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Coniferous Forest Habitat Types of Central and Southern Utah

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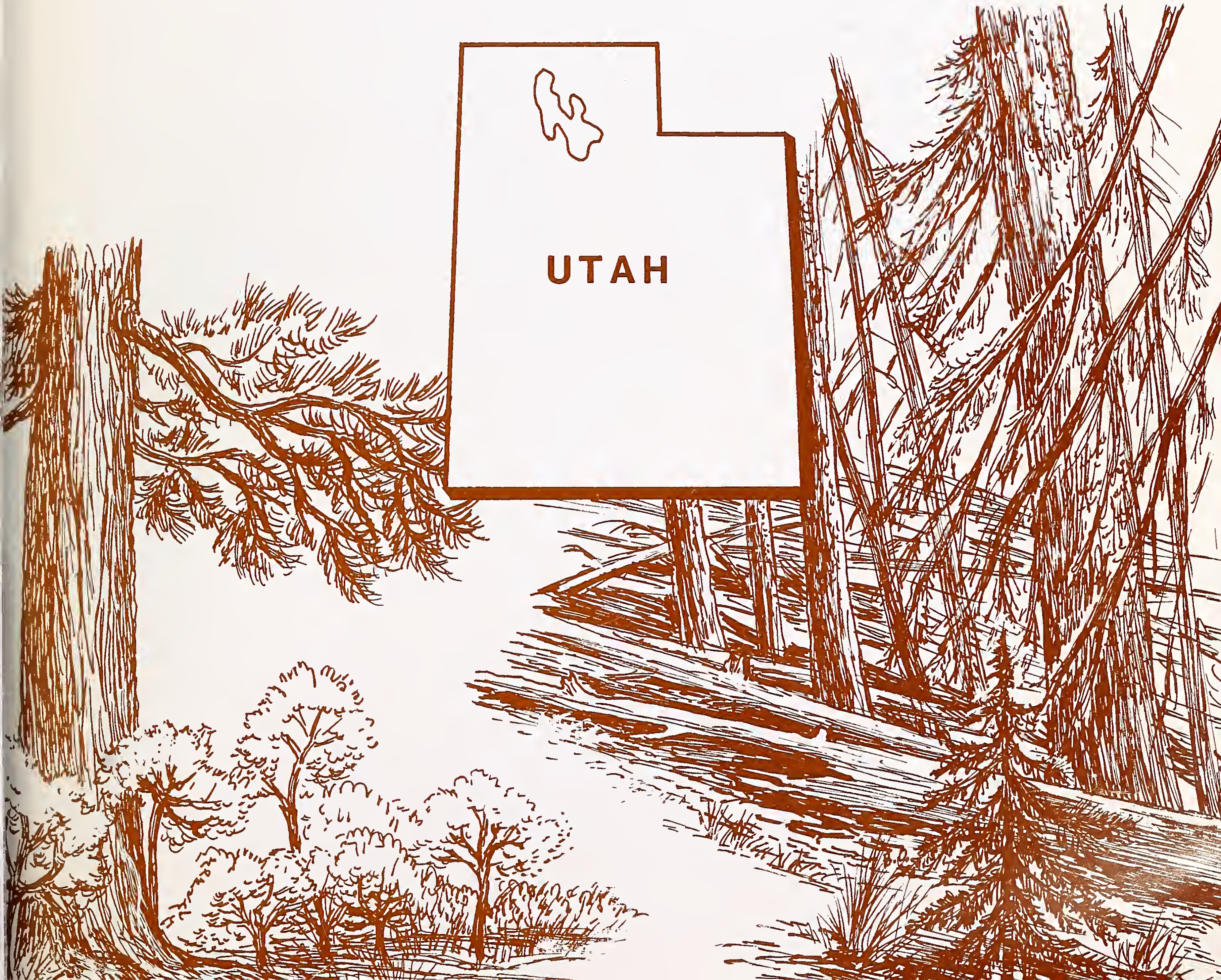

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Robert Steele, Walter Mueggler, and Robert Campbell of the Intermountain Research Station made significant contributions to the data analysis and manuscript preparation. Others who provided technical reviews were William Moir of the Forest Service, Southwest Region, Orville Engleby of the Forest Service, Intermountain Region, as well as Jan A. Henderson, Charles Kerr, and Steve Simon.

RESEARCH SUMMARY

A habitat type classification for the coniferous forests of central and southern Utah includes the hierarchical taxonomic system of land classification that is based on potential natural vegetation of forest sites and uses data from more than 720 sample stands. A total of 37 habitat types within seven series are defined and described. A diagnostic key will help in field identification of the habitat types based upon indicator plant species.

In addition, descriptions of mature forest communities include information on the ecological distribution of all species. Potential productivity for timber, climatic characteristics, surface soil characteristics, and distribution maps are provided for the major types. Preliminary silvicultural and wildlife habitat implications for natural resource management are based on field observations and current information.

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Coniferous Forest Habitat Types of Central and Southern Utah

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INTRODUCTION

The forests of central and southern Utah occupy an area of complex geology and terrain, contrasting climatic patterns, and merging floristic regimes. The resulting diversity of forest vegetation is often in various stages of successional development because of past disturbance. Each unit of vegetation may have a host of inherent resource values such as forage production for livestock, wildlife habitat for big game, or timber for commercial production. These values change as the vegetation changes. Classification of the forests for specific, single-resource purposes have often proved inadequate when applied to different resources. Resource managers frequently must rely upon a classification system that is not structured for one purpose but rather serves a broad spectrum of management needs simultaneously.

Classification of forested lands by habitat type provides an integrated, ecosystem-management approach to resource categorization. Units within the classification are sites or areas of land. The first habitat type system of site classification was developed by Daubenmire (1952) for northern Idaho and eastern Washington. Later work by Daubenmire and Daubenmire (1968) refined the concept and served as the model for most subsequent classifications. Classifications have now been developed for many areas in the Western United States (Pfister 1976). These provide the resource manager with a common framework for communication, management, and research.

Within central and southern Utah, Pfister (1972) has classified lands potentially capable of supporting *Abies lasiocarpa* and *Picea engelmannii*. Extensive areas at lower elevations supporting montane forests remained unstudied. In 1975, the Intermountain Region and the Intermountain Forest and Range Experiment Station of the Forest Service, U.S. Department of Agriculture, entered into a cooperative research effort with the Department of Forestry and Outdoor Recreation at Utah State University to complete a State-wide habitat type classification of conifer-dominated lands. Much of the early effort was directed toward completion of a classification for northern Utah, including the Wasatch and Uinta Mountains. Results of this work are presented by Mauk and Henderson (1984). Beginning in 1975, field crews led by Charles Kerr conducted sampling on the northern end of the Wasatch Plateau near Price, UT. As part of a broad wildland classification and information retrieval system, their work has been reported by Kerr and Henderson (1979). Concurrently, additional field crews led by Steve Simon sampled a larger portion of the same general area in an attempt to describe existing plant community types. From 1979 to 1981, an effort led by Ronald Mauk resulted in completion of field sampling throughout central and southern Utah. Data from (1) Pfister's (1972) thesis, (2) Kerr and Henderson's (1979) work near Price, (3) Simon's work on the Wasatch Plateau, and (4) fieldwork from 1979 to 1981 were combined for analysis and classification of habitat types. The resulting compilation forms the basis of this report.

The area covered by this classification extends roughly from Soldier Summit and Thistle on U.S. Highway 6 in central Utah south to the Arizona border (fig. 1). Specifically, the area includes lands within three National Forests (Manti-LaSal, Fishlake, and Dixie) and forested parts of Bryce Canyon National Park and Cedar Breaks National Monument. A small section of the Ashley National Forest south of Duschesne is included because it was not considered within the northern Utah classification. We have also included forested lands immediately adjacent to the above-named areas, regardless of ownership.

The objectives of this study were:

1. To contribute to a broad regional classification program of the Forest Service by the development of a habitat type classification for conifer-dominated forest lands of central and southern Utah based upon the potential climax vegetation.
2. To describe the general geographic, topographic, climatic, and edaphic features of each habitat type.
3. To describe the structural and floristic characteristics of late seral or climax vegetation of each habitat type.
4. To present information on successional development, resource values, and management opportunities for each habitat type.

This classification is intended to cover forested lands that are potentially capable of supporting at least 25 percent canopy cover of conifers, excluding the woodland species of *Juniperus osteosperma*, *Juniperus scopulorum*, *Pinus edulis*, or *Pinus monophylla*. Some lands supporting certain plant communities of questionable successional status were also not included. Riparian stands dominated by *Populus angustifolia* or *Populus fremontii* were ignored unless *Picea pungens* was also present. *Populus tremuloides* stands not having a well-developed understory of conifer are best described by a more specific classification resulting from the work of the

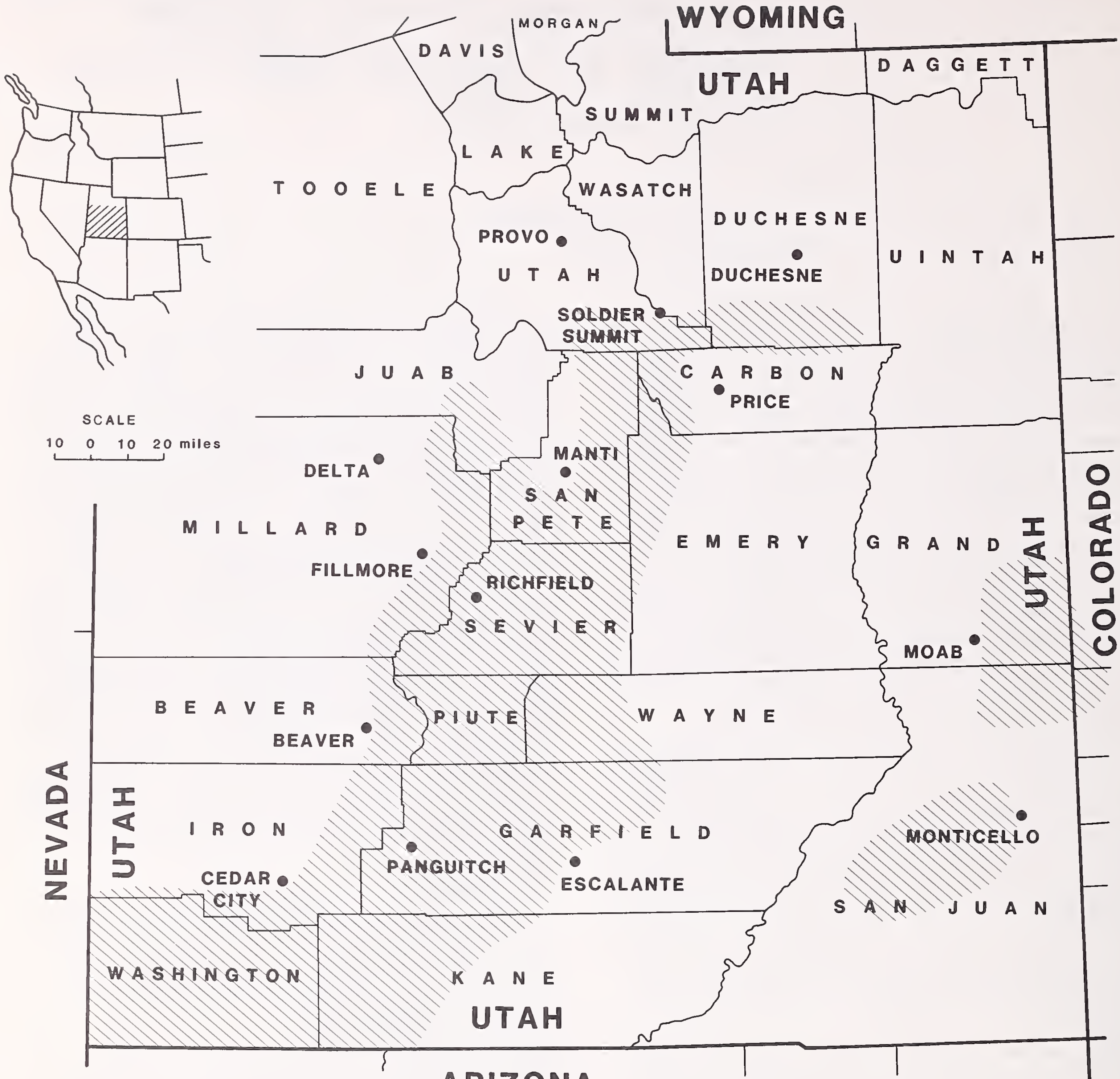


Figure 1.—Area covered by this classification (shaded) showing counties and major towns.

Intermountain Research Station (Mueggler and Campbell, in prep.). Likewise, shrublands dominated by *Quercus gambelii* or *Cercocarpus* were ignored unless the succession to conifers was obvious.

To provide a continuity with adjacent areas, this classification follows similar organization and terminology established by Pfister (1977) and used in other portions of the Intermountain Region (Steele and others 1981; Steele and others 1983; Mauk and Henderson 1984).

METHODS

Although fieldwork extended through 15 years and involved many individuals, overall concepts of sampling procedures and approaches remained relatively constant. Our purpose was to develop a natural taxonomic classification of forest environments based upon the potential climax vegetation and the site it reflects.

Field Methods

The objective of field sampling was to collect data on a full range of environmental conditions for the forested areas of central and southern Utah. The approach to sampling was similar to the "subjective without preconceived bias" concept of Mueller-Dombois and Ellenberg (1974), in that placement of plots was made without any assumption of eventual classification or apparent applicability to specific management problems, but rather for the representation of homogeneous vegetation. Field procedures generally follow those established by Franklin and others (1970), and modified by Henderson and West (1977) and Steele and others (1981, 1983).

Elevational road and trail transects were selected to reflect the range of environmental conditions of the area. Brief stops were made to note characteristics of potential sample stands such as overstory, undergrowth, substrate, topographic features, and the relationship to adjacent stands. Reconnaissance plots were then subjectively located in the most representative and homogeneous parts of the most mature stands of the area. Obvious ecotones, microsites, exceptionally dense clumps or openings, or areas of recent severe disturbance were avoided.

Reconnaissance plots of about one-eighth acre (500 m^2) were circular, with the centers generally referenced to physical road or trail landmarks to make return visits easier. For each plot, records were made of slope and aspect to the nearest degree, slope position and configuration, elevation to the nearest contour (USGS 7½- or 15-minute topographic map), and general location.

Canopy coverage amounts of all undergrowth vascular plant species were ocularly estimated to the nearest percent from 1 to 10 percent and to the nearest 5 percent thereafter. Also noted was the presence of species in the stand but not in the plot, and species with trace amounts less than 1 percent. From 1968 to 1970, Pfister used six coverage classes; during the analysis these data were converted to the midpoint of the class. The practice of multiple small quadrats (Daubenmire 1959; Daubenmire and Daubenmire 1968) was occasionally used for calibration and coordination among samplers. All unidentified plants on each plot were collected for subsequent identification or verification.

Canopy coverage estimates of tree species were made by three size classes: less than 1 dm diameter at breast height (d.b.h.), 1 to 3 dm d.b.h., and greater than 3 dm d.b.h. A stem tally by decimeter diameter classes was used to calculate basal area and volume for all plots except those by Pfister during 1968 to 1970 and by Simon during 1976. Trees less than 4.5 feet (1.37 m) tall were counted in a circular subplot, centered in the reconnaissance plot, with an area of 1,075 ft^2 (100 m^2). Several relatively free-growing trees of each species for each plot were measured for height, age, and diameter to estimate growth and site potential.

On most plots, thickness of the litter layer, texture of the upper 10 inches (25 cm) of soil, presence of charcoal, and relative presence of coarse fragments were noted. Cover of exposed rock and bare soil was recorded. Bedrock and surficial geology were determined using geologic maps (Stokes and Madsen 1961; Hintze 1963; Hintze and Stokes 1964).

Finally, notes were made on stand and fire history, past disturbances by insects, disease, wildlife, or livestock, and general relationships of the sampled stand to proximal vegetation types.

The data base for the development of the classification consisted of 727 plots, of which 110 were collected by Pfister from 1968 to 1970. From 1975 to 1976, Kerr sampled 76 stands along a narrow transect across the Wasatch Plateau. In 1976, an additional 78 stands of mature conifer were sampled by teams led by Simon. The remaining 463 plots were obtained from throughout the study area beginning in 1979. The distribution of sample stands is presented by geographical area in appendix A.

Office Methods

Analysis and compilation of a complete forest habitat type classification for the study area began in early 1983. The general procedures used are similar to work elsewhere in the Intermountain Region.

1. Sample data, collected by teams led by Mauk, were computer-coded. Stands were separated into groups having the same potential climax tree species. Synthesis tables (Mueller-Dombois and Ellenberg 1974), consisting of sample plot species and canopy coverage values, were computer-generated for each group. These tables were studied in detail to determine consistent differential distribution of species. Synthesis tables were rearranged several times in order to group similar stands into associations.
2. Characteristic vegetational and environmental factors for the plant associations were identified and briefly described. A first approximation of a dichotomus key, based upon diagnostic plant species, was developed.
3. Constancy and average cover values were calculated for the important species of each association. The key and preliminary habitat type factors were compared to published classifications for the surrounding areas to determine overlap and maintain continuity.
4. The preliminary key and classification were field-tested throughout the study area during the summer of 1983. This helped validate the groupings, clarify relationships with adjacent types, and derive potential management implications.
5. During the fall of 1983, the additional sample stand data were incorporated. Repeated synthesis tables with new groupings reflected a continual revision based upon the supplementary data and field testing.
6. Finally, a revised key was written and used to place all sample stands into their assigned type. This process required additional minor modifications to the key. Less than 4 percent of the sample stands did not fit the resulting classification. These apparently represent ecotones, vegetational mosaics, unusual seral conditions, or areas with unusual recent disturbance; it is possible that a few may reflect potential, localized habitat types for which we have insufficient data. Unclassified stands are briefly discussed following habitat type descriptions.

7. A description was prepared for each habitat type, including a map showing the known locations, a general discussion of the physiological environmental features and distribution, the key vegetation and successional trends, an overview of geologic and soil features, any preliminary management implications, and the relationship to similar conditions described elsewhere.

8. This classification can serve as a foundation for developing site-specific management implications such as wildlife habitat manipulation, fire effects studies, and silvicultural prescriptions. One of the key management implications developed in conjunction with this study is the appraisal of timber productivity for natural stands. A more detailed discussion of this is provided in the discussion section of individual attributes of habitat types following type descriptions.

Taxonomic Considerations

Unfortunately a complete, up-to-date flora for the study area was not available during the field sampling. Therefore, identifications were based on a number of treatments, including Harrington (1954), Hitchcock (1971), Cronquist and others (1972), and Hitchcock and Cronquist (1973). Nomenclature and synonomy were also checked against Holmgren and Reveal (1966). Many specimens were identified or verified by either Arthur Holmgren or Leila Shultz of the Intermountain Herbarium, Utah State University, Logan. A number of the better specimens are filed at this institution or the Department of Forestry and Outdoor Recreation, Utah State University. Additional vouchers are deposited at the Intermountain Station Herbarium, Missoula, MT, or the Intermountain Region Herbarium, Ogden, UT.

A number of species presented identification problems for the field crews. *Osmorhiza chilensis* and *Osmorhiza depauperata* are similar vegetatively and positive recognition requires mature fruit (schizocarp). Following the treatment of other workers in the northern and middle Rocky Mountains, these species are lumped as *O. chilensis* on the belief that they are ecologically similar. There also appears to be variability within the *Rosa nutkana-R. woodsii* complex. Both are easy to separate if flowers are present, but our material is most often from shaded stands where *Rosa* reproduces vegetatively. Therefore, the single epithet *woodsii* was used for both. *Artemisia arbuscula* and *A. nova* are apparently sharing morphological attributes when associated with *Pinus ponderosa*. Fluorescence in alcohol, however, indicated a closer affinity with *A. nova*. Following the treatment for Idaho and northern Utah (Steele and others 1981; Mauk and Henderson 1984), the name *Vaccinium globulare* was adopted for type designation and descriptions involving *Vaccinium membranaceum* and *V. globulare*. Occasionally it was necessary to lump graminoids by genus, such as *Poa* and *Carex*, when vegetative material prevented complete identification.

Complicating the taxonomic identification of the central and southern Utah flora is the presence of several converging floristic regimes. The LaSal Mountains, for example, represent a floristic outlier of the southern Rocky Mountains (Cronquist and others 1972). The Pine Valley Mountains in southwestern Utah are at the northern edge of the Mojavean Desert flora. The northern portion of the study area, principally the Wasatch Plateau, contains several species characteristic of the northern Rockies, including *Physocarpus malvaceus*, *Vaccinium globulare*, and *Vaccinium caespitosum*.

SYNECOLOGIC PERSPECTIVE AND TERMINOLOGY

To maintain continuity within the classification effort, the following discussion of concept and philosophy is taken, with only minor modification, directly from Pfister and others (1977) and Steele and others (1983).

The Habitat Type Concept

A habitat type is all land capable of producing similar plant communities at climax (Daubenmire and Daubenmire 1968). Because it is the end result of plant succession, the climax plant community reflects the most meaningful integration of environmental factors affecting vegetation. Each habitat type represents a relatively narrow segment of environmental variation and is delineated by a certain potential for vegetational development. Although one habitat type may support a variety of disturbance-induced or seral plant communities, the ultimate product of vegetational succession anywhere within one habitat type will be similar climax communities. Thus, the habitat type system is a method of site classification that uses the plant community as an indicator of integrated environmental factors as they affect species reproduction and plant community development.

The climax community type provides a logical name for the habitat type, such as *Abies lasiocarpa/Ribes montigenum*. The first part of the name is based on the climax tree species, usually the most shade-tolerant tree species adapted to the site. This level of stratification is called the series and encompasses all habitat types having the same dominant tree at climax. The second part of the name is based on the dominant or most diagnostic species in the undergrowth of the climax community.

Use of climax community types to name habitat types does not imply an abundance of climax vegetation across the present landscape. Actually, most of the vegetation within the study area reflects some form of disturbance and represents various stages of succession towards climax (refer to the section on "Successional Status"). Habitat type names do not imply that management be directed toward climax vegetation. In most cases, seral species are considered the most productive for timber and wildlife values. Furthermore, this method does not require the presence of a climax stand to identify the habitat type. It can be identified during most stages of succession by comparing the relative reproductive success of the tree species present with known successional trends and by inspecting the existing undergrowth vegetation. During succession, the undergrowth usually progresses toward climax more rapidly than the tree layer. The composition of the undergrowth may become relatively stable soon after the coniferous canopy closes. For stands in early successional stages, especially those dominated by young *Populus tremuloides*, the habitat type can often be identified by comparison with adjacent mature conifer stands having similar topographic and edaphic features.

Habitat types share certain traits with the systematic taxonomy and ecology of plant species. Both habitat types and plants have variable characteristics that complicate identification of individuals (units of land or plant specimens). Like plants, closely related habitat types share many traits and are distinguished by relatively few prominent features. Individual units of land within a habitat type may display some modal characteristics and traits, but they also have weak affinities to other habitat types. "Hybrid stands," like plants, are not uncommon, especially along transitions between major climatic regimes and floristic or physiographic provinces. Habitat types have geographic distributions and geographic variations that follow regional patterns of floristics, climate, and topography. As with many plant species, endemic and disjunct distributions occur within habitat types.

In developing habitat type classifications, potentially important differential or diagnostic species (indicator species) are evaluated in conjunction with stand characteristics, geographic distribution amplitudes, and zonal sequence of the types. The significance of habitat type indicators is not the presence of species per se, but rather their ability to dominate or survive under competition at climax in a segment of their environment. The opportunity to dominate is determined by the relative ecological amplitude of species. A species must have enough amplitude to extend beyond the environmental limits of its superior competitors. Generally, this results in a species becoming the climax dominant on sites where the environment is not optimum for the growth of that species. For example, *Pinus ponderosa* is able to survive on sites more droughty than *Pseudotsuga menziesii*, but is usually more productive on the more mesic sites that also support *Pseudotsuga*. In general, a species has the greatest opportunity to become a climax dominant between its own environmental limits or zone and the environmental limits of its superior competitors. Where this climax dominance denotes a relatively small segment of a species' total ecological amplitude, that species holds high potential as a habitat type indicator. In other cases, differential species are selected that do not attain climax dominance. These species have relatively narrow ecological amplitude and are therefore useful for indicating that narrow segment of the environment.

The competitive ability of forest species to survive at climax depends on their reproductive methods, growth habit, shade tolerance, and possible allelopathic resistance or influence. Most of our coniferous tree species reproduce primarily by seed. If seed production and seed bed conditions are adequate, superior competition is expressed through relative reproductive rates and shade tolerance. Many of the undergrowth species, and a few conifers, can reproduce vegetatively and thereby achieve an additional competitive advantage. During later successional stages, vegetative reproduction (rhizomes, stolons, root-collar sprouts, layering, and so forth) is often a primary factor in maintaining a competitive position. As a result, most species in the forest undergrowth that are selected as habitat type indicators can persist through vegetative reproduction.

In any classification system, intergrades between types exist. A choice exists between extreme concepts of either (1) many narrowly defined types with resultant broad ecotones or (2) a few broadly defined types with narrow ecotones. This habitat type classification for central and southern Utah attempts to achieve a manageable balance among numbers of classified units, natural variation, and application of the taxonomy to field conditions. The written descriptions of types portray modal conditions and emphasize the central characteristics of the type. The key, however, is written in specific terms that narrow the ecotones for field identification. Some variation is recognized within all habitat types. Where possible, phases are defined to reflect major within-type variation. Often, this reduces the geographic, topographic, or edaphic deviation.

In discussing the relationship of a habitat type to certain environmental features, the general polyclimax concept of Tansley (1935) has been followed. Thus, a climatic climax is found on deep loamy soils of gently undulating relief; an edaphic climax develops on the other soils and types of relief, and a topographic climax reflects compensating effects of aspect or different microclimatic effects. Some habitat types are exclusively one type of climax, but most can be found in any category, depending on the interaction of specific environmental features. In steep mountainous terrain, climatic climax sites are generally scarce, with most sites influenced strongly by topographic features such as aspect and slope. However, gentle terrain on the tops of some plateaus within our study area may represent climatic climax sites.

The habitat type classification is useful to forest management in several ways. It provides a permanent and ecologically based system of land stratification in terms of vegetational development (Daubenmire 1976). It also provides a classification system for near-climax forest communities. Each habitat type encompasses a certain amount of environmental variation, but the variation within a particular habitat type is generally less than between types. Thus, successional trends should be predictable for each habitat type and responses to management treatments should be similar on most lands within the same habitat type or phase. This should be most beneficial to the resource manager and land-use planner.

Habitat Type Versus Continuum Philosophy

For many years, ecologists who studied plant communities debated the interpretation of plant community organization. Although there are several philosophies, two extremes have developed: (1) advocates of typal communities argue that distinct vegetational types develop at climax and reappear across the landscape wherever environmental conditions are similar (Daubenmire 1966); (2) continuum advocates argue that even at climax, vegetation, like the environment, varies continuously over the landscape (Cottam and McIntosh 1966). This somewhat academic debate need not preoccupy natural resource managers and field biologists who need a logical, ecologically based environmental classification with which to work. More important is the "usefulness" of recognizing discrete communities and aggregating them into abstract classes or types for the purpose of studying, planning, and communicating (Whittaker 1975; Henderson and West 1977). Therefore, the objective of this classification effort is to develop a logical site classification based upon the natural patterns of potential climax vegetation. Local conditions that deviate from this classification can still be described in terms of how they differ from the typal descriptions presented herein.

THE PHYSICAL SETTING

A majority of the study area (fig. 2) is in the Colorado Plateau Province of the Rocky Mountain system (Fenneman 1931). The Pine Valley Mountains in southwestern Utah are transitional to the Basin and Range Province. Within central and south-central Utah, the Colorado Plateau Province is referred to as the High Plateaus, while southeastern Utah belongs to the Canyon Lands section. The plateaus begin in central Utah at the southern end of the Wasatch Mountains near Nephi on the west and the south end of the Uinta Basin to the east. The plateaus then extend southward almost to the Utah-Arizona border, a distance of about 175 miles (280 km). The western edge is a high scarp dropping into the Basin and Range Province of the western Utah desert while the eastern face overlooks the canyonlands of the Colorado River. Major distinguishing features of the plateaus include a relatively flat tableland with horizontal rocks and broad undulating surfaces, retreating escarpments, and great relief resulting from incision of deep canyons below rather than uplifted mountain ranges (Thornbury 1965). The plateaus are separated from each other by deep trenches containing the Sevier and San Pitch Rivers, Otter, and Soldier Creek. The western section of the Tavaputs Plateau is the most northern of the plateaus and is included in the Ashley National Forest. The Wasatch Plateau is the largest; it and the isolated LaSal and Abajo Mountains of the Canyon Lands section make up the Manti-LaSal National Forest. The Fishlake National Forest contains the southern extreme of the Wasatch Plateau, the Pahvant and Tushar Mountains, and the Fish Lake Plateau. To the south, the Markagunt, Sevier, Paunsaugunt, and Aquarius Plateaus, and the smaller Escalante, Boulder, and Pine Valley Mountains are within the Dixie National Forest.

Geology

The narrow east-west trending Tavaputs Plateau forms the southern rim of the Uinta Basin at 8,500 feet (2 590 m). Eocene deposits of lacustrine shale and siltstone predominate. These may contain oil shale, especially in the Parachute Creek member of the Green River Formation (Stokes and Madsen 1961). The Wasatch Plateau rises to over 11,000 feet (3 350 m) and presents a formidable barrier to the westerly storm track. A giant monocline on the west side drops 5,000 feet (1 520 m) to the edge of the San Pitch Valley. Sediments are chiefly Cretaceous and early Tertiary fluvial sandstones and mudstone in the North Horn Formation and limestone in the Frontier Formation. Along the eastern flank, older Cretaceous sediments are exposed, including the Black Hawk Group known for coal production, Mancos Shale, and the Star Point Formation of interbedded sandstone and marine shale (Stokes and Madsen 1961; Hintze and Stokes 1964). The Fish Lake Plateau has elevations similar to the Wasatch, but the sediments have been covered by volcanic extrusions. Late Tertiary basalt and basaltic andesite flows are common (Hintze 1963).

The easternmost plateau is the Aquarius, rising to 11,600 feet (3,530 m). The Boulder Mountains form a subdivision along the northeast side while the Escalante Mountains form the western front. Lava flows are extensive across most of the central Aquarius Plateau. Much of the southern escarpments expose Navajo sandstone of the late Jurassic Period. The Escalante Mountains consist of upper Cretaceous Straight Cliff sandstone, a massive coal-bearing sediment, and sandstone and sandy shale of the Kaiparowits Formation, and Tertiary continental sediments ranging from limestone to coarse conglomerate in the Wasatch Formation (Hintze 1963; Hintze and Stokes 1964). Large areas of the Plateau, mostly at lower elevations, are covered with recent alluvium, landslides, and glacial outwash.

The Sevier and Paunsaugunt Plateaus form the middle section of the High Plateaus and are distinguished by the Sevier Fault extending the entire length along the western side. Sediments on the Paunsaugunt Plateau are similar to the Escalante Mountains; the Wasatch Formation forms the top and Upper Cretacous sandstones are exposed at the escarpments. Results of weathering are vividly displayed along the flanks where Kaiparowits and Wahweap sandstones are eroded away, especially in Bryce Canyon National Park. To the north, the Wasatch Formation conglomerate of the Sevier Plateau has been covered by a thick blanket of andesite-trachyte-latite pyroclastics of early Tertiary time (Hintze 1963). This ash extends outward from the 11,036-foot (3 360-m) top of Mount Dutton.

The western plateaus and mountains are lower in elevation than the eastern section. In the north, the Pahvant Mountains rise to 10,000 feet (3 050 m) and are chiefly composed of Tertiary sediments of the North Horn Formation and Flagstaff Limestone. The crest of the range is white, pink, and yellow quartzite and limestone of Cambrian Period, Paleozoic Era (Hintze 1963). To the south, the Tushar Mountains are mostly volcanic and include tuffs, rhyolite, and latite. Small areas are consolidated conglomerate and volcanic debris. These are all Pliocene Epoch, Tertiary Period (Hintze 1963). The large Markagunt Plateau is similar to the Sevier, with Wasatch Formation conglomerate covered by lava, andesite flows, latitic ignimbrites, and other Tertiary volcanic rock. Both the Wasatch and Kaiparowits Formation are exposed at Cedar Breaks National Monument, where weathering along vertical joints has carved the walls

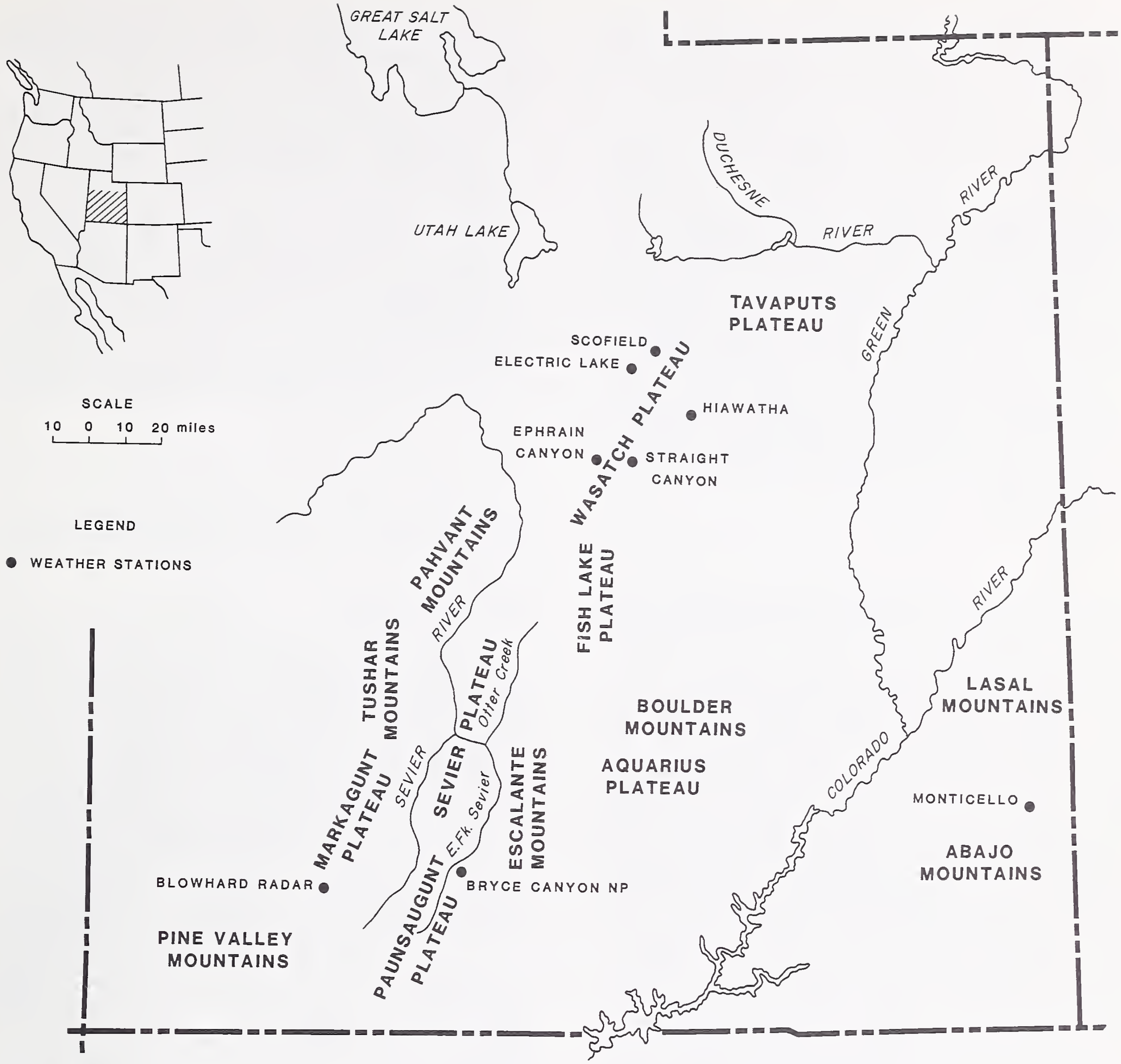


Figure 2.—Area covered by this classification showing major mountain ranges and plateaus, drainage patterns, and selected weather stations.

into colonnades of the Pink Cliffs (Fenneman 1931; Thornbury 1965).

Along the eastern Utah border, small portions of the Canyon Lands Section of the Colorado Plateau Province support coniferous forests. Two isolated sets of mountains included in this study are the LaSals and Abajos; both are giant laccoliths. The northern LaSal Mountains near Moab have a Tertiary core of porphyritic intrusive rocks rising to almost 13,000 feet (3 960 m). Sediments that have been domed up include the Morrison Formation of fluvial sandstone and mudstone and Navajo and Kayenta Sandstone of Jurassic and Triassic Periods (Hintze and Stokes 1964). Also present are uplifted and faulted glaciated grounds and moraines. The LaSal Mountains are in the midst of northwest-trending salt anticlines (Hunt 1958), forming broad deep valleys north, west, and east in Colorado. To the south, the Abajo Mountains are domed up with similar Tertiary intrusions. Subsequent erosion has stripped the overlying sedimentary rocks leaving the igneous core. Sediments on the flanks belong to the Mancos Shale of Upper Cretaceous, Dakota Sandstone, and Burro Canyon Formation of Lower Cretaceous and Morrison Formation of Upper Jurassic. Mount Linnaeus, Twin Peaks, and Horsehead Peak are all near 11,000 feet (3 350 m). To the west along Elk Ridge, lower elevations are older sediments of Navajo Sandstone, Chinle Formation of Jurassic Period, and Cedar Mesa Sandstone of Lower Permian. Deep erosional dissection has created the complex and jumbled topography.

In the extreme southwestern corner of Utah, the Pine Valley Mountains share features of both the Colorado Plateau and the Basin and Range Province (Fenneman 1931). These mountains are formed by the world's largest known laccolith (Cook 1960) and rise to over 10,000 feet (3 050 m). The surrounding sediments are largely the Muddy Creek Formation of tuffaceous sandstone and silt of the Tertiary Period, forming low hills and benchlands. Also present is the Claron Formation of lacustrine limestone conglomerate that resembles the Wasatch Formation of central Utah (Cook 1960).

Glaciation has modified topographic features of many of the higher elevation plateaus and mountains. The Markagunt, Fish Lake, and Wasatch Plateaus apparently had an ice cap during the Wisconsin glaciation (Thornbury 1965). Glaciated ground and moraines are common in the LaSal Mountains, resulting from ice of Pleistocene time (Hunt 1958). The Boulder Mountains, consisting of a fairly flat summit with numerous small lakes, received the most extensive glaciation (Cronquist and others 1972).

Climate

Baker (1944) and Brown (1960) present generalized descriptions of climatic patterns for the mountains of central and southern Utah. Dominant factors influencing the climate include latitude, elevation, position within the Intermountain-Great Basin Region, and distance from the principal moisture sources. Baker (1944) recognized Utah as a region of transition and divided the study area into three subareas. The Wasatch Plateau, especially the west slopes that fall away to the Great Basin, has a continental pattern of high winter snowfall and summer drought and resembles much of the northern Utah mountains. Beginning with the Pahvant Mountains and the Fish Lake Plateau and extending southward, an Arizona-type influence is noticeable, with increased summer precipitation. The east side of the Fish Lake and Aquarius Plateau and the entire LaSal and Abajo Mountains are affected by a pattern resembling that of western Colorado, including a late summer and fall peak in precipitation. Throughout the higher elevations of the study area, the dominant precipitation is in the form of winter and spring snow resulting from Pacific storms. Rainfall from summer thundershowers is usually associated with air masses moving northwest from the Gulf of Mexico or northeast from the Pacific off southern California. Rain shadow effects are common along the Wasatch and Fish Lake Plateaus.

Temperatures vary greatly with latitude and altitude. Inversions are common in some of the lower valleys, especially in the northern portion of the study area. This results from a semipermanent high pressure system that tends to dominate the Great Basin area, particularly during winter months (Brough and others 1983). In general, the diurnal variation in temperatures is relatively large during spring, summer, and fall but is reduced during the winter. Brown (1960) projects a lapse rate of −3 °F mean annual temperature per 1,000 feet increase in elevation (1.7 °C per 305 m) and a corresponding 1.5 to 2.0 °F (0.8 to 1.1 °C) decrease for each degree of latitude northward.

Summer convection storms delivering high-intensity rainfall, aided by orographic lifting, have been the cause of major debris floods within much of the study area. Rainfall intensities as high as 2.2 inches (56 mm) per hour for 20 minutes have been recorded on the Wasatch Plateau (Meeuwig 1960). Many floods have destroyed historic drainage patterns and property, killed livestock and people, and damaged communities at the base of the mountains.

Weather stations (fig. 2) within the study area are rarely situated to obtain long-term data applicable to the forested zone. However, the Ephraim and Straight Canyon watersheds on the Wasatch Plateau are locations of numerous Forest Service research efforts. Data from these and other appropriate stations are discussed by series in the sections on individual attributes of habitat types following type descriptions, and are presented by graphs in appendix H.

SUCCESSIONAL STATUS

Introduced activities such as logging and grazing, as well as changes in wildlife use, have had their effects on the study area.

Logging History

Early logging activities in central and southern Utah were concentrated in the most accessible, lower elevation forests immediately adjacent to small towns and villages, homesteads, and mining operations. Most cutting was indiscriminant, and soil damage may have occurred from the steep drag trails running down the hills. As early as 1870 and into the 1880's, numerous small mills operated along the western base of the Wasatch Plateau, producing railroad ties for the expanding transcontinental railroad. Some of these ties can still be seen in Sanpete County (Haymond 1972). Although sawtimber was abundant in the LaSal and Abajo Mountains, most logging was again intended for local consumption because of the great distances to markets and the primitive nature of transportation systems (Peterson 1975). A former Forest Service policy throughout the area allowed for a free-use system of logging, enabling early settlers to obtain timber for their own buildings, firewood, fencing, and prospecting. Competition for this use was especially concentrated above the growing population centers at the base of the Wasatch, Fish Lake, Markagunt, and Sevier Plateaus. Loggers also apparently set fire to the undergrowth to remove all obstacles and allow easier overstory removal. Many of these fires burned out entire drainages (USDA Forest Service, in prep.).

Following establishment during the first quarter of this century of the National Forests within the study area, the demand for wood products remained relatively constant. Portions of the Boulder Mountains were logged for *Picea engelmannii* following bark beetle epidemics ending around 1930. Much of this material was worked at small saw mills that sprang up throughout western Wayne County (Duane Stewart, Dixie National Forest, pers. comm.). At least 28 mills had operated on the LaSal and Abajo Mountain area prior to 1940 (Peterson 1975), supplying the local ranchers and townspeople with a variety of products on contract.

Finally, during the 1950's in Panguitch, UT, a large-capacity saw mill was established by Crofts-Pearson Industries. This mill, recently sold to Kaibab Industries, is primarily responsible for the dramatic increase in timber harvesting over much of the study area. During the 1950's and early 1960's, much of the *Pinus ponderosa* and *Picea engelmannii* from the Markagunt, Paunsaugunt, Aquarius, and Fish Lake Plateaus was transported to this mill. The principal product was 2-inch lumber (Choate 1965).

As a result of this long period of uncontrolled, piecemeal logging, followed by the more recent large patch or strip clearcutting, old-growth *Pinus ponderosa* stands are especially difficult to find. Closer to the larger communities of Manti, Beaver, and Ephraim, old-growth stands of *Pseudotsuga menziesii* and *Abies concolor* at low elevations are also rare.

Grazing History

The early cultural development of central and southern Utah is closely tied to domestic livestock grazing. Explorers, such as Captain John C. Fremont in 1842 and Major J. W. Powell in 1869, traveled across portions of the study area and noted the available forage for livestock. As early as 1884, almost a complete change in vegetation at Mountain Meadows in the Pine Valley Mountains was attributed to heavy grazing by cattle and then sheep, followed by flash flooding (Cottom 1929, 1961). During the last half of the 19th century, the Wasatch and Fish Lake Plateaus were used extensively by locally owned stock and herds of transient sheep owned by large operations centered outside Utah. It was common for many of the residents of the small communities that were scattered along the valleys to own and maintain small bands of sheep and cows to supplement their agricultural practices (Peterson 1975). There was little control of stock numbers, and sheep were apparently driven into the higher elevations of the mountains while snow was still on the ground (Haycock 1947). Beginning in the early 1900's as the Forest Reserves were transferred from the Department of the Interior to the Department of Agriculture, the predecessors of the current Manti-LaSal, Fishlake, and Dixie National Forests were established. A key issue was the permitting of cattle and sheep. U.S. Department of Agriculture figures show that 1900 was a peak year for sheep in Utah, with 3.8 million in the State; at least 150,000 head of cattle were on the Wasatch Plateau (Haymond 1972). Estimates of the number of sheep for a single grazing allotment on the present-day Fishlake National Forest were as high as 120,000. At sunset, local residents in the valley could count the bands on the mountain by the clouds of dust raised on the bed grounds (Haycock 1947). This number was reduced to about 2,200 sheep by 1919, but severe damage to the resource had already occurred. In an early report to Washington Office supervisors, Reynolds (1911) stated the Wasatch Plateau was "a vast dust bed, grazed, trampled, and burned to the utmost. The timber cover was reduced, the brush thinned, the weeds and grass cropped to the roots, and such sod as existed was broken and worn." Even today, evidence of close trailing, bedding, and burning can be seen on the Wasatch and Fish Lake Plateaus.

Wildlife History

Although most big game use, especially mule deer and elk, is concentrated in mixed shrub and aspen vegetation types within our study area (Julander and Jeffery 1964), the coniferous forests of central and southern Utah have been significantly influenced by wildlife populations. A dramatic increase in mule deer population levels during the 1920's followed a long period of reduced numbers. In 1930, the Fishlake, Manti, and Dixie National Forests reported about 42,500 deer, representing 80 percent of the deer in Utah (Peterson 1975). This trend continued into the 1950's and is at least partly the result of a reduction in domestic grazing permits coupled with the implementation of new grazing systems, and increased brushfields resulting from escaped logging slash fires (Urness 1976).

THE HABITAT TYPE CLASSIFICATION

Thirty-seven forest habitat types within seven series have been defined within the central and southern Utah study area. This seemingly large number of types reflects the environmental diversity resulting from topography, climate, geology, and converging floristic regimes.

For the rest of this publication, the term "habitat type" is abbreviated to "h.t." or "h.t.'s" for the plural. The h.t. names are also abbreviated to the commonly used first two letters of the genus and first two letters of the species of the two plants involved. For example, *Abies lasiocarpa/Ribes montigenum* is reduced to ABLA/RIMO. Complete scientific and abbreviated names of h.t.'s are listed in table 1. Common names are not used within the text to avoid confusion due to variation in local practices or customs.

The classification is presented in the following order:

1. Key to the series, habitat types, and phases: The first step in correct identification of the habitat type is to become familiar with the instructions presented with the key. The key provides an orderly process for first determining the series, then the habitat type, and finally the phase.

2. Series descriptions: Common attributes of habitat types having the same potential climax overstory are summarized at the series level. This also presents a general overview of conditions throughout the series.

3. Habitat type descriptions: Detailed type descriptions summarize the distribution, physical environment, relative abundance, characteristic vegetation, appropriate phasal distinctions, and general management implications.

Table 1.—Central and southern Utah coniferous forest habitat types and phases

Abbreviation	Habitat Type and Phase
	***Abies lasiocarpa* Series**
ABLA/ACCO h.t.	*Abies lasiocarpa/Aconitum columbianum* h.t.
ABLA/PHME h.t.	*Abies lasiocarpa/Physocarpus malvaceus* h.t.
ABLA/ACGL h.t.	*Abies lasiocarpa/Acer glabrum* h.t.
ABLA/VACA h.t.	*Abies lasiocarpa/Vaccinium caespitosum* h.t.
ABLA/VAGL h.t.	*Abies lasiocarpa/Vaccinium globulare* h.t.
ABLA/VAMY h.t.	*Abies lasiocarpa/Vaccinium myrtillus* h.t.
ABLA/BERE h.t.	*Abies lasiocarpa/Berberis repens* h.t.
-PIFL phase	-*Pinus flexilis* phase
-PIEN phase	-*Picea engelmannii* phase
-BERE phase	-*Berberis repens* phase
ABLA/RIMO h.t.	*Abies lasiocarpa/Ribes montigenum* h.t.
-MEAR phase	-*Mertensia arizonica* phase
-RIMO phase	-*Ribes montigenum* phase
ABLA/CAGE h.t.	*Abies lasiocarpa/Carex geyeri* h.t.
ABLA/JUCO h.t.	*Abies lasiocarpa/Juniperus communis* h.t.
ABLA/CARO h.t.	*Abies lasiocarpa/Carex rossii* h.t.
	***Abies concolor* Series**
ABCO/PHMA h.t.	*Abies concolor/Physocarpus malvaceus* h.t.
ABCO/ACGL h.t.	*Abies concolor/Acer glabrum* h.t.
ABCO/CELE h.t.	*Abies concolor/Cercocarpus ledifolius* h.t.
ABCO/ARPA h.t.	*Abies concolor/Arctostaphylos patula* h.t.
ABCO/QUGA h.t.	*Abies concolor/Quercus gambelii* h.t.
ABCO/BERE h.t.	*Abies concolor/Berberis repens* h.t.
-JUCO phase	-*Juniperus communis* phase
-BERE phase	-*Berberis repens* phase
ABCO/JUCO h.t.	*Abies concolor/Juniperus communis* h.t.
ABCO/SYOR h.t.	*Abies concolor/Symphoricarpos oreophilus* h.t.
	***Picea engelmannii* Series**
PIEN/RIMO h.t.	*Picea engelmannii/Ribes montigenum* h.t.
	***Picea pungens* Series**
PIPU/EQAR h.t.	*Picea pungens/Equisetum arvense* h.t.
PIPU/JUCO h.t.	*Picea pungens/Juniperus communis* h.t.
PIPU/BERE h.t.	*Picea pungens/Berberis repens* h.t.
	***Pinus flexilis-Pinus longaeva* Series**
	No h.t.'s differentiated
	***Pseudotsuga menziesii* Series**
PSME/PHMA h.t.	*Pseudotsuga menziesii/Physocarpus malvaceus* h.t.
PSME/CELE h.t.	*Pseudotsuga menziesii/Cercocarpus ledifolius* h.t.
PSME/ARPA h.t.	*Pseudotsuga menziesii/Arctostaphylos patula* h.t.
PSME/CEMO h.t.	*Pseudotsuga menziesii/Cercocarpus montanus* h.t.
PSME/QUGA h.t.	*Pseudotsuga menziesii/Quercus gambelii* h.t.
PSME/BERE h.t.	*Pseudotsuga menziesii/Berberis repens* h.t.
-PIPO phase	-*Pinus ponderosa* phase
-BERE phase	-*Berberis repens* phase
PSME/SYOR h.t.	*Pseudotsuga menziesii/Symphoricarpos oreophilus* h.t.
	***Pinus ponderosa* Series**
PIPO/CELE h.t.	*Pinus ponderosa/Cercocarpus ledifolius* h.t.
PIPO/ARPA h.t.	*Pinus ponderosa/Arctostaphylos patula* h.t.
PIPO/ARNO h.t.	*Pinus ponderosa/Artemisia nova* h.t.
PIPO/PUTR h.t.	*Pinus ponderosa/Purshia tridentata* h.t.
PIPO/QUGA h.t.	*Pinus ponderosa/Quercus gambelii* h.t.
-SYOR phase	-*Symphoricarpos oreophilus* phase
-QUGA phase	-*Quercus gambelii* phase
PIPO/SYOR h.t.	*Pinus ponderosa/Symphoricarpos oreophilus* h.t.
PIPO/MUMO h.t.	*Pinus ponderosa/Muhlenbergia montana* h.t.

