola* show greater similarities to *Arctostaphylos patula-A. nevadensis*. *Amelanchier-Acer* is most similar to their Mountain Hemlock/
Table 5. Percent species commonality$^a$ between Bear Lakes and Russian Peak$^b$ vegetation types.

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$^a$ Percent species commonality = \( \frac{2C}{n_1 + n_2} \times 100 \) where C is the number of species common to both types and \( n_1 + n_2 \) are the numbers of species in the two types being compared.

$^b$ Sawyer and Thornburgh, 1977.

$^c$ Trees & shrubs with greater than 10% presence, herbs with greater than 20% presence.
Quercus vaccinifolia and Red Fir/Q. vaccinifolia. Dodecatheon-Juncus is quite like their Mountain Hemlock/Phyllococe.

Sawyer and Thornburg's descriptions consistently suggest more heterogeneous habitats with more numerous mesic sites. When this is considered along with the rather different floras (only 28% species commonality with Russian Peak), it is not surprising that our vegetation types do not show greater similarities.

Factors responsible

The relatively depauperate flora and the simple vegetation pattern at Bear Lakes may be largely due to its distinctive climatic factors and topography.

A general trend of increasing aridity to the east within the Klamath Region (Waring, 1969) suggests that the study area would be drier than the Siskiyous and English Peak locales. Russian Peak should, however, be comparably dry (Fig. 1). The size of the Bear Lakes mountain mass may result in it being even drier. Russian Peak is part of a continuous, higher and more extensive terrain, more capable of orographically modifying weather. My area, however, is a small, isolated prominence.

Resulting in part from the small size is the area's environmental homogeneity. This is probably most important in accounting for the simpler floristics and differing
vegetation patterns seen at Bear Lakes. Steep terrain prevails. There is a scarcity of level areas, the only ones being the immediate environs of the three glacial lakes plus some dry narrow ridge tops. This paucity of level areas results in a shortage of moisture-retaining soils capable of supporting communities which in other areas are rich in species.

Glacial moraines are another type of environment supporting species-rich communities (Sawyer and Thornburgh, 1974). At Russian Peak and to a certain extent in the other areas discussed, these moraines occur at elevations where mid-elevation and high elevation floras mix. In my area the few remaining moraines are mostly lower. Here they do not form different microhabitats then the generally dry situations surrounding them.

The species rich forests at Russian Peak are thought to result from a diverse set of glacially produced microhabitats which have been locally disturbed (Sawyer and Thornburgh, 1977). They argue that disturbance can be important, a small amount leading to greater habitat and floristic diversity, while extensive or minimum disturbance leads to a homogeneous habitat which becomes floristically simple.

Disturbance by fire is the most important modern form of habitat perturbation. It is variable in extent, depending upon topography, soil moisture and vegetation. Although little recent evidence of extensive fire was
found in the study area, there can be no doubt, with the expansive, steep areas of montane chaparral surrounding the meager stands of forest, that when fires occur in the dry season, they would be extensive. Some other localized disturbances are found at Bear Lakes, but these occur more widely elsewhere. Avalanche, areas of late snowpack, seasonal or occasional inundation around lakes and in meadows occur rarely at Bear Lakes, further reducing habitat diversity.

The area's small size may contribute to a meager flora, especially when the majority of the area is covered by floristically simple montane chaparral. In addition, the lack of subalpine vegetation here diminishes the flora and precludes that contingent of species from comingling with and enriching the mid-elevation vegetation.
SUMMARY AND CONCLUSIONS

The flora of Bear Lakes is consistently depauperate when compared to other areas in the Klamath Region. Its vegetation reflects this meager, xerophytic flora in the simplicity of its pattern. Dry-herbaceous and chaparral types are extensive and are elevationally independent as compared to the less extensive, elevationally zoned forests.

Forest zonation at Bear Lakes is similar to other areas in the region. Some vegetation type descriptions suggest appreciable similarities. These floristic similarities become greater at higher elevations.

The smaller flora and simple vegetation patterns of Bear Lakes is due to a complex of factors, but especially the area's small size and lower summit elevations. The isolated nature of this granitic mountain mass results in steep slopes and sharp ridges. Small size and steepness result in few, extensive habitats. The more gentle and level terrains are scarce. These are the habitats which support species-rich vegetation elsewhere. The lack of highest alpine and sub-alpine habitats further reduces floristic richness.