Total number of series = 7
Total number of habitat types = 37
Total number of habitat types and phases = 43

Arrangement of habitat types within keys tends to progress along the environmental gradient from the least severe to the most severe. Often, the more moist types are encountered before the more moderate. Distributions of h.t.'s are usually illustrated with dot maps. The density of dots on some maps is a function of sampling intensity, as along the northern Wasatch Plateau. Relative abundance of an h.t., as an expression of the amount of land within the study area described by that h.t., is indicated by the terms "incidental," "minor," or "major." An incidental h.t. rarely occurs throughout the study area (therefore no map) but may extend into a portion of the study area from elsewhere. A minor h.t. seldom occurs as large acreages but may be common in the study area with a sporadic occurrence. It may be of major importance to the resource manager as an element of diversity. A major h.t. occupies extensive acreages in at least some portion of the study area. Arrows on some dot maps indicate occurrence of that h.t. beyond the study area. Appendix A lists the actual number of sample stands by habitat type, phase, and general vicinity.

KEY TO SERIES, HABITAT TYPES, AND PHASES

READ THESE INSTRUCTIONS FIRST!

1. Use this key for stands with mature coniferous overstories that are not severely disturbed. If the stand has been recently disturbed by fire, logging, or grazing, or is in an early successional stage, the habitat type can be determined by extrapolation from nearby mature stands on similar sites (same elevation, aspect, geologic material, topographic position, and so forth).
2. Accurately identify and record canopy coverage estimates for all indicator species (appendix I).
3. Record environmental data for plot (appendix I).
4. Identify the correct potential climax tree species using the Key to Climax Series. In general, a tree species is considered successfully reproducing if at least 10 individuals (including established seedlings) per acre occupy or will occupy the site. This often requires careful evaluation.
5. Within the appropriate series key, identify habitat type and phase. The first habitat type or phase in the key that fits the stand, based upon the estimates recorded on the field form, is generally the correct one.
6. Validate the determination by using the habitat type and phase descriptions and additional information presented in the appendixes.
7. The key is not the classification, but rather a tool to access the classification. Before leaving the stand, validate and record the proper habitat type and phase.

Key to Climax Series

(Do not proceed until you have read the instructions.)

1. *Abies lasiocarpa* present and reproducing successfully .... *Abies lasiocarpa* Series (item A)
1. *Abies lasiocarpa* not the indicated climax 2

   2. *Abies concolor* present and reproducing successfully .... *Abies concolor* Series (item B)
   2. *Abies concolor* not the indicated climax 3

3. *Picea engelmannii* present and reproducing successfully .... *Picea engelmannii* Series (item C)
3. *Picea engelmannii* not the indicated climax 4

   4. *Picea pungens* present and reproducing successfully .... *Picea pungens* Series (item D)
   4. *Picea pungens* not the indicated climax 5

5. *Pinus flexilis* or *Pinus longaeva* successfully reproducing and dominant, often sharing codominance with *Pseudotsuga* .... *Pinus flexilis-Pinus longaeva* Series (no h.t.'s differentiated)
5. *Pinus flexilis* and *Pinus longaeva* absent or clearly seral 6

   6. *Pseudotsuga menziesii* present and reproducing successfully .. *Pseudotsuga menziesii* Series (item E)
   6. *Pseudotsuga menziesii* not the indicated climax 7

7. *Pinus ponderosa* present and reproducing successfully .... *Pinus ponderosa* Series (item F)
7. *Pinus ponderosa* not the indicated climax .... 8. Unclassified Series, such as *Populus tremuloides* or *Juniperus scopulorum*

A. Key to *Abies lasiocarpa* Habitat Types

1. *Aconitum columbianum, Actaea rubra,* or *Senecio triangularis* at least 1 percent cover .... *Abies lasiocarpa /Aconitum columbianum* h.t. (p. 17)
1. Not as above 2
   2. *Physocarpus malvaceus* at least 5 percent cover .... *Abies lasiocarpa/Physocarpus malvaceus* h.t. (p. 17)*
   2. *Physocarpus malvaceus* less than 5 percent cover 3
3. *Acer glabrum* at least 1 percent cover .... *Abies lasiocarpa/Acer glabrum* h.t. (p. 18)*
3. *Acer glabrum* less than 1 percent cover 4
   4. *Vaccinium caespitosum* at least 1 percent cover .... *Abies lasiocarpa/Vaccinium caespitosum* h.t. (p. 18)*
   4. *Vaccinium caespitosum* less than 1 percent cover 5
5. *Vaccinium globulare* at least 5 percent cover .... *Abies lasiocarpa/Vaccinium globulare* h.t. (p. 19)*
5. *Vaccinium globulare* less than 5 percent cover 6
   6. *Vaccinium myrtillus* at least 5 percent cover .... *Abies lasiocarpa/Vaccinium myrtillus* h.t. (p.19)
   6. Not as above 7
7. *Berberis repens* or *Pachistima myrsinites* at least 1 percent cover .... *Abies lasiocarpa/Berberis repens* h.t. (p.20)
   7a. *Pinus flexilis* a major overstory component .... *Pinus flexilis* phase (p.20)
   7b. Not as above, *Picea engelmannii* present .... *Picea engelmanii* phase (p.21)
   7c. *Picea engelmannii absent* .... *Berberis repens* phase (p.22
7. *Berberis* and *Pachistima* less than 1 percent cover 8
   8. *Ribes montigenum* at least 1 percent cover, or dominant shrub in normally depauperate undergrowth .... *Abies lasiocarpa/Ribes montigenum* h.t. (p. 23)
      8a. *Mertensia arizonica, Mertensia ciliata, Polemonium pulcherrium, Trifolium longipes,* or *Geranium richardsonii* at least 5 percent cover, collectively or individually .... *Mertensia arizonica* phase (p. 24)
      8b. Not as above .... *Ribes montigenum* phase (p.24)
   8. *Ribes montigenum* less than 1 percent cover and other shrub dominant in undergrowth 9
9. *Carex geyeri* at least 5 percent cover .... *Abies lasiocarpa/Carex geyeri* h.t. (p.26)
9. *Carex geyeri* less than 5 percent cover 10
   10. *Juniperus communis* at least 1 percent cover .... *Abies lasiocarpa/Juniperus communis* h.t. (p.26)
   10. *Juniperus communis* less than 1 percent cover 11
11. *Carex rossii* present, usually at least 1 percent cover .... *Abies lasiocarpa/Carex rossii* h.t. (p.27)
11. *Carex rossii* absent .... Unclassified conditions

B. Key to *Abies concolor* Habitat Types

1. *Physocarpus malvaceus* at least 5 percent cover .... *Abies concolor/Physocarpus malvaceus* h.t. (p.29)*
1. *Physocarpus malvaceus* less than 5 percent cover 2
   2. *Acer glabrum* at least 5 percent cover .... *Abies concolor/Acer glabrum* h.t. (p.29)
   2. *Acer glabrum* less than 5 percent cover 3
3. *Cercocarpus ledifolius* at least 5 percent cover .... *Abies concolor/Cercocarpus ledifolius* h.t. (p.30)*
3. *Cercocarpus ledifolius* less than 5 percent cover 4
   4. *Arctostaphylos patula* at least 1 percent cover .... *Abies concolor/Arctostaphylos patula* h.t. (p.30)
   4. *Arctostaphylos patula* less than 1 percent cover 5

5. *Quercus gambelii* at least 5 percent cover .... *Abies concolor/Quercus gambelii* h.t. (p.32)*
5. *Quercus gambelii* less than 5 percent cover 6

6. *Berberis repens* at least 1 percent cover .... *Abies concolor/Berberis repens* h.t. (p.32)
6a. *Juniperus communis* at least 5 percent cover .... *Juniperus communis* phase (p.33)
6b. *Juniperus communis* less than 5 percent cover .... *Berberis repens* phase (p.33)
6. *Berberis repens* less than 1 percent cover 7

7. *Juniperus communis* at least 1 percent cover .... *Abies concolor/Juniperus communis* h.t. (p.34)*
7. *Juniperus communis* less than 1 percent cover 8

8. *Symphoricarpos oreophilus* at least 1 percent cover .... *Abies concolor/Symphoricarpos oreophilus* h.t. (p.34)
8. *Symphoricarpos oreophilus* less than 1 percent cover .... Unclassified conditions

C. Key to *Picea engelmanni* Habitat Types

1. *Ribes montigenum* present, usually dominant shrub in normally depauperate undergrowth .... *Picea engelmannii/Ribes montigenum* h.t. (p.36)
1. *Ribes montegenum* absent .... Unclassified conditions

D. Key to *Picea pungens* Habitat Types

1. *Equisetum arvense, Carex disperma,* or *Glyceria elata* at least 5 percent cover .... *Picea pungens/Equisetum arvense* h.t. (p.38)*
1. Not as above 2

2. *Arctostaphylos uva-ursi* at least 1 percent cover or *Juniperus communis* at least 5 percent cover .... *Picea pungens/Juniperus communis* h.t. (p.38)
2. Not as above 3

3. *Berberis repens* at least 1 percent cover .... *Picea pungens/Berberis repens* h.t. (p.40)
3. *Berberis repens* less than 1 percent cover .... Unclassified conditions

E. Key to *Pseudotsuga menziesii* Habitat Types

1. *Physocarpus malvaceus* at least 1 percent cover .... *Pseudotsuga menziesii/Physocarpus malvaceus* h.t. (p.43)*
1. *Physocarpus malvaceus* less than 1 percent cover 2

2. *Cercocarpus ledifolius* at least 5 percent cover .... *Pseudotsuga menziesii/Cercocarpus ledifolius* h.t. (p.43)
2. *Cercocarpus ledifolius* less than 5 percent cover 3

3. *Arctostaphylos patula* at least 1 percent cover .... *Pseudotsuga menziesii/Arctostaphylos patula* h.t. (p.44)*
3. *Arctostaphylos patula* less than 1 percent cover 4

4. *Cercocarpus montanus* or *Shepherdia rotundifolia* at least 1 percent cover .... *Pseudotsuga menziesii/Cercocarpus montanus* h.t. (p.45)*
4. Not as above 5

5. *Quercus gambelii* at least 5 percent cover .... *Pseudotsuga menziesii/Quercus gambelii* h.t. (p.45)*
5. *Quercus gambelii* less than 5 percent cover 6

6. *Berberis repens* at least 1 percent cover .... *Pseudotsuga menziesii/Berberis repens* h.t. (p.46)
6a. *Pinus ponderosa* present .... *Pinus ponderosa* phase (p.46)
6b. *Pinus ponderosa* absent .... *Berberis repens* phase (p.46)
6. *Berberis repens* less than 1 percent cover 7

7. *Symphoricarpos oreophilus* present .... *Pseudotsuga menziesii/Symphoricarpos oreophilus* h.t. (p.47)
7. *Symphoricarpos oreophilus* absent .... Unclassified conditions

F. Key to *Pinus ponderosa* Habitat Types

1. *Cercocarpus ledifolius* at least 1 percent cover	*Pinus ponderosa/Cercocarpus ledifolius* h.t. (p.49)*
1. *Cercocarpus ledifolius* less than 1 percent cover	2
2. *Arctostaphylos patula* or *Ceanothus martinii* at least 1 percent	*Pinus ponderosa/Arctostaphylos patula* h.t. (p.50)
2. Not as above	3
3. *Artemisia nova* or *Artemisia arbuscula* at least 5 percent cover or the dominant shrub in normally depauperate undergrowth	*Pinus ponderosa/Artemisia nova* h.t. (p.50)
3. Not as above	4
4. *Purshia tridentata* at least 1 percent cover	*Pinus ponderosa/Purshia tridentata* h.t. (p.52)
4. *Purshia tridentata* less than 1 percent cover	5
5. *Quercus gambelii* at least 5 percent cover	*Pinus ponderosa/Quercus gambelii* h.t. (p.53)
5a. *Symphoricarpos oreophilus* at least 5 percent cover	*Symphoricarpos oreophilus* phase (p.53)
5b. *Symphoricarpos oreophilus* less than 5 percent cover	*Quercus gambelii* phase (p.54)
5. *Quercus gambelii* less than 5 percent cover	6
6. *Symphoricarpos oreophilus* at least 5 percent cover	*Pinus ponderosa/Symphoricarpos oreophilus* h.t. (p.55)*
6. *Symphoricarpos oreophilus* less than 5 percent cover	7
7. *Bouteloua gracilis, Muhlenbergia montana,* or *Oryzopsis hymenoides* at least 1 percent cover, collectively or individually	*Pinus ponderosa/Muhlenbergia montana* h.t. (p.55)
7. Not as above	Unclassified conditions

*Incidental or minor habitat types in central and southern Utah; may not be listed in other charts and tables.

DESCRIPTIONS OF SERIES, HABITAT TYPES, AND PHASES

Abies lasiocarpa Series

Distribution.—Sites potentially capable of supporting *Abies lasiocarpa* are abundant throughout the entire study area and constitute the *Abies lasiocarpa* series. This series accounts for more than 50 percent of the sample stands used in building the classification. The series is divided into 11 h.t.'s; two have contrasting phases. Our h.t.'s range from the relatively warm and moist (ABLA/ACCO, ABLA/PHMA) to cool and dry (ABLA/JUCO, ABLA/CARO, ABLA/BERE) to cold (ABLA/RIMO). Generally the series represents the middle to upper elevation forested zone. Only the highest portions of the Tushar Mountains and the Aquarius Plateau area exceed the tolerance limits of *A. lasiocarpa*; these sites, if forested, belong to the *Picea engelmannii* series. Elevations within the *Abies lasiocarpa* series range from 8,100 to 11,000 feet (2 470 to 3 350 m). Within this broad belt, topography, parent material, and exposure influence site characteristics, resulting in the diversity of h.t.'s. The series most commonly occurs on steep northern exposures but can also be found on more moderate slopes and other aspects. The warmest and driest sites, if forested, may merge into the *Pinus flexilis-Pinus longaeva* series. Nonforested meadows or shrubfields may be interspersed throughout. Lower bounds of the series will differ locally, with either the *Abies concolor* or *Pseudotsuga menziesii* series adjacent. Occasionally the *Picea pungens* series, and especially the PIPU/EQAR h.t., may be included at lower elevations.

Vegetation.—Most of the central and southern Utah tree species are associates within the series. Although *Abies lasiocarpa* is the climax tree, rarely are pure *A. lasiocarpa* stands found. Instead, *Picea engelmannii*, *Abies concolor*, or *Pseudotsuga menziesii* often are present as persistent seral associates and may contribute greatly to the stand structure. *Populus tremuloides* is almost always an important seral component and may serve as a nurse crop. Only the ABLA/VAMY h.t. usually lacks *P. tremuloides*. Although specific sites may occasionally support scattered *Pinus ponderosa*, the *Abies lasiocarpa* series generally represents environments beyond the temperature limits of *Pinus edulis*, *Juniperus scopulorum*, and *Juniperus osteosperma*.

Undergrowth conditions range from dense, tall shrubs (ABLA/PHMA, ABLA/ACGL) to depauperate (ABLA/RIMO-RIMO, ABLA/BERE-PIEN). Low shrubs usually are used as indicator species. Contrasting conditions are represented by ABLA/ACCO, with diverse forbs, and ABLA/CAGE, in which graminoids dominate.

Soils/climate.—Parent material varies depending upon locale. A few h.t.'s within the series appear on all geologic material, indicating a more zonal or climatic climax. Other h.t.'s, such as ABLA/CAGE, ABLA/JUCO, and ABLA/VAMY, are apparently restricted to volcanics. Depositional material has been influenced by glacial, residual, colluvial, and fluvial actions. As a result of this diversity, corresponding surface textures may range from relatively coarse to fine. Surface rock and bare ground also vary by h.t., with ABLA/BERE-PIFL and ABLA/JUCO representing the most harsh sites. Litter accumulations are relatively constant, averaging 1.3 inches (3.2 cm).

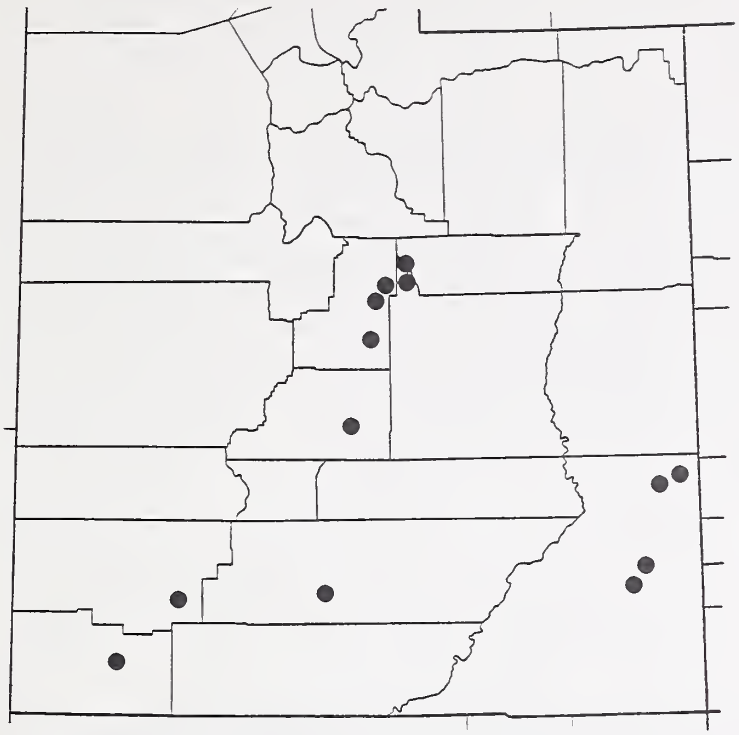
Climatic data for this series are limited because of the lack of year-round recording stations at these elevations. The most appropriate information is taken from Ephraim and Straight Canyon watersheds, Electric Lake on the Wasatch Plateau, and Blowhard Mountain on the Markagunt Plateau. In general, sites within this series are cold year-round, with mean annual temperatures below about 37.4 °F (3 °C). Precipitation is predominantly in the form of snow, which may persist until late summer. Frost is possible almost all summer and may be common in restricted topographic basins and benches.

Productivity/management.—Timber potentials range from very low to high and are best described by h.t. On most sites having potential for management, silvicultural prescriptions should favor *Picea engelmannii*. Lower site index and higher susceptibility to root rot (*Fomes annosus* or *Armillaria mellea*) prevent *Abies lasiocarpa* from being intensively managed. Hanley and others (1975) discuss silvicultural implications for management in the uneven-aged stands common in this series. When sites scheduled for overstory manipulation lie adjacent to natural openings such as forb meadows, careful consideration should be given to the potential for invasion by pocket gophers (*Thomomys talpoides*). Ecological processes and management recommendations are provided by Teipner and others (1983) and Anderson and MacMahon (1981). Crane (1982) reports on successional pathways and fire effects for sites in Colorado that appear similar to some of our h.t.'s. Most of our types appear to have long natural fire intervals.

Wildlife habitat values within the series are predominantly associated with summer range. Domestic livestock may find little forage in many of the h.t.'s that have depauperate undergrowth. Throughout the series, watershed protection should be a key concern because of the late snowmelt.

Other studies.—Our *Abies lasiocarpa* series shares many types common to northern Utah. In addition, a few types are incidental, occurring only in the LaSal and Abajo Mountains and extending into Colorado. These relationships are discussed by h.t. The central and southern Utah study area appears to be the southern extent of several major northern Rocky Mountain h.t.'s; ABLA/PHMA and ABLA/VAGL apparently terminate near the northern edge of the Wasatch Plateau. In contrast, ABLA/BERE and ABLA/RIMO appear to be centered within our study area and become progressively less prominent northward.

Abies lasiocarpa/Aconitum columbianum h.t. (ABLA/ACCO; Subalpine Fir/Monkshood)



Distribution.—ABLA/ACCO is a major h.t. of the *Abies lasiocarpa* series and occurs sporadically throughout the entire study area. It represents moist and cool toe slopes, steep streamside slopes, and mesic benches. Elevations are generally 8,800 to 10,000 feet (2 700 to 3 050 m), although one sample stand was found as low as 7,380 feet (2 250 m) along a stream bottom. Undulating topography is most common, but concave and straight slopes are also well represented. Exposures are generally northern. ABLA/ACCO can usually be found as relatively large, seepy microsites surrounded by drier h.t.'s such as ABLA/RIMO, ABLA/VAMY, ABLA/CAGE, or ABLA/VACA. Occasionally, it also represents a broad zonal ecotone on steep slopes near drainage bottoms, below the warmer and drier ABLA/BERE or ABCO/BERE h.t.'s.

Vegetation.—*Abies lasiocarpa* is usually present in seral stands and is the indicated climax. *Picea engelmannii* may codominate in seral stands and occasionally be long persistent. *Populus tremuloides* and *Pseudotsuga menziesii* are also seral associates. The dense undergrowth is characteristically forby. A diverse assemblage of tall forbs includes *Aconitum columbianum*, *Actaea rubra*, *Delphinium occidentalis*, *Geranium richardsonii*, *Senecio triangularis*, and *Thalictrum fendleri*. Common low forbs include *Aquilegia coerulea*, *Arnica cordifolia*, *Osmorhiza chilensis*, and *Pyrola secunda*. The most common graminoid is *Bromus ciliatus*. A sparse shrub stratum may often overtop the herbaceous layer and usually is an extension from the adjacent upland communities. *Ribes montigenum* is usually present while other species, depending upon locale, include *Symphoricarpos oreophilus*, *Vaccinium caespitosum*, *Vaccinium myrtillus*, and *Pachistima myrsinites*. *Sambucus racemosa* is also an associate, especially in seral or recently disturbed stands.

Soils.—Our sites have soils derived from a variety of parent materials including both sedimentary and igneous rocks (appendix F). Many sites show the influence of fluvial deposition. This and the expectantly high biomass turnover rates of the undergrowth result in negligible cover of bare ground and exposed rock. Litter accumulations averaged 1.6 inches (4.0 cm), highest for the series. Surface textures are variable, but are predominantly silt loam (appendix G).

Productivity/management.—This h.t. represents the highest potential timber yields for the study area (appendixes D and E). However, many site-specific limitations for management may reduce this expected volume. Steep slopes immediately adjacent to riparian zones or seasonally wet soils will often be major considerations for timber management. On more moderate terrain, shelterwood or group selection systems should maintain the cover, preventing any drastic change in water tables. ABLA/ACCO apparently provides quality summer range habitat for numerous wildlife species, especially big game. Both deer and elk may seek succulent forbs. Water may also be available at seeps or adjacent riparian sites. Squirrels may cache *Picea engelmannii* cones in the cool, moist sites of this h.t.

Other studies.—Mauk and Henderson (1984) describe similar moist sites in northern Utah and name two h.t.'s based upon the presence of *Actaea rubra* or *Streptopus amplexifolius*. Although both are often present on moist sites from our study area and represent the two extremes of the moisture gradient represented by the ABLA/ACCO h.t., it seemed appropriate to select a different species that represented more modal conditions, thereby avoiding confusion with ABLA/ACRU and ABLA/STAM of northern Utah.

Abies lasiocarpa/Physocarpus malvaceus h.t. (ABLA/PHMA; Subalpine Fir/Ninebark)

Distribution.—ABLA/PHMA is an incidental h.t. within our study area, occurring only in the northern portion of the Wasatch Plateau. It is more common in northern Utah, southeastern Idaho, and Wyoming (refer to "Other Studies"). Our sites are typically steep north-facing slopes at middle to low elevations within the *Abies lasiocarpa* zone. Elevations range from 8,200 to 9,350 feet (2 500 to 2 850 m). The type represents the most mesic conditions for the area. ABLA/PHMA is usually bounded by ABLA/ACGL, ABLA/BERE, or PSME/BERE on drier sites. More moist conditions are usually ABLA/ACCO.

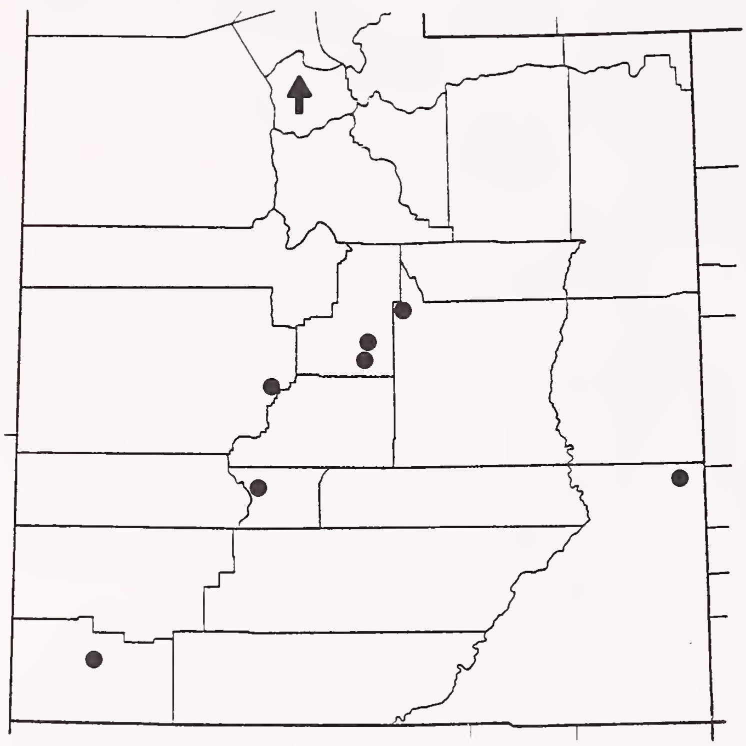
Vegetation.—*Abies lasiocarpa* is the indicated climax tree, but some sites may be dominated by persistent *Pseudotsuga menziesii*. *Populus tremuloides* and *Picea engelmannii* are also seral associates. The dense undergrowth is dominated by tall shrubs, including *Physocarpus malvaceus*, *Acer glabrum*, *Lonicera utahensis*, and *Shepherdia canadensis*. These overtop a low shrub stratum of *Berberis repens*, *Pachistima myrsinites*, *Ribes viscosissimum*, and *Symphoricarpos oreophilus*. The herbaceous component is usually relatively sparse and includes only small amounts of *Pyrola secunda*, *Osmorhiza chilensis*, *Arnica cordifolia*, and *Carex rossii*.

Soils.—Soils of the ABLA/PHMA h.t. in our study area are all derived from Cretaceous sandstones of marine origin. Litter accumulations average 0.7 inches (1.7 cm). Soils are usually shallow and coarse.

Management/productivity.—ABLA/PHMA presents limited opportunities for timber management. Shallow soils, steep slopes (sampled sites average 65 percent slope), and competition from vegetation will preclude most attempts of stand manipulation. On the most gentle extremes, light shelterwood systems may favor *Picea engelmanii* or *Pseudotsuga*.

Other studies.—ABLA/PHMA is a major type along the Idaho-Utah boundary (Steele and others 1981). Our h.t. follows the same concept developed for northern Utah (Mauk and Henderson 1984).

Abies lasiocarpa/Acer glabrum h.t. (ABLA/ACGL; Subalpine Fir/Mountain Maple)



Distribution.—The ABLA/ACGL h.t. is a minor type in central and southern Utah. Our sample sites are distributed sporadically throughout portions of the Wasatch Plateau and the mountains to the west. It also occurs in the Pine Valley and LaSal Mountains. Sites range in elevation from 8,300 to 9,900 feet (2 530 to 3 020 m) and are usually on steep straight slopes with northern aspects. The type is usually found close to the drier ABLA/BERE h.t.; slightly warmer conditions at the northern end of the Wasatch Plateau may belong to ABLA/PHMA.

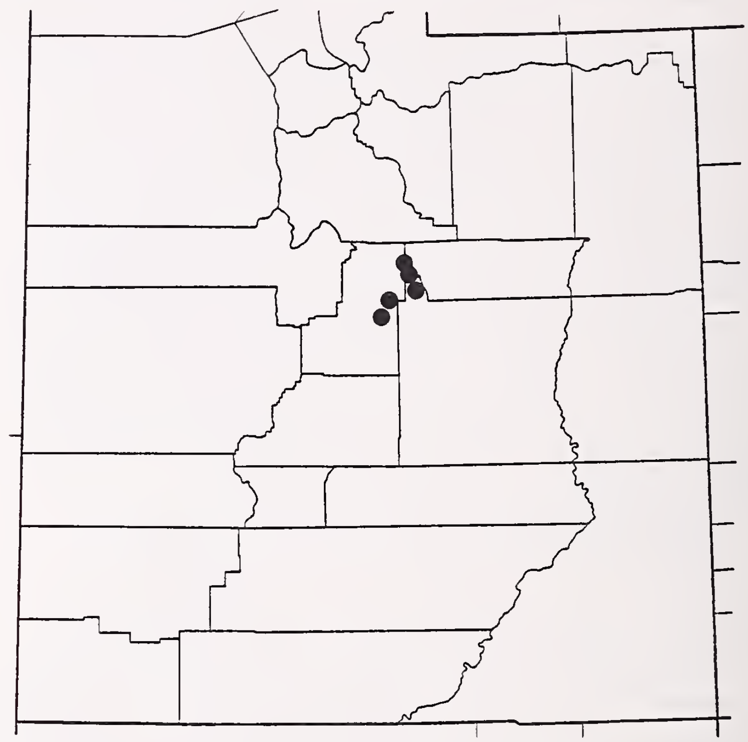
Vegetation.—*Abies lasiocarpa* is the indicated climax tree, but stands may be dominated by other conifers including *Pseudotsuga menziesii, Picea engelmannii, Abies concolor*, or sometimes *Picea pungens*. *Populus tremuloides* is also an important seral associate. The undergrowth usually consists of multiple strata. *Acer glabrum* and sometimes *Amelanchier alnifolia* create a notable tall shrub layer. A second, lower shrub stratum consists of *Berberis repens, Pachistima myrsinites, Rosa woodsii, Ribes viscosissimum*, and *Symphoricarpos oreophilus*. A diverse forb component includes *Osmorhiza chilensis, Lathyrus lanszwertii, Arnica cordifolia, Thalictrum fendleri*, and *Smilacina stellata*.

Soils.—Our sites are on predominantly Cretaceous and Tertiary sandstone parent material. Sample stands in the Pine Valley and Tushar Mountains had soils derived from andesitic volcanics. Litter accumulations average 1.6 inches (4 cm). Surface textures are mostly loam.

Productivity/management.—Limited data suggest timber yields appear low to moderate and represent relative low potentials for the series. Steep slopes will usually prevent conventional timber management practices. These sites may provide excellent habitat for big game because of the structural diversity and quality browse.

Other studies.—ABLA/ACGL has been described from central Idaho (Steele and others 1981), eastern Idaho and western Wyoming (Steele and others 1983), and northern Utah (Mauk and Henderson 1984). This treatment follows that of northern Utah.

Abies lasiocarpa/Vaccinium caespitosum h.t. (ABLA/VACA; Subalpine Fir/Dwarf Huckleberry)



Distribution.—ABLA/VACA is a minor h.t. in our study area, occurring only in the extreme northern portion of the Wasatch Plateau. However, it may be extensive within this distribution. Our sites belong to the *Picea engelmannii* (PIEN) phase, which serves as a geographical distinction between our study area and other phases of this h.t. in northern Utah and Idaho (refer to "Other Studies"). The ABLA/VACA h.t., PIEN phase is found on steep northern slopes at middle to low elevation within the *Abies lasiocarpa* zone. Our sites ranged in elevation from 8,400 to 9,600 feet (2 600 to 3 000 m), and all had slopes exceeding 45 percent. Boundaries with other types are diverse; ABLA/PHMA, ABLA/BERE, and PSME/BERE may be on warmer sites while ABLA/RIMO usually represents cooler environments.

Vegetation.—*Abies lasiocarpa* is the indicated climax tree, although mature stands may often be dominated by *Picea engelmannii*. One stand contained *Abies concolor* instead of *A. lasiocarpa*, although *A. lasiocarpa* is in the vicinity. This plot was placed here rather than the *Abies concolor* series because all other features were common to this h.t. *Populus tremuloides* is an important early seral associate throughout the h.t. The undergrowth is dominated by a dense mat of the low shrub *Vaccinium caespitosum*. Other shrubs, usually present in small amounts, include *Pachistima myrsinites*, *Ribes montigenum*, and *Symphoricarpos oreophilus*. Herbaceous species are negligible; only *Arnica cordifolia*, *Lathyrus lanszwertii*, *Osmorhiza chilensis*, and *Pyrola secunda* occur with relatively high constancy.

Soils.—All of our sites have Cretaceous sandstone as parent material. Common formations include Star Point, Price River, and the coal-bearing Black Hawk. Bare soil and surface rock are negligible, and litter accumulations average 1.5 inches (3.9 cm). Other soil data are not available for this h.t.

Productivity/management.—Timber potentials are moderate (appendixes D and E) and are similar to ABLA/RIMO. This h.t. has the highest average site index for *Abies lasiocarpa* in the study area. However, timber management may be severely limited by slope constraints. *Picea engelmannii* may be featured by light shelterwood or small clearcutting systems. *Populus tremuloides* may sucker in response to any major overstory manipulation.

Other studies.—ABLA/VACA has been described for Montana (Pfister and others 1977), central Idaho (Steele and others 1981), and the Uinta Mountains in northern Utah (Mauk and Henderson 1984). These authors describe typical sites as gentle slopes and benches with quartzitic parent material and glacial outwash basins that collect cold air. *Pinus contorta* is the principal seral species and is usually persistent with slow conversion to *Abies lasiocarpa*. Our sites, on steep northern slopes with sandstone parent material, support a different tree association with *Picea engelmannii* as the principal seral species. Differences in undergrowth vegetation also exist. Therefore, the ABLA/VACA h.t. in central Utah is a considerably different ecosystem than that described elsewhere, and it is distinguished as the PIEN phase.

Abies lasiocarpa/Vaccinium globulare h.t. (ABLA/VAGL; Subalpine Fir/Blue Huckleberrry)

Distribution.—ABLA/VAGL is an incidental h.t., known only from the Huntington Reservoir area on the Wasatch Plateau. It becomes increasingly important northward through northern Utah into southern Idaho (refer to "Other Studies"). Our sites range in elevation from 9,200 to 9,350 feet (2 800 to 2 850 m) and occurred on steep, usually northern exposures.

Vegetation.—The dense overstory of mature stands is composed solely of *Abies lasiocarpa* and *Picea engelmannii*. *Populus tremuloides* may be an early seral associate on some sites. The dense undergrowth is usually dominated by *Vaccinium globulare*, which may be overtopped by *Ribes montigenum* or *Symphoricarpos oreophilus*. *Pachistima myrsinites* is also usually present. *Sambucus racemosa* may persist in undisturbed stands but often increases with any major perturbation. Common herbaceous species include *Carex rossii*, *Bromus ciliatus*, *Arnica cordifolia*, *Osmorhiza chilensis*, and sometimes *Lathyrus lanszwertii*.

Soils.—Soils are derived from Cretaceous and Tertiary sandstone. Litter accumulations average 0.6 inches (1.5 cm). Other data are not available.

Productivity/management.—Although limited data suggest that timber potentials are moderate, this h.t. probably has greater value for watershed protection.

Other studies.—ABLA/VAGL has previously been recognized in Montana (Pfister and others 1977), central Idaho (Steele and others 1981), eastern Idaho and western Wyoming (Steele and others 1983), and northern Utah (Mauk and Henderson 1984). Similar conditions have been described by Kerr and Henderson (1979) on the Wasatch Plateau as the *Abies lasiocarpa/Vaccinium membranaceum* h.t. This description for our study area follows the concept developed for northern Utah.

Abies lasiocarpa/Vaccinium myrtillus h.t. (ABLA/VAMY; Subalpine Fir/Myrtle Whortleberry)

Distribution.—ABLA/VAMY, a minor h.t. of our study area, is locally common only in the LaSal Mountains. It occurs on moderate to steep slopes having northern exposures. Elevations range from 10,000 to 10,600 feet (3 050 to 3 230 m) and generally represent the middle to upper portion of the *Abies lasiocarpa* zone. Adjacent warmer sites usually belong to ABLA/BERE or ABLA/CAGE. Cooler sites most often are within the ABLA/RIMO h.t. Occasionally, ABLA/VAMY will be adjacent to moist seepy microsites that may key to ABLA/ACCO.

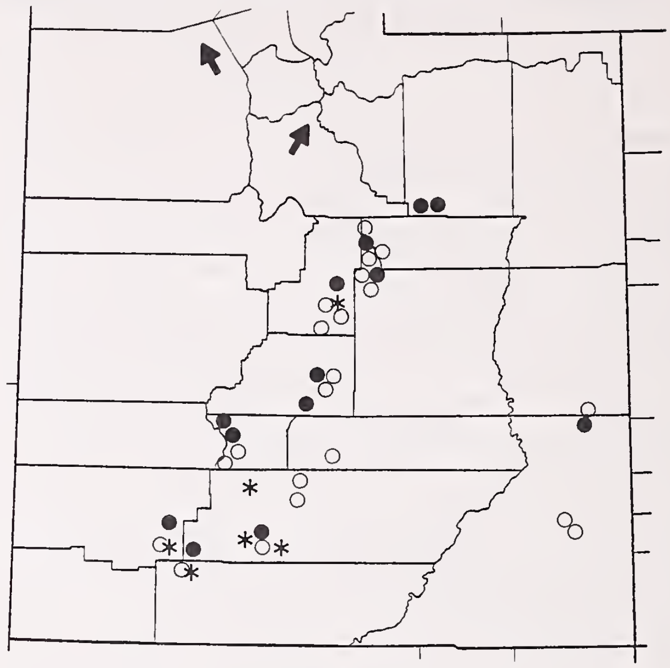
Vegetation.—Mature stands are usually dense and consist of a codominance of *Abies lasiocarpa* and *Picea engelmannii*. *Pseudotsuga menziesii* was observed in one low-elevation stand. ABLA/VAMY is unique for our study area in that *Populus tremuloides* is apparently not capable of tolerating environmental conditions of this h.t. *Populus tremuloides* is a prominent seral component in ABLA/CAGE and also occurs in ABLA/BERE and ABLA/RIMO that may be on similar substrates. Steele and others (1983) noted a comparable relationship with *Vaccinium scoparium* in eastern Idaho and western Wyoming. Limited soil data from the LaSals suggest that litter formed from *Vaccinium myrtillus* may exceed the acidity tolerance of *P. tremuloides*. Once incorporated into the mineral soil, the organic material may lower soil pH values and reduce the lateral extension of *P. tremuloides* roots. Normally, the undergrowth of the ABLA/VAMY h.t. is a dense carpet of the low-growing shrub *V. myrtillus*. This is usually overtopped by scattered *Lonicera involucrata* and *Ribes montigenum*. Herbaceous species include *Bromus ciliatus*, *Arnica* *cordifolia, Lathyrus lanszwertii, Osmorhiza chilensis, Pedicularis racemosa, Polemonium pulcherrimum,* and *Pyrola secunda.*

Soils.—Soils are usually shallow and rocky and are derived from intrusive porphyritics. Bare soil is negligible, but sites may have exposed rock. Litter accumulations average 1.1 inches (2.9 cm), relatively low for the *Abies lasiocarpa* series. Surface textures are predominantly silt loam.

Productivity/management.—Limited timber production data suggest that ABMY/VACA may be similar to ABLA/BERE, PIEN phase for *P. engelmannii* site index (appendix D). Attempts to regenerate *Picea* would be most successful using small clearcut or shelterwood systems. This h.t. may provide important watershed values of delayed snowmelt. Wildlife attributes include summer hiding and thermal cover and limited forage for big game in mature stand conditions.

Other studies.—Our ABLA/VAMY is similar to sites in western Colorado, Arizona, and New Mexico that have undergrowth dominated by *Vaccinium myrtillus* (Hoffman and Alexander 1983; Hoffman and Alexander 1980; Kormarkova 1982; Hess and Wasser 1982; Moir and Ludwig 1979). However, these authors also include *Vaccinium scoparium* in the association along with a variety of other shrubs and moist-site forbs and name the h.t. *Abies lasiocarpa/Vaccinium scoparium.* Often *Picea engelmannii* is added to the name. ABLA/VASC is a widespread and important h.t. of Montana, Idaho, Wyoming, and northern Utah (Pfister and others 1977; Steele and others 1981; Steele and others 1983; Hoffman and Alexander 1976; Mauk and Henderson 1984). Sites in these areas characteristically support *Pinus contorta* as a dominant seral associate. Timber management within the ABLA/VASC h.t. is usually directed toward artificial regeneration of even-aged stands of *P. contorta.* In contrast, our ABLA/VAMY appears sufficiently different because of the apparent lack of *Pinus contorta.* In order to avoid confusion in management implications with the ABLA/VASC h.t. found in the Uinta Mountains, the *Vaccinium myrtillus* epithet was chosen.

Abies lasiocarpa/Berberis repens h.t. (ABLA/BERE; Subalpine Fir/Oregon Grape)



Distribution.—ABLA/BERE is a major h.t. of the middle and northern Rocky Mountains and occurs throughout our study area. It is usually found at middle to lower elevations within the *Abies lasiocarpa* zone. Wide geographic distribution and contrasting environmental characteristics allow the h.t. to be divided into three phases, with differing management opportunities based upon overstory associates. In general, ABLA/BERE occupies relatively cool and dry environments. Elevations range from 8,100 to 10,800 feet (2 470 to 3 290 m), but the type is most often found between 9,000 and 10,000 feet (2 750 to 3 050 m). Aspects are usually northern, with variation discussed by phase. Slopes are gentle to steep, with a variety of configurations. ABLA/BERE is often found below ABLA/RIMO and above either ABCO/BERE or PSME/BERE. Other boundaries are discussed by phase.

Vegetation.—*Abies lasiocarpa* is the indicated climax tree and is often present in early seral stands. *Populus tremuloides* is an important seral species throughout the type. Other associates vary with phase. Mature stands are often dense, with almost complete shading of the undergrowth. A light to moderately dense stratum of shrubs is conspicuous in all phases and includes *Berberis repens, Pachistima myrsinites, Rosa woodsii,* and *Symphoricarpos oreophilus.*

Pinus flexilis (PIFL) phase: The warmest and driest portion of the ABLA/BERE h.t. is represented by the PIFL phase, which occurs on all aspects at middle to upper-elevation positions on straight slopes. The PIFL phase may be adjacent to drier sites belonging to the *Pinus flexilis-Pinus longaeva* series, especially on more southerly exposures. More moist or cooler sites belong to other phases of ABLA/BERE or ABLA/RIMO. This phase can be found throughout the range of the h.t. but is more common in the southern portions of the study area.

Mature stands are older than in the other phases (average age of overstory was 253 years) and usually contain a mixture of *Abies lasiocarpa*, *Pinus flexilis*, and *Pseudotsuga menziesii* in codominance (fig. 3). *Picea engelmannii*, if present, will normally be confined to the most moist and protected microsites. *Abies concolor* or *Picea pungens* may be locally abundant, especially on the Markagunt and Paunsaugunt Plateaus. In addition to the normal shrub association, *Juniperus communis* and *Ribes cereum* are usually present. *Amelanchier alnifolia* may account for small coverages. *Ribes montigenum* is present in small amounts on sites usually above 9,500 feet (2 900 m), representing colder conditions approaching the ABLA/RIMO h.t. More graminoids may be present in this phase than others. This stratum usually contains small clumps of *Carex rossii* and scattered *Bromus ciliatus*, *Poa fendleriana*, and *Sitanion hystrix*. Forbs are usually inconspicuous; only *Astragalus miser*, *Achillea millefolium*, and *Thalictrum fendleri* are present in at least 50 percent of the mature stands.

Picea engelmannii (PIEN) phase: Cooler and more moist portions of the ABLA/BERE h.t. are represented by the PIEN phase. It occurs throughout the range of the type and represents lower to upper portions or straight or concave slopes. Undulating topography can also be found. Exposures are strongly confined to the most northern aspects. Slopes range from gentle to oversteepened and average 42 percent. This phase usually represents a broad ecotone between the BERE phase and colder sites belonging to ABLA/RIMO or PIEN/RIMO. *Pseudotsuga menziesii* and *Picea engelmannii* share a seral role with *Populus tremuloides*. Mature stands are much younger than the PIFL phase; our overstories averaged 161 years. *Abies lasiocarpa* and *Picea engelmannii* are normally codominant in mature and climax conditions.

Figure 3.—*Abies lasiocarpa/Berberis repens* h.t., *Pinus flexilis* phase in the Escalante Mountains near Bryce Canyon National Park. The site is on a steep southwest-facing slope at 9,960 feet (3 040 m). *Pseudotsuga menziesii* and *Pinus flexilis* dominate the overstory. *Abies lasiocarpa* and *Picea engelmannii* occur in the understory. Undergrowth species include *Berberis repens, Ribes montigenum, Bromus ciliatus*, and *Poa fendleriana*.

The dense overstory shades out most undergrowth species (fig. 4). In addition to the normal light shrub association, *Ribes montigenum* may be present, especially on sites above 9,000 feet (2 740 m). Few graminoids are present. Common forbs include *Aquilegia coerulea, Osmorhiza chilensis, Pyrola secunda*, and *Thalictrum fendleri. Lathyrus lanszwertii* may occur in seral stands under *Populus tremuloides. Arnica cordifolia* may be found on sites on the Wasatch Plateau.

Berberis repens (BERE) phase: The modal portion of the h.t. occurs on moderate to steep lower to middle slopes throughout the range of the h.t. It represents cool and dry conditions in between the other phases. Exposures are usually northwest to northeast. In addition to other phases of the ABLA/BERE h.t., this phase may be bounded by ABLA/JUCO, ABLA/RIMO, or PIEN/RIMO on colder sites. Adjacent warm sites usually belong to PSME/BERE, ABCO/BERE, or the *Picea pungens* series.

Both *Pseudotsuga menziesii* and *Populus tremuloides* are important seral species. *Picea pungens* and *Abies concolor* are locally common. Mature to climax stands (ours averaged 122 years old) may be dominated solely by *Abies lasiocarpa*. In addition to the light shrub stratum listed for the h.t., *Juniperus communis* and the graminoids *Carex rossii* and *Bromus ciliatus* are usually present. Common forbs include *Thalictrum fendleri, Osmorhiza chilensis, Astragalus miser*, and *Achillea millefolium. Lathyrus lanszwertii* is common in seral stands.

Soils.—Our ABLA/BERE is usually found on colluvium or residual material derived from limestone or sandstone parent materials (appendix F). All three phases occur most often on the Wasatch Formation, a continental deposit of coarse conglomerate, sandstone, and limestone from the Tertiary Period. Both the PIEN and PIFL phases also occur on other Tertiary and Cretaceous sandstone rocks, including the North Horn, Star Point, and Black Hawk Formations. A few sites in each phase are also of igneous origin, especially in the Abajo and LaSal Mountains and the Aquarius Plateau. The Mount Dutton area of the Sevier Plateau and the Delano Peak area in the Tushar Mountains are of mixed volcanic origin, with BERE and PIFL phases commonly represented. In general, soils are normally shallow and coarse. Surface textures range from sandy loam to clay loam. Bare soil and exposed rock are common; amounts of exposed rock and boulders may be as high as 40 percent in the PIEN phase. Areas of bare soil averaged 12 percent in the PIFL phase and less for other phases.

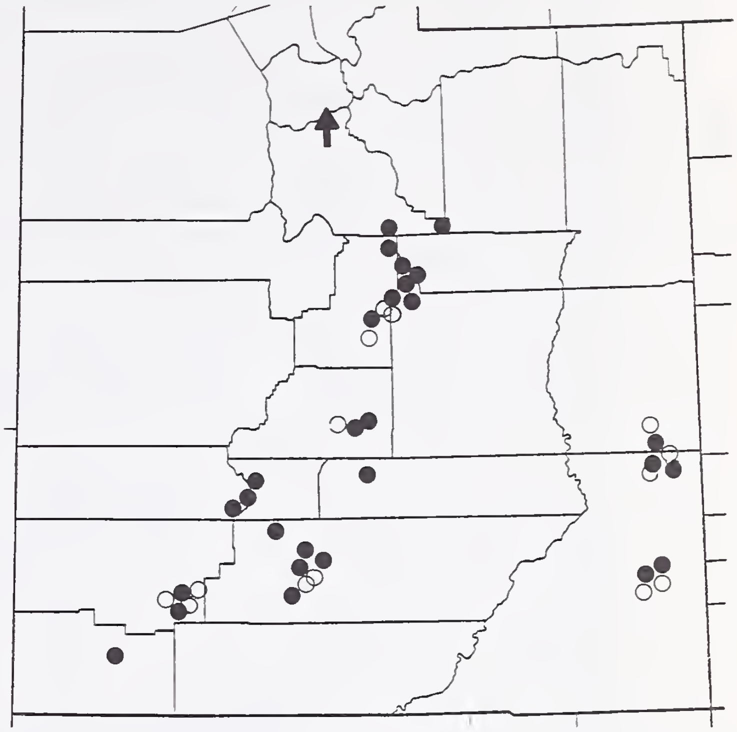
Figure 4.—*Abies lasiocarpa/ Berberis repens* h.t., *Picea engelmannii* phase on a cool, flat bench north of Navajo Lake on the Markagunt Plateau (9,600 feet, 2 930 m). *Abies lasiocarpa, Picea engelmannii*, and remnant *Populus tremuloides* comprise the overstory. The undergrowth contains small amounts of *Berberis repens, Ribes montigenum*, and *Carex rossii*.

Litter accumulations average 1.3 inches (3.3 cm) for BERE and PIEN phases but only 0.9 inch (2.4 cm) for the PIFL phase.

Productivity/management.—Timber potentials range from low to moderate and vary with phase (appendixes D and E). Yields are highest in the PIEN phase and lowest in the PIFL phase. Both PIEN and BERE phases represent areas having potential for timber management if sound silvicultural prescriptions are applied. *Picea engelmannii* and *Pseudotsuga menziesii* may be favored by light shelterwood or small clear-cutting systems in the PIEN phase. *Picea pungens* may be the most productive species to feature in the BERE phase, if it is common locally. The PIFL phase may represent sites with values other than timber production; lack of regeneration success and slow growth rates should preclude most stand manipulations. Throughout the h.t., opportunities exist for managing aspen, especially for wildlife habitat values such as increased forage and browse for deer. Elk may also use these sites extensively during the summer. The BERE and PIEN phases represent areas of prolonged snowpack accumulation and thus may be important for watershed protection.

Other studies.—ABLA/BERE was first described in Utah by Pfister (1972). He found the same common association of four shrubs and designated them the *Berberis repens* union. His concept of the ABLA/BERE h.t. is broader than this h.t.; it includes our ABLA/ACGL, all three phases of our ABLA/BERE, ABLA/CAGE, ABLA/JUCO, and ABLA/CARO, and portions of ABLA/RIMO. Pfister suggested three phases to subdivide the h.t., based upon presence or absence of *Ribes montigenum* and *Picea engelmannii*. His *Ribes montigenum* phase represented highest elevation sites and his *Abies lasiocarpa* phase described lowest elevation conditions. Our concept of the h.t. and phases follows that of northern Utah (Mauk and Henderson 1984), with a PIFL phase for dry exposures and a BERE phase for modal conditions. The use of *Picea engelmannii* rather than *Ribes montigenum* for a phasal break was based upon the similarity of stand conditions and the anticipated resource interpretations concerning timber management. The ABLA/BERE h.t. has also been described from southeastern Idaho and western Wyoming (Steele and others 1983) and the northern portion of the Wasatch Plateau (Kerr and Henderson 1979).

Abies lasiocarpa/Ribes montigenum h.t. (ABLA/RIMO; Subalpine Fir/Mountain Gooseberry)



Distribution.—ABLA/RIMO is common at middle to upper elevations of the *Abies lasiocarpa* zone and can be found in vast acreages on most of the high plateaus and mountains of central and southern Utah. It also extends northward into Idaho and Wyoming (refer to "Other Studies"). It accounts for almost one quarter of our sample stands. Our sites generally range in elevation from 9,500 to 11,000 feet (2 400 to 3 350 m) and are usually on northwest to northeast exposures. Other site characteristics are discussed by phase below.

Vegetation.—Mature or old-growth stands are dominated by both *Abies lasiocarpa* and *Picea engelmannii*. Both are often layering in the understory. Stands range from large and continuous to rather patchy or clumpy, interspersed with open meadow. *Populus tremuloides*, an important early seral associate, is usually present in mature or old growth conditions only as remnant stems of poor vigor. Occasionally, only downed logs indicate the previous stand of *P. tremuloides*. Sample stand data suggest the following generalized successional sequence for this h.t. Following a major stand-destroying disturbance such as natural fire, remnant *P. tremuloides* root systems resprout, creating a clone. Invasion of *Abies lasiocarpa* follows, and saplings may develop quickly under this nurse crop of *P. tremuloides*. Invasion of *Picea engelmannii* is much slower and may be restricted to areas of bare soil. Pfister (1972) suggests this progression to a pure *Abies-Picea* climax may require at least 1,000 years without additional disturbance. The eventual uneven-aged climax stand usually has abundant *A. lasiocarpa* seedlings and saplings in addition to vegetative layering. *Picea engelmannii*, although common in the overstory, is usually present in the understory on raised root mounds and depressions resulting from windthrow of the shorter lived *A. lasiocarpa* following root rot. Thus, the regeneration is confined to gaps created in the overstory.

Undergrowth vegetation is distinguished by two phases.

Mertensia arizonica (MEAR) phase: The MEAR phase represents the most hydric extent of the h.t. It is found throughout the distribution of the type in our study area but appears to be best represented in the Cedar Breaks area on the Markagunt Plateau. It generally occurs at the highest elevations within the type; our sample stands are usually above 10,000 feet (3 050 m). This phase may also be found on a wide variety of aspects in addition to the most northern exposures. Slopes or swales are usually gentle to moderate and are either straight or concave. Abundant ground moisture is apparently present throughout the growing season as a result of snowpack accumulations on lee slopes and numerous seeps and small springs. The MEAR phase is usually found above the RIMO phase of the ABLA/RIMO h.t. It often is patchy or broken, with graminoid-forb meadows surrounding. The PIEN/RIMO h.t. occasionally may abut, forming the upper boundary.

Total undergrowth canopy cover is about 40 percent, creating a relatively lush, dense ground cover. *Ribes montigenum* is conspicuous throughout the stand (fig. 5). The diverse herbaceous stratum contains numerous moist-site forbs, including *Mertensia arizonica, Mertensia ciliata, Geranium richardsonii, Polemonium pulcherrimum*, and *Trifolium longipes*. Other common species include *Achillea millefolium, Aquilegia coerulea, Arnica cordifolia, Delphinium barbeyi, Epilobium angustifolium, Osmorhiza chilensis, Pyrola secunda, Thalictrum fendleri*, and *Carex rossii*.

Ribes montigenum (RIMO) phase: Modal conditions are represented by the RIMO phase. It occurs most often on gentle to steep straight slopes with northern exposures. Our sample stands are most often at elevations between 9,500 and 10,500 feet (2 900 to 3 200 m). The RIMO phase may represent either climatic or topoedaphic climaxes depending upon locale. Many sites on steep northern slopes are above a wide variety of other h.t.'s, including ABLA/BERE-PIEN, ABLA/VACA, ABLA/VAMY, ABLA/CAGE, or ABLA/CARO. On more gentle undulating terrain, such as the relatively flat tops of some plateaus, this phase may be extensive. Higher and colder sites that support conifers are described by the PIEN/RIMO h.t.

A normally sparse undergrowth (fig. 6) contains a light, scattered canopy of *Ribes montigenum*, usually confined to near the base of large trees. Other shrubs, including *Sambucus racemosa, Symphoricarpos oreophilus*, and *Shepherdia canadensis*, may occur in openings or on recently disturbed areas. The depauperate herbaceous stratum includes *Thalictrum fendleri, Osmorhiza chilensis, Arnica cordifolia, Achillea millefolium*, and *Carex rossii*. Under disturbed conditions, or in seral stands with incomplete conifer canopies, *Lupinus argenteus, Lathyrus lanszwertii, Helenium hoopsii, Epilobium angustifolium, Aquilegia coerulea*, and *Achillea millefolium* are expected to increase.

Soils.—Because of its wide distribution, ABLA/RIMO is found on a variety of parent materials (appendix F). Bare soil and exposed rock average about 5 percent for both phases but can range as high as 45 percent in the RIMO phase and 30 percent in the MEAR phase. Litter accumulations average 1.2 inches (3 cm) for both phases. Major distinctions between phases exist in surface textures; MEAR is predominantly silt loam and clay loam, while the RIMO phase is often as coarse as sandy loam (appendix G).

Productivity/management.—Timber potentials vary slightly by phase but generally represent the best opportunities for management within the *Abies lasiocarpa* series (appendixes D and E). Management will usually feature *Picea engelmannii* as the most productive species. In general, silvicultural prescriptions should include a careful consideration of the natural unevenaged structure and the inability for *P. engelmannii* to regenerate without site protection. Throughout the study area, numerous examples of natural and artificial regeneration failures in large clearcuts indicate the need to provide partial protection for seedling survival. Small clearcuts, shelterwood, or group or individual tree selection methods should be designed to prevent seedling mortality from frost, desiccation from winter winds, sun scald, and soil movement. The MEAR phase may have additional constraints on overstory removal because of the apparent depth of the water table. As with PIEN/RIMO, the degree of slash removal in ABLA/RIMO must be

Figure 5.—*Abies lasiocarpa/ Ribes montigenum* h.t., *Mertensia arizonica* phase on a moderately steep north slope near North Creek Pass (10,200 feet, 3 100 m) in the Abajo Mountains. *Abies lasiocarpa* and *Picea engelmannii* are the only trees on the site. The dense undergrowth contains *Ribes montigenum* and a diverse assemblage of forbs.

Figure 6.—*Abies lasiocarpa/ Ribes montigenum* h.t., *Ribes montigenum* phase on a moderately steep northeast slope (10,480 feet, 3 200 m) of Mount Mellenthin in the LaSal Mountains. *Abies lasiocarpa* and *Picea engelmannii* are the only trees on the site. The depauperate undergrowth is dominated by scattered *Ribes montigenum* and *Osmorhiza chilensis*.

carefully balanced between site amelioration values and host sites for bark beetles (*Dendroctonus rufipennis*). *Abies lasiocarpa* is almost uniformly susceptible to decay by *Fomes annosus*, which increases the chances of windthrow. Many of our stands contained *A. lasiocarpa* infected with the yellow witches' broom rust (*Melampsorella caryophyllacearum*).

Domestic livestock will usually find little forage in mature stands belonging to the RIMO phase, but abundant succulent forbs in the MEAR phase may attract sheep. Deer and elk use is high in both phases; this h.t. may function as prime summer range. Many stands within the MEAR phase contain large squirrel caches.

Watershed protection is a principal resource value. Snow is often retained as late as August on the higher elevation sites.

Other studies.—ABLA/RIMO is a major h.t. through the Rocky Mountains, with descriptions for Montana (Pfister and others 1977), central Idaho (Steele and others 1981), eastern Idaho and western Wyoming (Steele and others 1983), and northern Utah (Mauk and Henderson 1984). Pfister (1972) originally described the h.t. for our study area and proposed three phases based upon the presence of (1) *Ribes montigenum*, (2) *Thalictrum fendleri*, or (3) *Lonicera involucrata*. Additional phases have been reported for northern Utah and Wyoming. This classification includes the mesic portions of Pfister's *Lonicera involucrata* and *Thalictrum fendleri* phases in the MEAR phase, while the modal RIMO phase comprises the remaining *Ribes montigenum* stands and the high-elevation portions of his *Abies lasiocarpa/Berberis repens* h.t.

Abies lasiocarpa/Carex geyeri h.t. (ABLA/CAGE; Subalpine Fir/Elk Sedge)

Distribution.—ABLA/CAGE is an incidental type in the LaSal and Abajo Mountains, but it also occurs in central Colorado (refer to "Other studies"). Our sites range from 8,800 to 9,800 feet (2 700 to 3 000 m) in elevation on mesic gentle slopes and benches. Exposures are northwest to northeast. Adjacent drier sites may belong to ABLA/BERE, while cooler sites usually belong to ABLA/RIMO or ABLA/VAMY.

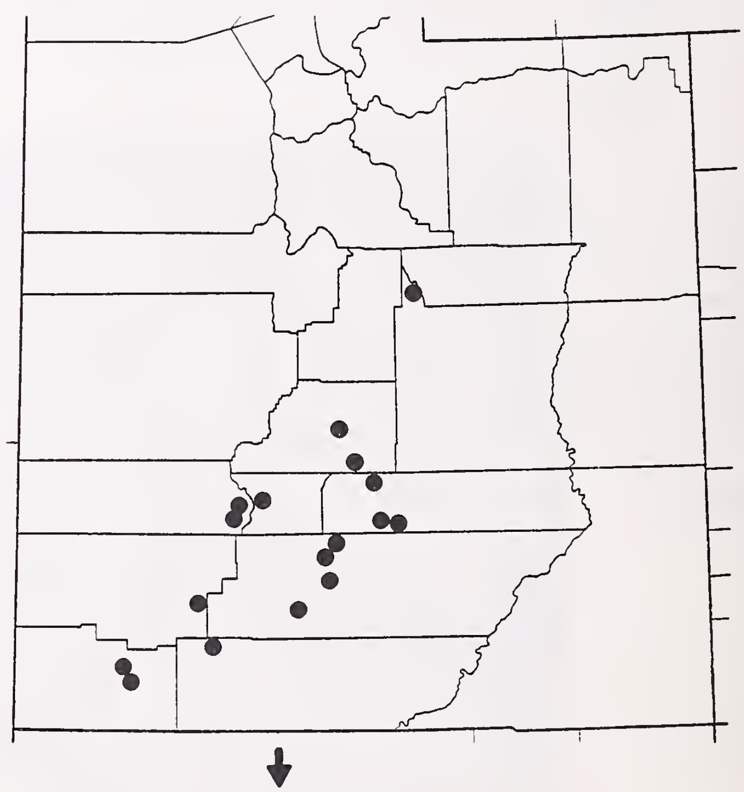
Vegetation.—Mature or climax stands are dominated by *Abies lasiocarpa*. *Picea engelmannii* may also be present in small amounts as a persistent seral associate. *Populus tremuloides* is the dominant seral component and was present in all our sample stands. The undergrowth is characterized by a relatively dense sward of *Carex geyeri*. This may be overtopped by scattered low shrubs, including *Berberis repens*, *Rosa woodsii*, and *Symphoricarpos oreophilus*. Forbs include *Achillea millefolium*, *Lathyrus lanszwertii*, *Osmorhiza chilensis*, and *Smilacina stellata*.

Soils.—ABLA/CAGE is apparently restricted to igneous parent materials in our study area. Soils were developed in residual material derived from intrusive porphyritics. Bare soil and exposed rock or boulders are negligible. Litter accumulations averaged 1.2 inches (3.1 cm). Textures are loam or silt loam.

Productivity/management.—Timber potentials are apparently moderate to high. Limited site index data for *Picea engelmannii* indicate it perhaps should be favored. Dense sod of *Carex geyeri* will prohibit natural regeneration unless sites are scarified. *Populus tremuloides* may also present opportunities for management. Both deer and cattle should find forage on these sites.

Other studies.—ABLA/CAGE was first described by Pfister and others (1977) in Montana as a minor type. It also occurs in central Idaho (Steele and others 1981), from Yellowstone National Park southward to southeastern Idaho (Steele and others 1983), and in southeastern Wyoming (Wirsing and Alexander 1975). These authors list both *Populus tremuloides* and *Pinus contorta* as principal seral associates. Our h.t. has closer affinities with ABLA/CAGE that is found on the Routt and White River National Forests of north-central Colorado, where *Pinus contorta* is not a component (Hoffman and Alexander 1983; Hoffman and Alexander 1980; Hess and Wasser 1982). Similar conditions also apparently exist on the Gunnison and Uncompahgre National Forests of western Colorado (Komarkova 1982).

Abies lasiocarpa/Juniperus communis h.t. (ABLA/JUCO; Subalpine Fir/Common Juniper)



Distribution.—A major h.t. of the southern portion of our study area, ABLA/JUCO occupies middle to upper elevation slopes, ridges, and benches on all aspects. Our sites ranged from 8,800 to 10,600 feet (2 680 to 3 330 m) in elevation, but most were above 9,500 feet (2 900 m). Topography may be straight, undulating, or convex. Slopes vary from gentle to steep and average 21 percent. ABLA/JUCO is usually on warmer aspects or elevations than ABLA/ RIMO or ABLA/CARO, while ABLA/BERE represents slightly more mesic conditions.

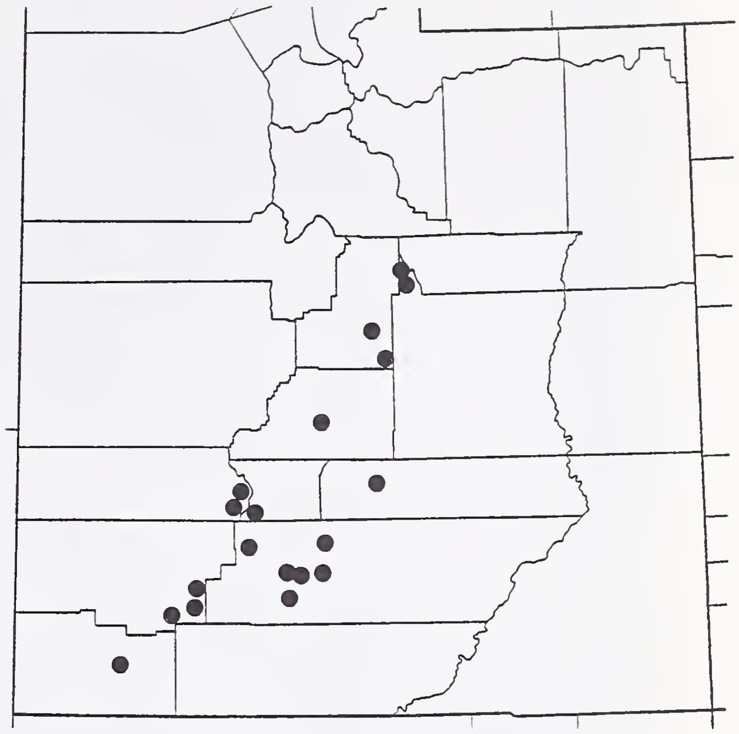
Vegetation.—*Abies lasiocarpa* is the indicated climax tree and is usually present in early seral to mature stands. Both *Picea engelmannii* and *Populus tremuloides* are important seral associates. Both *P. engelmannii* and *A. lasiocarpa* may layer in the understory. *Pseudotsuga menziesii* and *Picea pungens* may also be present as seral but persistent associates. The patchy undergrowth is dominated by *Juniperus communis*, which may develop into large horizontal clumps. Other common shrubs include *Rosa woodsii, Symphoricarpos oreophilus*, and occasionally *Berberis repens*. Site characteristics and abundance of *B. repens* should be carefully assessed in order to distinguish between this h.t. and ABLA/BERE, PIEN phase. In general, ABLA/JUCO is much more depauperate than ABLA/BERE.

Soils.—ABLA/JUCO occurs on soils derived almost exclusively from igneous parent materials, primarily basaltic flows (appendix F). Most sites have rocky surfaces with abundant bare soil. Litter accumulations average 1 inch (2.5 cm). Surface textures are predominantly sandy loam and loam (appendix G).

Productivity/management.—Timber potentials are generally low (appendixes D and E). This h.t. represents the lowest potential yields for the series. Natural regeneration appears to be sporadic and limited to only the most mesic microsites. Normal or standard procedures of manipulating the overstory for silvicultural purposes will usually be unsuccessful. Wildlife, especially big game, may find both cover and forage or browse on these sites, but most use will probably be associated with proximal plant communities.

Other studies.—Similar conditions exist in Idaho and Wyoming (Steele and others 1981, 1983) where the type also occurs along cold air drainages. These sites also support *Pinus contorta*. Along the Uinta Mountains north of our study area, sites supporting predominantly *Juniperus communis* occur and are included within the *Abies lasiocarpa/Berberis repens* h.t. (Mauk and Henderson 1984). Our sites show the most affinity to conditions described for the North Kaibab Plateau and mountains of northern New Mexico (Moir and Ludwig 1979).

Abies lasiocarpa/Carex rossii h.t. (ABLA/CARO; Subalpine Fir/Ross Sedge)



Distribution.—ABLA/CARO is a major h.t. of the *Abies lasiocarpa* series and can be found throughout the study area with the exception of the eastern LaSal and Abajo Mountains. The type commonly occurs on flat benches to straight and steep northern slopes at middle to upper elevations. Our sites ranged from 8,600 to 10,400 feet (2 620 to 3 170 m), but the type is most common above 9,500 feet (2 900 m). ABLA/CARO apparently represents sites drier than ABLA/BERE and slightly warmer than ABLA/RIMO.

Vegetation.—Mature or climax stands are relatively dense and are codominated by *Abies lasiocarpa* and *Picea engelmannii*. *Abies lasiocarpa* reproduction may also be present in the understory as vegetative layering. *Pseudotsuga menziesii* is locally important as a seral associate, especially on the Wasatch and Fish Lake Plateaus and the Tushar Mountains. Throughout the h.t., *Populus tremuloides* is an important seral associate and usually serves as a nurse crop for conifer regeneration. The undergrowth is depauperate (fig. 7), with only a light coverage of *Carex rossii* representing a diagnostic feature. Other species that may also occur that are usually associated with small openings include *Arnica cordifolia, Astragalus miser*, and *Rosa woodsii.*

Soils.—Parent materials depend upon locale and include limestone, Cretaceous sandstone, andesite, and most often basalt (appendix F). Both surface rock and bare soil are variable and may range from none to almost 50 percent. Litter accumulations average 1.4 inches (3.5 cm). Surface soil textures are mostly sandy loam and loam (appendix G).

Figure 7.—*Abies lasiocarpa/Carex rossii* h.t. on a moderately steep, northeast-facing slope (9,760 feet, 2 980 m) near New Harmony in the Pine Valley Mountains. *Picea engelmannii* and *Abies lasiocarpa* dominate the mature overstory. *Abies lasiocarpa* is layering in the understory. *Carex rossii* is the major component of a depauperate undergrowth.

Productivity/management.—Timber potentials are generally moderate (appendixes D and E) and are about average for the series. Successful silvicultural prescriptions for *Picea engelmannii* will likely involve small openings that maintain site protection. Many of our sites contain *Abies lasiocarpa* infected with the root rot *Fomes annosus*. According to Steele and others (1983), the root system of established *Carex rossii* may be sufficiently extensive to present severe competition for tree seedlings unless site treatment is prescribed. Opportunities also exist to manage *Populus tremuloides* for a variety of resource values including forage production for livestock.

Other studies.—ABLA/CARO has previously been described by Steele and others (1983) for southeastern Idaho. Their type appears to be similar except for the occurrence of *Pinus contorta* as a seral associate. Mauk and Henderson (1984) do not include ABLA/CARO in their classification for northern Utah, but some sites belonging to their ABLA/BERE and *Abies lasiocarpa/Osmorhiza chilensis* h.t.'s are comparable.

Abies concolor Series

Distribution.—The *Abies concolor* series, a major grouping of h.t.'s within the study area, is especially common on the southern plateaus. Our series includes eight h.t.'s, of which four are major and one incidental. Sites are characteristically cool and dry and are usually on northern exposures. Elevations range from 6,200 to 9,200 feet (1 890 to 2 800 m), with ABCO/QUGA representing the lower extreme and ABCO/BERE or ABCO/SYOR common at the higher altitudes. Several h.t.'s within the series, including ABCO/PHMA, ABCO/CELE, and ABCO/QUGA, represent lower timberline conditions. Other types, such as ABCO/ARPA and ABCO/BERE, are usually above closely related types within the *Pseudotsuga menziesii* series. Higher elevations or more moist conditions may support *Abies lasiocarpa* and belong to that series.

Vegetation.—Sites supporting *Abies concolor* as a climax species are apparently too warm and dry for *Abies lasiocarpa* and *Picea engelmannii*. The most common associates of this series include *Pseudotsuga menziesii* and *Pinus ponderosa*, with *Picea pungens* and *Populus tremuloides* present in the ABCO/BERE and ABCO/JUCO h.t.'s. The characteristically shrubby undergrowths are similar to the *Pseudotsuga menziesii* and portions of the *Pinus ponderosa* and *Abies lasiocarpa* series.

Soils/climates.—Our series shows a strong affinity for limestone and sandstone substrates (appendix F). ABCO/CELE and ABCO/JUCO are the only exceptions and are found most often on andesitic volcanics. This relationship is similar to the *Pseudotsuga menziesii* series. Amounts of bare soil and exposed rock are relatively uniform; only ABCO/ARPA represents sites with an average of more than 20 percent bare soil. Litter accumulations tend to be nonuniform and patchy, with depths ranging from 0.9 to 1.7 inches (2.3 to 4.4 cm) and averaging 1.2 inches (3.2 cm). Surface textures are variable and are best discussed by h.t. Many sites within this series have experienced severe erosion in the past.

Accurate, long-term climatological data for much of this series are lacking. However, analyses from two sites, and general observations and extrapolations, suggest that the series represents environments beyond the drought and temperature tolerances of *Abies lasiocarpa* and *Picea engelmannii* and within the zone of somewhat uniformly distributed annual precipitation. Thus, the series is found at elevations lower than *A. lasiocarpa* and *P. engelmannii* and is confined to the southern and western portion of the study area that receives summer moisture. Mauk and Henderson (1984) suggest that the northern distribution of the series, near Logan, UT, might correspond to a mean January temperature of about 32 °F (0 °C). Mean temperatures below this threshold apparently limit seedling establishment.

Productivity/management.—Our series generally represents sites with only limited opportunities for timber management. Yields are low and many sites are poorly stocked. Where present, *Pseudotsuga menziesii* presents the best opportunity for successful silvicultural manipulation. Low elevation, and especially lower timberline sites, often resemble the adjacent nonforest shrub communities and may have undergrowths of competing shrubs. Because of its proximity to rural communities, most of the series has had a history of selective harvesting.

Knowledge of fire ecology for *Abies concolor* sites is only superficial. Although many of our sample stands have burned as a result of historic logging, the natural fire interval probably is relatively short. *Abies concolor* is not very resistent to fire as a sapling or pole but becomes increasingly more tolerant with age as the thin smooth bark thickens. Low branches also increase its susceptibility. Fires that are carried by undergrowth species, such as *Quercus gambelii, Juniperus communis*, and graminoids, may easily torch-out on young *A. concolor. Pseudotsuga menziesii* and *Pinus ponderosa* may be favored by these fires because of greater fire resistence and the creation of favorable seed beds. Crane (1982) presents preliminary successional trends of *Abies concolor* h.t.'s in Colorado that appear reasonable for most of our types.

Wildlife values of this series are not well documented. Many of our h.t.'s apparently provide cover and browse for deer, presumably during spring and fall. Mauk and Henderson (1984) suggest the preference of *Abies concolor* cambium tissue as food for several rodent species, especially porcupines.

Abies concolor/Physocarpus malvaceus h.t. (ABCO/PHMA; White Fir/Ninebark)

Distribution.—ABCO/PHMA, an incidental h.t. sampled in the Pahvant Mountains, is confined to steep northern slopes immediately above the *Acer glabrum-Quercus gambelii* woodlands. Our sites were all below 7,500 feet (2 290 m) in elevation. Adjacent types are most likely ABCO/BERE, ABCO/ACGL, or undescribed nonforest communities.

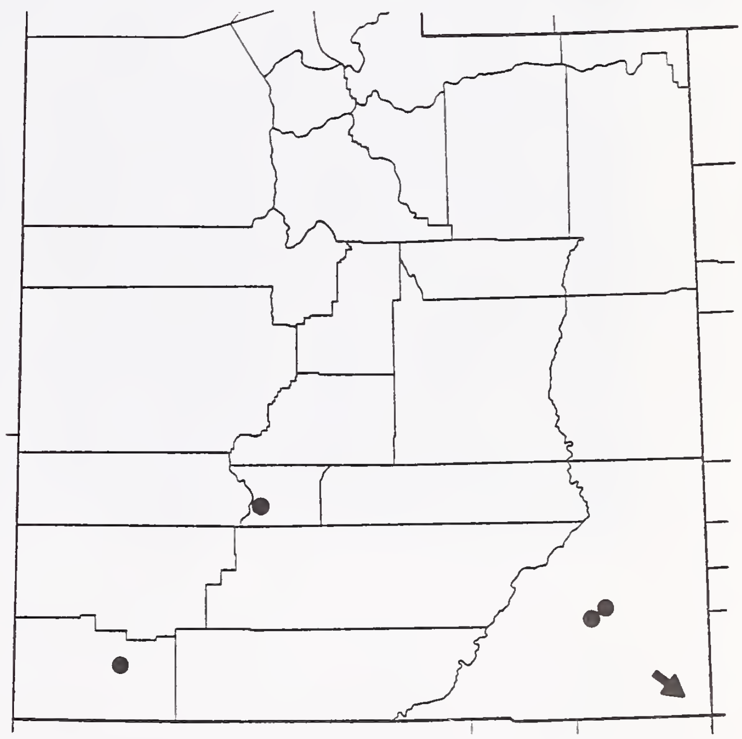
Vegetation.—Both *Abies concolor* and *Pseudotsuga menziesii* codominate in the overstory. The shrubby undergrowth consists of *Physocarpus malvaceus, Quercus gambelii*, and *Amelanchier alnifolia* in a tall shrub stratum, overtopping a lower stratum of *Berberis repens, Pachistima myrsinites*, and *Rosa woodsii*. Herbaceous species include *Carex geyeri, Lathyrus lanszwertii*, and *Lathyrus pauciflorus*.

Soils.—Sampled stands are on limestone and sandstone parent material. Litter accumulations are relatively high. Surface textures are loam and silt loam.

Productivity/management.—Individual trees may have relatively high site index values, but yields are expected to be low to moderate. Steep slopes and intense undergrowth competition may preclude most management alternatives. These sites may have highest value as spring and fall deer habitat. Other management implications should be similar to PSME/PHMA.

Other studies.—The ABCO/PHMA h.t. is similar to that described for the Wasatch and Stansbury Mountains of northern Utah by Mauk and Henderson (1984).

Abies concolor/Acer glabrum h.t. (ABCO/ACGL; White Fir/Mountain Maple)



Distribution.—ABCO/ACGL is a minor h.t. of our study area. Sites belonging to this type were found in the Pine Valley, Abajo, and Tushar Mountains. It represents lower to midslope positions at low elevations within the *Abies concolor* series; our sample sites ranged from 7,400 to 8,400 feet (2 260 to 2 560 m) in elevation. Exposures are northern and topography is usually concave or undulating. Adjacent drier sites usually belong to ABCO/BERE, while more moist sites are stream bottoms.

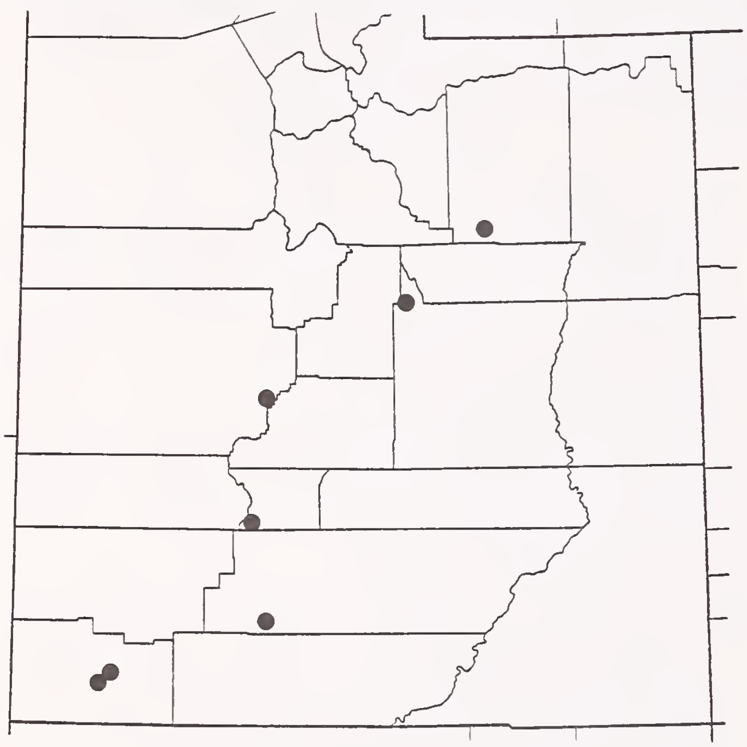
Vegetation.—A dense overstory in mature stands is composed of *Abies concolor*, with *Pseudotsuga menziesii* usually present as a persistent seral associate. *Populus tremuloides* is also an important early seral component. The shrubby undergrowth consists of a distinctly tall stratum, including *Acer glabrum, Quercus gambelii, Prunus virginiana*, and *Amelanchier alnifolia*, overtopping a low shrub stratum of *Berberis repens, Pachistima myrsinites, Rosa woodsii*, and *Symphoricarpos oreophilus*. *Bromus ciliatus* and *Carex rossii* are the most common graminoids. A diverse forb component includes *Thalictrum fendleri, Smilacina stellata*, and *Erigeron speciosus*.

Soils.—Parent materials are variable, depending upon locale. Our sites include both Tertiary sandstone and andesitic volcanics. Surface textures are mostly loam. Most of our sites contain relatively high amounts of exposed rock.

Productivity/management.—Yields and management appear similar to ABLA/ACGL.

Other studies.—Mauk and Henderson (1984) suggest that ABCO/ACGL may exist in the Wasatch Mountains near Salt Lake City. DeVelice and others (in press), and Moir and Ludwig (1979) describe similar conditions in southwestern Colorado and northern New Mexico.

Abies concolor/Cercocarpus ledifolius h.t. (ABCO/CELE; White Fir/Curlleaf Mountain-Mahagany)



Distribution.—ABCO/CELE, a minor h.t. of the *Abies concolor* series, is found sporadically throughout the lower elevations in the western part of the study area. It also occurs on the Wasatch and Tavaputs Plateaus. It may be most common in the Pine Valley Mountains in southwestern Utah. Our sites range in elevation from 7,000 to 9,400 feet (2 130 to 2 860 m) and are usually on gentle to steep straight or convex slopes with northern exposures. Adjacent sites usually support nonforest communities of *Quercus-Cercocarpus* woodlands, or on more moist sites, the ABCO/BERE h.t.

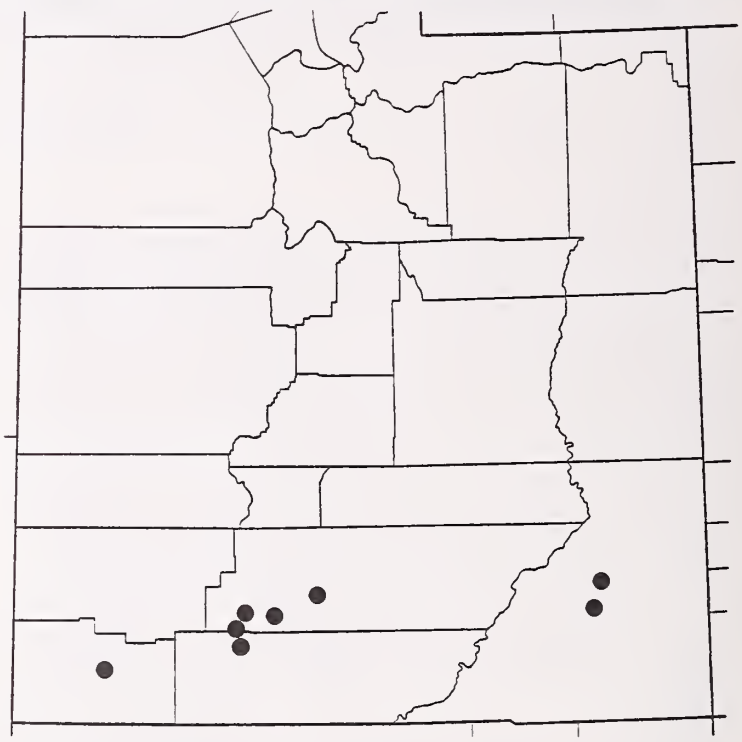
Vegetation.—Although *Abies concolor* is the indicated climax tree, mature stands of *A. concolor* are rarely found. Usually *Pseudotsuga menziesii* and *Pinus ponderosa* dominate these sites. *Pinus flexilis* and *Juniperus scopulorum* are often present in small amounts. The shrub-dominated undergrowth may become dense, with *Cercocarpus ledifolius, Quercus gambelii, Amelanchier alnifolia, Berberis repens*, and *Symphoricarpos oreophilus* usually present. *Carex rossii* and *Poa fendleriana* are the most characteristic graminoids. Forbs are negligible.

Soils.—Although a variety of sedimentary and igneous parent materials are represented, andesitic volcanics are the most common. Many sites have high amounts of exposed rock and bare soil. Patchy litter accumulations averaged only 1.1 inches (2.6 cm). Surface textures are predominantly loam and silt loam.

Productivity/management.—Limited timber data indicate potential yields are very low (appendix D), and represent the poorest sites of the series. Rocky sites and low stocking will reduce expected yields. These sites may function best as spring and fall range for big game, especially deer.

Other studies.—No other studies have described this h.t.

Abies concolor/Arctostaphylos patula h.t. (ABCO/ARPA; White Fir/Greenleaf Manzanita)



Distribution.—ABCO/ARPA is a major h.t. of the *Abies concolor* series in the southern portion of the study area. It usually occurs on relatively gentle benches with undulating topography at midslope positions. A variety of exposures are represented. Elevations range from 8,100 to 8,500 feet (2 470 to 2 590 m). ABCO/ARCA is usually found adjacent to the drier PIPO/ARPA, while more moist conditions are represented by ABCO/BERE, ABCO/SYOR, or PIPU/JUCO.

Vegetation.—*Abies concolor* is the indicated climax tree, but many sites may have open, uneven-aged overstories dominated by mature *Pseudotsuga menziesii* or *Pinus ponderosa* (fig. 8). *Abies concolor* should be present in the understory and will gradually increase. *Juniperus scopulorum* may persist on these dry sites, while *Pinus flexilis* is a long-lived seral associate. The undergrowth consists of dense patches of shrubs, characterized by the diagnostic *Arctostaphylos patula*, along with *Symphoricarpos oreophilus, Juniperus communis*, and *Berberis repens*. Graminoids and forbs are usually negligible.

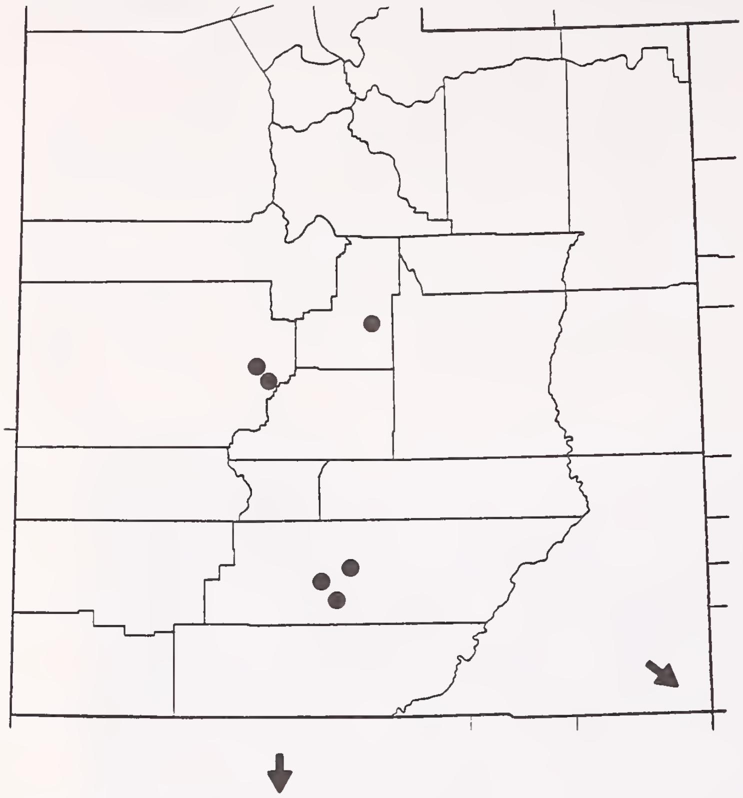
Soils.—ABCO/ARPA shows a strong affinity for limestone substrates, commonly occurring in our study on the Wasatch Formation (appendix F). Although exposed rock is usually less than 10 percent, amounts of bare soil may range up to 80 percent and average 21 percent. Consequently, litter accumulations are patchy and average only 1.1 inches (2.5 cm). Many sites contain evidence of erosion. Surface textures are predominantly loam and silt loam (appendix G).

Productivity/management.—Timber potentials are generally very low (appendixes D and E). Stocking limitations, droughty soils, and low site indexes will reduce expected yields. Individual trees grow slowly, with most sample stands exceeding 200 years. Attempts to manipulate the overstory in even-aged management may fail. Wildlife may use these sites for browse. Domestic livestock will find little forage.

Other studies.—No other studies have described this h.t.

Figure 8.—*Abies concolor/Arctostaphylos patula* h.t. on a steep southwest slope (8,580 feet, 2 610 m) in the East Fork Creek drainage on the Paunsaugunt Plateau. *Abies concolor* is scattered throughout the overstory, which also contains *Pinus ponderosa* and *Pseudotsuga menziesii*. Large patches of *Arctostaphylos patula* are common in the undergrowth.

Abies concolor/Quercus gambelii h.t. (ABCO/QUGA; White Fir/Gambel Oak)



Distribution.—ABCO/QUGA is a minor h.t. of the *Abies concolor* series and occurs primarily in the Pahvant Mountains and on the southern edge of the Aquarius Plateau. It also apparently extends southward into Kane County in Zion National Park. It was found on all but southern and southwestern exposures and ranged from 6,200 to 8,600 feet (1 890 to 2 620 m) in elevation. Our sites usually represent middle to lower slope positions, with straight slopes that are moderate to steep. ABCO/QUGA is usually adjacent to relatively high elevation PIPO/QUGA-SYOR in the Aquarius Plateau. In the Pahvant Mountains, it may be adjacent to *Quercus-Acer grandidentatum* woodlands, and thus represents the lower timberline zone of conifer forests. In both areas, ABCO/BERE may be found on cooler exposures and elevations.

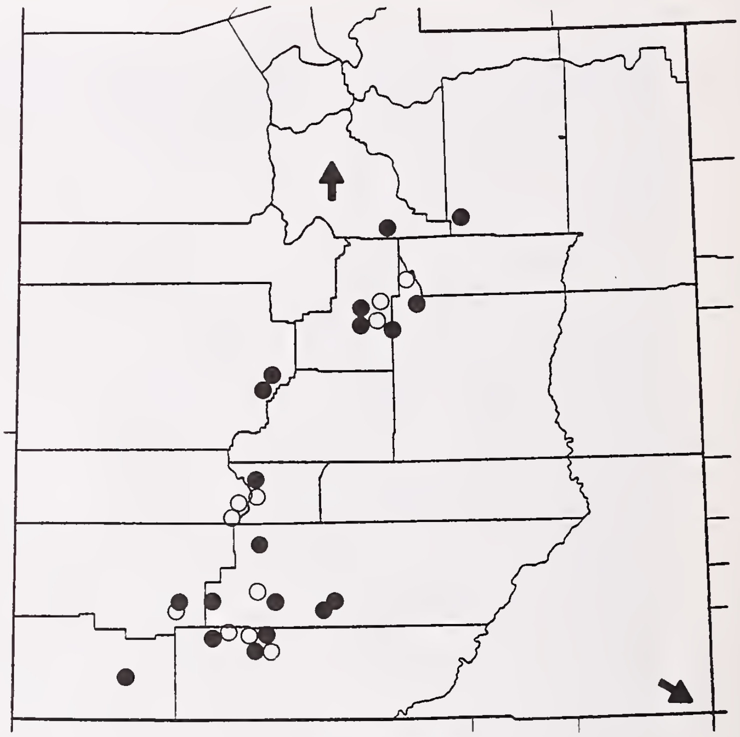
Vegetation.—*Abies concolor* is the indicated climax tree, although it may be poorly represented in many stands dominated by mature *Pseudotsuga menziesii* or *Pinus ponderosa. Juniperus scopulorum* is usually present in small amounts. *Populus tremuloides* is noticeably absent. The shrubby undergrowth is dominated by *Quercus gambelii* and *Amelanchier alnifolia*, which may overtop *Berberis repens, Pachistima myrsinites, Purshia tridentata, Rosa woodsii*, and *Symphoricarpos oreophilus*. A light and diverse herbaceous stratum includes *Carex rossii, Poa fendleriana, Sitanion hystrix, Eriogonum racemosa*, and sometimes *Balsamorhiza sagittata*.

Soils.—Parent materials are variable, depending upon locale. Sedimentary, metamorphic, and igneous types are represented (appendix F). Exposed rock and bare soil were present in all sample stands but averaged only 7 and 2 percent, respectively. Litter accumulations averaged 1.7 inches (4.4 cm). Surface textures are variable and range from loam to silt loam to clay loam.

Productivity/management.—Timber potentials range from very low to low (appendixes D and E). Limited data suggest that management should favor *Pseudotsuga menziesii* rather than *Pinus ponderosa* for maximum production. Other features may be similar to PSME/QUGA or ABCO/CELE.

Other studies.—Somewhat similar conditions apparently exist in New Mexico and Arizona and have been described as the *Abies concolor-Pseudotsuga menziesii/Quercus gambelii* h.t. by Moir and Ludwig (1979) and the ABCO/QUGA h.t. by DeVelice and others (in press).

Abies concolor/Berberis repens h.t. (ABCO/BERE; White Fir/Oregon Grape)



Distribution.—ABCO/BERE is a major h.t. of the *Abies concolor* series. Sample stands are distributed throughout the study area except for the easternmost LaSal and Abajo Mountains. Two phases are recognized, with slight differences in environmental site characteristics and management opportunities. In general the h.t. can be found between 7,300 and 9,600 feet (2 230 to 2 930 m) in elevation on a variety of exposures. The type usually represents relatively cool and dry midslope positions on gentle to steep slopes. Adjacent, colder sites, often at higher elevations, belong to the ABLA/BERE, PIPU/BERE, or ABCO/SYOR h.t.'s. Warmer sites may belong to a variety of different h.t.'s, including PSME/BERE, ABCO/ARPA, PIPO/SYOR, and sometimes PSME/SYOR, although parent material differences exist between some of these types. In the northern and western portion of the study area, ABCO/BERE may represent the lowest elevation coniferous timber sites, with nonforest communities dominated by *Populus tremuloides* or *Quercus* and *Acer* immediately adjacent.

Vegetation.—Old-growth stands are usually unevenaged and contain a variety of species in the overstory.

Pure *Abies concolor* stands are rare. *Pseudotsuga menziesii* and *Populus tremuloides* are the most common seral associates. In some areas, *Pinus ponderosa* may persist; it usually represents the drier extreme of the h.t. Undergrowth vegetation is characterized by a sparse layer of low shrubs, including *Berberis repens, Symphoricarpos oreophilus, Pachistima myrsinites*, and *Rosa woodsii*. Other features are distinguished by phase.

Juniperus communis (JUCO) phase: The dry extreme of the h.t. is represented by the JUCO phase, which is distributed throughout the study area. It usually occurs on middle to lower slopes and benches with predominantly southwest and northeast exposures. The overstory may include *Picea pungens* or *Pinus flexilis* in addition to the other seral species. Phasal difference is based upon the presence of *Juniperus communis*, which may have relatively high coverage in large patches (fig. 9). Forbs and graminoids are negligible.

Berberis repens (BERE) phase: Sites lacking abundant *Juniperus communis* belong to the BERE phase, which may represent slightly more moist conditions. It most commonly occurs on straight slopes above 8,000 feet (2 440 m) with northern or northeastern exposures. *Amelanchier alnifolia*, in addition to species listed for the h.t., create the shrub component. The BERE phase also contains more forbs than the JUCO phase, with *Geranium viscosissimum, Lathyrus lanszwertii*, and *Thalictrum fendleri* notable examples.

Soils.—Soils within the ABCO/BERE h.t. are usually derived from limestone or dolomite (appendix F) that has weathered in place or has been transported by colluvial action. A few sites within the JUCO phase also contain evidence of alluvial deposition. Cretaceous and Tertiary sandstones and andesitic parent materials are also represented. Soils are usually rocky and gravelly, with bare soil ranging as high as 30 percent in the JUCO phase. Accumulations of litter average 0.9 inch (2.3 cm) in the JUCO phase and 1.5 inches (3.9 cm) for the BERE phase. Surface textures show little difference by phase and range from loam to silt loam and clay loam (appendix G). Many of our sample sites have had serious gully and sheet erosion.