The small orographic mass of Bear Lakes makes it less capable of influencing its own weather, especially in terms of summer thunderstorms. The east to west precipitation gradient across the Klamath Region, though not significant
in explaining differences with the Russian Peak area, increases in importance with westerly distance from the Bear Lakes area.

Disturbance, in this case, has lead to vegetational simplification. Fire may have more uniformly influenced large portions of the area. It is elsewhere that a mixture of xeric, mesic and hydric habitats complicate fire effects, thus enhancing vegetation diversity. Disturbance by avalanche or lakeside or meadow inundation is insignificant at Bear Lakes.

Although the vegetation and flora at Bear Lakes shows some similarities to other areas in the Klamath Region, the differences are striking. These differences in both degree and kind illustrate the complexity of the Klamath Region vegetation and suggest that regional descriptions need to be flexible.
LITERATURE CITED


Appendix A. List of taxa found in the study area. Nomenclature follows Munz (1959, 1969) except for those taxa marked by an asterisk (*). Organization of families and genera is that used by Smith and Sawyer (1978).

EQUISETACEAE

Equisetum laevigatum

PTERIDACEAE

Adiantum pedatum L. var. aleuticum Rupr.
*Aspidotus densa (Brack.) Lellinger
Cheilanthes gracillima D.C. Eat. in Torr.
Cryptogramma acrostichoides R. Br. in Rich.
Pellaea brachyptera (T. Moore) Baker.
Pteridium aquilinum (L.) Kuhn var. pubescens Underw.

ASPIDIACEAE

Athyrium alpestre (Hoppe) Rylands var. americanum Butters
Cystopteris fragilis (L.) Bernh.
Polystichum munitum (Kaulf.) Presl. var. imbricans (D. C. Eat.) Maxon.

PINACEAE

Abies concolor (Gord. & Glend.) Lindl.
A. magnifica A. Murr. var. shastensis Lemmon
Pinus attenuata Lemmon.
P. jeffreyi Grev. & Balf. in A. Murr.
*P. contorta Dougl. ssp. latifolia (Engelm. ex Wats.) Critchf.
P. lambertiana Dougl.
P. monticola Dougl.
P. ponderosa Dougl. ex P. & C. Lawson
Pseudotsuga menziesii (Mirb.) Franco
Tsuga mertensiana (Bong.) Carr.
Picea breweriana (Wats.)

TAXACEAE

Taxus brevifolia Nutt.

CUPRESSACEAE

Calocedrus decurrens (Torr.) Florin
ACERACEAE

Acer glabrum Torr. var. torreyi (Greene) Smiley
A. macrophyllum Pursh

APOCYNACEAE

Apocynum pumilum (Gray) Greene

ASCLEPIADACEAE

Asclepias cordifolia (Benth.) Jeps.

BETULACEAE

Alnus sinuata (Regel) Rydb.
A. tenuifolia Nutt.

BORAGINACEAE

*Hackelia micrantha* (Eastwood) J. L. Gentry
Plagiobothrys cognatus (Greene) Jtn.

CAMPANULACEAE

Campula prenanthoides Durand

CAPRIFOLIACEAE

Lonicera conjugialis Kell.
Sambucus melanocarpa Gray.
Symphorocarpos hesperius G. N. Jones

CARYOPHYLLACEAE

Arenaria congesta Nutt. ex T. & G.
Cerastium arvense L.
Silene campanulata Wats.
S. grayii Wats.
S. menziesii Hook.
Stellaria jamesiana Torr.

CHENOPODIACEAE

Chenopodium album L.

COMPOSITAE

Achillea lanulosa Nutt.
Adenocaulon bicolor Hook.
Agoseris glauca (Pursh) Greene var. monticola (Greene) Q. Jones.
Anaphalis margaritacea (L.) Benth. ex C. B. Clarke
Antennaria argentea Benth.
A. rosea Greene
Arnica diversifolia Greene
A. mollis Hook.
A. viscosa Gray.
Artemisia douglasiana Bess. in Hook.
A. norvegica Fries. var. saxatilis (Bess. in Hook.) Jeps.
A. tridentata Nutt.
Aster ledophyllus (Gray) Gray
Brickellia grandiflora (Hook.) Nutt.
Cirsium callilepis (Greene) Jeps.
Chrysanthemus nauseosus (Pall.) Britton
Erigeron cervinus Greene
E. inornatus (Gray) Gray
E. inornatus (Gray) Gray var. angustatus Gray
E. peregrinus (Pursh) Greene ssp. callianthemus (Greene)
   Cronq. var. angustifolius (Gray) Cronq.
Eriophyllum lanatum (Pursh) Forbes var. lanceolatum
   (Howell) Jeps.
Haplopappus bloomeri Gray
H. whitneyi Gray
Helianthus bigelovii Gray
Hieracium albiflorum Hook.
H. bolanderi Gray
H. cynoglossoides Arv.-Touv. ex Gray
Luina hypoleuca Benth.
Madia bolanderi (Gray) Gray
Microseris nutans (Hook.) Sch.-Bip.
Senecio integerrimus Nutt. var. major (Gray) Cronq.
S. triangularis Hook.
Solidago canadensis L. ssp. elongata (Nutt.) Keck
Stephanomeria latucina Gray