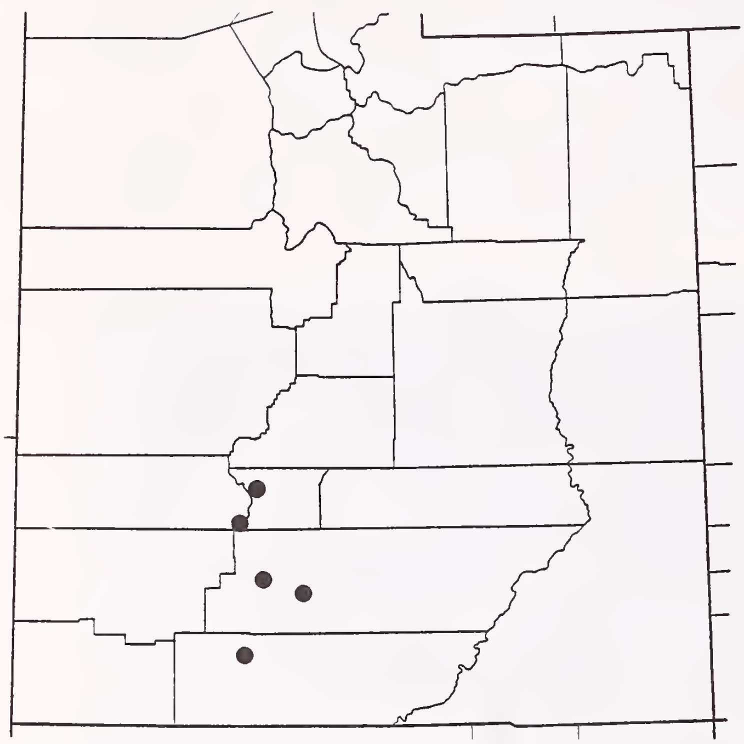
Productivity/management.—Timber yields are generally very low to low for the h.t. (appendixes D and E). The BERE phase may contain sites of higher productivity, presumably due to a more protected exposure. *Pseudotsuga menziesii* presents the best opportunity for management if silvicultural prescriptions are carefully developed. Many of the sites, especially at the lower elevations, contain evidence of past fire and cutting. This is assumed to be the result of early settlers seeking house logs and building products (refer to discussion of

Figure 9.—*Abies concolor/Berberis repens* h.t., *Juniperus communis* phase on a gentle northern slope (8,160 feet, 2 490 m) in Bryce Canyon National Park. Old-growth *Pinus ponderosa* and *Pseudotsuga menziesii* dominate the overstory, with *Abies concolor* throughout the understory. Large clumps of *Juniperus communis* are conspicuous. Other shrubs include *Berberis repens* and *Symphoricarpos oreophilus*.

logging history preceding h.t. descriptions). Recovery from both fire and selective logging (high-grading) has been slow. Dwarf mistletoe (*Arceuthobium douglasii*) may be common on *Pseudotsuga menziesii*. Big game, especially deer, apparently make heavy use of those sites, presumably during spring and fall.

Other studies.—Pfister (1972) first noted the presence of *Abies concolor* with undergrowth similar to the ABLA/BERE h.t. Our BERE phase extends into northern Utah where Mauk and Henderson (1984) describe it and another phase that resembles our ABCO/QUGA, ABCO/CELE, and ABCO/SYOR h.t.'s. Similar conditions exist south of our study area and have been described as the *Abies concolor-Pseudotsuga menziesii* h.t., *Berberis repens* phase in the San Juan Mountains (Moir and Ludwig 1979).

Abies concolor/Juniperus communis h.t. (ABCO/JUCO; White Fir/Common Juniper)



Distribution.—ABCO/JUCO is a minor h.t. in the Sevier and Paunsaugunt Plateaus, Escalante, and Tushar Mountains. It usually is found on gentle to steep northern slopes between 7,900 and 9,000 feet (2 410 and 2 740 m) in elevation. Adjacent, more moist sites may belong to ABCO/BERE, while drier sites are often ABCO/ARPA.

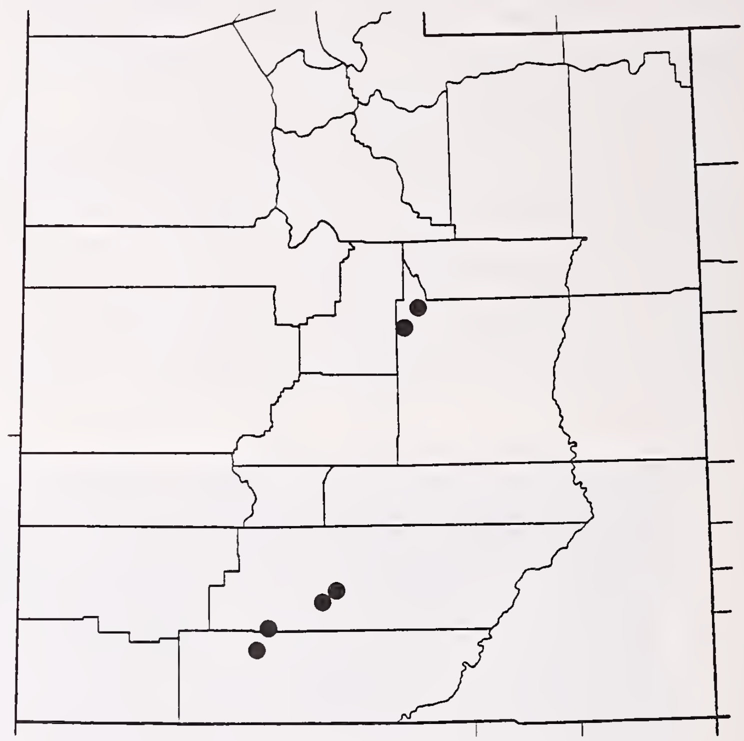
Vegetation.—*Abies concolor* is the indicated climax tree and usually dominates mature stands. *Pseudotsuga menziesii, Picea pungens, Pinus flexilis,* and *Populus tremuloides* are seral associates. The undergrowth is characterized by an easily noticeable and clumpy stratum of *Juniperus communis*. Other common shrubs include *Symphoricarpos oreophilus, Rosa woodsii, Ribes cereum,* and *Berberis repens*. The herbaceous stratum is usually depauperate; only *Carex rossii* has high constancy.

Soils.—Our sites contain gravelly soils derived from limestone and andesite and basaltic volcanic parent materials, with colluvial and residual depositional actions. Other features are similar to the series description.

Productivity/management.—Limited data suggest timber potentials are low because of low stocking levels and site index. In general, management options resemble those of low elevation sites within the ABLA/JUCO h.t.

Other studies.—No other studies have identified this h.t.

Abies concolor/Symphoricarpos oreophilus h.t. (ABCO/SYOR; White Fir/Snowberry)



Distribution.—ABCO/SYOR is a major h.t. of the *Abies concolor* series and is found primarily on the southern half of the Aquarius and Paunsaugunt Plateaus. It also occurs sporadically across the Wasatch Plateau. Typically, sites are midslope on moderate to steep northern slopes between 8,400 and 9,300 feet (2 560 and 2 830 m) in elevation. One site on the Wasatch Plateau was as low as 6,800 feet (2 070 m). ABCO/SYOR represents cool and dry conditions that are generally above the ABCO/JUCO and ABCO/BERE h.t.'s. More moist sites may be lower elevations of extremes within the ABLA/BERE or ABLA/JUCO h.t.'s.

Vegetation.—Mature stands are usually dominated by either *Pseudotsuga menziesii* or *Pinus ponderosa*, with only scattered *Abies concolor*. A light shrub canopy dominates the undergrowth (fig. 10) and contains *Symphoricarpos oreophilus, Rosa woodsii, Amelanchier alnifolia,* and occasionally trace amounts of *Berberis repens, Ribes cereum,* and *Quercus gambelii*. *Carex rossii* and *Poa fendleriana* are common graminoids. Forbs are noticeably sparse.

Figure 10.—*Abies concolor/Symphoricarpos oreophilus* h.t. on a steep western slope (8,400 feet, 2 560 m) just above the East Fork Creek on the Paunsaugunt Plateau. The overstory canopy is comprised of *Abies concolor, Pseudotsuga menziesii*, and scattered *Pinus ponderosa*. A depauperate undergrowth contains *Symphoricarpos oreophilus, Poa fendleriana*, and *Bromus ciliatus*.

Soils.—Our sample sites are on predominantly limestone or Tertiary sandstone (appendix F) that has either weathered in place or been modified by colluvial action. Bare soil and exposed rock are usually negligible, although a few sites contain as much as 20 percent. Litter accumulations average 1 inch (2.5 cm). Soils usually contain little gravel, although textures are predominantly sandy loam and loam (appendix G). As with ABCO/BERE, many sample sites have experienced sheet erosion.

Productivity/management.—Timber potentials are usually very low (appendix D). Because of proximity to early settlements, many stands show evidence of previous selective harvesting (high-grading). As with ABCO/BERE, fires have been frequent, although this type lacks the continuous ground fuels to burn under most normal conditions. Dwarf mistletoe (*Arceuthobium douglasii*) is relatively severe on *Pseudotsuga menziesii* throughout this type. Wildlife features are similar to the ABCO/BERE h.t.

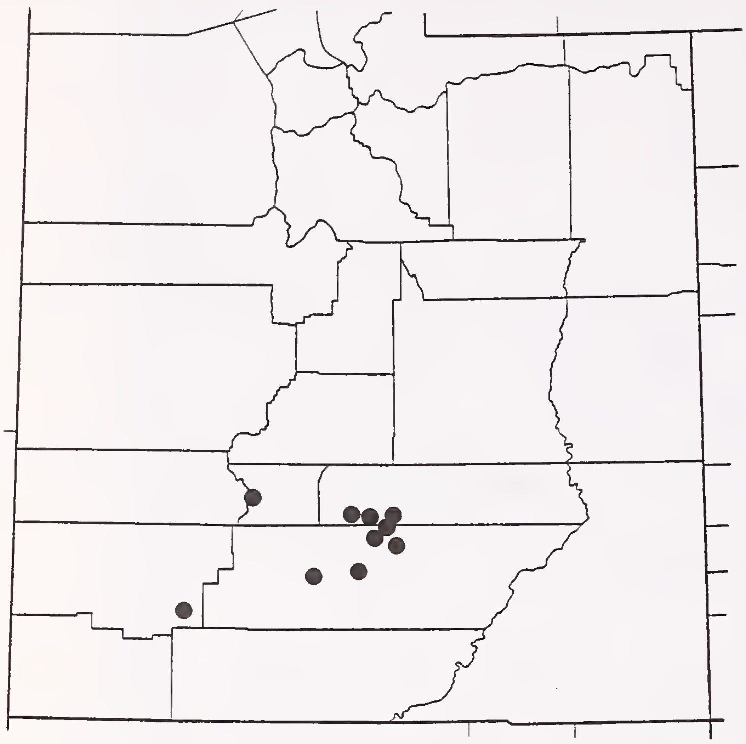
Other studies.—No other studies have described this h.t.

Picea engelmannii Series

A single h.t., PIEN/RIMO, belongs to our *Picea engelmannii* series. Although *Picea engelmannii* is often an important seral or even codominant associate in many of the *Abies lasiocarpa* and *Abies concolor* h.t.'s, interpretations of successional trends indicate that only in the absence of *Abies* is *P. engelmannii* technically climax. This rather narrow concept allows greater accuracy for the user. All sites potentially capable of supporting *A. lasiocarpa* or *A. concolor* are keyed elsewhere, and the *Picea engelmannii* series is left relatively pure.

The series description follows that of the PIEN/RIMO h.t.

***Picea engelmannii/Ribes montigenum* h.t. (PIEN/RIMO; Engelmann Spruce/Mountain Gooseberry)**



Distribution.—PIEN/RIMO is a major h.t. in the southern portion of the study area, occurring on the Aquarius and Markagunt Plateaus and throughout the Boulder, Escalante, and Tushar Mountains. It normally represents the coldest, highest elevation sites within the closed forests; it may grade into krummholz with increased stress from wind shear and winter desiccation. Warmer sites usually belong to the ABLA/RIMO h.t. PIEN/RIMO can be found on all aspects, but northern exposures are most common. Topography is usually moderate to steep, middle to upper slopes and benches, with elevations ranging from 10,000 to 11,440 feet (3 050 to 3 490 m).

Vegetation.—Stands may be solid and continuous, or patchy, with intermingled forb meadows. *Picea engelmannii* is normally the only conifer present on sites and often layers in addition to regenerating by seed. The presence of *Abies lasiocarpa* is accidental or may mark the ecotone to the warmer ABLA/RIMO h.t. *Populus tremuloides* is occasionally present as a minor seral component; however, successional rates presumably are relatively rapid. The depauperate undergrowth (fig. 11) is characterized by scattered *Ribes montigenum*, often found at or near the base of *P. engelmannii*, where snow tends to melt first. *Carex rossii, Festuca ovina,* and sometimes *Trisetum spicatum* are present in small amounts. Characteristic forbs include *Achillea millefolium, Aquilegia coerulea, Astragalus miser*, and

Figure 11.—*Picea engelmannii/Ribes montigenum* h.t. on a gentle southeastern slope (11,080 feet, 3 380 m) in the Boulder Mountains near Meeks Lake. *Picea engelmannii* is the only tree on the site. *Ribes montigenum* and *Carex rossii* characterize the depauperate undergrowth.

Polemonium pulcherrimum. Lupinus argenteus may occur in small patches where overstory canopy openings permit more sunlight.

Soils/climate.—PIEN/RIMO soils are almost exclusively derived from weathered andesitic flows (appendix F). Most sites, especially those in the Boulder Mountains, have relatively high amounts of rock exposed at the surface. Bare soil ranges from none to 60 percent. Litter depth is relatively constant in sites having little disturbance and averages 1 inch (2.5 cm). Surface textures range from sandy loam to clay loam, but loam and silt loam are most common (appendix G). Climatological data for the type are represented by the Blowhard Radar Station (appendix H). Although ambient air temperatures displayed are reasonable, this site receives extensive winds that may reduce snowpack accumulations representative of the complete range of the h.t. (Arlo Richardson, retired Utah State Climatologist, pers. comm.). It probably provides a characteristic example of *Picea engelmannii* krummholz.

Productivity/management.—Timber potentials are low to moderate (appendixes D and E). The low site index for *Picea engelmannii*, short growing seasons, and rocky soils combine to reduce yields. Under the best conditions at lower elevations, small openings that maintain the site protection from wind and high insolation may respond favorably. Careful consideration should be given the prevailing wind patterns and wind firmness of the existing stand before creating openings. Mielke (1950) and Schmid and Hinds (1974) discuss the severe overstory die-off of *P. engelmannii* resulting from bark beetle (*Dendroctonus rufipennis* [Kirby]; = *D. engelmannii* [Hopkins]) infestations in the Boulder Mountains, from 1916 to 1929. Schmid and Frye (1977) relate outbreaks of the beetle to a variety of factors, including blowdown and fuels accumulation. Periodic infestation has most likely helped create the existing all-age structure. Silvicultural prescriptions should be designed to eliminate quantities of slash that encourage beetle population buildups, but also to retain slash for amelioration of site conditions following overstory removal. Also likely to affect management of *P. engelmannii* is the presence of shoestring root rot, *Armillaria mellea*. Big game, especially deer and elk, may use the PIEN/RIMO h.t. for summer and fall hiding and thermal cover, moving out into adjacent meadows for forage. Canopy removal, by cutting or natural processes, may increase undergrowth forage slightly. On most sites, because of the late snowmelt, watershed protection will be the highest management emphasis.

Other studies.—Similar conditions have been described from the Wind River and Owl Creek Mountains in Wyoming, although these sites also support *Pinus contorta* and *Pinus albicaulis* (Steele and others 1983). In Utah, PIEN/RIMO was first described by Pfister (1972) from the Boulder Mountains. This treatment maintains the previous concept and extends the distribution to other high elevation plateaus.

Picea pungens Series

Distribution.—Stands containing *Picea pungens* as a component occur throughout the study area, with the exception of the LaSal, Abajo, and Pine Valley Mountains. *Picea pungens* becomes increasingly more important in central and southern Colorado (Eyre 1980). Its absence in the LaSal and Abajo Mountains may partially be the result of bedrock; these areas contain more igneous parent material within the elevational zone in which *P. pungens* might survive.

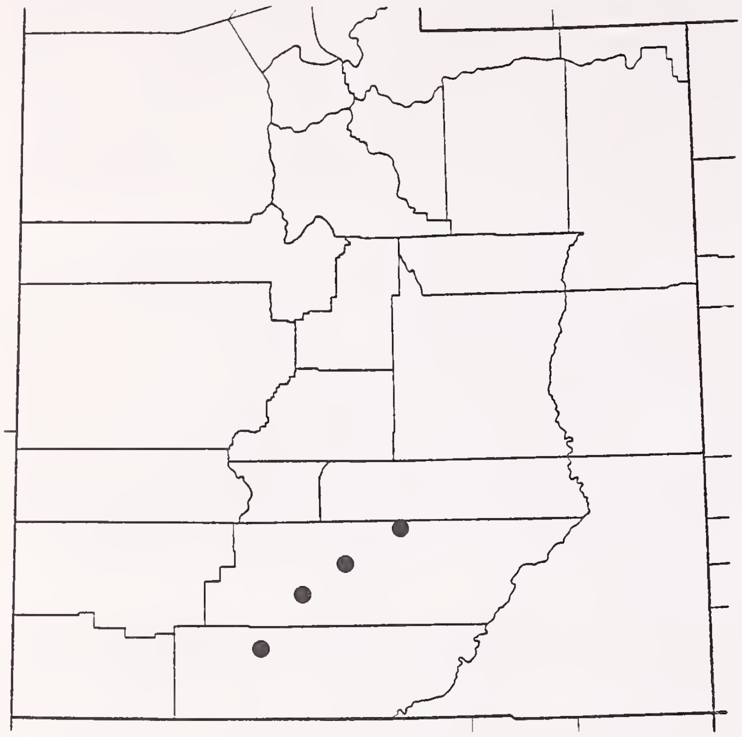
Picea pungens is a climax dominant in only three h.t.'s. The series is somewhat unique in that it contains moist sites (PIPU/EQAR) and relatively dry sites (PIPU/BERE and PIPU/JUCO) but lacks the full spectrum of mesic sites. Elevational ranges are best presented by h.t. but extend from 7,600 to 9,000 feet (2 320 to 2 740 m). Sites are normally on gentle slopes and benches or alluvial terraces, usually associated with cold air accumulation. Ecotones with adjacent types vary by h.t.

Vegetation.—Although *Picea pungens* is the climax tree, many other species are common associates. *Picea engelmannii* is also occasionally considered climax within this series when it occurs within the PIPU/EQAR h.t. Most important seral associates of the series include *Pseudotsuga menziesii, Populus tremuloides*, and *Pinus ponderosa*. *Picea pungens* is more intolerant than *Abies lasiocarpa, Abies concolor*, and *P. engelmannii*. It produces moderate to heavy cone crops in most years and thus may be relatively sensitive in its seedbed requirements (Jones 1974). Cones are often cached in large middens by the red squirrel (*Tamiasciurus hudsonicus*) in cool, moist sites (Finley 1969). These sites may belong to either the PIPU/JUCO or PIPU/EQAR h.t.'s. The undergrowth within the series varies by h.t. and is characteristically forby in PIPU/EQAR, shrubby in PIPU/JUCO, and almost depauperate in PIPU/BERE.

Soils/climate.—Alluvial, fluvial, and colluvial depositions are all represented within the series. Nonigneous parent material is more common but not exclusive (appendix F). Climatic data are not available for this rather narrow series.

Productivity/management.—Timber values are best on the most moderate portions of PIPU/BERE, but limited opportunities also exist within the PIPU/JUCO h.t. *Pinus ponderosa*, if present, presents the most opportunities for management. Otherwise, *Pseudotsuga menziesii, Picea pungens*, and even *Populus tremuloides* may be considered, depending upon h.t. Watershed protection constraints in the PIPU/EQAR h.t. will usually outweigh other resource values.

Picea pungens/Equisetum arvense h.t. (PIPU/EQAR; Blue Spruce/Common Horsetail)



Distribution.—PIPU/EQAR is a minor h.t. that occurs in the southern portion of the study area, including the Aquarius and Paunsaugunt Plateau. It ranges in elevation from 8,000 to 9,000 feet (2 440 to 2 740 m) and is restricted to gentle lower subirrigated slopes and benches or terraces adjacent to streams. It most commonly occurs on northwest to northeast aspects, but probably is more significantly influenced by edaphic relationships. Surface topography is usually hummocky. Adjacent drier sites are strongly contrasting and usually belong to PIPU/JUCO, PSME/SYOR, PSME/BERE, ABLA/RIMO, ABLA/BERE, ABLA/JUCO, or ABLA/CARO. More moist sites usually support riparian communities such as those dominated by *Populus angustifolia*.

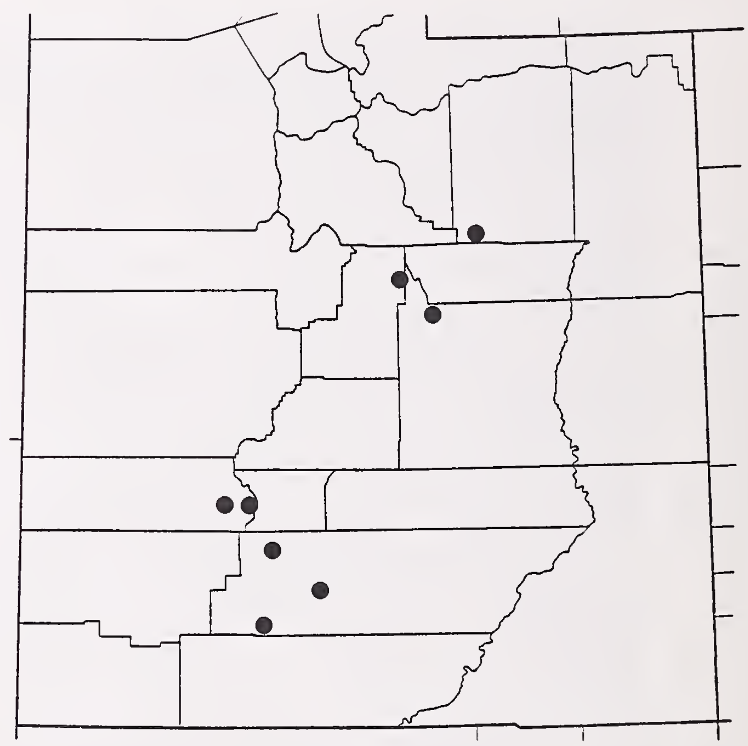
Vegetation.—*Picea pungens* dominates the site. On well-drained extremes of this type, *Populus tremuloides* may persist as a seral component. *Pseudotsuga menziesii, Abies lasiocarpa*, or *Picea engelmannii* may also occur infrequently; their presence is usually associated with raised microsites created by root crown hummocks and windthrow mounds. The dense undergrowth is dominated by forbs and graminoids. Coverage of *Equisetum arvense, Geranium richardsonii, Smilacina stellata, Osmorhiza chilensis*, and *Thalictrum fendleri* is abundant. Common graminoids include *Carex disperma* and *Glyceria elata*. At the wet extreme of this type, undisturbed sites may be dominated by a single species such as *Equisetum, Carex*, or *Glyceria*. Increased disturbance usually results in higher diversity of associated forbs. A light shrub layer may sometimes exist consisting of *Lonicera involucrata, Rosa woodsii*, or *Symphoricarpos oreophilus*, usually on raised hummocks.

Soils.—Parent materials usually consist of basalt or Cretaceous sandstone. Soils show strong influence of fluvial deposition and lack coarse fragments. Textures are silt loam to clay loam. Most sites have a thick accumulation of litter and partially decomposed organic matter; this averages 5.6 inches (14.4 cm). Ground-disturbing activities can often churn this into muck because of the high water tables. Bare soil and exposed rock are negligible.

Productivity/management.—Timber potentials are moderate, but site instability presents major considerations for any attempts in overstory removal. Even small group or single-tree selection systems, with activity contained to when soils are frozen, will result in a raised water table and possible soil loss. *Picea*, growing under these moist conditions, is also extremely susceptible to windthrow. Big game, especially black bear and elk, may make seasonal use of these sites.

Other studies.—PIPU/EQAR is similar to conditions in western Wyoming and central Idaho described by Steele and others (1983) and Steele and others (1981), except *Picea pungens* is replaced by *Picea engelmannii*. These researchers distinguished two different h.t.'s based upon the presence of *Equisetum arvense* and *Carex disperma*. The PIEN/EQAR h.t. is also found in northern Utah, where it includes *P. pungens* (Mauk and Henderson 1984). This treatment combines *Equisetum arvense* and *Carex disperma* for southern Utah because of their ecological similarities in site and the similarities in management.

Picea pungens/Juniperus communis h.t. (PIPU/JUCO; Blue Spruce/Common Juniper)



Distribution.—PIPU/JUCO, a major h.t. within the central portion of the study area, occupies middle to lower slopes, benches, and stream bottoms where cold air accumulates. It occurs on a variety of aspects and elevations, but northwest to northeast at 8,000 to 8,600 feet (2 440 to 2 620 m) are most common. Ecotones with adjacent types are relatively sharp and distinct; more moist sites may belong to PIPU/EQAR or undescribed riparian types, while warmer sites usually belong to PIPU/BERE or PSME/BERE.

Vegetation.—*Picea pungens* is the dominant conifer in seral and relatively open, mature stands. *Pinus ponderosa, Pseudotsuga menziesii, Pinus flexilis, Juniperus scopulorum*, and *Populus tremuloides* may all be present as seral associates. The undergrowth is dominated by a low, light shrub canopy consisting of *Juniperus communis, Arctostaphylos uva-ursi, Symphoricarpos oreophilus, Rosa woodsii, Pachistima myrsinites*, and *Berberis repens* (fig. 12). The herbaceous stratum is usually depauperate and may include *Carex rossii, Achillea millefolium, Geranium viscosissimum*, and *Thalictrum fendleri* in trace amounts.

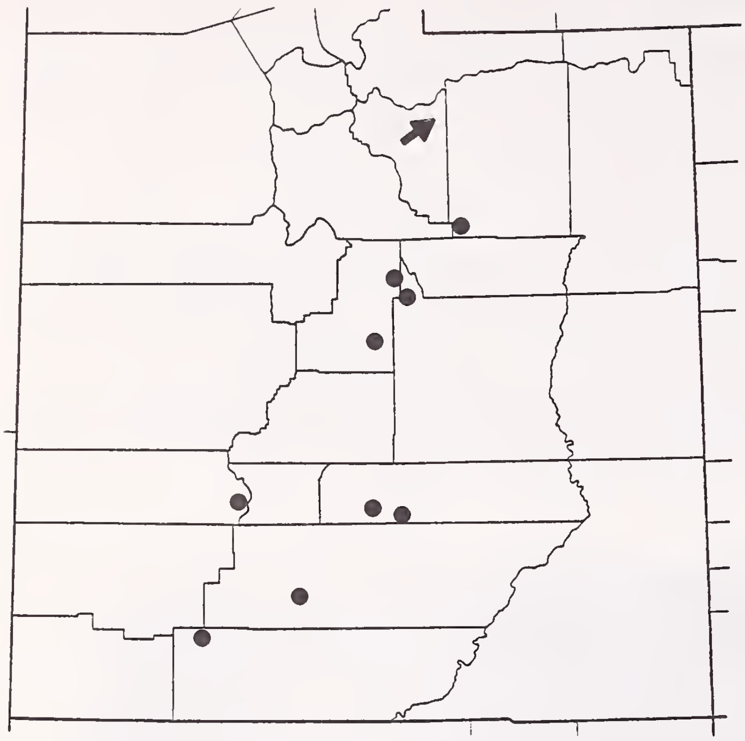
Soils.—Most sites are in alluvium or colluvium derived from limestone, dolomite, or Cretaceous sandstone (appendix F). About half the samples had some gravel in the subsurface. Exposed rock at the surface is negligible; however, bare soil ranges from none to 60 percent. undisturbed sites have litter accumulations of about 1.2 inches (3 cm). Surface textures range from sandy loam to clay loam (appendix G).

Productivity/management.—Timber potentials are very low (appendix D), and management opportunities are dependent upon the presence of the associated species. In the warm extremes of this type, *Pinus ponderosa* may be favored by light shelterwood systems. *Pseudotsuga* and *Picea pungens* may also respond to shelterwood methods. Careful consideration needs to be given to the potential for increasing the effects of cold air drainage and frost pockets.

Other studies.—No other studies have described the PIPU/JUCO h.t., although it appears to have a weak affinity with the *Picea pungens-Pseudotsuga menziesii* h.t., *Juniperus communis* phase described for the Sangre de Cristo and San Juan Mountains in Colorado and New Mexico (Moir and Ludwig 1979). Portions of the PIPU/BERE h.t. described by Kerr and Henderson (1979) are contained within this type.

Figure 12.—*Picea pungens/Juniperus communis* h.t. on a gentle northern slope (8,130 feet, 2 480 m) north of Pine Lake in the Escalante Mountains. *Picea pungens* and scattered *Pinus ponderosa* and *Juniperus scopulorum* create a broken canopy. *Juniperus communis* clumps are conspicuous in the undergrowth.

Picea pungens/Berberis repens h.t. (PIPU/BERE; Blue Spruce/Oregon Grape)



Distribution.—PIPU/BERE is a major type within the *Picea pungens* series and is found throughout the study area, except for the LaSal, Abajo, and Pine Valley Mountains. It occupies a variety of aspects from 7,800 to 9,000 feet (2 380 to 2 740 m) in elevation. Typical sites are cool and dry steep midelevation slopes or benches. Many have undulating terrain. This type represents the zone of climatic climax for *Picea pungens*; its distribution at lower elevations is usually associated with riparian systems. PIPU/BERE may border ABCO/BERE, PSME/BERE, or ABLA/BERE at the higher elevation extremes.

Vegetation.—Although *Picea pungens* is the climax tree, *Pseudotsuga menziesii, Pinus flexilis*, and *Populus tremuloides* may dominate as seral associates in relatively open stands. In some places, *Pinus ponderosa* may also persist and might deserve recognition as a separate phase. The undergrowth is characterized by a dominance of shrubs. The low canopy consists of *Berberis repens, Juniperus communis, Pachistima myrsinites, Ribes cereum, Rosa woodsii, Symphoricarpos oreophilus*, and *Artemisia tridentata* ssp. *vaseyana*. The herbaceous stratum is normally depauperate; only *Achillea millefolium, Poa fendleriana*, and the ubiquitous *Carex rossii* have relatively high constancy but low average cover.

Soils.—Parent materials are variable, depending upon geographic locale, and include limestone and dolomite, Tertiary and Cretaceous sandstones, basalt and andesite (appendix F). Most sites are in colluvium or residual material. Surface textures range from sandy loam to clay loam (appendix G); the majority are in the finer classes. Most sites have some exposed rock and bare soil, although the amounts are not extreme. Litter accumulations average 0.9 inch (2.4 cm).

Productivity/management.—Timber potentials are very low (appendixes D and E). In the more moderate extremes of this h.t., small clearcuts and shelterwood systems may be successful for regeneration of *Picea pungens* and *Pseudotsuga menziesii*. Site index is relatively high for both *P. pungens* and *Pinus ponderosa*, but stocking limitations will reduce yields. There also appear to be opportunities for managing *Populus tremuloides* within this h.t. Big game use will normally be restricted to seasonal hiding and thermal cover; only limited browse is available. Domestic livestock will find only negligible herbage, usually in association with seral *P. tremuloides* communities.

Other studies.—Pfister (1972) first suggested the presence of a PIPU/BERE h.t. in southern Utah, although he provided no description. Kerr and Henderson (1979) described the type from the northern portion of the Wasatch Plateau. This treatment divides their concept, resulting in this and the PIPU/JUCO h.t.'s. PIPU/BERE also extends into northern Utah, where it occurs locally in the southeastern Uinta Mountains (Mauk and Henderson 1984). Their stands contain *Pinus contorta*, missing from southern Utah, and a somewhat expanded shrub association. A *Picea pungens-Pseudotsuga menziesii* h.t. with several phases has been described for parts of Arizona and New Mexico (Moir and Ludwig 1979) that environmentally resembles PIPU/BERE, although it contains greater variability in the shrub and forb components and lacks *Pinus ponderosa*.

Pinus flexilis-Pinus longaeva Series

Distribution.—The *Pinus flexilis-Pinus longaeva* series occurs throughout the study area and denotes some of the driest sites capable of supporting trees other than *Juniperus*. It can be found on all aspects but is more common on southwest exposures on steep convex slopes and ridges between 9,000 and 10,200 feet (2 740 and 3 100 m). At the lower elevations, the series may form the lower timberline zone merging with savannalike *Juniperus* or *Cercocarpus* woodlands. More commonly, it represents a topographic or edaphic climax within the *Abies lasiocarpa* and upper *Pseudotsuga menziesii* zones.

Vegetation.—The series is named for the tentative union of two climax trees, *Pinus flexilis* and *Pinus longaeva*. Bailey (1970) and Cronquist and others (1972) recently showed that *P. longaeva* is sufficiently different from typical *Pinus aristata* in needle characteristics, thus warranting a new name, *P. longaeva*, based upon age of the individuals. Probably just as important is the distribution of the two species. *P. aristata* is more common in the easternmost ranges of the Colorado Rockies and into New Mexico, while *P. longaeva* occurs from eastern California through southeastern Nevada and into central Utah; thus, the ranges do not overlap (Eyre 1980). *Pinus flexilis* and *P. longaeva* are both long-lived, with *P. flexilis* reaching 2,500 years and *P. longaeva* at least 4,000 years. Natural regeneration of *P. flexilis* appears to be closely associated with caching of the large wingless seeds, primarily by Clark's nutcracker *(Nucifraga columbiana)* (Lanner and Vander Wall 1980). Germination of cached seeds often results in the multiple-stemed clumps characteristic of these sites, although the species may produce multiple stems from boles damaged near the ground. Germination and rooting will sometimes be restricted to crevices in rock. *Pinus longaeva* has smaller, winged seeds and should be wind disseminated. However, caching by nutcrackers does take place, especially when other *Pinus* species are also available (Dr. Ronald Lanner, Utah State University, pers. comm.).

Scattered, open-grown *Pseudotsuga menziesii* often occur as a common associate of the *Pinus flexilis-Pinus longaeva* series. Its presence can usually be interpreted as indicating the more moderate extremes of the series. On the most severe sites, *Pseudotsuga menziesii* may be accidental or absent, and the more intolerant and drought-resistant *Pinus* species will persist (fig. 13). With increasing moisture, *P. menziesii* may gain a competitive edge over *P. flexilis*. The resulting ecotone between this series and the warm and dry *Pseudotsuga* h.t.'s such as PSME/CEMO, PSME/CELE, and PSME/SYOR may be somewhat tenuous. Other occasional associates of the series include seral clones of *Populus tremuloides* and scattered *Juniperus scopulorum*.

Undergrowth within the *Pinus flexilis-Pinus longaeva* series is extremely diverse and thus does not allow clear h.t. distinctions. Most sites are characterized as shrubby and support scattered *Symphoricarpos oreophilus, Juniperus communis, Cercocarpus ledifolius, Cercocarpus montanus, Ribes cereum, Berberis repens, Rosa woodsii*, or *Haplopappus suffruticosus*. Less often the shrub stratum is missing, and bunchgrasses such as the ubiquitous *Carex rossii*, and *Leucopoa kingii, Elymus salina*, or *Muhlenbergia montana* become somewhat conspicuous. Common forbs include *Astragalus miser, Achillea millefolium, Hymenoxys richardsonii*, and, on the most mesic sites, *Thalictrum fendleri*. Two h.t.'s were tentatively considered; the diagnostic undergrowth species are *Cercocarpus ledifolius* and a union of *Juniperus communis* and *Symphoricarpos oreophilus*. However, insufficient data and overall management similarities result in no distinctions beyond the series level.

Soils.—The series occurs on a variety of substrates but is best represented on colluvium derived from limestone and dolomite or Tertiary and Cretaceous sandstone (appendix F). A characteristic feature is the predominance of bare soil; almost all sites have some and most sites have between 25 and 50 percent. Consequently, litter accumulations are slight and intermittent. Most sites are droughty with gravel in the shallow subsurface horizons. Surface textures vary depending upon parent material. Steep slopes, high-intensity summer convection storms, and only partial ground cover for interception often result in severe sheet erosion of fine particles. This usually leads to the development of gravel pavements. Additional erosion can be expected from wind action. High insolation and wind during the winter usually result in reduced snowpack accumulations. However, soils can be expected to freeze. Plant evapotranspirational stresses should be high year-long. Climatological data representative of this series are not available.

Productivity/management.—Timber potentials are very low to low and represent the poorest sites within the study area (appendix D). Even when occasional *Pseudotsuga* may have respectable site indexes, stocking reductions and regeneration failures will preclude any management attempts. Higher values include the limited watershed protection and, probably most important, wildlife habitat attributes. The series often provides key winter range for big game, especially when browse such as *Cercocarpus, Rosa woodsii*, and *Ribes cereum* are available. Even in years of low snowpack, sites will receive intense pressure for all available forage. As

Figure 13.—A typical site within the *Pinus flexilis-Pinus longaeva* series, near Cedar Breaks National Monument on the Markagunt Plateau. The site is at 9,660 feet (2 940 m) on a southwest aspect. *Pinus longaeva* creates the canopy, with scattered *Pinus flexilis* saplings also present.

previously noted, the pinenuts provide a critical food supply for the nutcracker. Small mammals and birds may also benefit from this caching, and thus hawks and owls rely upon these sites for their prey base. Fire histories within this series are scant. Some sites show evidence of past light surface wildfires, but the effect upon undergrowth is difficult to determine. Most sites develop such low and discontinuous fuel accumulations that fire spread is negligible. Generalized successional models and hypothesized fire effects for climax *Pinus flexilis* sites in Colorado are presented by Crane (1982) and appear reasonable for many of the graminoid-dominated situations within this series in southern Utah. Her work does not appear appropriate for the more common shrub-dominated sites.

Other studies.—The *Pinus flexilis* series is present in many other areas, and h.t.'s have been described from Montana (Pfister and others 1977), central Idaho (Steele and others 1983), and northern Utah (Mauk and Henderson 1984). In central Utah, Ellison (1954) described *Pinus flexilis* communities on the Wasatch Plateau growing on dry limestone cliffs and ridges. Pfister (1972) also notes the presence of climax *P. flexilis* and briefly describes two sites supporting *Pinus longaeva* on outcrops of Wasatch limestone. Workers in Colorado have described several bunchgrass-type h.t.'s for *Pinus aristata*; these should not be confused with this series.

Pseudotsuga menziesii Series

Distribution.—Sites supporting *Pseudotsuga menziesii* as the dominant climax tree are not as common within the study areas as either *Abies lasiocarpa*, *Abies concolor*, *Picea engelmannii*, or *Pinus ponderosa*. The *Pseudotsuga menziesii* series consists of seven h.t.'s; all but two (PSME/BERE and PSME/SYOR) are considered minor or incidental. Types are generally found scattered throughout the eastern half of the study area and range in elevation from 7,200 to 9,700 feet (2 190 to 2 960 m). Typically, climax *P. menziesii* sites are on cool slopes above *P. ponderosa* and below *A. lasiocarpa* series. Occasionally the *Abies concolor* series, more common along the western flank of the Wasatch, Fish Lake, and Sevier Plateaus, will form the upper boundary with this series. Both PSME/CELE and PSME/CEMO represent lower timberline conditions and are often adjacent to shrublands.

Vegetation.—Only PSME/PHMA, PSME/BERE, and PSME/SYOR represent sites capable of supporting closed, dense stands of *Pseudotsuga menziesii*. Other h.t.'s within the series are more open and savannalike. *Populus tremuloides* or *Pinus ponderosa* are important seral associates on most sites. Undergrowth is often dominated by a variety of tall shrubs; only PSME/BERE and PSME/SYOR have open, low shrub strata.

Soils/climate.—Our series shows a strong affinity for limestones and sandstones rather than igneous parent materials (appendix F). Only PSME/SYOR is found most often on basaltic bedrock. This relationship with non-acidic substrates was first presented by Steele and others (1983) based on work in Idaho and Wyoming. It apparently also holds in northern Utah (Mauk and Henderson 1984). The *Pseudotsuga* series often represents sites with shallow, rocky soils and relatively high amounts of bare ground. Climatic patterns for the series are best represented by the Hiawatha and Joes Valley stations (appendix H). In general, this series represents cool sites with spring or early summer droughts sufficient to exclude establishment of *Abies concolor* or *Abies lasiocarpa*.

Productivity/management.—Timber management appears feasible on better sites within the PSME/BERE and PSME/SYOR h.t.'s. Shelterwood or occasionally small clearcutting systems will encourage *Pseudotsuga* regeneration if sites are protected from high insolation and wind. *Pinus ponderosa* should be favored within the PIPO phase of PSME/BERE. When silvicultural prescriptions are developed, careful consideration should be given to competition from shrubs and graminoids, stocking limitations on rocky sites, severity of *Arceuthobium douglasii* infection, and browsing by wildlife.

Fire may play an important part in shaping many stands within the *Pseudotsuga* series. The presence of *Populus tremuloides*, *Quercus gambelii*, and *Arctostaphylos patula* may be indicative of sites with recent fires. However, our series does not contain the common graminoids that are so important for frequent light surface fires characteristic of other areas, especially Idaho and Montana. On some sites, especially within PSME/CELE and PSME/CEMO, fires may be infrequent because of noncontinuous ground fuels. Crane (1982) presents generalized fire effects and successional trends for some Colorado types that appear appropriate for our PSME/BERE-BERE, PSME/PHMA, and PSME/SYOR h.t.'s if *Pinus ponderosa* is not present.

***Psedotsuga mensiesii/Physocarpus malvaceus* h.t. (PMSE/PHMA; Douglas-Fir/Ninebark)**

Distribution.—PSME/PHMA is an incidental type confined to the northern Fish Lake and Wasatch Plateaus. It also extends along the Wasatch Front into Idaho (refer to "Other studies"). It typically occurs on steep middle to upper elevation slopes with northern aspects. Within the study area, sites ranged from 8,000 to 9,100 feet (2 440 to 2 780 m); lower elevations are more common northward. The type may be adjacent to drier, less protected sites described by PSME/CEMO or PSME/BERE. More moist sites typically belong to the *Abies lasiocarpa* or *Abies concolor* series.

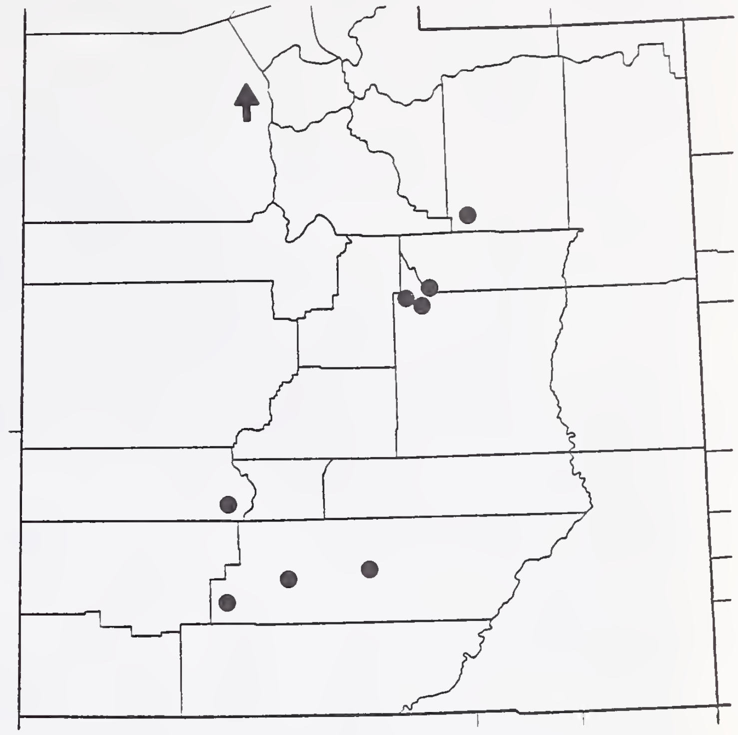
Vegetation.—*Pseudotsuga menziesii* is normally the only conifer on the site. *Populus tremuloides* may occur as a seral associate. The undergrowth is characterized by a dense layer of shrubs, including *Physocarpus malvaceus, Symphoricarpos oreophilus*, and *Amelanchier alnifolia*. These usually overtop *Berberis repens, Pachistima myrsinites*, and *Rosa woodsii*.

Soils.—Stands developed on coarse soils derived from limestone and sandstone. This is consistent with similar conditions throughout the PSME/PHMA h.t. outside this study area.

Productivity/management.—Timber potentials are usually low. The steep slopes, loose soils, and dense shrub layers reduce opportunities of overstory manipulations. Best management stratagies may involve big game habitat protection because of the hiding and thermal cover associated with these sites.

Other studies.—Originally described by Daubenmire and Daubenmire (1968) for northern Idaho, the PSME/PHMA h.t. has a relatively large geographical distribution. It is a common type in Montana (Pfister and others 1977) where a *Calamagrostis rubescens* phase, with seral *Pinus ponderosa*, and a modal *Physocarpus* phase are identified. Two additional phases exist in central Idaho. The *Pinus ponderosa* and *Pseudotsuga menziesii* phases differ in their seral associations (Steele and others 1981). A geographical variant, named for the presence of *Pachistima myrsinites*, is described from eastern Idaho and western Wyoming (Steele and others 1983). This phase apparently extends through northern Utah (Mauk and Henderson 1984) and forms the basis for this description.

***Pseudotsuga menziesii/Cercocarpus ledifolius* h.t. (PSME/CELE; Douglas-Fir/Curlleaf Mountain-Mahogany)**



Distribution.—PSME/CELE, a relatively minor h.t. throughout the study area, may be locally common along the eastern portion of the Wasatch Plateau. Typical sites are on steep (samples averaged 55 percent) convex to straight slopes on a variety of aspects. Elevations generally range from 8,500 to 9,300 feet (2 590 to 2 830 m), but normally represent lower timberline conditions. Nonforest communities dominated by *Cercocarpus ledifolius, Juniperus*, or *Artemisia*-steppe usually abut the lower or drier portions. Cooler, more moist sites are often influenced by soil characteristics and the abundance of surface rock and may belong to PSME/BERE.

Vegetation.—Usually *Pseudotsuga menziesii* is the dominant conifer on the site. In southern Utah, *Pinus ponderosa* becomes increasingly more important as a seral associate. These sites represent a broad transition between the more northern PSME/CELE sites and the PIPO/CELE h.t. found in the Pine Valley Mountains and Markagunt and Sevier Plateaus. Other conifers include *Juniperus scopulorum* and *Pinus edulis*. *Populus tremuloides* is sometimes a seral component, although it probably is responding to microsite influences in soils. The shrubby undergrowth is usually more dense than the open-canopied overstory (fig. 14) and consists of *Cercocarpus ledifolius, Symphoricarpos oreophilus, Artemisia tridentata* ssp. *vaseyana*, and *Berberis repens*. Herbaceous associates are minor and inconsistent, with only *Poa fendleriana* occurring in about half the sample stands.

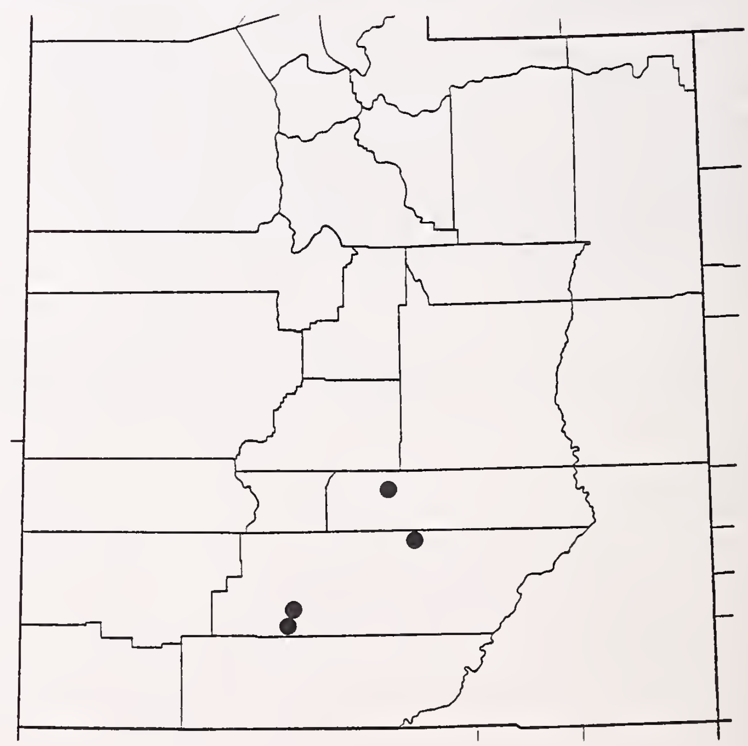
Figure 14.—*Pseudotsuga menziesii/Cercocarpus ledifolius* h.t. on a steep, rocky north slope (8,000 feet, 2 440 m) southwest of Panguitch. *Pinus ponderosa* and *Pseudotsuga menziesii* create an open overstory. *Cercocarpus ledifolius, Artemisia tridentata* ssp. *vaseyana*, and *Juniperus scopulorum* extend downward into the nonforest shrublands.

Soils.—Soil parent materials are predominantly Cretaceous and Tertiary sandstone, although igneous bedrock is also represented (appendix F). Surface textures are usually coarse. Most sites had some bare soil and exposed rock. Litter accumulations are charateristically low, averaging 0.5 inch (1.3 cm).

Productivity/management.—Timber potentials are very low (appendix D). Low stocking, rocky steep slopes, and droughty soils will hamper any regeneration attempts. The PSME/CELE should provide high quality seasonal big game habitat, especially for deer.

Other studies.—PSME/CELE was first described from central Idaho (Steele and others 1981) and eastern Idaho (Steele and others 1983). It also occurs sporadically throughout the Wasatch and Stansbury Ranges of northern Utah (Mauk and Henderson 1984).