CONVOLVULACEAE

Calystegia malacophyllus (Greene) Munz

CORNACEAE

Cornus nuttallii Aud.
C. stolonifera Michx.

CRASSULACEAE

Sedum obtusatum Gray ssp. boreale Clausen

CRUCIFERAE

Arabis platysperma Gray
A. sparsiflora Nutt. in T. & G.
A. suffrutescens Wats.
Barbara orthoceras Ledeb.
Dentaria californica Nutt.
Draba howellii Wats.
Erysimum capitatum (Dougl.) Greene
Streptanthus barbatus Wats.
S. tortuosus Kell.
Thlaspi glaucum A. Nels. var. hesperium Pays.

CUSCUTACEAE

Cuscuta californica H. & A.

CYPERACEAE

Scirpus congdonii Britton
S. criniger Gray
Carex ablata Bailey
C. amplifolia Boott.
C. hassei Bailey
C. hoodii Boott.
C. integra Mkze.
C. interior Bailey
C. kelloggii W. Boott.
C. multicaulis Bailey
C. multicoslata Mkze.
C. preslei Steud.
C. rostrada Stokes
C. subfuscic W. Boott.
Eleocharis sp.

ERICACEAE

Arctostaphylos nevadensis Gray
A. patula Greene
Cassiope mertensiana (Bong.) G. Don.
Kalmia polifolia Wang. var. microphylla (Hook.) Rehd.
Ledum glandulosum Nutt. var. californicum (Kell.) C.L. Hitchc.
Leucothoe davisea Torr.
Phyllodoce empetriformis (Sm.) D. Don.
Rhododendron occidentale (T. & G.) Gray
Vaccinium arbuscula (Gray) Merriam
Vaccinium membranaceum Doug.

FAGACEAE

Chrysolepis sempervirens (Kell.) Hjelmquist
Lithocarpus densiflora (H. & A.) Rehd. var. echinoides
(R. Br.) Abrams
Quercus chrysolepis Liebm.
Q. chrysolepis Liebm. var. nana (Jeps.) Jeps.
Q. kelloggii Newb.
Q. vaccinifolia Kell.
FUMARIACEAE

Dicentra formosa (Andr.) Walp.
D. pauciflora Wats.

GARRYACEAE

Garrya fremontii Gray

GRAMINEAE

Agrostis palustris (Huds.) Pers.
A. scabra Willd.
A. variabilis Rydb.
Bromus marginatus Nees.
B. orcuttianus Vasey.
Calamagrostis koelerioides Vasey.
C. purpurascens R. Br. in Richards.
Danthonia unispicata (Thurb.) Munro ex Macoun.
Dichenthelium lanuginosum (Ell.) Gould var. fasciculatum (Torr.) Spell.
Elymus glaucus Buckl.
Festuca arundinacea Schreb.
F. californica Vasey.
F. occidentalis Hook.
Glyceria elata (Nash) Hitchc.
Melica subulata (Grieseb.) Scribn.
Muhlenbergia montana (Nutt.) Hitchc.
M. filiformis (Thurb.) Rydb.
Poa suksdorffii (Beal.) Vasey ex Piper.
Sitanion hystrix (Nutt.) J. G. Sm.
Stipa columbiana Macoun
S. occidentalis Thurb.
S. williamsii Scribn.

GROSSULARIACEAE

Ribes montigenum McClat.
R. nevadense Kell.
R. roeslili Regel
R. viscosissimum Pursh

HYDROPHYLLACEAE

Draperia systyla (Gray) Torr.
Hydrophyllum occidentale (Wats.) Gray.
Nama lobbi Gray
Phacelia mutabilis Greene
P. leonis J.T. Howell

HYPERICACEAE

Hypericum anagalloides Cham. & Schlect.
IRIDACEAE

Iris tenuissima Dykes.
Sisyrinchium bellum Wats.