Pseudotsuga menziesii/Arctostaphylos patula h.t. (PSME/ARPA; Douglas-Fir/Greenleaf Manzanita)



Distribution.—The PSME/ARPA is a minor h.t. confined to the Paunsaugunt and southern Fish Lake Plateaus and the Escalante and Boulder Mountains. It usually occurs on steep, undulating middle to lower slopes between 7,200 and 8,700 feet (2 190 and 2 650 m). It can be found on a variety of aspects but most typically on eastern and western aspects at the lower range of the *Pseudotsuga menziesii* series. As such, it represents a broad ecotone with the *Pinus ponderosa* series and most likely the PIPO/ARPA or PIPO/QUGA h.t.'s and the cooler PSME/SYOR, PSME/QUGA, or PSME/BERE h.t.'s or *Abies concolor* series.

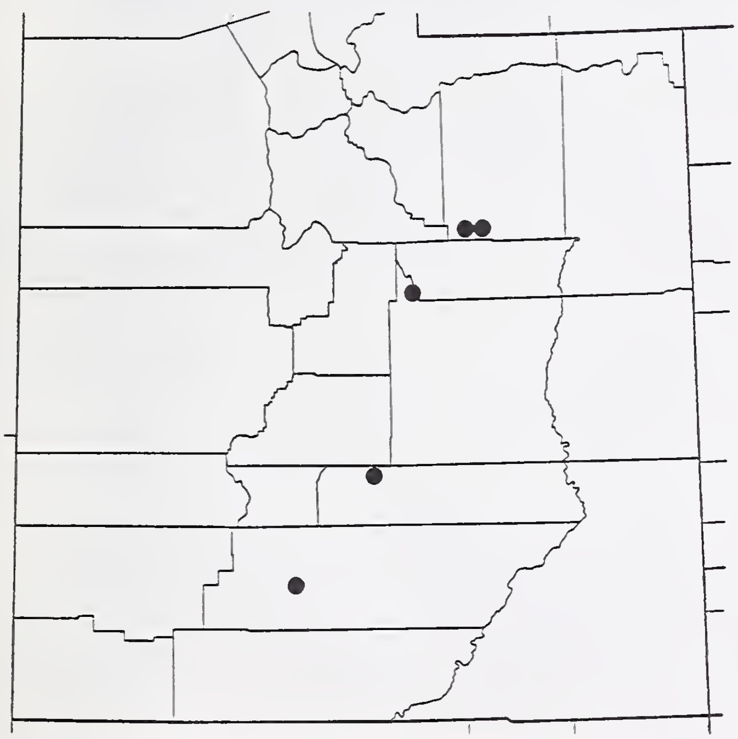
Vegetation.—Both *Pseudotsuga menziesii* and *Pinus ponderosa* dominate the overstory, often with *P. ponderosa* more abundant. *Juniperus scopulorum* is usually present, and *Pinus flexilis* may also be found. A low, dense shrub layer consists of *Arctostaphylos patula, Berberis repens, Ceanothus martinii*, and *Symphoricarpos oreophilus*. Forbs and graminoids are usually sparse.

Soils.—Parent materials are usually sandstones and limestones. Surface soil horizons usually contain gravels and stones. Surface textures are loam to sandy loam.

Productivity/management.—Timber potentials are apparently low, resulting from low site index for both *Pseudotsuga menziesii* and *Pinus ponderosa* and from stocking limitations. *Arceuthobium douglasii* appears to present management problems within this type.

Other studies.—No other studies have described the PSME/ARPA h.t.

Pseudotsuga menziesii/Cercocarpus montanus h.t. (PSME/CEMO; Douglas-Fir/Mountain-Mahogany)



Distribution.—PSME/CEMO is a minor h.t. occurring throughout the eastern half of the study area on steep, rocky, northern aspects at midslope positions. Elevations range from 7,200 to 8,200 feet (2 190 to 2 500 m) and represent the lower bounds of the *Pseudotsuga* series. Adjacent, more moist sites normally belong to PSME/BERE; drier sites are often *Juniperus* woodlands.

Vegetation.—Open stands of *Pseudotsuga menziesii* dominate sites, often with *Pinus edulis, Juniperus scopulorum*, and *Juniperus osteosperma* scattered throughout. A low canopy of shrubs, including *Cercocarpus, Shepherdia rotundifolia, Berberis repens*, and *Symphoricarpos oreophilus*, dominates the relatively open undergrowth. *Carex rossii* and *Oryzopsis hymenoides* are often present in trace amounts. Forb cover is inconsistent.

Soils.—Most sampled sites occur on sandstone. There is usually a high amount of surface rock. Bare soil may exceed 50 percent, apparently more than all other types within the study area. In contrast, litter accumulations may be the lowest for all types. Surface soil textures are coarse.

Productivity/management.—Timber potentials are very low. Poor stocking, rocky sites, and steep slopes limit management opportunities. This type probably has high value for big game habitat, providing key browse and seasonal cover requirements. It may be especially important in some areas for spring and fall range for mule deer (Smith and Julander 1953).

Other studies.—Similar plant communities have been described in Colorado (Terwilliger and others 1979). This h.t. has not been previously described.

Pseudotsuga menziesii/Quercus gambelii h.t. (PSME/QUGA; Douglas-Fir/Gambel Oak)

Distribution.—PSME/QUGA is an incidental h.t. occurring in the extreme southern portions of the Abajo Mountains and the Aquarius Plateau. It also extends into Colorado and New Mexico (refer to "Other studies"). Sites range from 7,500 to 9,100 feet (2 290 to 2 770 m) on steep slopes having northern to northwestern aspects. Adjacent cooler sites may belong to the PSME/BERE h.t. Warmer sites often belong to the *Pinus ponderosa* series.

Vegetation.—*Pinus ponderosa* and *Pseudotsuga menziesii* dominate seral stands. Trees are usually widely spaced, especially in more mature conditions. *Juniperus scopulorum* may also be present in minor amounts. The undergrowth is dominated by shrubs, especially *Quercus gambelii* and *Symphoricarpos oreophilus*. *Quercus* may also assume a more treelike appearance. *Arctostaphylos patula, Berberis repens, Rosa woodsii*, and *Ribes cereum* may also occur, usually in minor amounts. Graminoids, including *Carex rossii, Poa fendleriana, Koeleria nitida*, and *Sitanion hystrix*, have high constancy but low average cover. Forbs are usually absent.

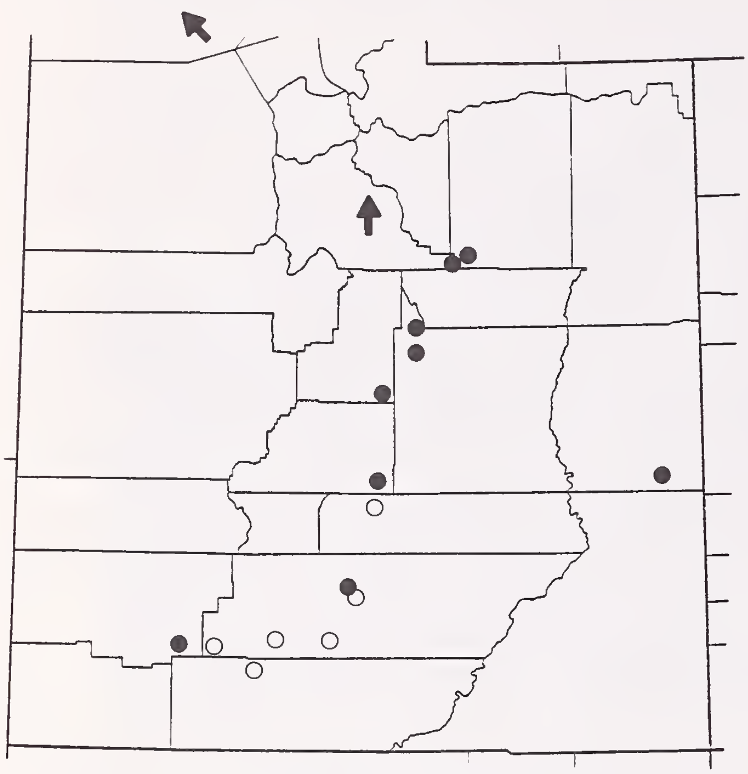
Soils.—Parent materials consist of mixed sandstones, basalts, and andesites. Surface textures range from sandy loam to loam. Subsurface horizons contain gravels and cobbles.

Productivity/management.—Timber potentials are usually low, resulting from site index and stocking limitations. The structural characteristics—that is, vertical diversity of shrubs—may be important for many avian wildlife species. *Quercus* mast and browse are also important for many game species.

Other studies.—Similar conditions have been described from western Colorado (Boyce 1977) and south-central Colorado (Terwilliger and others 1979). The

PSME/QUGA h.t., with phasal distinctions of *Festuca arizonica*, has also been described from northern New Mexico and southern Colorado (DeVelice and others in press).

Pseudotsuga menziesii/Berberis repens h.t. (PSME/BERE; Douglas-Fir/Oregon Grape)



Distribution.—The PSME/BERE h.t. is a major type within the *Pseudotsuga menziesii* series. It occurs sporadically across the Markagunt, Paunsaugunt, Aquarius, and Fish Lake Plateaus and the LaSal Mountains and extends northward throughout the eastern side of the Wasatch Plateau into the Tavaputs Plateau and northern Utah. Sites range from 7,800 to 9,700 feet (2 380 to 2 960 m), and average 9,260 feet (2 820 m) on southwest aspects, 8,800 feet (2 680 m) on northeast aspects, and 8,000 feet (2 440 m) on north aspects. Occurrence on southern and southeastern aspects is relatively uncommon. Slopes are usually steep and straight. This type generally represents middle to upper elevations within the *Pseudotsuga menziesii* series and may be surrounded by cooler, more moist h.t.'s within the *Abies lasiocarpa* or *Abies concolor* series, or warmer sites belonging to the PSME/CELE or PSME/QUGA h.t.'s or the *Pinus flexilis-Pinus longaeva* series.

Vegetation.—*Pseudotsuga menziesii* is the dominant tree. *Juniperus scopulorum* and *Populus tremuloides* may be present as seral species. The normally depauperate undergrowth is characterized by a moderate cover of low shrubs consisting of *Berberis repens*, *Symphoricarpos oreophilus*, and sometimes *Pachistima myrsinites*. Other features vary with the phases noted below.

Pinus ponderosa (PIPO) phase: This phase is more common on steep middle to lower slopes, usually about 600 feet (180 m) below adjacent BERE phase sites. It is restricted to the southern portion of the range of the h.t., apparently not extending north into the Wasatch Plateau or east into the LaSal Mountains. *Pinus ponderosa* is a long-lived seral dominant within this phase. *Juniperus communis* and *Amelanchier alnifolia* are usually present in small amounts. The herbaceous stratum is noticeably absent, with only *Carex rossii* and *Sitanion hystrix* usually present in trace amounts.

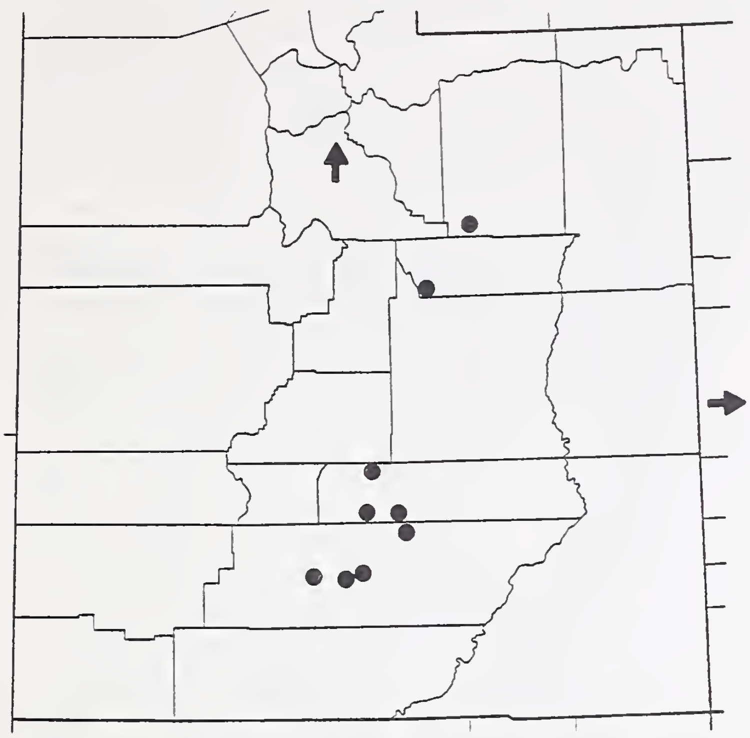
Berberis repens (BERE) phase: The BERE phase is the more common phase throughout the study area, except for the extreme southern plateaus. *Picea pungens* may be found as accidentals, and *Pinus flexilis* may occur as a seral component. In contrast to the PIPO phase, *Sitanion hystrix* is more uncommon. The herbaceous stratum is only slightly more developed, consisting of small amounts of *Stipa lettermannii, Thalictrum fendleri, Osmorhiza chilensis*, and *Lathyrus* species.

Soils.—Soil parent materials are mainly Cretaceous and Tertiary sandstones in the BERE phase, while the PIPO phase occurs on a wide mixture of types, including sandstone and limestones, basalts, and andesites (appendix F). The PIPO phase apparently represents more severe environmental conditions, with about 11 percent surface rock exposed and 6 percent bare soil, and surface textures ranging from loam to silt loam. Most sample sites had significant amounts of gravel and stones in the subsurface. Sites belonging to the BERE phase usually have only about 7 percent surface rock exposed, similar amounts of bare soil, and surface textures from loam to clay loam. There is also a slight increase in litter accumulation, averaging about 1.3 inches (3.2 cm).

Productivity/management.—Timber potentials are generally low (appendixes D and E). *Pseudotsuga menziesii* may respond favorably to small clearcuts that provide protection from wind and insolation. Light shelterwood systems may also be appropriate, especially in the BERE phase. *Pinus ponderosa* presents limited opportunities for uneven-aged management within the PIPO phase. Many of the sampled stands within this h.t. were infected with *Arceuthobium douglasii*, which will influence management alternatives. Deer apparently make heavy use of this h.t., especially when natural openings that provide forage are nearby. Domestic livestock will usually find little forage within this type.

Other studies.—PSME/BERE is a widespread type with different phases in the northern Rockies, with previous descriptions from central Idaho (Steele and others 1981) and eastern Idaho and western Wyoming (Steele and others 1983). It also extends into northern Utah (Mauk and Henderson 1984). This treatment of our study area combines the SYOR and BERE phases of northern Utah and presents the PIPO phase as a new subdivision.

***Pseudotsuga menziesii/Symphoricarpos oreophilus* h.t. (PSME/SYOR; Douglas-Fir/Mountain Snowberry)**



Distribution.—PSME/SYOR is a major h.t. in southern Utah that occurs mainly on the southern Fish Lake and Aquarius Plateaus and the Boulder Mountains. A somewhat disjunct distribution also occurs sporadically along the northeastern portion of the Wasatch Plateau and the Tavaputs Plateau. The type is most commonly found on straight and steep northern slopes between 8,000 and 9,300 feet (2 440 and 2 830 m). It represents middle to upper elevations for the *Pseudotsuga menziesii* series. Warmer and drier adjacent sites may belong to PSME/BERE-PIPO or PIPO/SYOR. Benches with cold air accumulation may belong to PIPO/PUTR or PIPU/JUCO. More moist conditions usually will support *Abies lasiocarpa*.

Vegetation.—Open stands of *Pseudotsuga menziesii* dominate the site. *Pinus ponderosa* and *Populus tremuloides* may be present as important seral components. *Juniperus scopulorum* is also usually present, either as a seral or minor climax associate. A light shrub canopy of *Symphoricarpos*, with trace amounts of *Berberis repens*, *Rosa woodsii*, and *Ribes cereum*, dominate the undergrowth (fig. 15). The normally depauperate herbaceous stratum may contain trace amounts of *Carex rossii*, *Poa fendleriana*, *Sitanion hystrix*, and *Hymenoxys richardsonii*.

Figure 15.—*Pseudotsuga menziesii/Symphoricarpos oreophilus* h.t. on a steep northwest slope (8,850 feet, 2 700 m) near Wildcat Pasture in the Boulder Mountains. *Pinus ponderosa* creates an open canopy in the overstory; *Pseudotsuga menziesii* is scattered throughout the understory. The undergrowth consists of *Symphoricarpos oreophilus*, *Poa fendleriana*, and *Lupinus argenteus*.

Soils.—Parent materials for the PSME/SYOR h.t. appear to be predominantly basaltic, although a few sites in the Tavaputs Plateau occurred on Tertiary and Cretaceous sandstone (appendix F). Deposition is usually colluvial. Surface rock exposed averages 10 percent, and most sites have bare soil, averaging 11 percent. Litter accumulations are highly variable, ranging from none to 3.9 inches (10 cm), and averaging 1.3 inches (3.4 cm). Soil textures range from sandy loam to clay loam (appendix G).

Productivity/management.—Timber potentials are low (appendix D). Low site indexes for *Pseudotsuga menziesii* and *Pinus ponderosa*, and stocking limitations, reduce potential yields. Most stands have had repeated moderate to heavy ground fires, and *P. menziesii* has regenerated under the natural shelterwood conditions. *Arceuthobium douglasii* is present in many stands. Big game, especially deer, may make seasonal use of these sites.

Other studies.—The PSME/SYOR h.t. is a major type throughout the northern and middle Rocky Mountains. Its presence has been noted for Montana (Pfister and others 1977), central Idaho (Steele and others 1981), eastern Idaho and western Wyoming (Steele and others 1983), and northern Utah (Mauk and Henderson 1984). Somewhat similar conditions exist in Colorado (Komarkova 1982; Hess and Wasser 1982).

Pinus ponderosa Series

Distribution.—The *Pinus ponderosa* series is a major group of h.t.'s found throughout southern Utah. Scattered sites on the Tavaputs Plateau also belong to this series. It occupies warm and dry exposures through an elevational belt ranging from about 6,800 to 9,000 feet (2 070 to 2 740 m). Slopes are generally gentle to moderately steep; only PIPO/ARNO and sometimes PIPO/PUTR tend to occur in flat benches. The series usually represents the lowest coniferous forests in the area and borders unclassified communities such as *Juniperus scopulorum* woodlands or *Cercocarpus ledifolius*, *Arctostaphylos patula*, *Artemisia*, or *Quercus gambelii* shrubfields. These often resemble the undergrowth of the adjacent forested communities. The upper boundary or cooler, more moist sites, are recognized by the presence of more tolerant species of conifers such as *Abies concolor* or *Pseudotsuga menziesii*. Again, changes in the undergrowth may not coincide with the climax overstory, and the ecotone between PIPO/ARPA, PIPO/QUGA, PIPO/CELE, and PIPO/SYOR and their counterparts in the *Pseudotsuga menziesii* or *Abies concolor* series may be relatively broad and indefinite. When the series abuts lower elevation sites within the *Picea pungens* series, the demarcation is usually more abrupt.

Vegetation.—The structure of mature stands varies from rather open in PIPO/MUMO, PIPO/ARNO, and PIPO/ARPA to locally dense in the PIPO/QUGA and PIPO/SYOR. All of our h.t.'s represent sites potentially capable of supporting at least 25 percent canopy cover of trees, thus constituting open forests rather than true savanna as used by other researchers (Pfister and others 1977; Mauk and Henderson 1984). Although *Pinus ponderosa* is normally the only conifer, stands may sometimes contain significant amounts of *Juniperus scopulorum*, *Juniperus osteosperma*, or *Pinus edulis*. *Populus tremuloides*, so important in other series, is poorly represented here, occurring in only small amounts within the PIPO/QUGA and PIPO/SYOR h.t.'s. Mature stands range in age from about 100 years for PIPO/CELE to 200 years for PIPO/MUMO and PIPO/QUGA.

The undergrowth is conspicuously shrubby. Only PIPO/MUMO lacks a diagnostic woody stratum and resembles the open grassy undergrowth so characteristic of *P. ponderosa* stands in Arizona and New Mexico.

Soils/climate.—Soils are usually derived from igneous parent material, including basalt, basaltic and andesitic flows, intrusive granitoids and porphyrites, and tuffs (appendix F). Only PIPO/ARPA and PIPO/QUGA occur more commonly on nonigneous substrates such as limestone, dolomites, and various sandstones. Surface textures are highly variable and range from sand in PIPO/ARPA to predominantly loam in PIPO/ARNO and loam and silt loam in PIPO/MUMO (appendix G). All types contain some bare soil and exposed rock, with relatively extreme amounts in PIPO/ARPA. Litter accumulations are fairly consistent between types, only ranging from 1.1 inches (2.8 cm) in PIPO/ARPA to 1.9 inches (4.9 cm) in PIPO/QUGA.

Climatic data for the series are best represented by the Bryce Canyon National Park Headquarters, Monticello, and Orange Olsen reporting stations (appendix H). The Bryce Canyon and Orange Olsen stations are at the upper extent of the series, while Monticello is at the lower extreme. In general, this series receives significant precipitation during the warm growing season, especially during August and early September. Mean annual temperatures appear to be above 40.1 °F (4.5 °C), and mean annual precipitation is less than 15.6 inches (390 mm).

Productivity/management.—The *Pinus ponderosa* series presents unusual management opportunities and problems for the resource specialist. Timber values range from very low to low and appear best in the PIPO/SYOR and PIPO/QUGA h.t.'s (appendixes D and E). Almost all sites have limitations of some degree as a result of poor stocking, unfavorable soil moisture conditions, or competition from undergrowth vegetation. As a general guideline, group selection or shelterwood systems should provide the best chance for successful regeneration. Some sites, especially in the PIPO/MUMO, PIPO/QUGA-SYOR, PIPO/ARPA, and maybe PIPO/ARNO h.t.'s, may support *Pinus ponderosa* severely damaged from the dwarf mistletoe *Arceuthobium vaginatum* ssp. *cryptopodum*. Work in southwestern Colorado (Merrill 1983) has shown a positive relationship between severity of dwarf mistletoe infection and environmental factors such as slope, elevation, and topography, as expressed by different h.t.'s. *Arceuthobium vaginatum* occurred more often and more severely on the driest sites where temperatures and insolation were the greatest. Heidmann (1983) presents recommendations for silvicultural prescriptions appropriate to mature stands of *P. ponderosa* heavily infected with dwarf mistletoe, but these appear feasible only in sites with the highest timber potentials. Throughout the series, mountain pine beetle (*Dendroctonus ponderosae*) may also infest stands and influence timber management.

Fire has played an important part in stand development for most of the h.t.'s in this series. The exception might be sites within the PIPO/ARNO or PIPO/PUTR h.t.'s, where discontinuous ground fuels may prevent the normal surface fires. Fire histories of the area are scarce and difficult to categorize by h.t. Research in Zion National Park may be applicable to the PIPO/ARPA and PIPO/QUGA h.t.'s and suggests a normal time interval between 4 and 7 years prior to 1882 (Madany 1981; Madany and West 1980, 1983). After this date, livestock grazing may have reduced fine fuels, allowing shrub densities to increase with a resulting increase in the fire interval. This apparently occurred before fire prevention programs became effective. Field data from the isolated areas receiving no livestock grazing still indicate sufficient canopy coverage of shrubs to easily determine the h.t. and help indicate the potential conditions for mature stands. Crane (1982), based on work from Colorado, gives more detailed descriptions of fire effects for vegetation and hypothesized successional trends following fire that appear reasonable for our PIPO/QUGA, PIPO/MUMO, and PIPO/PUTR h.t.'s. Short-term responses of birds and mammals to prescribed burning in *P. ponderosa* have been reported by Bock and Bock (1983).

Livestock grazing is an important management concern for many of the h.t.'s within this series. Almost all sites show evidence of past grazing disturbance to some degree, and ecological and successional relationships are often unclear. Many mature, uneven-aged stands of *P. ponderosa* contain relatively high coverages of disturbance species such as *Sitanion hystrix*, which may have increased when other more palatable species were consumed. Also present in many h.t.'s is the perennial composite *Hymenoxys richardsonii*, which may be toxic to sheep and cattle (Hermann 1966). In general, our series lacks the grassy undergrowth that constitutes high quality range.

Wildlife habitat values within the series are highly variable and are best discussed by h.t. Structural characteristics may be important for a variety of small mammal and avian species, while big game usually find abundant browse, especially in the PIPO/CELE, PIPO/ARPA, PIPO/QUGA, and sometimes PIPO/PUTR h.t.'s.

Other studies.—The *Pinus ponderosa* series is extensive throughout the Rocky Mountains. Relationship to other areas is discussed by h.t. but generally is highest with adjacent portions of Colorado. Several types have somewhat disjunct distributions, with extensions in central Idaho and south-central Oregon.

Pinus ponderosa/Cercocarpus ledifolius h.t. PIPO/CELE; Ponderosa Pine/Curlleaf Mountain-Mahogany)

Distribution.—PIPO/CELE is a minor h.t. within the study area and occurs on the Tavaputs Plateau in the north and in the Markagunt and Sevier Plateaus and Pine Valley Mountains in the south. It can be found on all aspects and ranges from 6,800 to 8,100 feet (2 070 to 2 470 m) in elevation on gentle to moderately steep lower slopes and benches. It usually represents the lowest elevation sites within the *Pinus ponderosa* series and may be adjacent to *Juniperus* woodlands. Cooler sites may belong to PIPO/QUGA, PSME/CELE, or ABCO/CELE, although these are often found on different geological substrates.

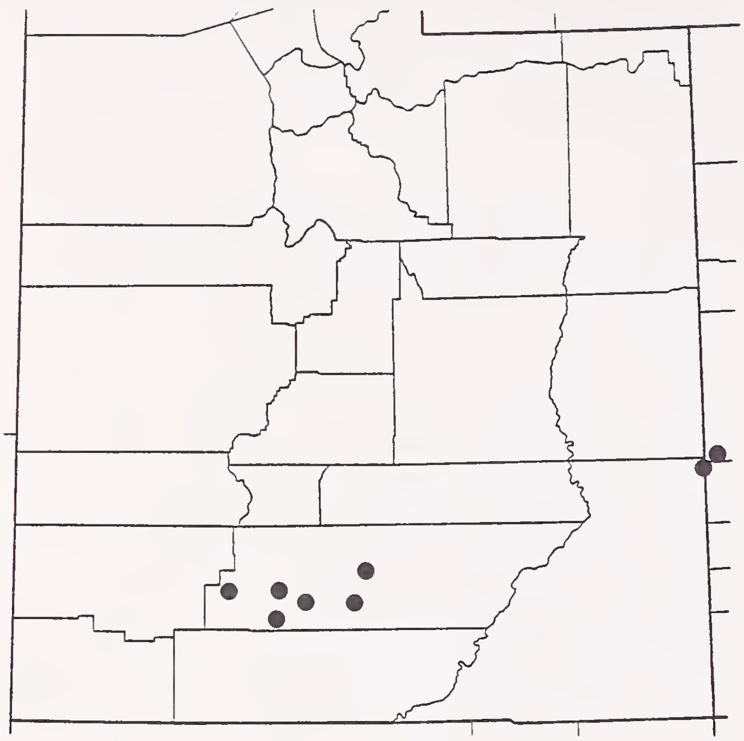
Vegetation.—*Pinus ponderosa* creates an open canopy, usually accompanied by *Juniperus scopulorum* and sometimes *Pinus edulis. Abies concolor* and *Pseudotsuga menziesii* may appear as accidentals. The dense undergrowth is conspicuously shrubby and consists of *Cercocarpus ledifolius, Juniperus osteosperma, Quercus gambelii, Chrysothamnus viscidiflorus, Artemisia tridentata*, and *Symphoricarpos oreophilus*. Forbs and graminoids are noticeably absent, with only *Sitanion hystrix* and *Eriogonum racemosa* having fairly high constancy. Sites on the Tavaputs Plateau may contain modest cover of *Elymus salina*, while those in southwestern Utah appear to support *Stipa comata*.

Soils.—PIPO/CELE on the Tavaputs Plateau occurs on Tertiary sandstone, while sites in the southwestern portion of the study area are on andesite. Regolith is either residual or colluvium. Sites have relatively low amounts of bare soil and exposed surface rock, and litter accumulations average 1.5 inches (3.9 cm). Surface textures are mostly loam and sandy loam. Most sites have gravelly coarse fragments.

Productivity/management.—Timber potentials appear to be very low. Individual trees may have widely varying site indexes, but stocking limitations will greatly reduce yields. Competition from shrubs may severely limit regeneration efforts. Most sites contain evidence of grazing by domestic livestock, although only limited forage is available. This h.t. should be key seasonal habitat for deer because of available browse and low elevation.

Other studies.—Outside our study area, several workers have described plant communities dominated by *Pinus ponderosa* and *Cercocarpus ledifolius* in south-central Oregon on dry residual soils (Franklin and Dyrness 1973). These communities also contained *Festuca idahoensis*, indicating slightly cooler and more moist conditions than in our study area. No other workers have described the PIPO/CELE h.t.

Pinus ponderosa/Arctostaphylos patula h.t. (PIPO/ARPA; Ponderosa Pine/Greenleaf Manzanita)



Distribution.—PIPO/ARPA, a major h.t. with the *Pinus ponderosa* series, occurs in large acreages within the southern portion of the study area. It can also be found in the LaSal and Abajo Mountains to the east. It represents warm and dry conditions on gentle to moderate middle to lower slopes, benches, and ridges between 7,500 and 8,500 feet (2 290 and 2 590 m). Southwest aspects are most common, although a variety are represented. Cooler, more moist adjacent sites may belong to PIPO/QUGA, PIPO/PUTR, or PSME/ARPA h.t.'s. Warmer sites are often *Juniperus* woodlands.

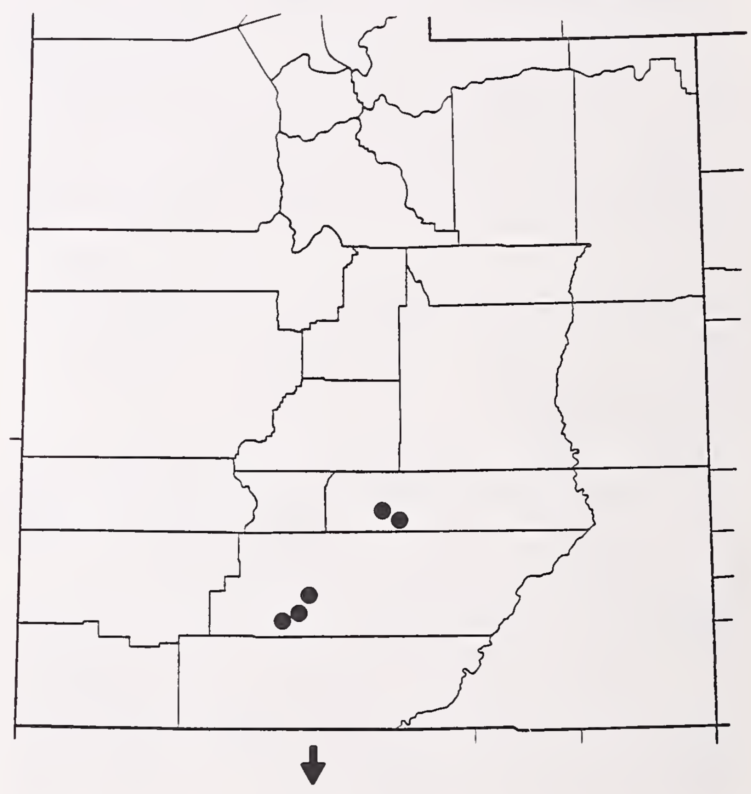
Vegetation.—Usually *Pinus ponderosa* and small amounts of *Juniperus scopulorum* are the only trees present in relatively open stands. *Pinus flexilis* and *Pseudotsuga menziesii* may occur as accidentals; successful reproduction by these species will indicate the PSME/ARPA h.t. The open undergrowth is conspicuously shrubby and consists of *Arceuthobium patula, Quercus gambelii, Berberis repens, Ceanothus martinii, Purshia tridentata*, and *Tetradymia canescens*. The herbaceous stratum is depauperate, with only small amounts of *Carex rossii, Oryzopsis hymenoides*, and *Eriogonum racemosa* occurring in about half the sites.

Soils.—Parent materials for PIPO/ARPA are diverse and include limestones, sandstones, and a few sites on basalt and andesite (appendix F). Most soils are in colluvium, although a few also occur in alluvial material. Bare soil is the highest for the series and averages 13 percent. Most sites have gravelly subsurfaces with minor amounts of surface rock exposed. Surface textures range from sand to silt loam, with loam the most common (appendix G). Litter accumulation averages 1.1 inches (2.8 cm).

Productivity/management.—Timber potentials are generally very low (appendixes D and E). Stocking limitations and seedling competition may limit yields. Gentle terrain and the relative ease of harvesting may make these sites desirable for timber management, but successful regeneration efforts are sometimes questionable. *Arctostaphylos patula* may increase with disturbance, especially fire, although it shows greatly reduced suckering and seedling establishment following fire in southern Utah as compared with areas in California (Madany 1981). All sample sites in our study area contain evidence of deer use. Domestic livestock will find only limited forage on these sites.

Other studies.—Communities dominated by *Pinus ponderosa* and *Arctostaphylos patula* have been noted for south-central Oregon (Franklin and Dyrness 1973), but they contain significant amounts of *Abies concolor* and *Festuca idahoensis*, indicating different conditions. *Arctostaphylos patula* is a diagnostic component of a phase of the *Pinus ponderosa/Festuca idahoensis* h.t. in the Uinta Mountains (Mauk and Henderson 1984); this phase resembles our h.t. in physical site characteristics. In addition to the prominence of *Festuca*, it differs in having *Pinus contorta* and *Populus tremuloides* as principal seral associates. No other studies have identified the PIPO/ARPA h.t.

Pinus ponderosa/Artemisia nova h.t. (PIPO/ARNO; Ponderosa Pine/Black Sagebrush)



Distribution.—PIPO/ARNO is a major h.t. within the *Pinus ponderosa* series. It represents the lower timberline zone along the Boulder and Escalante Mountains but is also likely to occur on the Sevier and Paunsaugunt Plateaus. It typically is found on gentle lower slopes or benches with a variety of aspects and ranges from 8,000 to 9,000 feet (2 440 to 2 740 m) in elevation. Nonforest communities adjacent are usually graminoid wet meadows or *Artemisia* steppe. Upland sites on steeper slopes often belong to PIPO/ARPA.

Vegetation.—The open, savannalike overstory contains predominantly *Pinus ponderosa* (fig. 16), although *Juniperus scopulorum* is usually also present. *Pinus flexilis* and *Pseudotsuga menziesii* are accidentals. The undergrowth is characterized by a low and often open shrub canopy consisting of *Artemisia nova* or *Artemisia arbuscula* with *Chrysothamnus viscidiflorus* and *Tetradymia canescens* as common associates. Taxonomy of low *Artemisia* apparently is not distinct within this type, with collected specimens often sharing attributes belonging to either *A. nova* or *A. arbuscula.* Florescence of ethanol-saturated leaf material in longwave ultraviolet light indicates closer affinities with *Artemisia nova* (Alma Winward, USDA Forest Service, Intermountain Region, pers. comm.). Coverage of graminoids and forbs is usually negligible, although this may be the result of often severe domestic livestock grazing pressure. Undisturbed sites should support a light, scattered mixture of *Bouteloua gracilis, Koeleria nitida, Poa fendleriana,* and *Eriogonum racemosa*. Disturbed sites often have *Hymenoxys richardsonii* and *Sitanion hystrix* more conspicuous.

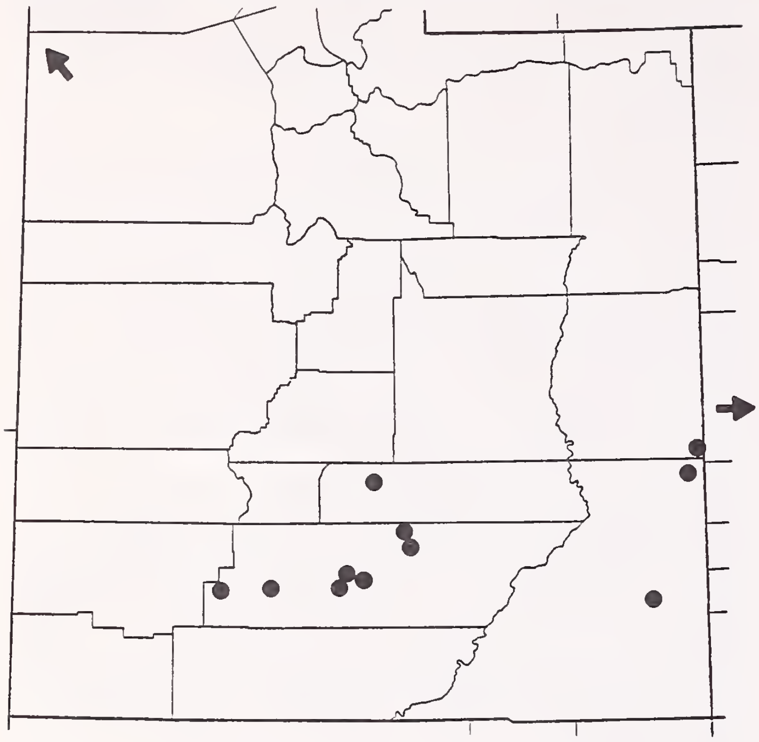
Soils.—PIPO/ARNO is found on colluvium and sometimes alluvium derived from basalt (appendix F). A few sites are on sandstone. There are usually small amounts of exposed rock and bare soil, and litter accumulations average 1.3 inches (3.2 cm). Most soils contain gravel in the subsurface horizons, and surface textures are predominantly loam and silt loam (appendix G). Sites potentially have seasonal high water tables and even ponding. They also have shallow rooting depths due to some restrictive subsurface horizon.

Productivity/management.—Timber potentials are generally very low and are the lowest for the series (appendix D). These sites have excessive stocking limitations, and trees regenerate only occasionally. Domestic livestock may find limited forage on these sites but may congregate here for shade if water and forage is nearby.

Other studies.—Similar sites have been found in the San Juan Mountains of New Mexico (DeVelice and others in press).

Figure 16.—*Pinus ponderosa/Artemisia nova* h.t. on a northwest bench east of Widtsoe, UT (8,050 feet, 2 450 m). Scattered *Artemisia nova* and *Elymus salina* constitute the undergrowth.

***Pinus ponderosa/Purshia tridentata* h.t. (PIPO/PUTR; Ponderosa Pine/Bitterbrush)**



Distribution.—PIPO/PUTR is a major h.t. within the southern portion of the study area and was observed from the Markagunt Plateau east to the LaSal and Abajo Mountains. It also extends into Colorado (refer to "Other studies"). It occupies gentle to moderate midslopes and benches between 7,100 and 9,000 feet (2 160 and 2 740 m) on a variety of aspects but is more common above 8,000 feet (2 440 m) on southeastern to southwestern slopes. It represents middle to upper elevation sites within the *Pinus ponderosa* series and may often be found above the warmer PIPO/QUGA or PIPO/ARPA h.t.'s. Cooler, more moist sites are often within the ABCO/BERE, PSME/BERE, PSME/SYOR, PIPU/JUCO, or *Abies lasiocarpa* series of h.t.'s. To a limited degree, PIPO/PUTR may indicate areas where cooler air accumulates.

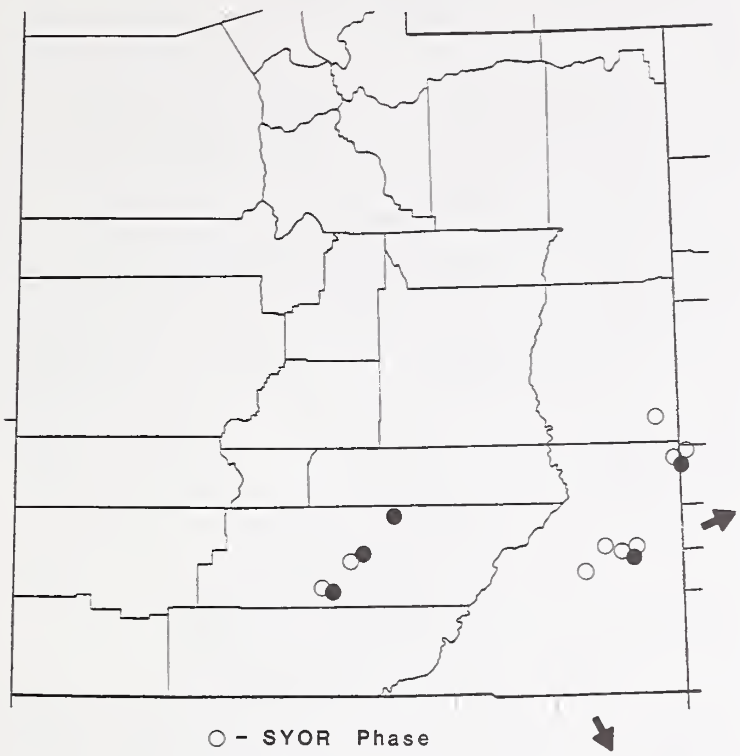
Vegetation.—*Pinus ponderosa* is the dominant conifer, although *Juniperus scopulorum* and *Pinus edulis* may occasionally be present. *Pinus flexilis* and *Pseudotsuga menziesii* can be found as accidentals but usually represent ecotones with adjacent types. *Quercus gambelii* will sometimes be a codominant with *Purshia tridentata* in a light and broken shrub stratum. Other common shrubs include *Artemisia tridentata* (probably ssp. *vaseyana*), *Berberis repens*, and *Symphoricarpos oreophilus*. The herbaceous stratum is also light and diverse and includes small amounts of *Agropyron spicatum, Carex rossii, Muhlenbergia montana, Poa fendleriana, Stipa comata, Eriogonum racemosa*, and *Hymenoxys richardsonii*. Density and cover of *Purshia* and *Artemisia* within this type may be closely tied to recent disturbances and overstory canopy closures. Sites with *Purshia* present only in full sunlight may represent seral conditions of other h.t.'s such as PIPO/ARPA, PIPO/QUGA, or other series (Harper and Buchanan 1983).

Soils.—PIPO/PUTR usually occurs in colluvium or residual material derived from basalt or sometimes in Jurassic sandstone in the LaSal and Abajo Mountains (appendix F). Many of the sites in the Boulder Mountains have 10 to 35 percent of the surface in bare rock. Amounts of bare soil are relatively low, with litter accumulations averaging 1.3 inches (3.2 cm). Most sites have some coarse fragments in the subsurface horizons including gravels, stones, and cobbles. Surface textures range from sandy loam to silt loam (appendix G).

Productivity/management.—Timber potentials for the PIPO/PUTR h.t. are generally very low (appendix D). *Pinus ponderosa* can be featured by even-aged management and by small clearcut and small group selection systems. Stocking reductions may be necessary for areas in the Boulder Mountains because of rockiness. Most sample sites contained little or no evidence of past natural fires, although fire is certainly an important factor in *Pinus ponderosa* and *Purshia tridentata* ecology (Crane 1982; Lotan and others 1981; Weaver 1968; Martin and Driver 1983). Although most sites show evidence of past grazing, domestic livestock will find little forage here. Wildlife, especially deer, may seek these sites during the summer for available browse.

Other studies.—PIPO/PUTR h.t., a major type in the Western United States, has been described from eastern Washington and Oregon and northern Idaho (Franklin and Dyrness 1973; Hall 1973; Daubenmire and Daubenmire 1968). PIPO/PUTR in southern Utah is similar to the PIPO/PUTR, *Agropyron spicatum* phase described for Montana (Pfister and others 1977) and central Idaho (Steele and others 1981). The difference is that our sites are generally less productive, especially the herbaceous stratum. In Colorado, Hess (1981) found the PIPO/PUTR h.t. on the northern portion of the Roosevelt National Forest.

Pinus ponderosa/Quercus gambelii h.t. (PIPO/QUGA; Ponderosa Pine/ Gambel Oak)



Distribution.—PIPO/QUGA is a major h.t. within the *Pinus ponderosa* series and accounts for large areas within southeastern Utah. It also extends into Colorado and New Mexico (refer to "Other studies"). It occurs on gentle lower to midelevation slopes and benches throughout eastern portions of the Abajo and LaSal Mountains and lower slopes of the Aquarius Plateau. Sites range from 7,300 to 8,800 feet (2 230 to 2 680 m) in elevation and occur on all aspects, with slight differences as noted by phases below. In general, PIPO/QUGA represents the lowest elevation forested site where it occurs. It may gradually intergrade with *Quercus* woodland or, with breaks in topography, it may exist immediately above sandstone cliffs and talus. Drier southwest slopes and ridges may belong to PIPO/ARPA. Cooler sites on benches and more moist aspects are often PIPO/PUTR.

Vegetation.—*Pinus ponderosa* is the dominant conifer on most sites, although *Juniperus scopulorum* may be present as scattered individuals. Mature overstories of *Pinus ponderosa* are relatively dense. The undergrowth is conspicuously shrubby with differences noted by two phases.

Symphoricarpos oreophilus (SYOR) phase: This phase represents the cooler portions of the h.t. occurring at upper elevations and on more northern aspects. On some sites, *Populus tremuloides* may be an early seral associate. In addition to the diagnostic *Quercus gambelii*, which may assume a treelike appearance (fig. 17), and

Figure 17.—*Pinus ponderosa/Quercus gambelii* h.t., *Symphoricarpos oreophilus* phase on a gentle southern slope (7,440 feet, 2 270 m) near Hells Backbone on the Aquarius Plateau, north of Escalante, UT. *Pinus ponderosa* and scattered *Juniperus scopulorum* create the overstory. *Pinus ponderosa* is also present as saplings. The shrubby undergrowth consists of *Quercus gambelii, Symphoricarpos oreophilus*, and *Rosa woodsii.*

Symphoricarpos oreophilus, the shrub stratum consists of *Amelanchier alnifolia*, *Berberis repens*, and *Rosa woodsii*. *Carex geyeri* may sometimes dominate a diverse and often depauperate herbaceous stratum that includes *Carex rossii*, *Koeleria nitida*, *Poa fendleriana*, and *Wyethia amplexicaulis*. *Hymenoxys richardsonii*, present in all other *Pinus ponderosa* h.t.'s, is absent. This phase represents conditions with the highest structural diversity within the *Pinus ponderosa* series.

Quercus gambelii (QUGA) phase: This phase represents the slightly warmer portions of the h.t., appearing more commonly on eastern aspects at lower elevations. *Quercus gambelii* is usually the dominant shrub in mature undergrowth and rarely achieves the treelike stature noted above (fig. 18). In addition, *Symphoricarpos oreophilus* is not present. *Pinus edulis*, *Juniperus osteosperma*, and *Artemisia tridentata* ssp. *vaseyana* may occur as scattered individuals. Other species are common to the SYOR phase.

Soils.—PIPO/QUGA is most common on Cretaceous and Jurassic sandstone that has weathered in place, but it also occurs on basalt and andesitic flows (appendix F). Surface textures range from sandy loam common in the QUGA phase to loam and silt loam in the SYOR phase (appendix G). Both phases contain normally small amounts of bare soil and exposed rock. Litter accumulations average 1.9 inches (4.9 cm) on undisturbed sites.

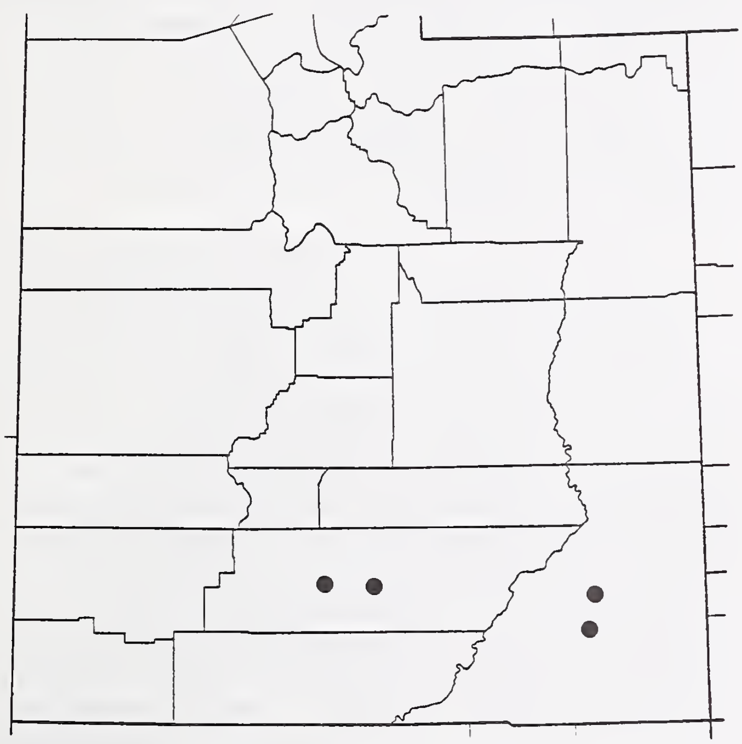
Productivity/management.—Timber potentials for the PIPO/QUGA h.t. range from very low to low but are relatively high for the series (appendixes D and E). Site index of *Pinus ponderosa* is only moderately high, but stands usually can be fully stocked. Most ground disturbances associated with timber management, such as burning and scarification, will stimulate *Quercus gambelii* suckering. Because of the structural diversity, these sites also have potentially high wildlife values, especially for birds. Deer may also make use of the browse and mast. Steinhoff (1978), working in southwestern Colorado, found a similar *Pinus ponderosa* and *Quercus gambelii* plant association and listed a number of wildlife species dependent upon this type, including passerine birds and turkeys. Presumably similar relationships would apply for this study area. Effects of natural fire are discussed by Crane (1982). Natural fire frequencies appear to range from 3 to 20 years (Steinhoff 1978, Dieterich 1980, Madany and West 1980). The successional status and problems associated with attempts to control *Q. gambelii* will normally prevent the conversion of shrub to graminoid-dominated undergrowths more suited to livestock (Engle and others 1983).

Other studies.—PIPO/QUGA is a major type south and east of this study area. Similar conditions have been described for the San Juan National Forest in Colorado (Terwilliger and others 1979) where *Symphoricarpos*

Figure 18.—*Pinus ponderosa/Quercus gambelii* h.t., *Quercus gambelii* phase on a steep southern aspect (8,390 feet, 2 560 m) near Wildcat Pasture in the Boulder Mountains. *Pinus ponderosa* is the dominant conifer, with small amounts of *Pinus edulis* and *Juniperus scopulorum* also present. The undergrowth consists of *Quercus gambelii* and *Shepherdia rotundifolia*.

oreophilus and *Berberis repens* phases exist. The type has also been described from central Colorado, where *Carex geyeri* is a conspicuous dominant in what resembles our SYOR phase (Hess and Wasser 1982). Although the same name is used in New Mexico and Arizona (Hanks and others 1983), the presence of *Festuca arizonica* probably represents differences significant enough to warrant distinction. Three phases, also based upon presence or absence of *F. arizonica* and *Pinus edulis*, have been described for northern New Mexico and southern Colorado (DeVelice and others in press); their *Q. gambelii* phase resembles the SYOR phase of this study.

***Pinus ponderosa/Symphoricarpos oreophilus* h.t. (PIPO/SYOR; Ponderosa Pine/Mountain Snowberry)**



Distribution.—PIPO/SYOR is a minor h.t. within the *Pinus ponderosa* series and appears to be locally common only on the Aquarius Plateau and in the Abajo Mountains. It occurs on gentle to moderate middle slopes with southeastern or western exposures. Elevations range from 7,900 to 8,800 feet (2 410 to 2 680 m) but are most commonly above 8,400 feet (2 560 m). It may abut a variety of dry h.t.'s within the same series, including PIPO/PUTR, PIPO/MUMO, or PIPO/QUGA, or share a boundary with the low elevation, warm and dry extreme of PSME/SYOR or ABCO/SYOR.

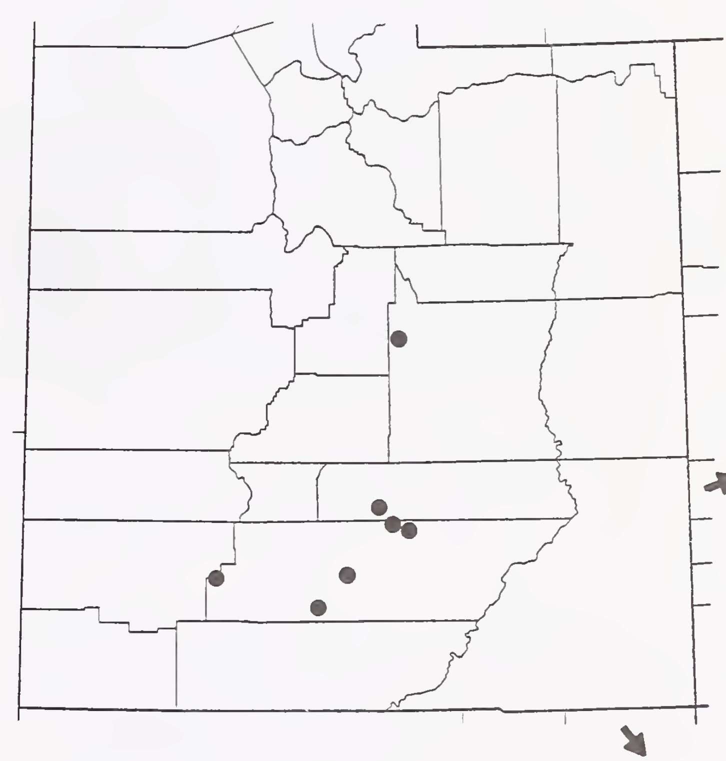
Vegetation.—Mature stands are relatively dense with pure *Pinus ponderosa. Juniperus scopulorum* and *Populus tremuloides* may be present in trace amounts as seral associates. *Pseudotsuga menziesii* or *Abies concolor* are accidental. A low conspicuous shrub layer dominates the undergrowth, consisting of *Symphoricarpos oreophilus* and usually *Berberis repens*. Sometimes small amounts of *Amelanchier alnifolia, Purshia tridentata, Rosa woodsii*, and *Xanthocephalum sarothrae* may also be present. Graminoids also present in small amounts include *Carex rossii, Koeleria nitida*, and *Muhlenbergia montana*. The forb component is characteristically absent.

Soils.—Parent materials depend upon locality, with Abajo Mountain sites on Triassic sandstone and Aquarius Plateau sites on basalt or andesite flows (appendix F). Colluvial or residual material is most common, and surface textures are sandy loam to silt loam. Most sites have small amounts of bare soils and exposed rock; one site on the Aquarius Plateau had 35 percent rock. Litter accumulations average 1.8 inches (4.6 cm).

Productivity/management.—Timber potentials are generally low for the h.t. but are relatively high for the series (appendixes D and E). Yields are similar to PIPO/QUGA. Gentle slopes on the Aquarius Plateau present few problems for timber management if small clearcuts, shelterwood, or group selection methods are considered. Steeper slopes in the Abajo Mountains may increase transportation costs. Wildlife features are similar to PIPO/MUMO. Domestic livestock may find moderate forage on these sites.

Other studies.—Steele and others (1981) describe a PIPO/SYOR h.t. from southern Idaho occurring on basalt and granitic parent material. Although associated vegetation and some site characteristics appear similar, overall productivity of our PIPO/SYOR appears to be much higher. This Utah variant of PIPO/SYOR should thus be considered unique.

***Pinus ponderosa/Muhlenbergia montana* h.t. (PIPO/MUMO; Ponderosa Pine/Mountain Muhly)**



Distribution.—PIPO/MUMO is locally common in the southern portion of the study area and was also observed as far north as the Joes Valley portion of the Wasatch Plateau. It occupies dry, low to midelevation portions of the *Pinus ponderosa* series and ranges from 7,100 to 8,800 feet (2 160 to 2 680 m) in elevation on predominantly southern exposures. Slopes range from gentle to steep and are usually convex or straight. PIPO/MUMO may share boundaries with PIPO/SYOR or PIPO/PUTR and occasionally PIPO/QUGA.

Vegetation.—Mature uneven-aged stands of *Pinus ponderosa* are characteristically open and relatively parklike. *Juniperus scopulorum* may be found as a persistent seral associate. All other trees, including *Pinus flexilis, Pseudotsuga menziesii, Juniperus osteosperma*, or *Populus tremuloides*, are considered accidental. PIPO/MUMO represents the most depauperate undergrowths within the *Pinus ponderosa* series, averaging only about 18 percent canopy cover. The shrub stratum is noticeably absent except for scattered *Artemesia tridentata*. Other shrubs that may be present in trace amounts include *Purshia tridentata, Ribes cereum, Symphoricarpos oreophilus*, and *Xanthocephalum sarothrae*. A light but conspicuous graminoid layer consists of *Bouteloua gracilis, Carex rossii, Muhlenbergia montana*, and *Oryzopsis hymenoides*. Graminoids such as *Poa fendleriana* and *Sitanion hystrix* may have increased as other, more palatable, species have been grazed. Forbs are conspicuously absent; only *Hymenoxys richardsonii* and *Erigonum racemosa* have high constancy with trace amounts of cover.

Productivity/management.—Timber potentials are very low (appendix D). Stocking limitations and low site index on some sites will reduce expected yields. Competition from undergrowth species, primarily graminoids, may affect artificial or natural regeneration. The dwarf mistletoe *Arceuthobium vaginatum* ssp. *cryptopodum* may present management concerns. In Colorado, Merrill (1983) showed it to have the potential for higher severity on warm dry sites. Although evidence of fire was not noted for all stands, this h.t. most likely has a relatively high natural fire interval with a surface fire burning every 3 to 10 years carried by the graminoid-dominated undergrowth. Wildlife may find both forage and cover within this type. Turkey habitat may be a key concern because of high visibility within the open parklike undergrowth. Graminoid species may host grasshopper populations. Most stands contain evidence of deer use. Small brush piles, retained during timber harvesting, may benefit turkeys and many species of small mammals by increasing cover.

Other studies.—PIPO/MUMO is a more common type south and east of our study area. It occurs in the San Juan Mountains of southern Colorado and northern New Mexico (DeVelice and others in press) and is scattered throughout central Colorado (Terwilliger and others 1979; Hess 1981). These authors note its development on shallow soils derived from granitic parent material. Our PIPO/MUMO also corresponds to the most mesic portions of *Pinus ponderosa/Bouteloua gracilis* h.t. described from northern Arizona (Hanks and others 1983) and New Mexico (DeVelice and others in press).

Unclassified Stands

Several sample stands throughout the study area are dominated by *Populus tremuloides*. Although sufficient conifer regeneration exists, permitting a determination of the potential climax overstory, undergrowth composition does not allow full h.t. classification. These stands often contain species indicative of heavy grazing. Several stands on the Wasatch Plateau have mature canopies of *Abies lasiocarpa* and *Picea engelmannii* and undergrowth that is excessively depauperate. These stands are often close to stands easily classified into the ABLA/BERE-PIEN h.t. One stand contains *Sambucus racemosa* as the dominant undergrowth species. One *Picea pungens* stand in the Boulder Mountains is in an apparent ecotone; the stream bottom site supports *Ribes lacustre, Salix*, and a variety of species common in PIPU/BERE. Four stands dominated by *Picea englemannii* are not classified. Again, most resemble stands belonging to ABLA/BERE, and two are adjacent to *Abies lasiocarpa* sites. One stand on the Paunsaugunt Plateau apparently contains *Ribes lacustre* instead of *Ribes montigenum*; other features are similar to those of the PIEN/RIMO h.t. Many of the unclassified stands would probably belong to the *Pinus ponderosa* series. Several stands contain significant amounts of *Poa fendleriana* and *Sitanion hystrix* and are assumed to be disturbed enough by grazing to warrant exclusion.

INDIVIDUAL ATTRIBUTES OF HABITAT TYPES

Our study concentrated on the following habitat type attributes: the ecological role of plant species, the timber productivity, soils, climate, wildlife habitat values, and the zonal relationships of habitat types.

Ecological Role of Plant Species

The functional role of a plant species often changes within different portions of its environment distribution. This is most easily seen in some of the tree species found in our study area. A given species, such as *Pseudotsuga menziesii*, can be either dominant, codominant, or subordinate, and either climax or seral, depending upon the environmental conditions. Factors that affect its role also determine the associated species' role. Thus, environmental conditions of a site might be ideal for growth and reproduction of *Pseudotsuga*, and also adequate for *Abies lasiocarpa*, which will outcompete *Pseudotsuga*. The functional role of a species depends upon its own environmental amplitude as well as the relative amplitude of its competitors.

The occurrence and role of tree species reflects the relative amplitude and successional status of the species within our study area. Appendix B may provide the user with a number of ecological insights into the classification and its application on the ground. For example, the relative importance of *Populus tremuloides* in all but the *Pinus ponderosa* series is readily apparent. Resource managers may find many situations where consideration of the role and function of *P. tremuloides* is warranted. *Populus tremuloides* may serve as a nurse crop for conifer establishment, as a key wildlife habitat component, or as an important element in revegetation prescriptions. The user is advised to consult a more detailed classification of the *P. tremuloides* ecosystem by Mueggler and Campbell (in prep.) for additional management implications and recommendations. Appendix B also indicates the h.t.'s in which a species is climax, seral, or absent. In general, a seral species is usually selected to favor in timber management because it is easier to regenerate and has higher productivity. The h.t.'s that present opportunities for timber management favoring *Picea engelmannii* are easily determined. More importantly, those sites that do not naturally support *P. engelmannii* can be identified and avoided.

The constancy and average cover data (appendix C) portray the wide diversity between h.t.'s of our study area. The relative amplitude of major forest species, along with the relative importance throughout the complete environmental distribution, is also readily apparent. For example, *Berberis repens* has a wide amplitude, occurring in 29 h.t.'s. However, it is only a relatively important component in the undergrowth of three h.t.'s. Comparisons between h.t.'s allow the user to make meaningful predictions about the occurrence of given species. A number of these observations are discussed within the text; for example, the apparent negative correlation between *Populus tremuloides* and *Vaccinium myrtillus*. A somewhat similar trend also exists with *P. tremuloides* and *Quercus gambelii*. These tables condense the vegetation component information of each h.t. and reduce the need for lengthy type descriptions.

Timber Productivity

Timber productivity was a principal management implication of this study. Site trees were selected to determine the potential height growth of relatively free-growing trees for most species on the site. Unfortunately, site tree data were not always gathered for every sample stand because of stand characteristics. Also, Pfister's data do not include his site index data, although he did report on means and ranges for his types based upon a few samples (Pfister 1972). As a result, projections for some types are tentative. However, the total number of samples (997 trees on 496 sites) does allow a reasonable comparison of productivity between major h.t.'s as well as within most types. The determination of site index from the height-age data follows the procedures established by Pfister and others (1977) and Steele and others (1983). Criteria used to determine total age, as well as the source of site index curve and yield capability data, depend upon the tree species.

For *Picea engelmannii, Abies lasiocarpa*, and *Picea pungens*, Alexander's (1967) curves for *P. engelmannii* were used, with a 50-year base for site index. These curves were based on age at breast-height. Yield capabilities were calculated following a procedure developed by Pfister (1977) and Alexander and others (1975), with yield capability = −26.0 + 1.84 site index (50). Similar application of Alexander's work in northern Utah (Mauk and Henderson 1984), central Idaho (Steele and others 1981), and eastern Idaho and western Wyoming (Steele and others 1983) allows comparisons of yield and site index for similar h.t.'s of different areas within the middle and northern Rockies.

For a similar group of species, including *Pseudotsuga menziesii, Abies concolor*, and *Pinus flexilis*, the site index curves of Lynch (1958) for *Pinus ponderosa* were used. A 15-year estimate of breast-height age was added to the sampled age of *P. menziesii* and *A. concolor*, while *P. flexilis* ages were increased by 20 years. Yield capability estimates are based upon work by Brickell (1970). Again, this procedure allows for comparisons between the species that commonly grow together, and for comparisons with reported data from outside our study area.

Finally, *Pinus ponderosa* stands were treated somewhat differently. Although Lynch's (1958) site index curves were used with 15-year breast-height age corrections, field observations and comparisons with estimates of yield based upon Brickell's (1970) work for *P. ponderosa* suggested a significant difference between *P. ponderosa* stands in our study area and both southwestern and Inland Empire stands. In general, *P. ponderosa* in central and especially southern Utah appear to maintain diameter growth after a relatively early cessation of height growth. The result is a short, thick bole with a more cylindrical rather than conical shape. Therefore, projected yields based upon available site index and yield capability relationships were underestimated. The most appropriate solution appeared to be the use of Stage's (1973, 1975) stand growth model prognosis. Total standing volume for each sample stand containing *P. ponderosa* was calculated using a Utah variant of the model developed by the Forest Service's Intermountain Region.

Our best estimate of timber productivity is presented in appendixes D and E. Mean basal area and site index by species within each h.t. (appendix D) allow for comparisons by species. This table, combined with appendix B, form much of the basis for recommendation on the most silviculturally appropriate species to favor by management. However, site index alone may not adequately express productivity within a given h.t. Estimated net yield capability (cubic feet), based upon mature and natural stands, is often more useful. As stated by Brickell (1970) and used by Steele and others (1981, 1983) and Mauk and Henderson (1984): "Yield capability, as used by Forest Survey, is defined as mean annual increment of growing stock attainable in fully stocked natural stands at the age of culmination of mean annual increment." Yield capability therefore is the maximum mean annual increment attainable under the constraint of stands being fully stocked and natural. Current estimates of yield capability (in cubic feet/acre/year) for most types are presented in appendix E.

Soils

Characteristics of the upper 3.9 inches (10 cm) of the soil and the surficial geology are summarized in appendix F. Soil sampling throughout the fieldwork leading to this classification was designed to allow simple and preliminary characterization of the surface soils for each h.t. rather than detailed soil-vegetation investigations. However, a number of apparent relationships are suggested by the limited data available. Many h.t.'s within our study area are restricted to particular substrates. These trends are discussed within either the series or h.t. descriptions. Of particular interest is the predominance of major, widespread types, such as ABLA/BERE, ABCO/BERE, PSME/BERE, ABCO/ARPA, and PIPO/ARPA, on sedimentary substrates, especially Tertiary limestone and sandstone. In contrast, ABLA/JUCO, ABLA/CARO, PIEN/RIMO, PSME/SYOR, and PIPO/PUTR are more common on igneous parent materials.

Surface textures for major h.t.'s are arranged along a hypothesized gradient of coarse to fine in appendix G. Although these data are for limited sample sizes and are not intended to replace site-specific soil surveys, they do allow a generalized concept of site conditions for most types. A few h.t.'s with wide geographical distribution, such as ABLA/RIMO-RIMO or ABLA/BERE, also have a relatively wide amplitude in surface textures. Types with fluvial or alluvial depositions have relatively fine textures. Generally, h.t.'s named after the presence of *Berberis repens*, such as ABLA/BERE, PSME/BERE, or ABCO/BERE, tend to have relatively fine surface textures. In contrast, coarser textures are found on types named after *Symphoricarpos oreophilus* or *Juniperus communis*.

Climate

Generalized climatic factors for several weather stations within or adjacent to major h.t.'s are displayed in appendix H, following the graphical representation suggested by Walter (1973). Although many h.t.'s are expected to contain wide variation in annual temperature and precipitation, the overall pattern should be relatively consistent. Interpretation of exact climatic patterns for many h.t.'s is complicated by the effects of soils, topography, and wind.

Wildlife Habitat Values

Although the fieldwork methodology was not designed to determine h.t.-wildlife species relationships, noteworthy observations are included in the specific h.t. descriptions. In general, wildlife may be responding more to the structural characteristics of our h.t.'s than to the exact plant species assemblages. If this is true, then the data reported in appendix C, constancy and average cover of major plant species, can be used to develop a relative ranking of wildlife habitat values for any number of wildlife species. The user must remember these data represent mature stands; early seral conditions, which may be important for wildlife, are not included.

Zonal Relationships of Habitat Types

To depict the relative position and topographic relationship of major h.t.'s within the study area, schematic diagrams (figs. 19—27) are presented for representative localities. Habitat types are arranged in ascending order corresponding to elevation and moisture. Only major or dominant types in the area are shown. The restrictive, usually topoedaphic types, such as those found on stream bottoms, alluvial benches, or steep rocky side slopes, are usually omitted. As Steele and others (1983) note, these diagrams are complicated by the difficulty of depicting a three-dimensional landscape or a multidimensional environment with two axes, but the result is still useful in portraying a concept of the h.t. variation for the different geographic areas.

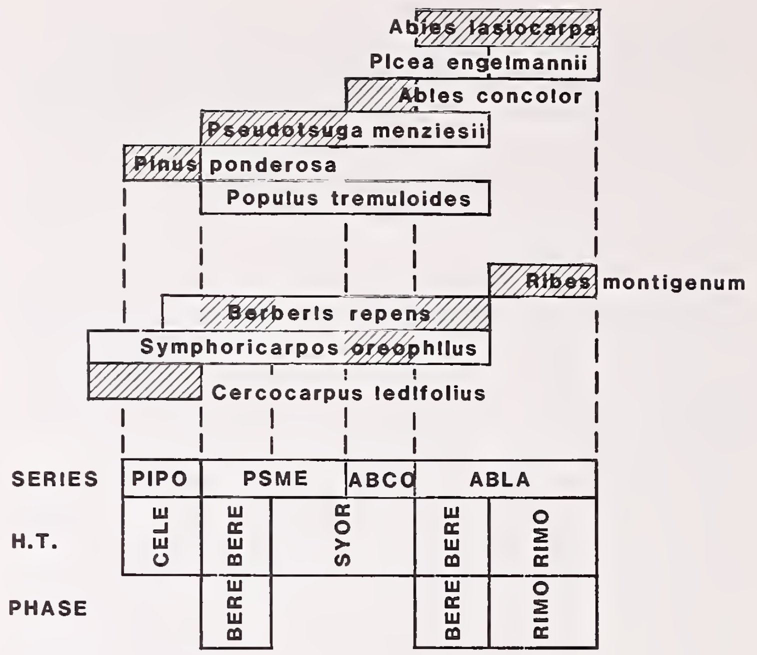


Figure 19.—General relationship of forest vegetation on the Tavaputs Plateau south of Duchesne, UT.

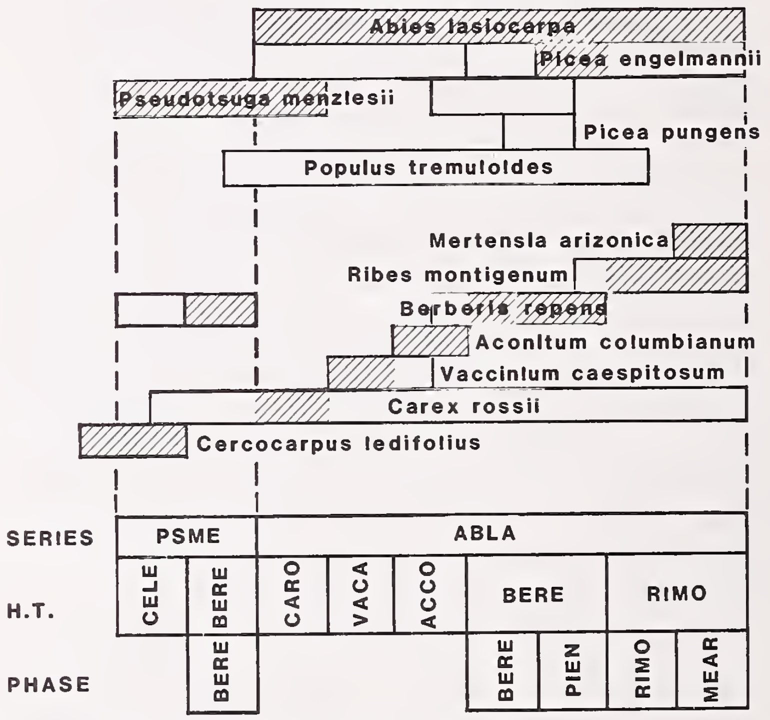


Figure 20.—General relationship of forest vegetation on the Wasatch Plateau near Price, UT.

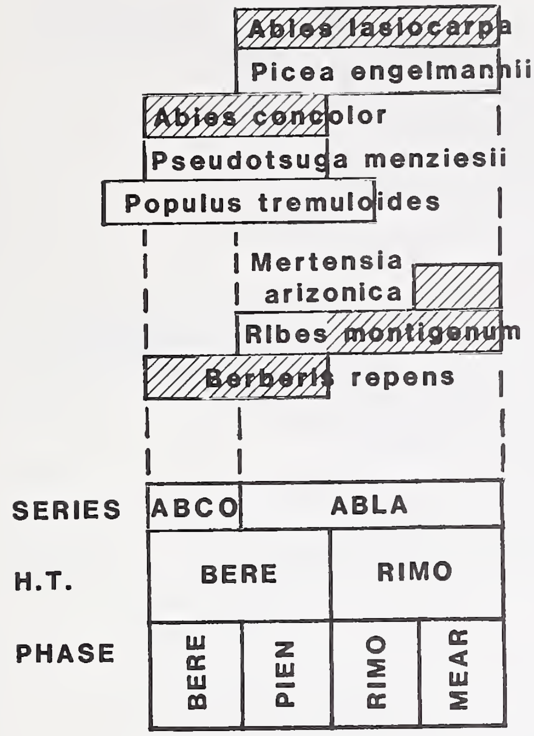


Figure 21.—General relationship of forest vegetation on the Wasatch Plateau near Ephraim, UT.

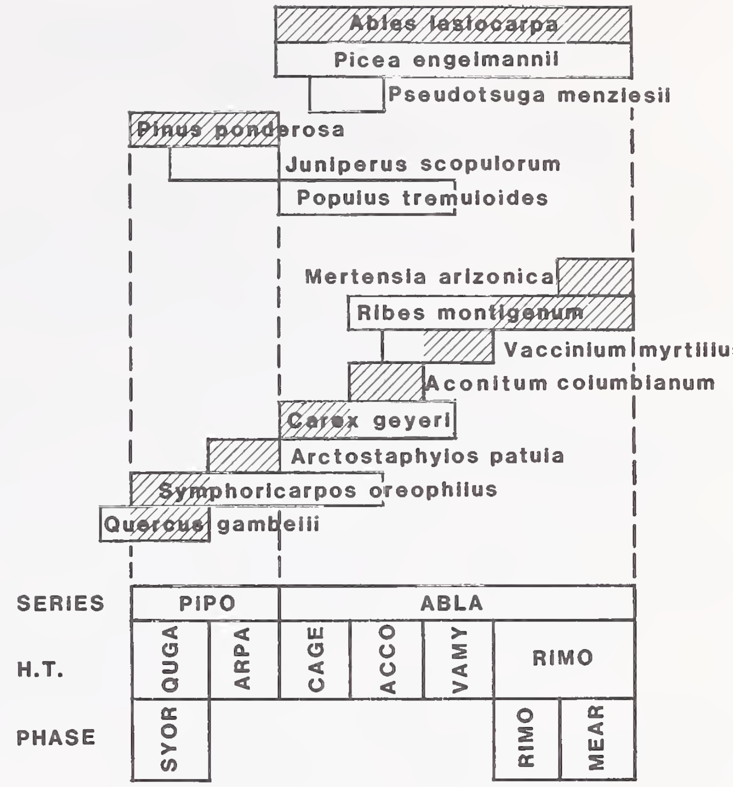


Figure 23.—General relationship of forest vegetation in the LaSal Mountains near Moab, UT.

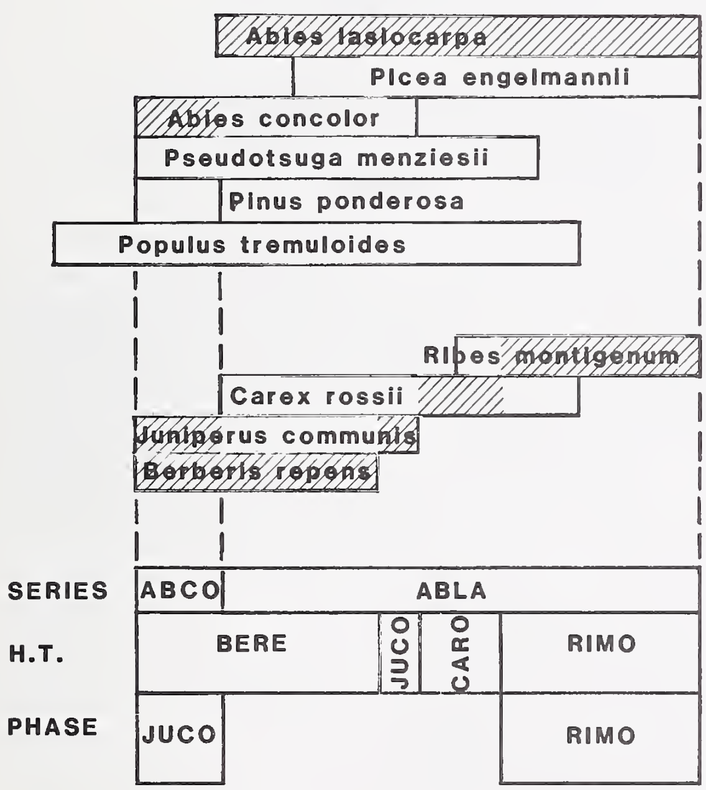


Figure 22.—General relationship of forest vegetation in the Tushar Mountains near Beaver, UT.

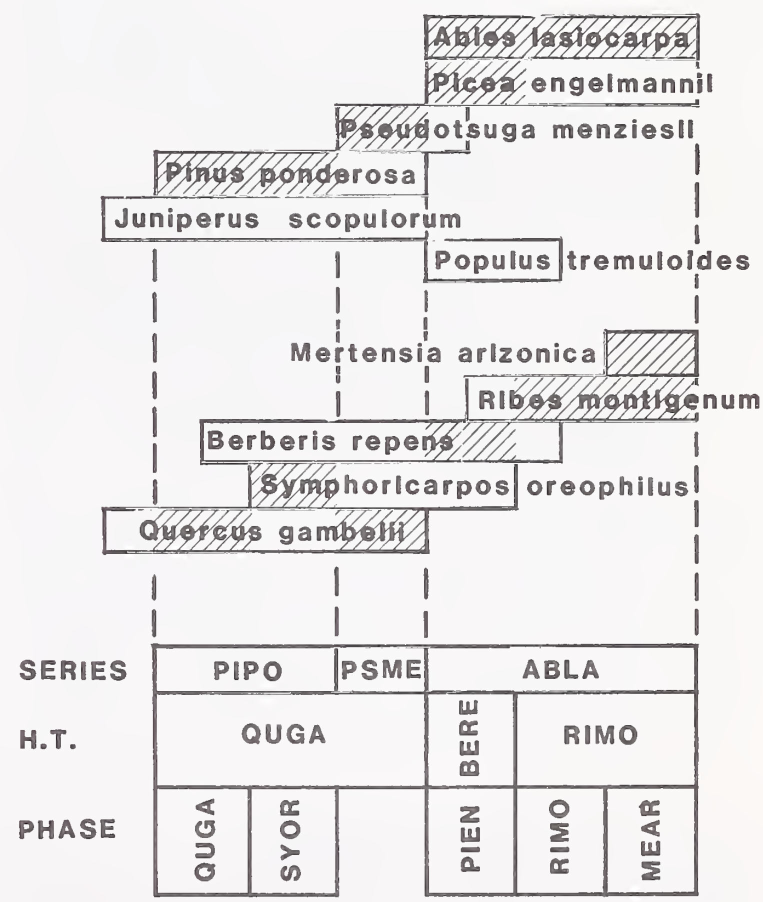


Figure 24.—General relationship of forest vegetation in the Abajo Mountains near Monticello, UT.

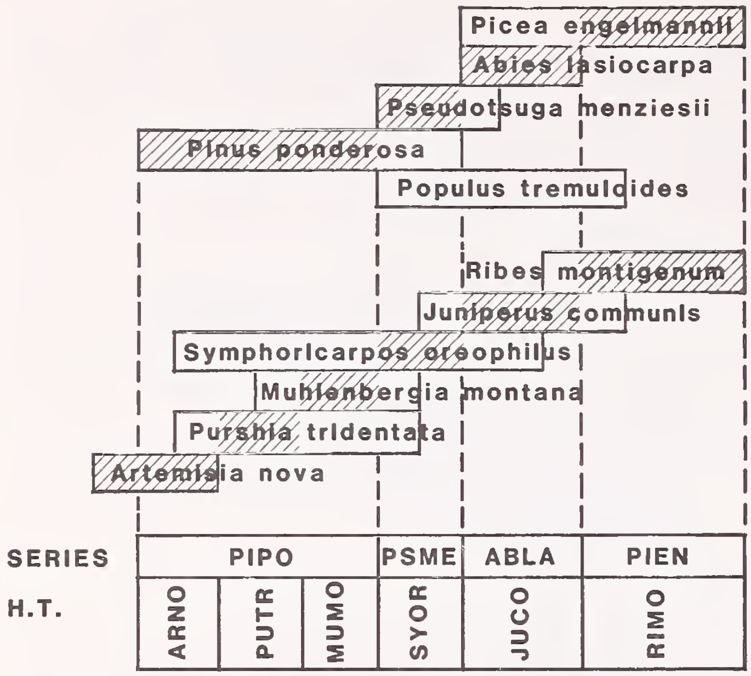


Figure 25.—General relationship of forest vegetation in the Boulder Mountains near Teasdale, UT.

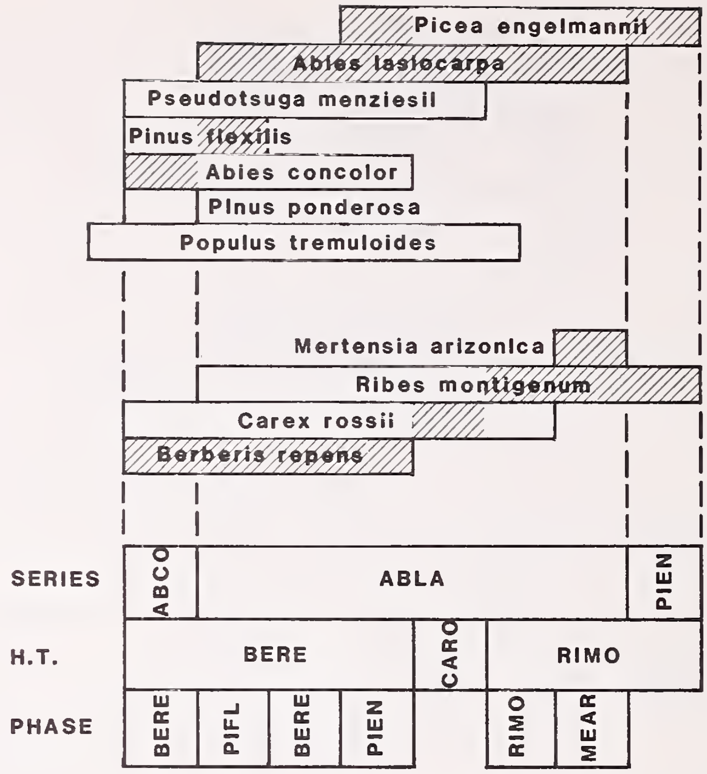


Figure 27.—General relationship of forest vegetation on the Markagunt Plateau near Cedar City, UT.

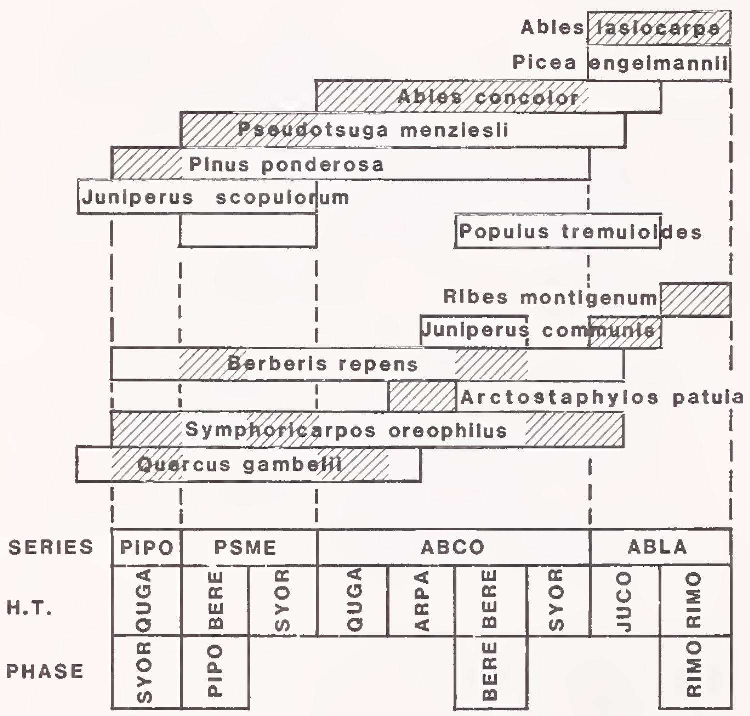


Figure 26.—General relationship of forest vegetation on the Aquarius Plateau north of Escalante, UT.

RELATIONSHIP TO PREVIOUS HABITAT TYPE CLASSIFICATIONS IN THE STUDY AREA

Although much of this classification includes new and previously undescribed h.t.'s, earlier work by Pfister (1972) and Kerr and Henderson (1979) was incorporated. Pfister's treatment of the subalpine forests and Kerr and Henderson's classification for a small test strip of the Wasatch Plateau were considered first approximations and therefore influenced the conceptual development of types reported by the classification. Where appropriate, these relationships are displayed in figure 28. In general, the increase in sample stand numbers over a larger area allowed for the refinement of more h.t.'s representing smaller partitions of the environment. The most notable difference between this work and that reported by Kerr and Henderson (1979) is the standardization of nomenclature for the *Abies lasiocarpa* series. The ABLA/BERE h.t. described by Pfister (1972) has had major revision to incorporate phasal distinctions based upon overstory associations that affect timber management and undergrowth differences that apparently represent significantly different site conditions.

SUBALPINE FOREST (Pfister, 1972)	PRICE DISTRICT (Kerr & Henderson, '79)	CENTRAL & SOUTHERN UTAH
	PIEN-ABLA/RIMO (in part)	ABLA/ACCO
	PIEN-ABLA/VACA	ABLA/VACA,PIEN
	PIEN-ABLA/VAME	ABLA/VAGL
ABLA/BERE,ABLA		ABLA/ACGL
		ABLA/BERE,BERE
ABLA/BERE,RIMO (In part)		ABLA/BERE,PIFL
ABLA/BERE,BERE	PIEN-ABLA/BERE (in part)	ABLA/BERE,PIEN
		ABLA/CAGE
		ABLA/JUCO
ABLA/RIMO,RIMO (in part)	PIEN-ABLA/OSCH PIEN-ABLA/BERE (in part)	ABLA/CARO
ABLA/BERE,RIMO (In part) ABLA/RIMO,RIMO (In part) ABLA/RIMO,THFE	PIEN-ABLA/ARCO ABLA/RIMO	ABLA/RIMO,RIMO
	PIEN-ABLA/RIMO (in part)	ABLA/RIMO, MEAR
ABLA/RIMO,LOIN		ABLA/VAMY
PIEN/RIMO		PIEN/RIMO
	PIPU/BERE	PIPU/BERE
		PIPU/JUCO

Figure 28.—Relationship with previous habitat type classifications in central and southern Utah.

USE OF THE CLASSIFICATION

This classification attempts to provide a natural stratification of the coniferous forest lands in central and southern Utah. The classification is based upon the potential natural vegetation and is designed to reflect the combined effects of the environment upon a given site. An accurate and specific determination of the exact environmental factors affecting each site is thus unwarranted. Indeed, the overall goal of this classification effort is to develop types that are meaningful and useful to the resource manager, who may be more concerned with management practices and their consequences than with ecophysiological requirements and adaptations. Therefore, validation will only come with application. Even though this classification is considered extensive, based upon 12 years of work and over 727 sample stands, additional minor or unique situations may exist and warrant description. Users may forward recommendations for further refinement to the Regional Ecology and Classification Program, Intermountain Region, USDA Forest Service, Ogden, UT.

Pfister (1976) and Steele and others (1983) have outlined potential values of habitat types in resource management. They suggest the most important use is a land stratification system that designates areas of land with approximately equivalent environments or biotic potential. Resource managers should immediately recognize the benefits of incorporating h.t.'s into the long-range planning process. Some other current and potential uses include:

1. Communication - the classification provides a common framework for users with different disciplines and allows for the extrapolation of existing knowledge to new and different sites.
2. Timber management - the classification provides an assessment of relative timber productivity and silvicultural methods.
3. Range and wildlife management - the classification provides a basis for determining wildlife and range values and changes following disturbances.
4. Forest protection - the classification provides a basis for describing relative rates of fuels accumulations, fire effects and the role of natural fire, and the natural susceptibility of forest sites to insects and disease.
5. Natural area preservation and research - the classification indicates the degree of diversity that requires representation within the research natural area system and provides a stratification level in future research study designs.

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APPENDIX A.—NUMBER OF SAMPLE STANDS BY HABITAT TYPE, PHASE, AND VICINITY IN CENTRAL AND SOUTHERN UTAH

PV = Pine Valley Mountains, Dixie National Forest
DP = Markagunt, Paunsaugunt, Sevier, and Aquarius Plateaus, Escalante and Boulder Mountains in the Dixie National Forest
AM = Abajo Mountains, Manti-LaSal National Forest
LM = LaSal Mountains, Manti-LaSal National Forest
FL = Fish Lake Plateau, Tushar, and Pahvant Mountains in the Fishlake National Forest
WP = Wasatch Plateau, Manti-LaSal National Forest
TP = Tavaputs Plateau, Ashley National Forest
CB = Cedar Breaks National Monument
BC = Bryce Canyon National Park

	Vicinity									
Habitat type, phase	PV	DP	AM	LM	FL	WP	TP	CB	BC	Total
Abies lasiocarpa Series										
ABLA/ACCO	1	1	2	3	1	8	•	1	•	17
ABLA/PHMA	•	•	•	•	•	5	•	•	•	5
ABLA/ACGL	1	•	•	1	2	3	•	•	•	7
ABLA/VACA,PIEN	•	•	•	•	•	14	•	•	•	14
ABLA/VAGL	•	•	•	•	•	4	•	•	•	4
ABLA/VAMY	•	•	1	6	•	•	•	•	•	7
ABLA/BERE,PIFL	•	14	•	•	•	2	•	•	•	16
ABLA/BERE,PIEN	•	16	3	2	6	24	•	•	•	51
ABLA/BERE,BERE	•	9	•	2	11	5	3	•	•	30
ABLA/RIMO,MEAR	•	9	4	7	2	9	•	6	•	37
ABLA/RIMO,RIMO	1	25	6	10	17	63	6	•	•	128
ABLA/CAGE	•	•	2	4	•	•	•	•	•	6
ABLA/JUCO	2	14	•	•	8	1	•	•	•	25
ABLA/CARO	1	12	•	•	9	5	•	•	•	27
										374
Abies concolor Series										
ABCO/PHMA	•	•	•	•	2	•	•	•	•	2
ABCO/ACGL	1	•	1	•	1	•	•	•	•	4
ABCO/CELE	3	•	•	•	3	1	1	•	1	9
ABCO/ARPA	1	7	2	•	•	•	•	•	2	12
ABCO/QUGA	•	2	•	•	2	1	•	•	•	7
ABCO/BERE,JUCO	•	5	•	•	3	3	•	•	2	13
ABCO/BERE,BERE	1	12	•	•	3	8	•	•	2	26
ABCO/JUCO	•	3	•	•	2	•	•	•	•	5
ABCO/SYOR	•	5	•	•	•	2	2	•	2	11
										89
Picea engelmannii Series										
PIEN/RIMO	•	18	•	•	2	•	•	•	•	20
										20
Picea pungens Series										
PIPU/EQAR	•	5	•	•	•	•	•	•	•	5
PIPU/JUCO	•	7	•	•	2	3	1	•	•	13
PIPU/BERE	•	5	•	•	1	4	2	•	•	12
										30
Pinus flexilis-Pinus longaeva Series	•	7	•	•	2	6	3	•	•	18
										18

(con.)

APPENDIX A.—(Con.)

Habitat type, phase	Vicinity									
	PV	DP	AM	LM	FL	WP	TP	CB	BC	Total
Pseudotsuga menziesii Series										
PSME/PHMA	•	•	•	1	1	1	•	•	•	3
PSME/CELE	•	2	•	•	1	7	1	•	•	11
PSME/ARPA	•	1	•	•	1	•	•	•	•	5
PSME/CEMO	•	1	•	•	1	1	2	•	3	5
PSME/QUGA	•	2	3	•	•	•	•	•	•	5
PSME/BERE,PIPO	•	7	•	•	1	•	•	•	•	8
PSME/BERE,BERE	•	2	•	1	1	13	4	•	•	21
PSME/SYOR	•	13	•	•	3	1	2	•	•	19
										77
Pinus ponderosa Series										
PIPO/CELE	2	2	•	•	•	•	2	•	•	6
PIPO/ARPA	•	9	•	3	•	•	•	•	3	15
PIPO/ARNO	•	7	•	•	•	•	•	•	1	8
PIPO/PUTR	•	16	1	2	1	•	•	•	1	21
PIPO/QUGA,SYOR	•	3	6	6	•	•	•	•	•	15
PIPO/QUGA,QUGA	•	4	8	2	•	•	•	•	•	14
PIPO/SYOR	•	3	3	•	•	•	•	•	•	6
PIPO/MUMO	•	7	•	•	•	1	•	•	•	8
										93
Unclassified stands	•	16	1	•	•	9	•	•	•	26
										26
Total	14	272	44	50	90	204	29	7	17	727

APPENDIX B.—OCCURRENCE AND SUCCESSIONAL ROLE OF TREE SPECIES BY HABITAT TYPE AND PHASE FOR CENTRAL AND SOUTHERN UTAH

C = major climax species c = minor climax species
S = major seral species s = minor seral species
a = accidental ( ) = only in portions of h.t.

Habitat type, phase	Species											
	JUOS	JUSC	PIED	POTR	PIPO	PSME	PIFL	PILO	PIPU	PIEN	ABCO	ABLA
ABLA/ACCO	•	•	•	(s)	a	(s)	a	•	•	c	(S)	C
ABLA/PHMA	•	•	•	S	•	S	•	•	•	(S)	•	C
ABLA/ACGL	•	•	•	S	•	S	(s)	•	(s)	S	S	C
ABLA/VACA,PIEN	•	•	•	S	•	a	•	•	•	S	a	C
ABLA/VAMY	•	•	•	•	•	a	•	•	•	S	•	C
ABLA/BERE,PIFL	•	•	•	S	a	S	S	a	s	•	(s)	C
ABLA/BERE,PIEN	•	•	•	S	•	(S)	a	•	(s)	S	(s)	C
ABLA/BERE,BERE	•	•	•	S	a	S	a	a	(S)	a	(S)	C
ABLA/RIMO,MERE	•	•	•	(S)	•	a	a	•	•	c	a	C
ABLA/RIMO,RIMO	•	•	•	(S)	•	(s)	a	•	•	c	•	C
ABLA/CAGE	•	•	•	S	•	(s)	•	•	•	S	•	C
ABLA/JUCO	•	•	•	S	•	(s)	(s)	(s)	(s)	S	(s)	C
ABLA/CARO	•	•	•	S	a	S	a	•	a	S	•	C
ABCO/CELE	•	s	•	a	S	S	(s)	•	•	•	C	•
ABCO/ARPA	•	c	•	a	S	S	S	(s)	(s)	•	C	•
ABCO/QUGA	•	c	a	•	S	S	a	•	•	•	C	•
ABCO/BERE,JUCO	•	a	•	S	S	S	s	(s)	S	a	C	•
ABCO/BERE,BERE	•	(s)	•	S	S	S	(s)	(s)	(s)	•	C	a
ABCO/JUCO	•	(s)	•	S	a	s	s	•	S	•	C	a
ABCO/SYOR	•	c	•	(s)	S	S	a	•	a	•	C	•
PIEN/RIMO	•	•	•	(s)	•	•	•	•	•	C	•	a
PIPU/EQAR	•	•	•	S	•	(s)	•	•	C	(c)	•	a
PIPU/JUCO	•	s	•	S	(S)	(s)	(s)	a	C	a	•	a
PIPU/BERE	•	(S)	•	S	S	S	S	a	C	•	•	a
PIFL-PILO	•	(c)	a	(s)	a	(c)	C	(C)	•	a	a	a
PSME/CELE	•	c	(s)	(s)	(s)	C	•	(s)	•	•	a	•
PSME/ARPA	•	c	•	•	S	C	S	•	•	•	•	•
PSME/CEMO	c	c	c	•	a	C	•	•	•	•	a	•
PSME/QUGA	•	c	•	a	S	C	•	•	•	•	a	•
PSME/BERE,PIPO	•	s	•	S	S	C	a	•	•	•	•	a
PSME/BERE,BERE	•	s	•	s	a	C	(s)	•	a	•	•	•
PSME/SYOR	•	c	a	s	S	C	a	•	a	•	•	a
PIPO/CELE	(s)	c	s	•	C	a	•	•	•	•	a	•
PIPO/ARPA	•	c	•	•	C	a	(s)	•	a	a	•	•
PIPO/ARNO	•	c	•	•	C	a	(s)	•	a	a	•	•
PIPO/PUTR	•	c	a	•	C	a	a	•	•	a	•	•
PIPO/QUGA,SYOR	•	s	•	a	C	a	•	•	•	•	•	•
PIPO/QUGA,QUGA	(s)	s	(s)	•	C	a	•	•	•	•	•	•
PIPO/SYOR	•	s	•	(s)	C	a	•	•	•	•	a	a
PIPO/MUMO	a	s	a	a	C	a	a	•	•	•	•	•

APPENDIX C.—CONSTANCY AND AVERAGE COVER (THE LATTER IN PARENTHESES) OF IMPORTANT PLANTS IN CENTRAL AND SOUTHERN UTAH HABITAT TYPES AND PHASES

	ABLA/ ACCO	ABLA/ PHMA	ABLA/ ACGL	ABLA/ VACA PIEN	ABLA/ VAMY	ABLA/ BERE PIFL	ABLA/ BERE PIEN	ABLA/ BERE BERE
NO. STANDS IN H.T.	17	5	7	14	7	16	51	30
TREES								
ABIES LASIOCARPA	100(24)	100(45)	100(38)	93(21)	100(29)	100(37)	100(45)	100(57)
ABIES CONCOLOR	6(45)	-(-)	57(22)	7(1)	-(-)	25(17)	2(65)	13(32)
PICEA ENGELMANNII	100(48)	40(40)	86(15)	100(33)	100(76)	56(19)	100(33)	7(1)
PICEA PUNGENS	-(-)	-(-)	14(T)	-(-)	-(-)	31(18)	12(5)	33(30)
PSEUDOTSUGA MENZIESII	12(25)	60(14)	71(43)	7(5)	14(6)	81(33)	43(21)	57(38)
PINUS FLEXILIS	6(12)	-(-)	29(11)	-(-)	-(-)	100(11)	8(1)	7(1)
PINUS LONGAEVA	-(-)	-(-)	-(-)	-(-)	-(-)	13(3)	-(-)	3(T)
PINUS PONDEROSA	6(4)	-(-)	-(-)	-(-)	-(-)	13(6)	-(-)	10(2)
POPULUS TREMULOIDES	41(8)	60(17)	57(13)	57(6)	-(-)	81(22)	71(20)	90(36)
PINUS EDULIS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
JUNIPERUS SCOPULORUM	-(-)	-(-)	14(7)	-(-)	-(-)	-(-)	-(-)	-(-)
JUNIPERUS OSTEOSPERMA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
SHRUBS								
ACER GLABRUM	6(1)	40(8)	100(6)	-(-)	-(-)	-(-)	-(-)	3(T)
AMELANCHIER ALNIFOLIA	18(3)	-(-)	43(2)	-(-)	-(-)	44(1)	12(T)	7(T)
ARCTOSTAPHYLOS PATULA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	3(40)
ARCTOSTAPHYLOS UVA-URSI	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	3(2)
ARTEMISIA NOVA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
ARTEMISIA TRIDENTATA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
BERBERIS REPENS	12(T)	60(1)	71(5)	21(2)	-(-)	100(11)	67(6)	90(7)
CEANOTHUS MARTINII	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
CERCOCARPUS LEDIFOLIUS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
CERCOCARPUS MONTANUS	-(-)	-(-)	14(1)	-(-)	-(-)	-(-)	-(-)	-(-)
CHRYSOTHAMNUS PARRYI	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
CHRYSOTHAMNUS VISCIDIFLORUS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
JUNIPERUS COMMUNIS	6(T)	-(-)	14(T)	7(T)	29(T)	94(9)	39(7)	50(10)
LINNAEA BOREALIS	6(4)	-(-)	-(-)	14(11)	-(-)	-(-)	-(-)	-(-)
LONICERA INVOLUCRATA	29(2)	-(-)	-(-)	-(-)	86(4)	-(-)	4(T)	-(-)
LONICERA UTAHENSIS	12(1)	60(8)	43(7)	14(T)	14(3)	-(-)	22(4)	7(2)
PACHISTIMA MYRSINITES	24(2)	80(3)	86(1)	86(2)	14(1)	63(1)	75(4)	47(3)
PHYSOCARPUS MALVACEUS	-(-)	100(10)	14(4)	-(-)	-(-)	-(-)	2(T)	7(1)
PRUNUS VIRGINIANA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
PURSHIA TRIDENTATA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
QUERCUS GAMBELII	6(T)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
RIBES CEREUM	6(10)	-(-)	-(-)	-(-)	-(-)	38(4)	4(1)	7(10)
RIBES MONTIGENUM	88(6)	40(1)	-(-)	50(1)	100(8)	50(5)	45(5)	7(4)
RIBES VISCOSISSIMUM	-(-)	80(4)	43(11)	21(1)	-(-)	-(-)	10(2)	-(-)
ROSA WOODSII	18(1)	20(T)	57(5)	14(1)	-(-)	63(2)	41(2)	70(3)
SALIX SCOULERIANA	6(T)	-(-)	-(-)	-(-)	-(-)	-(-)	2(8)	-(-)
SAMBUCUS RACEMOSA	41(2)	40(1)	-(-)	14(2)	-(-)	13(1)	16(1)	10(1)
SHEPHERDIA CANADENSIS	6(T)	40(2)	-(-)	29(2)	-(-)	6(T)	14(2)	10(13)
SHEPHERDIA ROTUNDIFOLIA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
SYMPHORICARPOS OREOPHILUS	53(2)	40(1)	86(10)	50(1)	-(-)	88(5)	65(5)	80(6)
VACCINIUM CAESPITOSUM	6(35)	-(-)	-(-)	100(25)	-(-)	-(-)	-(-)	-(-)
VACCINIUM MYRTILLUS	6(35)	-(-)	-(-)	-(-)	100(56)	-(-)	2(2)	-(-)
XANTHOCEPHALUM SAROTHRAE	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)

(con.)