JUNCACEAE

Juncus ensifolius Wikstr.
J. mertensianus Bong.
J. parryi Engelm.
J. ziphoides E. Mey.
Luzula comosa E. Mey.
L. divaricata Wats.

LABIATAE

Monardella odoratissima Benth.
M. odoratissima Benth. ssp. pallida (Heller) Epl.
Prunella vulgaris L. ssp. lanceolata (Barton) Hult.
Scutellaria antirrhinoides Benth.
Stachys rigida Nutt. ex Benth.
Trichostema oblongum Benth.

LEGUMINOSAE

Lathyrus palustrus L.
Lotus crassifolius (Benth.) Greene
L. nevadensis Greene
L. oblongifolius (Benth.) Greene
L. pinnatus Hook.
L. purshianus (Benth.) Clem. & Clem.
Lupinus croceus Eastw.
L. lyallii Gray var. danaus (Gray) Wats.
Trifolium breweri Wats.
T. longipes Nutt.
T. productum Greene

Vicia americana Muhl. ssp. oregana (Nutt.) Abrams
V. americana Muhl. ssp. oregana (Nutt.) Abrams var.
   truncata (Nutt.) Brew.

LILIACEAE

Allium campanulatum Wats.
A. tolmii Baker.
Brodiaea multiflora Benth.
Calochortus elegans Pursh. var. nanus Wood.
C. nudus Wats.
Clintonia uniflora (Schult.) Kunth
Erythronium grandiflorum Pursh. var. pallidum St. John.
Fritillaria atropurpurea Nutt.
Lilium kellyanum Lemmon.
Narthecium californicum Baker
Schoenolirion album Durand
Smilacina racemosa (L.) Desf. var. amplexicaulis (Nutt.) Wats.
S. racemosa (L.) Desf. var. glabra (Macbr.) St. John
S. stellata (L.) Desf.
Smilax californica (A. DC.) Gray
Streptopus amplexifolius (L.) D.C. var. denticulatus Fassett
Tofieldia glutinosa (Michx.) Pers. ssp. occidentalis (Wats.) C. L. Hitchc.
Trillium ovatum Pursh
Veratrum californicum Durand
Xerophyllum tenax (Pursh) Nutt.

MALVACEAE

Sidalcea oregana (Nutt.) Gray
S. oregana (Nutt.) Gray ssp. spicata (Regel) C.L. Hitchc.

ONAGRACEAE

Circaea alpina L. var. pacifica (Asch. & Magnus.) Jones
Epilobium angustifolium L.
E. glaberrimum Barb.
E. minutum Lindl. ex Hook. var. foliosum T. & G.
E. paniculatum Nutt. ex T. & G.
E. pringleanum Hausskn.

ORCHIDACEAE

Corallorhiza maculata Raf.
C. mertensiana Bong
Goodyera oblongifolia Raf.
Listera convallaroides (Sw.) Torr.
*Piperia unalascensis (Spreng.) Rydberg.
*Platanthera dilatata Lindl. var. leucostachys (Lindl.) Luer

OROBANCHACEAE

Orobanche uniflora L. var. purpurea (Heller) Achy.

POLEMONIACEAE

Collomia grandiflora Dougl. ex Lindl.
C. tinctoria Kell.
Gilia capillaris Kell.
Phlox diffusa Benth.
Polemonium pulcherrimum Hook.

POLYGALACEAE

Polygala cornuta Kell.
POLYGONACEAE

Eriogonum lobbii T. & G.
E. marifolium T. & G.
E. nudum Dougl. ex Benth.
E. umbellatum Torr.
Polygonum bistortoides Pursh
P. davisiae Brew. ex Gray
P. spergularioides Meissn.
P. Shastense Brew. ex Gray

PORTULACACEAE

Calyptridium umbellatum (Torr.) Greene
Claytonia lanceolata Pursh
Lewisia leana (Porter) Rob. in Gray
L. nevadensis (Gray) Rob. in Gray
Montia perfoliata (Donn) Howell
M. siberica (L.) Howell

PRIMULACEAE

Dodecatheon jeffreyi Van Houtte.

PYROLACEAE (including MONOTROPACEAE)

Chimaphila menziesii (R. Br. ex D. Don) Spreng.
C. umbellata (L.) Barton var. occidentalis (Rydb.) Blake
Pyrola picta Sm.
P. secunda L.
Sarcodes sanguinea Torr.