APPENDIX C.—(Con.)

	ABLA/ ACCO	ABLA/ PHMA	ABLA/ ACGL	ABLA/ VACA PIEN	ABLA/ VAMY	ABLA/ BERE PIFL	ABLA/ BERE PIEN	ABLA/ BERE BERE
NO. STANDS IN H.T.	17	5	7	14	7	16	51	30
GRAMINOIDS								
AGROPYRON SPICATUM	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
BOUTELOUA GRACILIS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
BROMUS CARINATUS	12(8)	-(-)	-(-)	-(-)	-(-)	19(1)	-(-)	3(2)
BROMUS CILIATUS	65(1)	-(-)	-(-)	43(1)	71(1)	44(2)	31(3)	47(1)
CAREX DISPERMA	6(1)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
CAREX GEYERI	24(6)	-(-)	14(30)	-(-)	43(4)	6(T)	8(17)	7(15)
CAREX ROSSII	24(1)	40(1)	-(-)	50(2)	14(T)	81(3)	67(1)	77(1)
ELYMUS GLAUCUS	12(2)	-(-)	14(1)	-(-)	-(-)	-(-)	8(1)	3(2)
FESTUCA OVINA	-(-)	-(-)	-(-)	-(-)	-(-)	25(1)	2(T)	3(T)
GLYCERIA ELATA	6(5)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
KOELERIA NITIDA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
MUHLENBERGIA MONTANA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
ORYZOPSIS HYMENOIDES	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
POA	12(2)	-(-)	-(-)	-(-)	29(T)	13(1)	4(T)	3(3)
POA FENDLERIANA	-(-)	-(-)	-(-)	-(-)	-(-)	31(1)	6(3)	17(1)
POA NERVOSA	-(-)	-(-)	-(-)	-(-)	-(-)	19(1)	2(T)	7(T)
POA PRATENSIS	-(-)	-(-)	-(-)	7(2)	-(-)	-(-)	-(-)	7(4)
SITANION HYSTRIX	-(-)	-(-)	-(-)	-(-)	-(-)	44(1)	8(1)	27(1)
STIPA COLUMBIANA	6(T)	-(-)	-(-)	-(-)	-(-)	-(-)	2(T)	7(13)
STIPA COMATA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
STIPA LETTERMANII	-(-)	-(-)	-(-)	7(5)	-(-)	25(2)	6(1)	13(1)
TRISETUM SPICATUM	-(-)	-(-)	-(-)	14(T)	-(-)	13(1)	8(T)	-(-)
FORBS								
ACHILLEA MILLEFOLIUM	35(1)	-(-)	-(-)	14(T)	-(-)	56(1)	20(3)	33(2)
ACONITUM COLUMBIANUM	53(7)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
ACTAEA RUBRA	47(2)	-(-)	14(T)	-(-)	-(-)	-(-)	-(-)	3(T)
AQUILEGIA COERULEA	59(1)	20(1)	14(1)	29(T)	43(1)	31(1)	45(3)	20(1)
ARABIS DRUMMONDII	-(-)	-(-)	-(-)	-(-)	-(-)	13(T)	8(T)	20(T)
ARNICA CORDIFOLIA	47(3)	40(3)	43(1)	50(5)	71(2)	6(2)	37(5)	13(3)
ASTER ENGELMANNII	24(1)	-(-)	-(-)	57(1)	-(-)	6(15)	14(3)	3(1)
ASTRAGALUS MISER	-(-)	-(-)	14(2)	-(-)	-(-)	63(2)	22(2)	27(7)
BALSAMORHIZA SAGITTATA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
DELPHINIUM BARBEYI	12(5)	-(-)	-(-)	-(-)	14(2)	-(-)	4(9)	3(2)
DELPHINIUM OCCIDENTALE	47(12)	-(-)	-(-)	-(-)	-(-)	-(-)	2(1)	-(-)
EPILOBIUM ANGUSTIFOLIUM	29(1)	20(T)	14(2)	36(1)	43(T)	6(T)	25(2)	17(1)
ERIGERON PEREGRINUS	29(3)	-(-)	-(-)	-(-)	43(3)	13(2)	10(4)	10(1)
ERIOGONUM RACEMOSUM	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
GERANIUM RICHARDSONII	76(8)	-(-)	-(-)	7(T)	43(1)	13(8)	-(-)	-(-)
GERANIUM VISCOSISSIMUM	-(-)	-(-)	29(1)	-(-)	-(-)	25(1)	4(1)	10(1)
HAPLOPAPPUS PARRYI	6(T)	-(-)	29(2)	-(-)	-(-)	19(6)	24(5)	20(2)
HELENIUM HOOPESII	12(1)	-(-)	-(-)	14(T)	43(1)	-(-)	16(3)	10(6)
HERACLEUM LANATUM	24(6)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
HYMENOXYS RICHARDSONII	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
LATHYRUS LANSZWERTII	41(2)	20(4)	57(3)	57(2)	71(11)	19(6)	37(8)	23(11)
LATHYRUS PAUCIFLORUS	6(2)	-(-)	-(-)	-(-)	14(1)	-(-)	4(15)	-(-)
LIGUSTICUM PORTERI	35(T)	-(-)	14(T)	-(-)	14(T)	19(1)	8(4)	3(2)
LUPINUS ARGENTEUS	-(-)	-(-)	-(-)	-(-)	-(-)	6(T)	10(2)	20(1)
MERTENSIA ARIZONICA	24(9)	-(-)	-(-)	-(-)	-(-)	13(1)	20(2)	7(1)
MERTENSIA CILIATA	35(9)	-(-)	-(-)	7(T)	29(T)	-(-)	6(1)	3(3)
OSMORHIZA CHILENSIS	82(11)	80(1)	57(4)	86(1)	100(6)	19(5)	67(4)	37(3)
PEDICULARIS RACEMOSA	12(11)	-(-)	-(-)	-(-)	57(5)	-(-)	4(6)	-(-)
POLEMONIUM PULCHERRIMUM	12(6)	-(-)	-(-)	7(2)	71(7)	6(T)	4(2)	-(-)
PYROLA SECUNDA	53(1)	60(3)	29(1)	71(3)	86(2)	19(1)	51(3)	27(3)
SENECIO TRIANGULARIS	12(33)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
SMILACINA STELLATA	35(6)	20(T)	43(2)	-(-)	-(-)	6(T)	10(1)	13(2)
STREPTOPUS AMPLEXIFOLIUS	18(9)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
THALICTRUM FENDLERI	71(3)	40(T)	43(3)	43(T)	43(3)	56(3)	49(3)	50(7)
TRIFOLIUM LONGIPES	24(7)	-(-)	-(-)	-(-)	-(-)	25(6)	4(4)	13(5)
EQUISETUM ARVENSE	6(4)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)

(con.)

APPENDIX C.—(Con.)

	ABLA/ RIMO MEAR	ABLA/ RIMO RIMO	ABLA/ CAGE	ABLA/ JUCO	ABLA/ CARO	ABCO/ CELE	ABCO/ ARPA	ABCO/ QUGA
NO. STANDS IN H.T.	37	128	6	25	27	9	12	7
TREES								
ABIES LASIOCARPA	100(45)	99(38)	100(57)	100(29)	100(47)	-(-)	-(-)	-(-)
ABIES CONCOLOR	3(2)	-(-)	-(-)	12(14)	-(-)	100(15)	100(11)	100(27)
PICEA ENGELMANNII	97(59)	94(52)	83(11)	76(35)	89(39)	-(-)	-(-)	-(-)
PICEA PUNGENS	-(-)	-(-)	-(-)	32(17)	11(1)	-(-)	17(5)	-(-)
PSEUDOTSUGA MENZIESII	3(1)	6(14)	17(3)	40(21)	26(32)	67(17)	100(13)	86(16)
PINUS FLEXILIS	5(1)	3(1)	-(-)	20(12)	11(4)	56(5)	75(13)	14(T)
PINUS LONGAEVA	-(-)	-(-)	-(-)	4(23)	-(-)	-(-)	25(7)	-(-)
PINUS PONDEROSA	-(-)	-(-)	-(-)	8(16)	4(22)	67(20)	100(16)	57(42)
POPULUS TREMULOIDES	27(27)	38(18)	100(70)	88(16)	85(20)	11(5)	8(5)	-(-)
PINUS EDULIS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	14(1)
JUNIPERUS SCOPULORUM	-(-)	-(-)	-(-)	-(-)	-(-)	44(3)	33(1)	71(1)
JUNIPERUS OSTEOSPERMA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
SHRUBS								
ACER GLABRUM	-(-)	-(-)	17(T)	-(-)	-(-)	11(T)	-(-)	-(-)
AMELANCHIER ALNIFOLIA	-(-)	-(-)	33(1)	16(T)	4(T)	67(2)	25(2)	57(13)
ARCTOSTAPHYLOS PATULA	-(-)	-(-)	-(-)	4(T)	4(50)	22(8)	100(9)	-(-)
ARCTOSTAPHYLOS UVA-URSI	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
ARTEMISIA NOVA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
ARTEMISIA TRIDENTATA	-(-)	2(2)	-(-)	4(2)	-(-)	22(T)	8(1)	-(-)
BERBERIS REPENS	-(-)	4(T)	67(T)	40(T)	26(T)	67(9)	83(2)	71(12)
CEANOTHUS MARTINII	-(-)	-(-)	-(-)	-(-)	-(-)	11(T)	8(T)	-(-)
CERCOCARPUS LEDIFOLIUS	-(-)	-(-)	-(-)	4(T)	-(-)	100(22)	8(2)	14(4)
CERCOCARPUS MONTANUS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	25(1)	14(8)
CHRYSOTHAMNUS PARRYI	-(-)	-(-)	-(-)	4(1)	-(-)	-(-)	17(T)	14(T)
CHRYSOTHAMNUS VISCIDIFLORUS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
JUNIPERUS COMMUNIS	11(2)	9(2)	33(1)	100(7)	33(T)	33(1)	58(2)	29(3)
LINNAEA BOREALIS	-(-)	-(-)	-(-)	4(5)	-(-)	-(-)	-(-)	-(-)
LONICERA INVOLUCRATA	14(2)	8(1)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
LONICERA UTAHENSIS	16(1)	5(3)	17(T)	12(1)	-(-)	-(-)	-(-)	-(-)
PACHISTIMA MYRSINITES	5(T)	8(T)	-(-)	12(T)	19(T)	33(1)	42(1)	29(2)
PHYSOCARPUS MALVACEUS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	14(T)
PRUNUS VIRGINIANA	-(-)	-(-)	-(-)	4(T)	-(-)	22(8)	-(-)	29(1)
PURSHIA TRIDENTATA	-(-)	-(-)	-(-)	4(T)	-(-)	22(1)	33(3)	29(4)
QUERCUS GAMBELII	-(-)	-(-)	17(3)	-(-)	-(-)	44(16)	17(13)	100(17)
RIBES CEREUM	5(1)	2(T)	-(-)	24(2)	-(-)	22(1)	50(T)	29(T)
RIBES MONTIGENUM	100(13)	100(7)	17(T)	16(T)	7(T)	-(-)	-(-)	-(-)
RIBES VISCOSISSIMUM	-(-)	2(1)	-(-)	-(-)	4(T)	-(-)	8(T)	-(-)
ROSA WOODSII	3(T)	5(1)	50(2)	52(1)	41(1)	33(1)	42(T)	43(2)
SALIX SCOULERIANA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
SAMBUCUS RACEMOSA	19(2)	27(2)	17(T)	4(T)	7(T)	-(-)	8(T)	43(T)
SHEPHERDIA CANADENSIS	-(-)	-(-)	-(-)	28(1)	4(T)	-(-)	8(T)	-(-)
SHEPHERDIA ROTUNDIFOLIA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
SYMPHORICARPOS OREOPHILUS	11(14)	30(1)	50(24)	40(2)	30(4)	67(6)	92(7)	71(11)
VACCINIUM CAESPITOSUM	-(-)	-(-)	-(-)	-(-)	4(T)	-(-)	-(-)	-(-)
VACCINIUM MYRTILLUS	5(3)	2(1)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
XANTHOCEPHALUM SAROTHRAE	-(-)	-(-)	-(-)	-(-)	-(-)	11(2)	17(T)	43(1)

(con.)

APPENDIX C.—(Con.)

	ABLA/ RIMO MEAR	ABLA/ RIMO RIMO	ABLA/ CAGE	ABLA/ JUCO	ABLA/ CARO	ABCO/ CELE	ABCO/ ARPA	ABCO/ QUGA
NO. STANDS IN H.T.	37	128	6	25	27	9	12	7
GRAMINOIDS								
AGROPYRON SPICATUM	-(-)	2(2)	-(-)	-(-)	-(-)	11(4)	-(-)	-(-)
BOUTELOUA GRACILIS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
BROMUS CARINATUS	8(1)	2(1)	17(5)	-(-)	-(-)	11(1)	-(-)	-(-)
BROMUS CILIATUS	27(1)	40(2)	-(-)	28(2)	30(1)	11(T)	8(T)	14(T)
CAREX DISPERMA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
CAREX GEYERI	14(6)	6(9)	100(24)	-(-)	-(-)	11(1)	-(-)	43(1)
CAREX ROSSII	54(2)	51(2)	-(-)	88(1)	100(2)	78(4)	100(1)	71(1)
ELYMUS GLAUCUS	-(-)	4(1)	17(8)	-(-)	-(-)	-(-)	-(-)	-(-)
FESTUCA OVINA	11(1)	5(5)	-(-)	32(T)	19(1)	-(-)	-(-)	14(T)
GLYCERIA ELATA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
KOELERIA NITIDA	-(-)	1(1)	-(-)	8(1)	-(-)	11(T)	25(T)	-(-)
MUHLENBERGIA MONTANA	-(-)	-(-)	-(-)	4(2)	-(-)	11(2)	-(-)	14(1)
ORYZOPSIS HYMENOIDES	-(-)	-(-)	-(-)	-(-)	4(2)	11(T)	25(T)	-(-)
POA	16(2)	7(2)	-(-)	16(1)	11(1)	-(-)	8(1)	14(T)
POA FENDLERIANA	-(-)	2(1)	-(-)	36(1)	19(1)	67(4)	33(1)	71(1)
POA NERVOSA	3(T)	5(1)	-(-)	-(-)	7(T)	-(-)	-(-)	-(-)
POA PRATENSIS	-(-)	-(-)	33(23)	-(-)	-(-)	11(10)	-(-)	29(T)
SITANION HYSTRIX	3(T)	2(T)	-(-)	52(T)	19(T)	44(1)	58(1)	57(4)
STIPA COLUMBIANA	-(-)	-(-)	17(15)	-(-)	-(-)	33(2)	-(-)	14(1)
STIPA COMATA	-(-)	-(-)	-(-)	4(1)	-(-)	11(2)	8(1)	-(-)
STIPA LETTERMANII	3(T)	13(1)	17(2)	12(5)	7(T)	11(2)	8(T)	29(T)
TRISETUM SPICATUM	14(1)	14(1)	17(T)	12(T)	11(1)	-(-)	-(-)	-(-)
FORBS								
ACHILLEA MILLEFOLIUM	54(3)	42(1)	67(3)	32(1)	44(1)	22(T)	25(T)	43(T)
ACONITUM COLUMBIANUM	-(-)	1(T)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
ACTAEA RUBRA	3(T)	2(T)	17(T)	-(-)	-(-)	-(-)	-(-)	-(-)
AQUILEGIA COERULEA	62(2)	38(1)	33(1)	12(T)	26(1)	-(-)	-(-)	-(-)
ARABIS DRUMMONDII	5(2)	8(T)	-(-)	36(T)	19(1)	-(-)	17(T)	14(T)
ARNICA CORDIFOLIA	43(6)	41(4)	-(-)	8(T)	44(1)	-(-)	-(-)	-(-)
ASTER ENGELMANNII	5(1)	16(2)	-(-)	-(-)	7(2)	-(-)	-(-)	14(T)
ASTRAGALUS MISER	14(4)	16(1)	-(-)	32(1)	44(2)	-(-)	25(T)	-(-)
BALSAMORHIZA SAGITTATA	-(-)	-(-)	-(-)	-(-)	-(-)	11(4)	17(T)	43(5)
DELPHINIUM BARBEYI	27(5)	6(3)	17(2)	-(-)	-(-)	-(-)	-(-)	-(-)
DELPHINIUM OCCIDENTALE	14(3)	7(4)	-(-)	-(-)	4(4)	-(-)	-(-)	-(-)
EPILOBIUM ANGUSTIFOLIUM	30(1)	23(1)	17(T)	40(1)	26(1)	-(-)	-(-)	-(-)
ERIGERON PEREGRINUS	8(1)	12(1)	-(-)	16(T)	11(T)	-(-)	-(-)	-(-)
ERIOGONUM RACEMOSUM	-(-)	-(-)	-(-)	-(-)	-(-)	22(T)	17(T)	57(T)
GERANIUM RICHARDSONII	32(4)	11(1)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
GERANIUM VISCOSISSIMUM	-(-)	6(1)	33(2)	20(1)	4(T)	-(-)	17(T)	29(T)
HAPLOPAPPUS PARRYI	22(5)	10(1)	-(-)	12(T)	26(1)	-(-)	-(-)	-(-)
HELENIUM HOOPESII	8(3)	25(2)	50(1)	4(T)	4(4)	-(-)	-(-)	-(-)
HERACLEUM LANATUM	3(4)	4(1)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
HYMENOXYS RICHARDSONII	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	14(T)
LATHYRUS LANSZWERTII	16(9)	37(5)	67(15)	4(T)	22(2)	-(-)	8(T)	29(1)
LATHYRUS PAUCIFLORUS	3(40)	7(6)	-(-)	-(-)	-(-)	22(T)	-(-)	43(1)
LIGUSTICUM PORTERI	24(10)	13(1)	50(1)	4(T)	7(1)	-(-)	-(-)	14(1)
LUPINUS ARGENTEUS	24(5)	14(3)	-(-)	8(T)	26(2)	-(-)	-(-)	-(-)
MERTENSIA ARIZONICA	54(10)	19(1)	-(-)	4(2)	7(6)	-(-)	-(-)	-(-)
MERTENSIA CILIATA	5(6)	15(1)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
OSMORHIZA CHILENSIS	86(9)	76(3)	100(1)	-(-)	15(2)	11(1)	-(-)	14(T)
PEDICULARIS RACEMOSA	19(8)	5(3)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
POLEMONIUM PULCHERRIMUM	41(6)	8(1)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
PYROLA SECUNDA	43(3)	41(2)	17(2)	12(1)	26(1)	-(-)	-(-)	-(-)
SENECIO TRIANGULARIS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
SMILACINA STELLATA	3(T)	5(3)	67(5)	4(T)	-(-)	-(-)	-(-)	-(-)
STREPTOPUS AMPLEXIFOLIUS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
THALICTRUM FENDLERI	65(7)	54(3)	100(11)	16(T)	26(1)	33(T)	8(T)	-(-)
TRIFOLIUM LONGIPES	-(-)	12(1)	-(-)	4(2)	11(1)	-(-)	-(-)	-(-)
EQUISETUM ARVENSE	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)

(con.)

APPENDIX C.—(Con.)

NO. STANDS IN H.T.	ABCO/ BERE JUCO 13	ABCO/ BERE BERE 26	ABCO/ JUCO 5	ABCO/ SYOR 11	PIEN/ RIMO 20	PIPU/ EQAR 5	PIPU/ JUCO 13	PIPU/ BERE 12
TREES								
ABIES LASIOCARPA	15(1)	8(1)	20(T)	-(-)	15(1)	20(13)	15(T)	25(1)
ABIES CONCOLOR	100(39)	100(37)	100(39)	100(23)	-(-)	-(-)	-(-)	-(-)
PICEA ENGELMANNII	15(5)	-(-)	-(-)	-(-)	100(54)	20(5)	-(-)	8(1)
PICEA PUNGENS	38(38)	19(12)	40(23)	9(T)	-(-)	100(53)	100(38)	100(21)
PSEUDOTSUGA MENZIESII	85(22)	92(31)	80(6)	82(32)	-(-)	40(1)	23(15)	42(24)
PINUS FLEXILIS	54(9)	27(5)	60(6)	9(1)	-(-)	-(-)	23(2)	50(7)
PINUS LONGAEVA	15(10)	4(19)	20(65)	-(-)	-(-)	-(-)	8(1)	8(6)
PINUS PONDEROSA	54(15)	38(17)	20(T)	73(16)	-(-)	-(-)	38(11)	25(38)
POPULUS TREMULOIDES	62(26)	42(16)	60(33)	18(2)	15(7)	80(15)	38(32)	58(12)
PINUS EDULIS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
JUNIPERUS SCOPULORUM	15(T)	38(2)	20(15)	45(4)	-(-)	-(-)	46(7)	25(1)
JUNIPERUS OSTEOSPERMA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
SHRUBS								
ACER GLABRUM	31(2)	8(1)	-(-)	-(-)	-(-)	-(-)	-(-)	8(T)
AMELANCHIER ALNIFOLIA	38(1)	62(1)	20(T)	45(3)	-(-)	-(-)	23(1)	8(T)
ARCTOSTAPHYLOS PATULA	8(T)	15(T)	20(T)	9(T)	-(-)	-(-)	8(2)	-(-)
ARCTOSTAPHYLOS UVA-URSI	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	31(6)	-(-)
ARTEMISIA NOVA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
ARTEMISIA TRIDENTATA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	25(1)
BERBERIS REPENS	100(11)	100(13)	40(T)	55(T)	-(-)	-(-)	46(2)	75(2)
CEANOTHUS MARTINII	8(1)	8(T)	-(-)	9(T)	-(-)	-(-)	8(T)	-(-)
CERCOCARPUS LEDIFOLIUS	-(-)	4(T)	-(-)	-(-)	-(-)	-(-)	8(T)	-(-)
CERCOCARPUS MONTANUS	-(-)	4(T)	-(-)	27(1)	-(-)	-(-)	-(-)	8(1)
CHRYSOTHAMNUS PARRYI	-(-)	4(T)	-(-)	18(5)	-(-)	-(-)	8(T)	8(T)
CHRYSOTHAMNUS VISCIDIFLORUS	-(-)	8(T)	-(-)	-(-)	-(-)	-(-)	15(T)	-(-)
JUNIPERUS COMMUNIS	100(12)	27(2)	100(20)	18(T)	20(1)	20(T)	100(18)	67(1)
LINNAEA BOREALIS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
LONICERA INVOLUCRATA	-(-)	-(-)	-(-)	-(-)	-(-)	20(30)	8(1)	-(-)
LONICERA UTAHENSIS	8(1)	-(-)	20(T)	-(-)	-(-)	-(-)	15(1)	-(-)
PACHISTIMA MYRSINITES	85(2)	58(3)	20(1)	27(T)	-(-)	20(T)	38(2)	50(1)
PHYSOCARPUS MALVACEUS	8(4)	8(1)	-(-)	9(1)	-(-)	-(-)	-(-)	-(-)
PRUNUS VIRGINIANA	-(-)	4(4)	-(-)	-(-)	-(-)	-(-)	-(-)	8(T)
PURSHIA TRIDENTATA	-(-)	8(T)	-(-)	36(T)	-(-)	-(-)	23(T)	17(2)
QUERCUS GAMBELII	8(3)	19(1)	-(-)	36(1)	-(-)	-(-)	-(-)	8(T)
RIBES CEREUM	15(T)	27(1)	40(8)	45(1)	-(-)	-(-)	15(T)	42(1)
RIBES MONTIGENUM	8(1)	-(-)	-(-)	-(-)	100(8)	-(-)	-(-)	8(1)
RIBES VISCOSISSIMUM	8(7)	8(1)	20(1)	-(-)	-(-)	-(-)	8(1)	-(-)
ROSA WOODSII	92(1)	62(1)	40(T)	55(2)	5(T)	60(5)	77(2)	67(1)
SALIX SCOULERIANA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
SAMBUCUS RACEMOSA	-(-)	12(1)	-(-)	18(T)	-(-)	20(1)	8(T)	-(-)
SHEPHERDIA CANADENSIS	8(1)	4(1)	20(T)	9(T)	-(-)	-(-)	31(8)	33(2)
SHEPHERDIA ROTUNDIFOLIA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
SYMPHORICARPOS OREOPHILUS	92(5)	100(11)	80(1)	100(16)	-(-)	60(1)	85(3)	75(10)
VACCINIUM CAESPITOSUM	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
VACCINIUM MYRTILLUS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
XANTHOCEPHALUM SAROTHRAE	-(-)	8(1)	-(-)	27(2)	-(-)	-(-)	15(T)	8(T)

(con.)

APPENDIX C.—(Con.)

NO. STANDS IN H.T.	ABCO/ BERE JUCO 13	ABCO/ BERE BERE 26	ABCO/ JUCO 5	ABCO/ SYOR 11	PIEN/ RIMO 20	PIPU/ EQAR 5	PIPU/ JUCO 13	PIPU/ BERE 12
GRAMINOIDS								
AGROPYRON SPICATUM	-(-)	4(T)	-(-)	9(5)	-(-)	-(-)	8(T)	-(-)
BOUTELOUA GRACILIS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	8(T)
BROMUS CARINATUS	-(-)	-(-)	20(T)	-(-)	-(-)	-(-)	8(T)	-(-)
BROMUS CILIATUS	46(1)	27(1)	20(1)	18(1)	-(-)	20(T)	38(1)	42(3)
CAREX DISPERMA	-(-)	-(-)	-(-)	-(-)	-(-)	80(15)	-(-)	-(-)
CAREX GEYERI	-(-)	19(13)	-(-)	-(-)	-(-)	-(-)	-(-)	8(T)
CAREX ROSSII	69(2)	77(1)	100(2)	91(1)	80(1)	-(-)	77(2)	83(2)
ELYMUS GLAUCUS	-(-)	4(T)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
FESTUCA OVINA	-(-)	4(T)	-(-)	-(-)	75(4)	-(-)	-(-)	25(1)
GLYCERIA ELATA	-(-)	-(-)	-(-)	-(-)	-(-)	100(12)	-(-)	-(-)
KOELERIA NITIDA	-(-)	-(-)	-(-)	27(1)	5(T)	-(-)	15(T)	-(-)
MUHLENBERGIA MONTANA	-(-)	4(T)	-(-)	9(T)	-(-)	-(-)	8(6)	17(8)
ORYZOPSIS HYMENOIDES	8(T)	12(1)	-(-)	36(T)	-(-)	-(-)	23(1)	25(1)
POA	15(T)	-(-)	20(T)	-(-)	40(1)	40(1)	8(T)	-(-)
POA FENDLERIANA	31(T)	35(1)	-(-)	64(4)	5(T)	-(-)	31(2)	33(6)
POA NERVOSA	15(8)	12(1)	-(-)	-(-)	5(T)	-(-)	-(-)	17(T)
POA PRATENSIS	-(-)	4(1)	-(-)	-(-)	-(-)	20(3)	8(T)	-(-)
SITANION HYSTRIX	31(T)	27(1)	20(3)	45(1)	10(T)	-(-)	46(1)	33(1)
STIPA COLUMBIANA	8(1)	12(1)	20(35)	9(T)	-(-)	-(-)	-(-)	17(3)
STIPA COMATA	-(-)	-(-)	20(3)	9(T)	-(-)	-(-)	-(-)	17(1)
STIPA LETTERMANII	15(T)	31(1)	20(T)	36(1)	15(1)	-(-)	23(T)	25(1)
TRISETUM SPICATUM	-(-)	8(T)	-(-)	-(-)	45(1)	-(-)	-(-)	-(-)
FORBS								
ACHILLEA MILLEFOLIUM	23(6)	27(T)	40(1)	27(T)	95(1)	60(T)	54(1)	50(1)
ACONITUM COLUMBIANUM	-(-)	-(-)	-(-)	-(-)	-(-)	40(2)	-(-)	-(-)
ACTAEA RUBRA	-(-)	-(-)	-(-)	-(-)	-(-)	40(1)	-(-)	-(-)
AQUILEGIA COERULEA	8(2)	12(1)	-(-)	-(-)	45(1)	-(-)	-(-)	17(T)
ARABIS DRUMMONDII	8(T)	8(T)	-(-)	-(-)	35(T)	-(-)	15(1)	17(T)
ARNICA CORDIFOLIA	8(3)	12(12)	40(1)	9(4)	20(2)	-(-)	-(-)	-(-)
ASTER ENGELMANNII	-(-)	15(1)	-(-)	-(-)	-(-)	-(-)	-(-)	8(T)
ASTRAGALUS MISER	38(1)	19(1)	40(1)	-(-)	50(4)	-(-)	15(1)	33(3)
BALSAMORHIZA SAGITTATA	-(-)	4(T)	-(-)	36(9)	-(-)	-(-)	-(-)	-(-)
DELPHINIUM BARBEYI	-(-)	-(-)	-(-)	-(-)	10(2)	-(-)	-(-)	-(-)
DELPHINIUM OCCIDENTALE	-(-)	-(-)	-(-)	-(-)	5(T)	-(-)	-(-)	8(T)
EPILOBIUM ANGUSTIFOLIUM	-(-)	-(-)	-(-)	-(-)	40(1)	40(1)	15(T)	-(-)
ERIGERON PEREGRINUS	-(-)	-(-)	-(-)	-(-)	15(T)	-(-)	8(T)	-(-)
ERIOGONUM RACEMOSUM	-(-)	12(T)	-(-)	36(T)	-(-)	-(-)	8(T)	17(T)
GERANIUM RICHARDSONII	-(-)	-(-)	-(-)	-(-)	-(-)	100(3)	-(-)	-(-)
GERANIUM VISCOSISSIMUM	31(T)	42(2)	20(T)	9(T)	-(-)	-(-)	46(1)	25(2)
HAPLOPAPPUS PARRYI	23(6)	8(T)	20(T)	-(-)	5(4)	-(-)	8(1)	-(-)
HELENIUM HOOPESII	-(-)	-(-)	20(T)	-(-)	20(T)	-(-)	8(T)	8(T)
HERACLEUM LANATUM	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
HYMENOXYS RICHARDSONII	-(-)	4(T)	-(-)	9(T)	-(-)	-(-)	23(1)	8(T)
LATHYRUS LANSZWERTII	15(3)	38(1)	20(T)	18(3)	-(-)	-(-)	-(-)	25(3)
LATHYRUS PAUCIFLORUS	15(3)	12(7)	-(-)	-(-)	-(-)	-(-)	-(-)	8(8)
LIGUSTICUM PORTERI	-(-)	12(1)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
LUPINUS ARGENTEUS	-(-)	-(-)	-(-)	-(-)	15(1)	-(-)	8(3)	8(T)
MERTENSIA ARIZONICA	-(-)	4(T)	-(-)	-(-)	20(5)	20(1)	-(-)	8(T)
MERTENSIA CILIATA	-(-)	-(-)	20(T)	-(-)	30(T)	20(T)	-(-)	-(-)
OSMORHIZA CHILENSIS	8(1)	12(1)	-(-)	-(-)	-(-)	60(1)	-(-)	8(T)
PEDICULARIS RACEMOSA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
POLEMONIUM PULCHERRIMUM	-(-)	-(-)	-(-)	-(-)	85(3)	-(-)	-(-)	-(-)
PYROLA SECUNDA	8(T)	-(-)	20(T)	-(-)	5(1)	-(-)	-(-)	-(-)
SENECIO TRIANGULARIS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
SMILACINA STELLATA	8(T)	8(1)	-(-)	-(-)	-(-)	80(2)	38(T)	17(1)
STREPTOPUS AMPLEXIFOLIUS	-(-)	-(-)	-(-)	-(-)	-(-)	20(2)	-(-)	-(-)
THALICTRUM FENDLERI	15(1)	42(2)	40(1)	36(2)	10(1)	60(6)	46(1)	25(T)
TRIFOLIUM LONGIPES	-(-)	8(2)	-(-)	-(-)	10(2)	20(T)	-(-)	17(2)
EQUISETUM ARVENSE	-(-)	-(-)	-(-)	-(-)	-(-)	100(22)	15(T)	-(-)

(con.)

	PIFL-PILO	PSME/CELE	PSME/ARPA	PSME/CEMO	PSME/QUGA	PSME/BERE PIPO	PSME/BERE BERE	PSME/SYOR
NO. STANDS IN H.T.	18	11	5	5	5	8	21	19
TREES								
ABIES LASIOCARPA	6(2)	-(-)	-(-)	-(-)	-(-)	13(T)	-(-)	5(T)
ABIES CONCOLOR	11(T)	18(2)	-(-)	20(3)	20(T)	-(-)	-(-)	-(-)
PICEA ENGELMANNII	6(4)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
PICEA PUNGENS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	5(3)	11(1)
PSEUDOTSUGA MENZIESII	61(16)	100(15)	100(8)	100(15)	100(27)	100(28)	100(62)	100(24)
PINUS FLEXILIS	89(26)	-(-)	40(T)	-(-)	-(-)	25(T)	10(6)	5(T)
PINUS LONGAEVA	44(22)	9(13)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
PINUS PONDEROSA	6(1)	18(18)	100(19)	20(T)	80(38)	100(33)	5(1)	74(31)
POPULUS TREMULOIDES	22(12)	18(20)	-(-)	-(-)	20(1)	50(12)	33(6)	37(3)
PINUS EDULIS	6(2)	18(14)	-(-)	60(13)	-(-)	-(-)	-(-)	5(T)
JUNIPERUS SCOPULORUM	22(2)	55(11)	100(3)	60(3)	40(2)	75(6)	29(2)	42(2)
JUNIPERUS OSTEOSPERMA	-(-)	-(-)	-(-)	40(10)	-(-)	-(-)	-(-)	-(-)
SHRUBS								
ACER GLABRUM	-(-)	9(T)	-(-)	-(-)	20(T)	-(-)	19(2)	-(-)
AMELANCHIER ALNIFOLIA	22(1)	9(T)	-(-)	-(-)	80(2)	88(T)	38(1)	26(1)
ARCTOSTAPHYLOS PATULA	6(30)	9(T)	100(14)	-(-)	-(-)	-(-)	-(-)	-(-)
ARCTOSTAPHYLOS UVA-URSI	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
ARTEMISIA NOVA	-(-)	9(3)	-(-)	-(-)	-(-)	-(-)	-(-)	11(4)
ARTEMISIA TRIDENTATA	22(4)	45(8)	-(-)	-(-)	-(-)	13(T)	14(1)	11(1)
BERBERIS REPENS	44(3)	45(4)	100(1)	40(1)	80(3)	100(7)	100(9)	47(T)
CEANOTHUS MARTINII	-(-)	-(-)	80(5)	-(-)	-(-)	25(1)	-(-)	5(T)
CERCOCARPUS LEDIFOLIUS	11(23)	100(22)	20(1)	-(-)	-(-)	-(-)	5(T)	-(-)
CERCOCARPUS MONTANUS	17(4)	-(-)	40(4)	80(12)	20(T)	-(-)	5(T)	5(T)
CHRYSOTHAMNUS PARRYI	-(-)	-(-)	20(T)	-(-)	-(-)	13(T)	-(-)	21(1)
CHRYSOTHAMNUS VISCIDIFLORUS	17(8)	27(1)	20(T)	-(-)	-(-)	25(T)	14(T)	21(1)
JUNIPERUS COMMUNIS	67(7)	9(T)	20(T)	20(5)	40(3)	50(5)	33(2)	21(1)
LINNAEA BOREALIS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
LONICERA INVOLUCRATA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
LONICERA UTAHENSIS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
PACHISTIMA MYRSINITES	22(1)	9(T)	-(-)	20(1)	40(2)	-(-)	48(1)	5(T)
PHYSOCARPUS MALVACEUS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
PRUNUS VIRGINIANA	11(2)	-(-)	-(-)	-(-)	20(T)	13(T)	10(1)	11(1)
PURSHIA TRIDENTATA	6(T)	27(1)	20(8)	20(T)	20(T)	50(2)	-(-)	26(3)
QUERCUS GAMBELII	-(-)	18(10)	40(1)	-(-)	100(20)	13(2)	5(4)	16(1)
RIBES CEREUM	56(7)	27(1)	40(T)	20(1)	60(2)	13(T)	10(2)	42(1)
RIBES MONTIGENUM	11(2)	-(-)	-(-)	-(-)	-(-)	-(-)	19(1)	-(-)
RIBES VISCOSISSIMUM	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	10(1)	5(T)
ROSA WOODSII	39(2)	9(4)	20(1)	-(-)	60(2)	50(T)	48(2)	37(1)
SALIX SCOULERIANA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
SAMBUCUS RACEMOSA	11(T)	9(6)	40(T)	-(-)	-(-)	-(-)	10(T)	11(T)
SHEPHERDIA CANADENSIS	6(3)	-(-)	-(-)	-(-)	-(-)	-(-)	10(T)	5(T)
SHEPHERDIA ROTUNDIFOLIA	-(-)	-(-)	20(2)	40(3)	-(-)	-(-)	-(-)	-(-)
SYMPHORICARPOS OREOPHILUS	72(10)	73(7)	80(3)	60(3)	100(32)	100(4)	95(15)	100(2)
VACCINIUM CAESPITOSUM	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
VACCINIUM MYRTILLUS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
XANTHOCEPHALUM SAROTHRAE	6(3)	9(1)	20(2)	20(T)	-(-)	25(T)	-(-)	16(1)

(con.)

	PIFL-PILO	PSME/CELE	PSME/ARPA	PSME/CEMO	PSME/QUGA	PSME/BERE PIPO	PSME/BERE BERE	PSME/SYOR
NO. STANDS IN H.T.	18	11	5	5	5	8	21	19
GRAMINOIDS								
AGROPYRON SPICATUM	6(1)	9(1)	20(7)	-(-)	-(-)	-(-)	10(1)	16(3)
BOUTELOUA GRACILIS	-(-)	-(-)	20(T)	20(T)	-(-)	-(-)	-(-)	11(1)
BROMUS CARINATUS	17(1)	-(-)	-(-)	-(-)	-(-)	-(-)	10(T)	5(T)
BROMUS CILIATUS	6(T)	-(-)	20(T)	-(-)	20(T)	13(T)	19(T)	16(T)
CAREX DISPERMA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
CAREX GEYERI	-(-)	-(-)	20(T)	-(-)	20(20)	-(-)	5(45)	11(2)
CAREX ROSSII	56(1)	45(1)	80(1)	80(T)	100(1)	100(1)	67(1)	74(1)
ELYMUS GLAUCUS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
FESTUCA OVINA	22(1)	9(T)	-(-)	20(T)	-(-)	38(2)	-(-)	37(1)
GLYCERIA ELATA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
KOELERIA NITIDA	6(2)	9(1)	20(T)	-(-)	60(2)	38(T)	5(T)	32(1)
MUHLENBERGIA MONTANA	11(9)	-(-)	20(T)	-(-)	40(T)	-(-)	-(-)	26(1)
ORYZOPSIS HYMENOIDES	11(3)	18(1)	40(T)	40(1)	20(T)	38(T)	-(-)	11(1)
POA	-(-)	-(-)	-(-)	-(-)	20(2)	-(-)	5(1)	-(-)
POA FENDLERIANA	22(1)	45(8)	80(2)	-(-)	100(2)	50(3)	24(1)	68(4)
POA NERVOSA	-(-)	-(-)	-(-)	-(-)	20(3)	-(-)	5(3)	5(T)
POA PRATENSIS	11(1)	9(6)	-(-)	-(-)	-(-)	-(-)	5(T)	5(1)
SITANION HYSTRIX	22(1)	18(4)	60(1)	20(T)	60(2)	100(1)	24(T)	74(1)
STIPA COLUMBIANA	6(T)	9(2)	-(-)	-(-)	-(-)	13(T)	14(1)	-(-)
STIPA COMATA	6(1)	27(1)	20(T)	-(-)	-(-)	13(3)	-(-)	16(4)
STIPA LETTERMANII	22(2)	9(3)	-(-)	-(-)	40(13)	25(T)	43(1)	5(2)
TRISETUM SPICATUM	6(T)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
FORBS								
ACHILLEA MILLEFOLIUM	33(1)	9(2)	40(T)	-(-)	40(1)	38(1)	5(T)	11(1)
ACONITUM COLUMBIANUM	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
ACTAEA RUBRA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
AQUILEGIA COERULEA	17(T)	-(-)	-(-)	-(-)	-(-)	-(-)	5(T)	-(-)
ARABIS DRUMMONDII	11(T)	9(T)	-(-)	-(-)	20(T)	25(T)	10(T)	5(T)
ARNICA CORDIFOLIA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	5(T)	-(-)
ASTER ENGELMANNII	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
ASTRAGALUS MISER	33(7)	-(-)	20(T)	20(1)	-(-)	38(1)	-(-)	-(-)
BALSAMORHIZA SAGITTATA	6(2)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
DELPHINIUM BARBEYI	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
DELPHINIUM OCCIDENTALE	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
EPILOBIUM ANGUSTIFOLIUM	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
ERIGERON PEREGRINUS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
ERIOGONUM RACEMOSUM	-(-)	18(T)	60(T)	-(-)	20(T)	25(T)	5(T)	21(T)
GERANIUM RICHARDSONII	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
GERANIUM VISCOSISSIMUM	11(T)	-(-)	-(-)	-(-)	-(-)	50(T)	5(T)	21(1)
HAPLOPAPPUS PARRYI	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
HELENIUM HOOPESII	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	5(2)
HERACLEUM LANATUM	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
HYMENOXYS RICHARDSONII	39(2)	18(1)	80(T)	20(T)	20(T)	13(1)	-(-)	47(1)
LATHYRUS LANSZWERTII	33(1)	18(15)	-(-)	-(-)	40(2)	-(-)	29(2)	11(2)
LATHYRUS PAUCIFLORUS	11(3)	9(2)	-(-)	-(-)	20(T)	-(-)	14(7)	-(-)
LIGUSTICUM PORTERI	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	10(1)	11(T)
LUPINUS ARGENTEUS	6(T)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	11(2)
MERTENSIA ARIZONICA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	5(T)	-(-)
MERTENSIA CILIATA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
OSMORHIZA CHILENSIS	-(-)	9(T)	-(-)	-(-)	-(-)	-(-)	24(1)	-(-)
PEDICULARIS RACEMOSA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
POLEMONIUM PULCHERRIMUM	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
PYROLA SECUNDA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
SENECIO TRIANGULARIS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
SMILACINA STELLATA	17(1)	-(-)	-(-)	-(-)	20(1)	-(-)	14(1)	-(-)
STREPTOPUS AMPLEXIFOLIUS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
THALICTRUM FENDLERI	-(-)	-(-)	-(-)	-(-)	40(2)	63(1)	48(1)	21(T)
TRIFOLIUM LONGIPES	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
EQUISETUM ARVENSE	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)

(con.)

APPENDIX C.—(Con.)

	PIPO/ CELE	PIPO/ ARPA	PIPO/ ARNO	PIPO/ PUTR	PIPO/ QUGA SYOR	PIPO/ QUGA QUGA	PIPO/ SYOR	PIPO/ MUMO
NO. STANDS IN H.T.	6	15	8	21	15	14	6	8
TREES								
ABIES LASIOCARPA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	17(T)	-(-)
ABIES CONCOLOR	17(T)	-(-)	-(-)	-(-)	-(-)	-(-)	17(T)	-(-)
PICEA ENGELMANNII	-(-)	7(1)	-(-)	5(T)	-(-)	-(-)	-(-)	-(-)
PICEA PUNGENS	-(-)	7(T)	13(1)	-(-)	-(-)	-(-)	-(-)	-(-)
PSEUDOTSUGA MENZIESII	17(1)	7(1)	25(T)	14(1)	13(1)	7(T)	33(T)	13(T)
PINUS FLEXILIS	-(-)	20(1)	25(4)	14(T)	-(-)	-(-)	-(-)	13(1)
PINUS LONGAEVA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
PINUS PONDEROSA	100(30)	100(31)	100(26)	100(35)	100(47)	100(45)	100(51)	100(34)
POPULUS TREMULOIDES	-(-)	-(-)	-(-)	-(-)	13(20)	-(-)	33(8)	13(T)
PINUS EDULIS	33(6)	-(-)	-(-)	14(1)	-(-)	7(25)	-(-)	13(7)
JUNIPERUS SCOPULORUM	83(9)	80(3)	75(2)	57(4)	27(2)	29(1)	33(1)	38(3)
JUNIPERUS OSTEOSPERMA	17(2)	-(-)	-(-)	-(-)	-(-)	7(20)	-(-)	13(T)
SHRUBS								
ACER GLABRUM	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
AMELANCHIER ALNIFOLIA	33(3)	20(2)	-(-)	10(T)	73(3)	50(2)	50(2)	13(T)
ARCTOSTAPHYLOS PATULA	-(-)	100(8)	-(-)	-(-)	7(T)	-(-)	-(-)	13(T)
ARCTOSTAPHYLOS UVA-URSI	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
ARTEMISIA NOVA	-(-)	7(T)	100(14)	-(-)	-(-)	-(-)	-(-)	25(T)
ARTEMISIA TRIDENTATA	50(13)	7(T)	25(1)	24(12)	27(5)	57(6)	17(1)	25(18)
BERBERIS REPENS	33(1)	73(1)	-(-)	48(1)	80(5)	64(5)	67(5)	25(T)
CEANOTHUS MARTINII	-(-)	40(2)	-(-)	14(T)	-(-)	7(T)	-(-)	-(-)
CERCOCARPUS LEDIFOLIUS	100(12)	-(-)	-(-)	5(T)	-(-)	7(1)	-(-)	-(-)
CERCOCARPUS MONTANUS	-(-)	13(8)	-(-)	5(1)	13(T)	7(T)	-(-)	-(-)
CHRYSOTHAMNUS PARRYI	-(-)	33(T)	50(1)	19(1)	-(-)	7(T)	-(-)	25(T)
CHRYSOTHAMNUS VISCIDIFLORUS	50(1)	13(T)	63(1)	19(3)	13(1)	7(2)	-(-)	38(T)
JUNIPERUS COMMUNIS	-(-)	-(-)	25(T)	5(T)	7(1)	-(-)	-(-)	-(-)
LINNAEA BOREALIS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
LONICERA INVOLUCRATA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
LONICERA UTAHENSIS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
PACHISTIMA MYRSINITES	-(-)	-(-)	-(-)	-(-)	7(T)	-(-)	-(-)	-(-)
PHYSOCARPUS MALVACEUS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
PRUNUS VIRGINIANA	17(2)	-(-)	-(-)	-(-)	7(T)	-(-)	-(-)	-(-)
PURSHIA TRIDENTATA	17(1)	67(4)	50(2)	100(8)	27(T)	43(T)	50(T)	75(T)
QUERCUS GAMBELII	33(24)	33(8)	13(T)	48(8)	100(35)	100(29)	100(1)	50(1)
RIBES CEREUM	17(1)	13(T)	25(T)	14(1)	7(1)	-(-)	-(-)	50(1)
RIBES MONTIGENUM	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
RIBES VISCOSISSIMUM	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
ROSA WOODSII	17(8)	7(T)	-(-)	5(T)	60(8)	21(1)	50(T)	-(-)
SALIX SCOULERIANA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
SAMBUCUS RACEMOSA	-(-)	20(T)	-(-)	5(T)	-(-)	7(T)	-(-)	-(-)
SHEPHERDIA CANADENSIS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
SHEPHERDIA ROTUNDIFOLIA	-(-)	-(-)	-(-)	5(1)	-(-)	7(3)	-(-)	13(2)
SYMPHORICARPOS OREOPHILUS	67(1)	33(1)	38(1)	62(2)	100(29)	71(2)	100(17)	75(1)
VACCINIUM CAESPITOSUM	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
VACCINIUM MYRTILLUS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
XANTHOCEPHALUM SAROTHRAE	-(-)	40(T)	38(1)	29(1)	20(1)	21(T)	50(T)	50(1)

(con.)