RANUNCULACEAE

Aconitum columbianum Nutt. in T. & G.
Aquilegia formosa Fisch. in DC. var. truncata (F. & M.) Baker
Delphinium nuttallianum Pritz. ex Walp.
Ranunculus alismaefolius Geyer ex Benth. var. hartwegii
(Greene) Jeps.
R. macounii Britton
R. occidentalis Nutt. var. dissectus Henders.

RHAMNACEAE

Ceanothus cordulatus Kell.
C. integerrimus H. & A. var. macrothyrsus (Torr.) G. T. Benson
C. prostratus Benth.
C. velutinus Dougl. ex Hook.
Rhamnus purshiana DC.
ROSACEAE

*Amelanchier pallida* Greene
*Fragaria vesca* L. ssp. *californica* Staudt.
*Holodiscus microphyllus* Rydb.
*Horkelia tridentata* Torr.
*Luethiea pectinata* (Pursh) Kuntze.
*Potentilla flabellifolia* Hook. ex T. & G.
*P. glandulosa* Lindl.
*Prunus emarginata* (Dougl.) Walp.
*Rosa nutkana* Presl.
*R. pisocarpa* Gray
*R. leucodermis* Dougl. ex T. & G.
*R. parviflorus* Nutt.
*Sibbaldia procumbens* L.
*Sorbus californica* Greene
*Spiraea densiflora* Nutt. ex T. & G.
*S. douglasii* Hook.

RUBIACEAE

*Galium bifolium* Wats.
*G. bolanderi* Gray
*G. triflorum* Michx.
*Kelloggia galioides* Torr.

SALICACEAE

*Salix commutata* Bebb.
*S. exigua* Nutt.

SARRACENIACEAE

*Darlingtonia californica* Torr.

SAXIFRAGACEAE

*Boykinia major* Gray
*Heuchera merriamii* Eastw.
*Lithophragma parviflora* (Hook.) Nutt.
*Parnassia palustris* L. var. *californica* Gray
*Saxifraga aprica* Greene
*S. bryophora* Gray
*S. ferruginea* Grah.

SCROPHULARIACEAE

*Castilleja arachnoidea* Greene
*C. applegatei* Fern.
*C. miniata* Dougl. ex Hook.
*Collinsia torreyi* Gray var. *latifolia* Newsom
*Keckiella lemmontii* (Gray) Straw
*Mimulus brevistylus* (Greene) Cov.
M. layneae (Greene) Jeps.
M. moschatus Dougl. ex Lindl.
M. nanus H. & A.
M. primuloides Benth. ssp. linearifolius (Grant) Munz
M. pulsilerae Gray
Pedicularis densiflora Benth. ex Hook.
Penstemon densatus Dougl. ex Lindl.
P. laxus Gray ssp. roezlii (Regel) Keck
P. newberrii Gray ssp. berrii (Eastw.) Keck
P. procerus Dougl. ex Gray. ssp. brachyanthus (Penn.) Keck
Veronica cusickii Gray

SOLANACEAE

Solanum parishii Heller

UMBELLIFERAE

Angelica arguta Nutt. ex T. & G.
Heracleum lanatum Michx.
Ligusticum californicum Coult. & Rose
Lomatium macrocarpum (H. & A.) Coult. & Rose
Osmorhiza chilensis H. & A.
Perideridia parishii Nels. & Macbr.
Sanicula tuberosa Torr.

VALERIANACEAE

Valeriana sitchensis Bong.

VIOLACEAE

Viola glabella Nutt.
V. macloskeyi Lloyd
APPENDIX B. Sample plot sheet completed in the field.

PLOT NO. 186       CREW JPCP       DATE 14 July 26
T. 39 N  R. 7 W  Sec. 28  Quadrangle Borrego Mtn.

TOPOGRAPHIC POSITION: Alluvial Terrace (High) (Low) (Near Creek)
Ravine, Draw, Lower Slope, Mid-Slope, Upper Slope, Ridge, Summit,
Seep.

ELEVATION 1200'       SLOPE 30'       % PARENT MATERIAL 50

SURFACE TEXTURE  duff       CHARACTER MOD ORG

HUMUS L' R. dry

ASPECT: NNE NE N ENE NNW E NW ESE WNW W WSW S SW SSW

HISTORY: fire, other

NOTE: (UNIQUE PLOT CHARACTERISTICS, ETC.)

LOCATION: Between Bear L. trail and Bear Cr @ 4900'

COVER CLASSES 1-one specimen, 2-sparse, 3 less than 10%, 4-10-25%
5-25-50%, 6-50-75%, 7 more than 75%

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SHRUB LAYER

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