APPENDIX C.—(Con.)

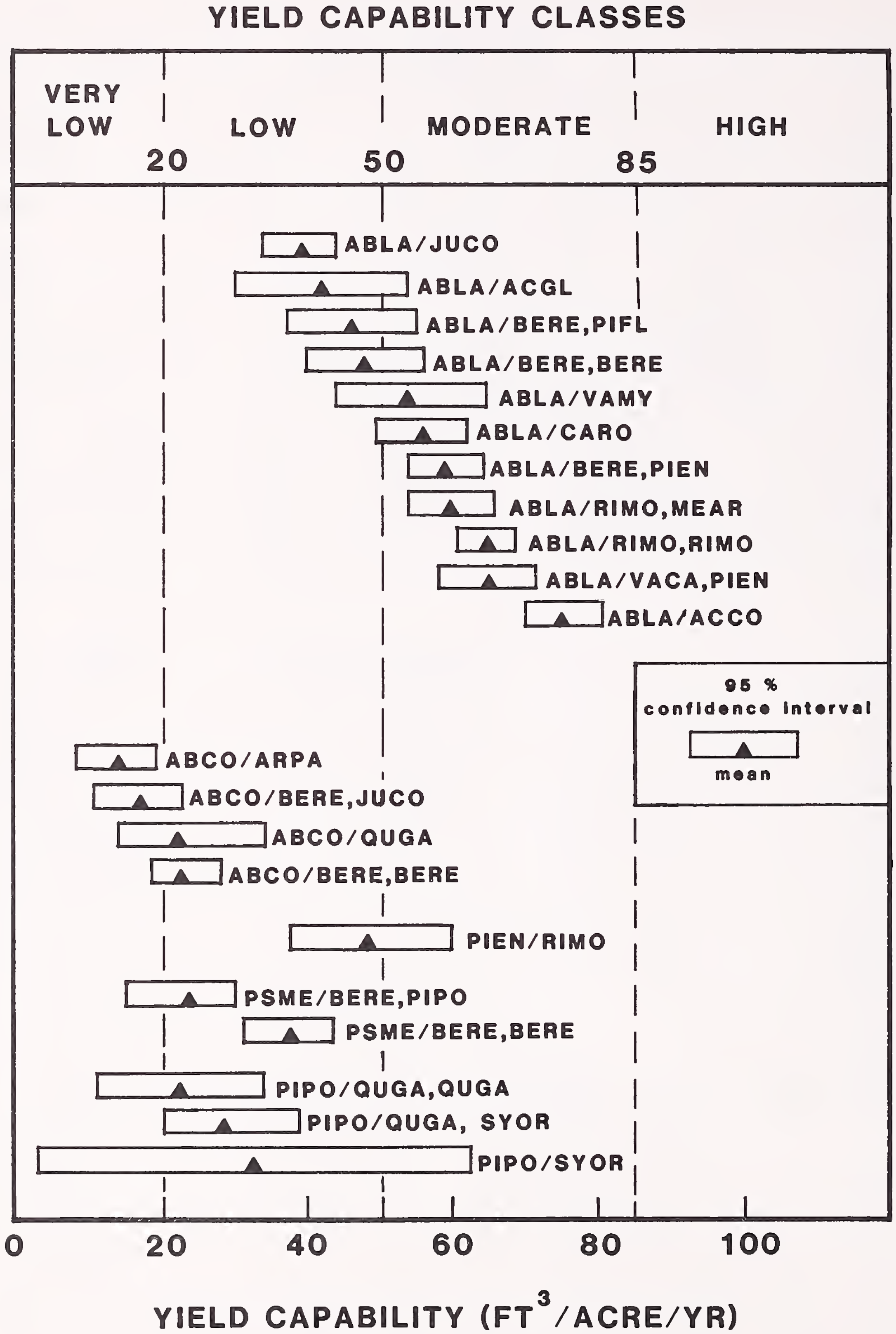
	PIPO/ CELE	PIPO/ ARPA	PIPO/ ARNO	PIPO/ PUTR	PIPO/ QUGA SYOR	PIPO/ QUGA QUGA	PIPO/ SYOR	PIPO/ MUMO
NO. STANDS IN H.T.	6	15	8	21	15	14	6	8
GRAMINOIDS								
AGROPYRON SPICATUM	-(-)	13(1)	13(T)	19(1)	-(-)	-(-)	-(-)	-(-)
BOUTELOUA GRACILIS	17(3)	7(T)	63(1)	38(1)	20(2)	21(1)	-(-)	50(2)
BROMUS CARINATUS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
BROMUS CILIATUS	-(-)	13(4)	13(T)	-(-)	27(1)	7(T)	17(T)	-(-)
CAREX DISPERMA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
CAREX GEYERI	-(-)	-(-)	-(-)	29(1)	33(24)	14(T)	-(-)	25(2)
CAREX ROSSII	33(1)	87(1)	38(3)	57(1)	73(1)	57(1)	83(1)	50(1)
ELYMUS GLAUCUS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
FESTUCA OVINA	-(-)	7(1)	13(1)	14(1)	-(-)	-(-)	-(-)	25(T)
GLYCERIA ELATA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
KOELERIA NITIDA	17(1)	20(1)	63(1)	33(2)	67(2)	57(3)	67(1)	-(-)
MUHLENBERGIA MONTANA	-(-)	13(T)	13(T)	43(1)	20(3)	21(1)	67(1)	50(1)
ORYZOPSIS HYMENOIDES	17(3)	53(1)	38(2)	38(T)	-(-)	7(T)	17(T)	63(1)
POA	-(-)	-(-)	-(-)	-(-)	7(T)	7(15)	17(2)	-(-)
POA FENDLERIANA	17(1)	47(2)	38(5)	81(6)	93(4)	86(4)	100(7)	88(2)
POA NERVOSA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
POA PRATENSIS	33(5)	7(T)	-(-)	-(-)	40(20)	7(15)	-(-)	-(-)
SITANION HYSTRIX	67(3)	47(1)	75(1)	90(4)	93(4)	79(2)	100(6)	100(3)
STIPA COLUMBIANA	-(-)	-(-)	-(-)	-(-)	27(3)	7(T)	-(-)	-(-)
STIPA COMATA	33(4)	20(1)	25(2)	38(1)	33(4)	36(4)	33(3)	38(T)
STIPA LETTERMANII	17(2)	13(2)	-(-)	5(2)	7(T)	-(-)	-(-)	-(-)
TRISETUM SPICATUM	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
FORBS								
ACHILLEA MILLEFOLIUM	17(T)	13(T)	13(T)	10(T)	73(1)	36(1)	50(2)	13(T)
ACONITUM COLUMBIANUM	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
ACTAEA RUBRA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
AQUILEGIA COERULEA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
ARABIS DRUMMONDII	-(-)	13(T)	-(-)	5(T)	20(T)	-(-)	-(-)	13(T)
ARNICA CORDIFOLIA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
ASTER ENGELMANNII	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
ASTRAGALUS MISER	-(-)	-(-)	-(-)	10(T)	-(-)	-(-)	-(-)	13(1)
BALSAMORHIZA SAGITTATA	-(-)	13(1)	-(-)	10(1)	13(T)	14(1)	-(-)	-(-)
DELPHINIUM BARBEYI	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
DELPHINIUM OCCIDENTALE	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
EPILOBIUM ANGUSTIFOLIUM	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
ERIGERON PEREGRINUS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
ERIOGONUM RACEMOSUM	67(T)	53(T)	75(T)	81(T)	60(T)	86(T)	83(T)	75(T)
GERANIUM RICHARDSONII	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
GERANIUM VISCOSISSIMUM	-(-)	-(-)	-(-)	-(-)	-(-)	7(T)	-(-)	13(T)
HAPLOPAPPUS PARRYI	-(-)	7(T)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
HELENIUM HOOPESII	-(-)	-(-)	-(-)	5(T)	-(-)	-(-)	-(-)	-(-)
HERACLEUM LANATUM	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
HYMENOXYS RICHARDSONII	33(T)	40(T)	75(1)	67(1)	-(-)	7(T)	50(T)	63(T)
LATHYRUS LANSZWERTII	17(T)	-(-)	-(-)	5(1)	40(3)	21(1)	33(2)	-(-)
LATHYRUS PAUCIFLORUS	-(-)	-(-)	-(-)	-(-)	13(3)	-(-)	-(-)	-(-)
LIGUSTICUM PORTERI	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
LUPINUS ARGENTEUS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	17(1)	-(-)
MERTENSIA ARIZONICA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
MERTENSIA CILIATA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
OSMORHIZA CHILENSIS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
PEDICULARIS RACEMOSA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
POLEMONIUM PULCHERRIMUM	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
PYROLA SECUNDA	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
SENECIO TRIANGULARIS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
SMILACINA STELLATA	-(-)	-(-)	13(T)	-(-)	7(1)	-(-)	-(-)	-(-)
STREPTOPUS AMPLEXIFOLIUS	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)
THALICTRUM FENDLERI	-(-)	-(-)	-(-)	-(-)	7(1)	-(-)	-(-)	13(T)
TRIFOLIUM LONGIPES	-(-)	-(-)	-(-)	-(-)	7(2)	-(-)	-(-)	13(T)
EQUISETUM ARVENSE	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)	-(-)

APPENDIX D.—MEAN BASAL AREAS AND 50-YEAR SITE INDEXES FOR CENTRAL AND SOUTHERN UTAH HABITAT TYPES AND PHASES

Means are shown where n = 4 or more; confidence limits (95 percent) for estimating the mean are given where n = 5 or more.

Habitat type, phase	Basal area (ft^2/acre)	Site index by species							Total number of site trees
		ABLA	ABCO	PIEN	PSME	PIPU	PIFL	PIPO	
ABLA/ACCO	233±63	50±10	•	56± 3	•	•	•	•	34
ABLA/VACA,PIEN	182±56	52± 9	•	49± 4	•	•	•	•	31
ABLA /VAMY	306± ?	•	•	48± ?	•	•	•	•	7
ABLA/BERE,PIFL	224±48	•	•	•	42± 9	•	•	•	16
ABLA/BERE,PIEN	208±24	44± 5		49± 4	45± 7	42± ?	•	•	91
ABLA/BERE,BERE	181±37	44±11	•	•	35± 4	46± 7	•	•	26
ABLA/RIMO,MEAR	293±43	42± 6	•	47± 6	•	•	•	•	34
ABLA/RIMO,RIMO	245±17	45± 3	•	50± 2	45±12	•	•	•	228
ABLA/JUCO	179±24	33± 9	•	35± 6	30± 5	36± 7	•	•	40
ABLA/CARO	199±22	44± 7	•	50± 4	35± 4	•	•	•	56
ABCO/CELE	101±61	•	30± 8	•	32±11	•	•	32±11	12
ABCO/ARPA	122±29	•	21± ?	•	34± 9	•	•	34± 9	11
ABCO/QUGA	128±50	•	37± 7	•	47± 5	•	•	39±12	11
ABCO/BERE,JUCO	189±36	•	39±14	•	40± 7	•	•	46± ?	18
ABCO/BERE,BERE	196±24	•	38± 6	•	41± 4	•	•	36±10	40
ABCO/SYOR	113±25	•	31± ?	•	29± 8	•	•	30±12	12
PIEN/RIMO	160±64	•	•	38± 6	•	•	•	•	20
PIPU/JUCO	137±32	•	•	•	•	41± 4	•	33±12	19
PIPU/BERE	168±71	•	•	•	33± 8	51± 7	•	42±26	14
PIFL-PILO	130±74	•	•	•	27± ?	•	19± ?	•	13
PSME/CELE	47± ?	•	•	•	27±14	•	•	•	4
PSME/BERE,PIPO	150±55	•	•	•	34± 5	•	•	42± 6	11
PSME/BERE,BERE	158±36	•	•	•	36± 4	•	•	•	23
PSME/SYOR	126±26	•	•	•	36± 6	•	•	40± 7	19
PIPO/CELE	57±42	•	•	•	•	•	•	42±14	6
PIPO/ARPA	81±19	•	•	•	•	•	•	32± 3	25
PIPO/ARNO	73±27	•	•	•	•	•	•	33± 8	10
PIPO/PUTR	87±21	•	•	•	•	•	•	32± 3	29
PIPO/QUGA,SYOR	156±27	•	•	•	•	•	•	40± 4	25
PIPO/QUGA,QUGA	134±35	•	•	•	•	•	•	37± 4	27
PIPO/SYOR	150±29	•	•	•	•	•	•	45± 9	7
PIPO/MUMO	100±35	•	•	•	•	•	•	36± 5	12

APPENDIX E.—ESTIMATED YIELD CAPABILITIES FOR CENTRAL AND SOUTHERN UTAH HABITAT TYPES AND PHASES BASED UPON SITE INDEX, GROWTH, AND STOCKABILITY FACTORS



APPENDIX F.—SUBSTRATE FEATURES OF CENTRAL AND SOUTHERN UTAH HABITAT TYPES AND PHASES

Series	*Abies lasiocarpa*							
Habitat type	**ACCO**	**VACA**	**VAMY**	**BERE**	**BERE**	**BERE**	**RIMO**	**RIMO**
Phase		**PIEN**		**PIFL**	**PIEN**	**BERE**	**MEAR**	**RIMO**
No. of samples	**17**	**14**	**7**	**16**	**51**	**30**	**37**	**128**
	COARSE FRAGMENT TYPE (percent of samples)[1]							
SEDIMENTARY								
Limestone, dolomite[2]	12	•	•	56	38	13	24	35
Tertiary sandstone[3]	10	•	•	14	10	19	20	10
Cretaceous sandstone[4]	30	100	•	6	18	12	12	10
Jurassic sandstone[5]	•	•	•	•	2	•	•	2
Other sandstone[6]	•	•	•	•	•	•	•	1
METAMORPHIC								
Quartzite[7]	•	•	•	•	•	•	3	•
IGNEOUS								
Andesite[8]	36	•	100	12	16	28	24	16
Basaltic[9]	12	•	•	12	16	17	17	26
Unknown	•	•	•	•	•	11	•	•
	SUBSTRATE CHARACTERISTICS[10]							
EXPOSED ROCK (mean %)	3	2	4	5	8	6	5	4
BARE SOIL (mean %)	1	2	T	12	7	4	4	6
No. of observations	12	4	5	11	12	18	19	76
LITTER DEPTH (cm)	4.0	3.9	2.9	3.3	3.4	2.4	3.0	3.0
No. of observations	14	12	7	13	49	25	31	119

(con.)

APPENDIX F. (Con.)

Series	*Abies lasiocarpa*			*Abies concolor*					
Habitat type	CAGE	JUCO	CARO	CELE	QUGA	ARPA	BERE	BERE	SYOR
Phase							JUCO	BERE	
No. of observations	6	25	27	9	7	12	13	26	11
	COARSE FRAGMENT TYPE (percent of samples)[1]								
SEDIMENTARY									
Limestone, dolomite[2]	•	8	15	12	14	73	53	30	45
Tertiary sandstone[3]	•	4	•	13	30	•	26	16	28
Cretaceous sandstone[4]	•	•	11	13	•	•	6	30	9
Jurassic sandstone[5]	•	•	•	•	14	•	•	•	•
Other sandstone[6]	•	•	•	•	•	18	•	•	•
METAMORPHIC									
Quartzite[7]	•	•	•	12	14	•	•	4	•
IGNEOUS									
Andesitic[8]	100	28	19	38	14	9	15	16	9
Basaltic[9]	•	56	48	12	14	•	•	4	9
Unknown	•	4	7	•	•	•	6	•	•
	SUBSTRATE CHARACTERISTICS[10]								
EXPOSED ROCK (mean %)	T	15	5	5	7	3	3	8	3
BARE SOIL (mean %)	T	6	6	8	2	21	7	6	7
No. of observations	4	24	21	8	7	11	10	21	10
LITTER DEPTH (cm)	3.1	2.5	3.5	2.6	4.4	2.5	2.3	3.9	2.5
No. of observations	6	24	22	8	7	11	13	25	10

Series	*Picea engelmannii*	*Picea pungens*		*Pinus flexilis-Pinus longaeva*	*Pseudotsuga menziesii*		
Habitat type	RIMO	JUCO	BERE		CELE	BERE	BERE
Phase						PIPO	BERE
No. of observations	20	13	12	18	11	8	21
	COARSE FRAGMENT TYPE (percent of samples)[1]						
SEDIMENTARY							
Limestone, dolomite[2]	5	53	18	28	•	26	5
Tertiary sandstone[3]	•	•	27	28	9	•	33
Cretaceous sandstone[4]	•	31	12	33	64	37	48
Jurassic sandstone[5]	•	•	•	•	•	•	•
Other sandstone[6]	•	•	•	•	•	•	•
METAMORPHIC							
Quartzite[7]	•	•	•	•	•	•	•
IGNEOUS							
Andesitic[8]	95	16	10	13	18	12	5
Basaltic[9]	•	•	27	16	9	25	10
Unknown	•	•	6	•	•	•	•
	SUBSTRATE CHARACTERISTICS						
EXPOSED ROCK (mean %)	14	2	4	4	7	11	7
BARE SOIL (mean %)	11	9	13	32	8	6	5
No. of observations	20	11	9	14	4	8	10
LITTER DEPTH (cm)	2.5	3.0	2.4	1.8	1.3	2.4	3.2
No. of observations	14	13	10	14	10	7	18

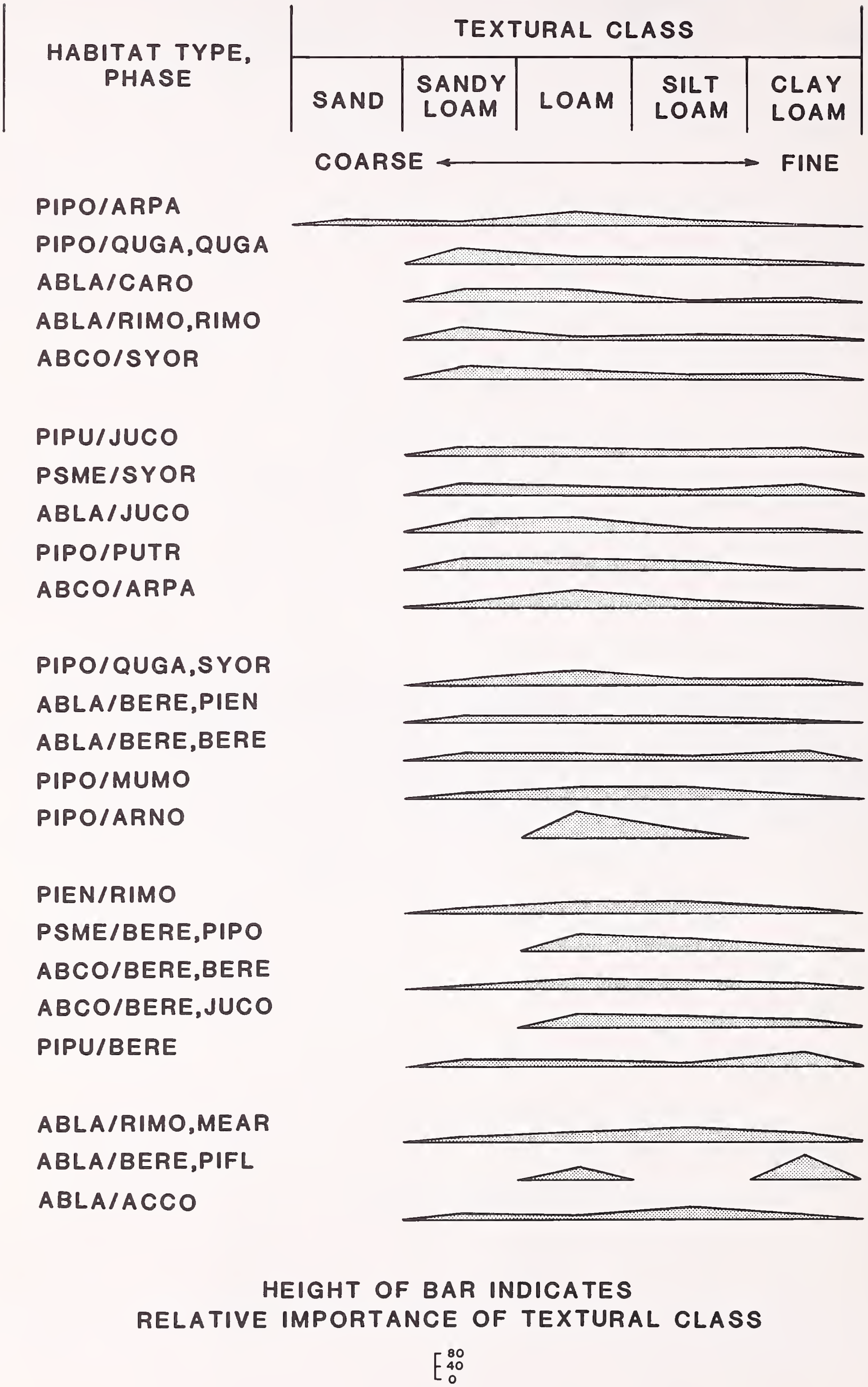
(con.)

APPENDIX F. (Con.)

Series	*Pseudotsuga menziesii*	*Pinus ponderosa*							
Habitat type	**SYOR**	**CELE**	**ARPA**	**ARNO**	**PUTR**	**QUGA**	**QUGA**	**SYOR**	**MUMO**
Phase						**SYOR**	**QUGA**		
No. of observations	**19**	**6**	**15**	**8**	**21**	**15**	**14**	**6**	**8**
				COARSE FRAGMENT TYPE (percent of samples)[1]					
SEDIMENTARY									
Limestone, dolomite[2]	•	•	53	25	10	33	14	•	•
Tertiary sandstone[3]	11	33	•	•	4	•	•	•	12
Cretaceous sandstone[4]	•	•	7	13	•	27	21	•	•
Jurassic sandstone[5]	•	•	7	•	24	27	29	•	•
Other sandstone[6]	•	•	19	•	•	7	7	50	•
METAMORPHIC									
Quartzite[7]	•	•	•	•	•	•	•	•	•
IGNEOUS									
Andesitic[8]	•	67	7	•	9	•	7	•	25
Basaltic[9]	84	•	7	62	4	6	22	50	63
Unknown	5	•	•	•	•	•	•	•	•
				SUBSTRATE CHARACTERISTICS					
EXPOSED ROCK (mean %)	10	2	3	2	9	1	5	8	9
BARE SOIL (mean %)	11	4	13	4	4	3	4	2	3
No. of observations	18	6	15	8	21	15	14	6	8
LITTER DEPTH (cm)	3.4	3.9	2.8	3.2	3.2	5.5	4.3	4.6	4.9
No. of observations	17	5	15	8	21	15	14	6	6

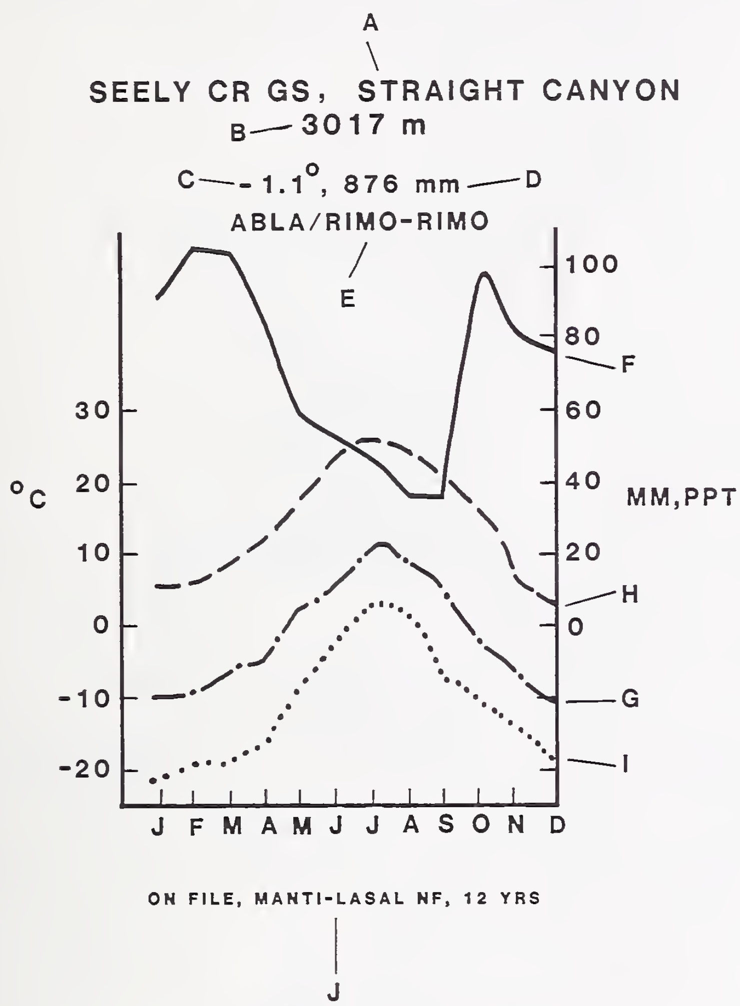
[1]Based upon geology maps.
[2]Includes undifferentiated limestone and sandstones, and Flagstaff and Wasatch Formations of Tertiary Period, Cenozoic Era.
[3]Includes Duchesne River, Green River member of Parachute, Uinta, and North Horn Formations of Tertiary Period, Cenozoic Era.
[4]Includes Black Hawk Group, Kaiparowits, Straight Cliffs, Star Point, Price River, and Dakota member of Burrow Canyon Formations of Cretaceous Period, Mesozoic Era.
[5]Includes Morrison, Entrata, and Navajo Formations of Jurassic Period, Mesozoic Era.
[6]Includes Moss Back member of Chinle and Hoskinnini member of Moenkopi Formations of Triassic Period, Mesozoic Era; Weber and Morgan Formations of Paleozoic Era; and Mancos Formation of Cretaceous Period.
[7]Includes Tintic Formation and Prospect member of Pioche Formation of Cambrian Period, Paleozoic Era.
[8]Includes intrusive granitoids and porphyrites, andesitic pyroclastics, latite flows, latitic ignimbrites, and tuffs of Tertiary Period, Cenozoic Era.
[9]Includes basalt, basaltic, and andesitic flows, breccia, and basaltic pyroclastics of Quaternary and Tertiary Periods, Cenozoic Era.
[10]T = trace.

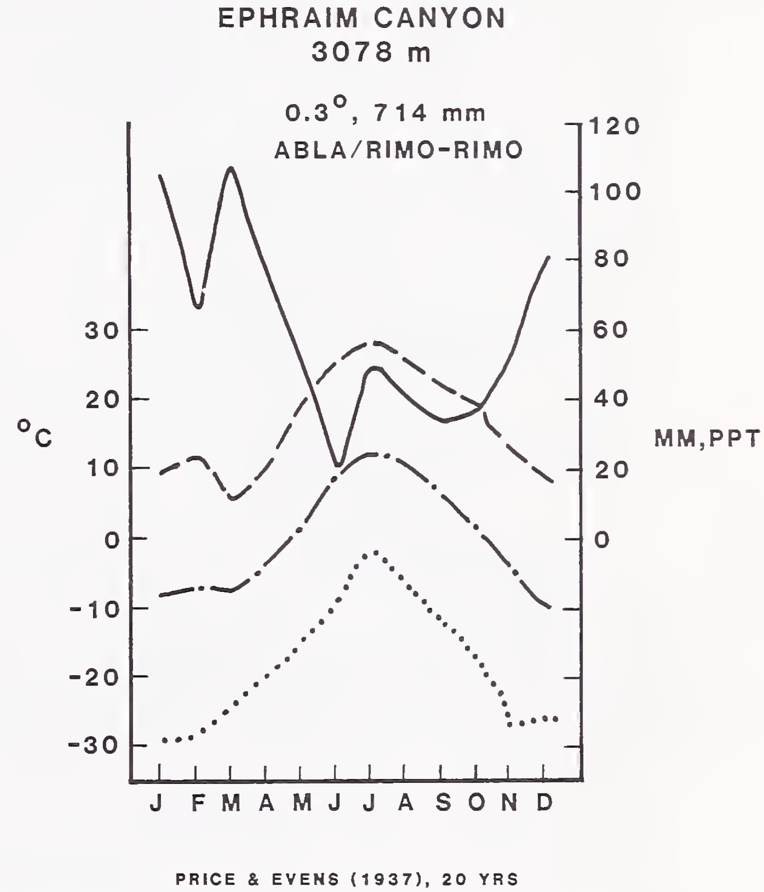
APPENDIX G.—GENERALIZED SURFACE TEXTURAL RELATIONSHIPS FOR CENTRAL AND SOUTHERN UTAH HABITAT TYPES AND PHASES



APPENDIX H.—CLIMATIC FACTORS FOR WEATHER STATIONS WITHIN SELECTED HABITAT TYPES IN CENTRAL AND SOUTHERN UTAH

A. Station location
B. Elevation (m)
C. Mean annual temperature (°C)
D. Mean annual precipitation (mm)
E. Habitat type for or adjacent to station
F. Pattern of mean monthly precipitation (mm)
G. Pattern of mean monthly temperature (°C)
H. Pattern of mean monthly maximim temperature (°C)
I. Pattern of mean monthly minimum temperature (°C)
J. Source of data and length of record



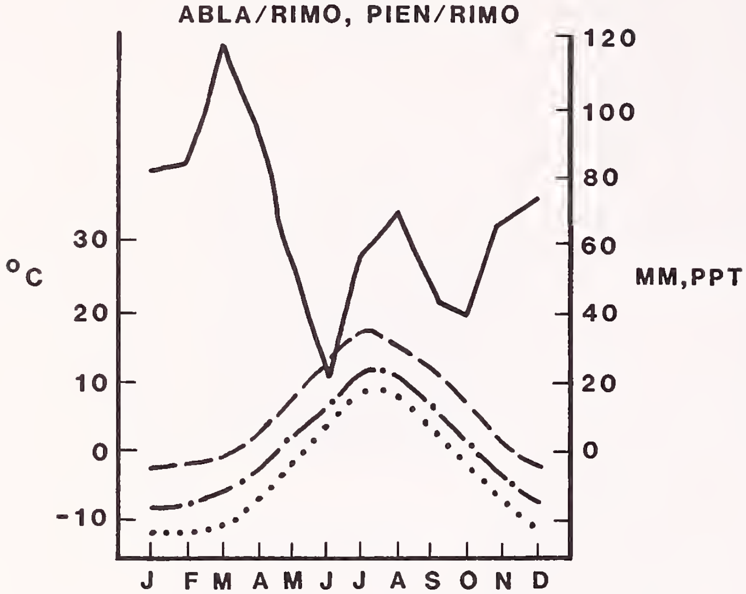


(con.)

APPENDIX H. (Con.)

BLOWHARD MTN RADAR
3260 m

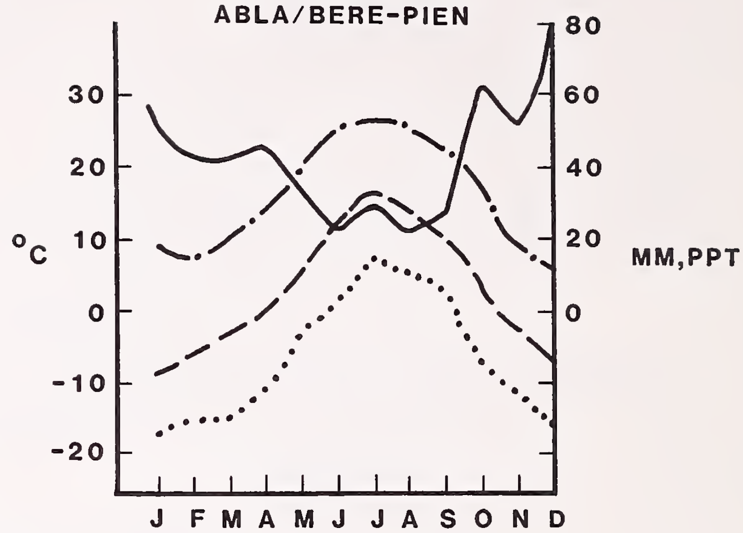
1.2°, 796 mm
ABLA/RIMO, PIEN/RIMO



NOAA, PROJECTED BY RICHARDSON, 20 YRS

ELECTRIC LAKE
2545 m

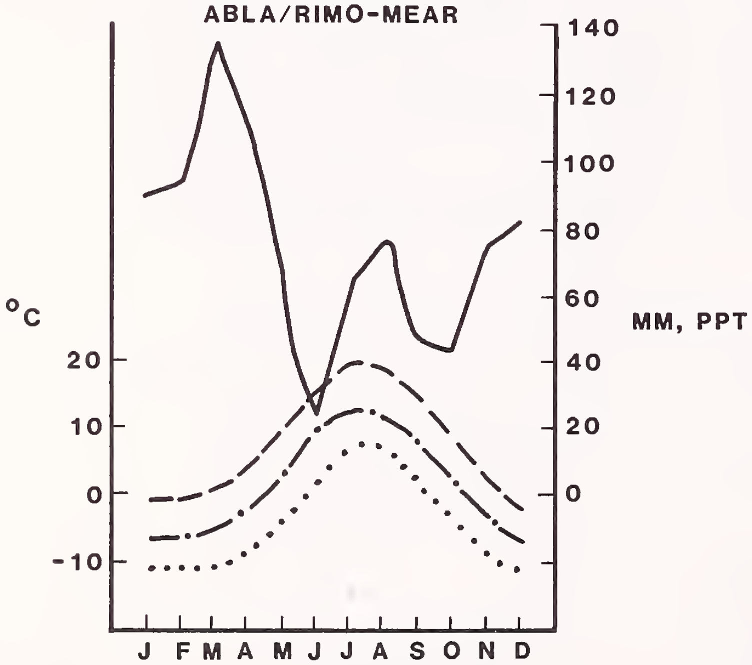
2.7°, 518 mm
ABLA/BERE-PIEN



ON FILE, MANTI-LASAL NF, 7 YRS

BLOWHARD MTN SITE B
3084 m

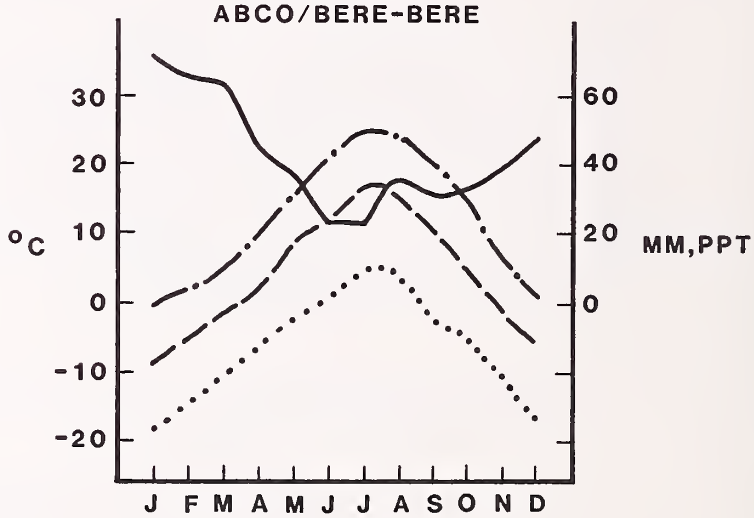
1.9°, 897 mm
ABLA/RIMO-MEAR



PROJECTED BY RICHARDSON

SCOFIELD
2353 m

3.9°, 515 mm
ABCO/BERE-BERE



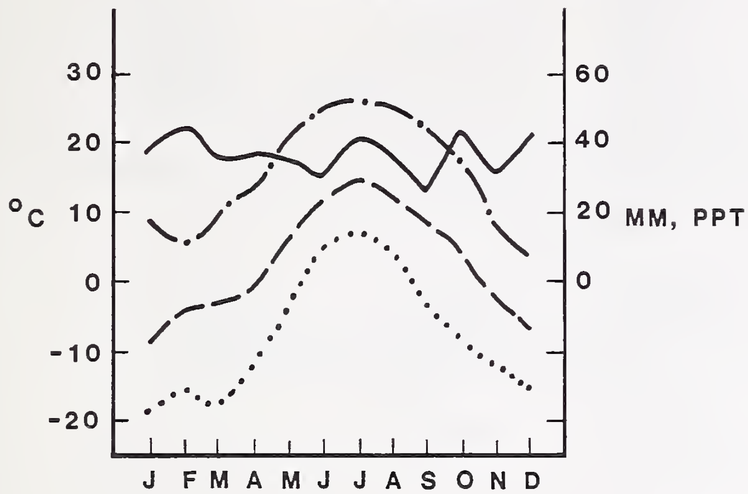
NOAA, 30 YRS

(con.)

APPENDIX H. (Con.)

CENTRAL WEATHER,
STRAIGHT CANYON
2712 m

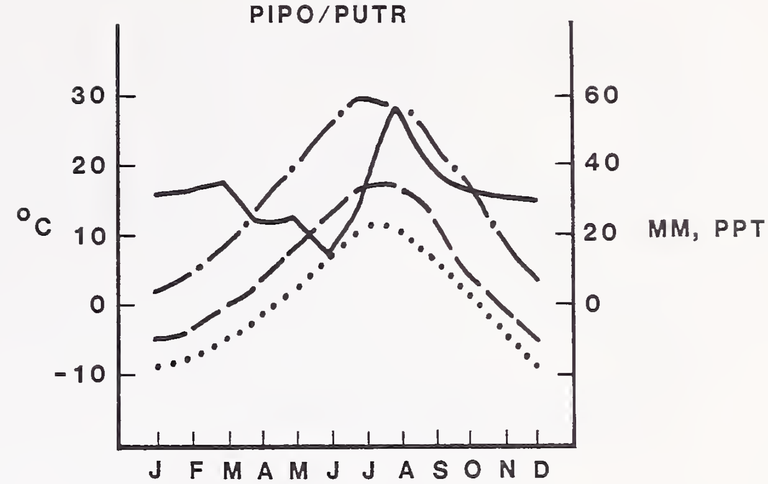
4.1°, 440 mm
ABCO/BERE-BERE



ON FILE, MANTI-LASAL NF, 12 YRS

BRYCE CANYON NP HDQ.
2412 m

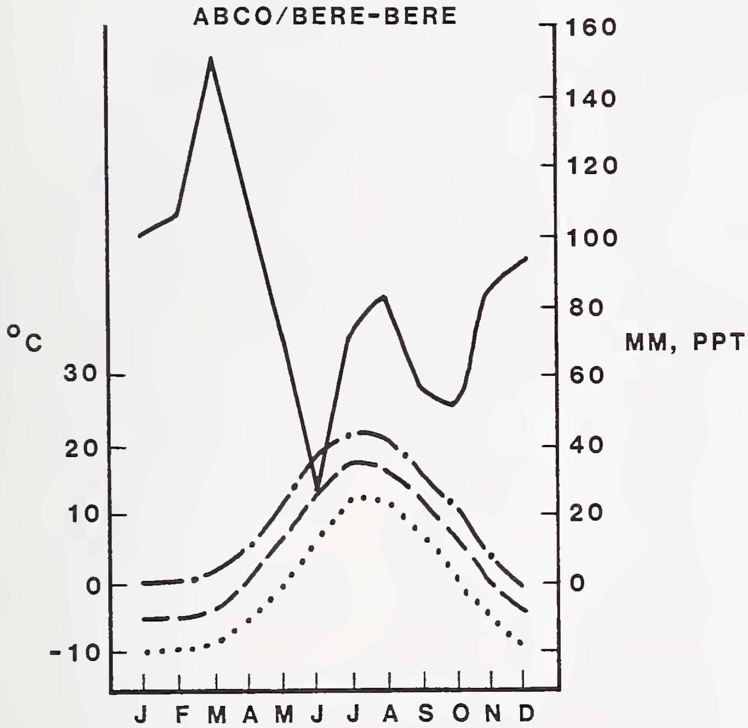
4.6°, 381 mm
PIPO/PUTR



NOAA, 30 YRS

BLOWHARD MTN SITE A
2682 m

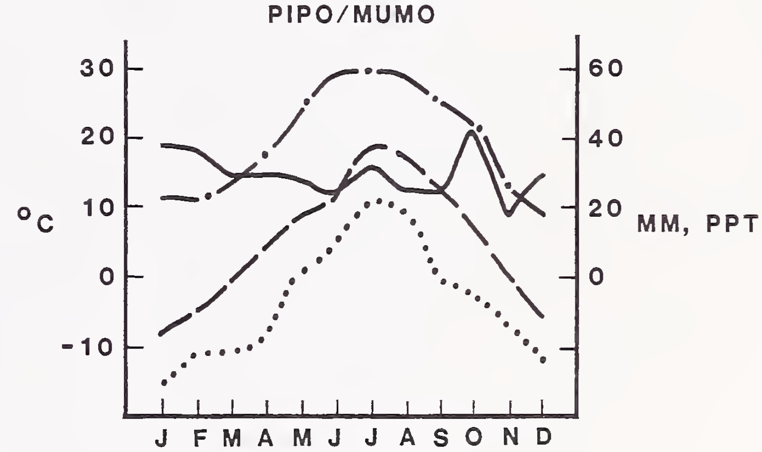
4.3°, 1019 mm
ABCO/BERE-BERE



PROJECTED BY RICHARDSON

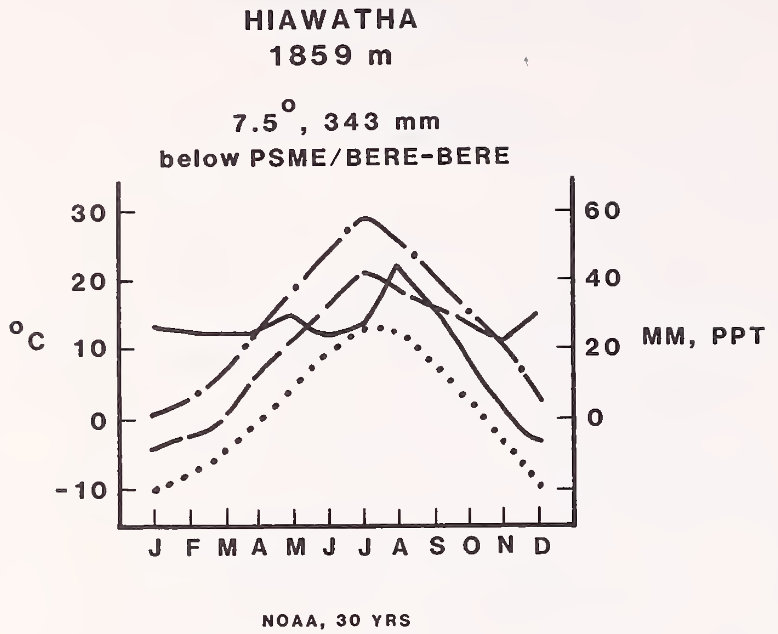
ORANGE OLSEN GS,
STRAIGHT CANYON
2207 m

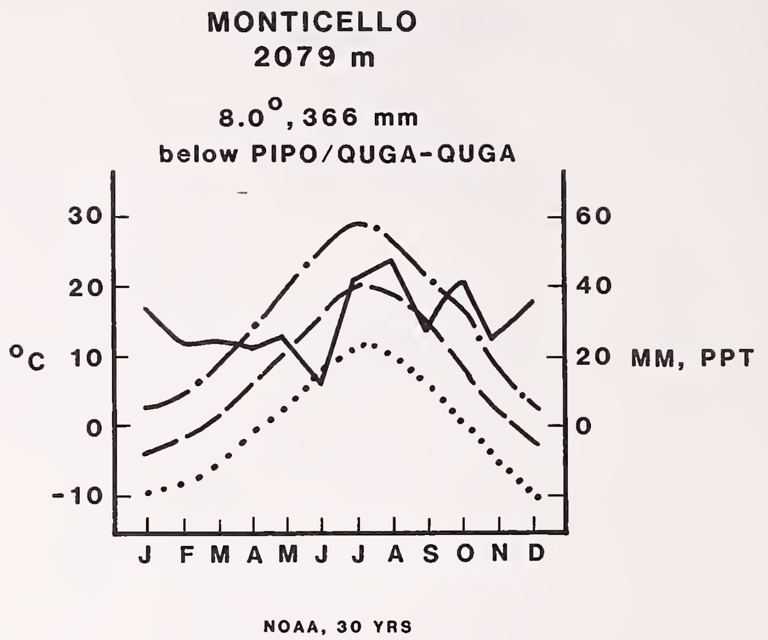
4.9°, 355 mm
PIPO/MUMO



ON FILE, MANTI-LASAL NF, 12 YRS

(con.)


HIAWATHA
1859 m
7.5°, 343 mm
below PSME/BERE-BERE
30
20
°C 10
0
-10
60
40
20 MM, PPT
0
J F M A M J J A S O N D
NOAA, 30 YRS


MONTICELLO
2079 m
8.0°, 366 mm
below PIPO/QUGA-QUGA
30
20
°C 10
0
-10
60
40
20 MM, PPT
0
J F M A M J J A S O N D
NOAA, 30 YRS

APPENDIX I.—CENTRAL AND SOUTHERN UTAH CONIFEROUS FOREST HABITAT TYPE FIELD FORM

NAME ____________ **Date** ____________

Topography:	Horizontal Configuration	
1- Ridge	1- Convex	Plot Number ______
2- Upper slope	2- Straight	Location ______
3- Mid-slope	3- Concave	T.R.S. ______
4- Lower slope	4- Undulating	Elevation ______
5- Bench or flat		Aspect ______
6- Stream bottom		Slope ______
		Topography ______
		Configuration ______

SCIENTIFIC NAME	ABBREV	COMMON NAME	CANOPY COV (%)
TREES			
Abies concolor	ABCO	white fir	______
Abies lasiocarpa	ABLA	subalpine fir	______
Picea engelmannii	PIEN	Engelmann spruce	______
Picea pungens	PIPU	blue spruce	______
Pinus flexilis	PIFL	limber pine	______
Pinus longaeva	PILO	bristlecone pine	______
Pinus ponderosa	PIPO	ponderosa pine	______
Pseudotsuga menziesii	PSME	Douglas-fir	______
SHRUBS			
Acer glabrum	ACGL	mountain maple	______
Arctostaphylos patula	ARPA	greenleaf manzanita	______
Arctostaphylos uva-ursi	ARUV	bearberry	______
Artemisia arbuscula	ARAR	low sagebrush	______
Artemisia nova	ARNO	black sagebrush	______
Berberis repens	BERE	Oregon grape	______
Ceanothus martinii	CEMA	Martin ceanothus	______
Cercocarpus ledifolius	CELE	curlleaf mountain-mahogany	______
Cercocarpus montanus	CEMO	mountain-mahogany	______
Juniperus communis	JUCO	common juniper	______
Pachistima myrsinites	PAMY	myrtle pachistima	______
Physocarpus malvaceus	PHMA	ninebark	______
Purshia tridentata	PUTR	bitterbrush	______
Quercus gambelii	QUGA	Gambel oak	______
Ribes montigenum	RIMO	mountain gooseberry	______
Shepherdia rotundiflora	SHRO	roundleaf buffaloberry	______
Symphoricarpos oreophilus	SYOR	mountain snowberry	______
Vaccinium caespitosum	VACA	dwarf huckleberry	______
Vaccinium globulare	VAGL	blue huckleberry	______
Vaccinium myrtillus	VAMY	myrtle whortleberry	______
GRAMINOIDS			
Bouteloua gracilis	BOGR	blue grama	______
Carex disperma	CADI	soft-leaved sedge	______
Carex geyeri	CAGE	elk sedge	______
Carex rossii	CARO	Ross sedge	______
Glyceria elata	GLEL	tall mannagrass	______
Muhlenbergia montana	MUMO	mountain muhly	______
Oryzopsis hymenoides	ORHY	Indian ricegrass	______
FORBS			
Aconitum columbianum	ACCO	monkshood	______
Actaea rubra	ACRU	baneberry	______
Equisetum arvense	EQAR	common horsetail	______
Geranium richardsonii	GERI	Richardson geranium	______
Mertensia arizonica	MEAR	Arizonica bluebells	______
Mertensia ciliata	MECI	mountain bluebells	______
Polemonium pulcherrium	POPU	skunkleaf polemonium	______
Senecio triangularis	SETR	arrowleaf groundsel	______
Trifolium longipes	TRLO	longstalk clover	______

Series ______________
Habitat Type ______________
Phase ______________

Youngblood, Andrew P.; Mauk, Ronald L. Coniferous forest habitat types of central and southern Utah. General Technical Report INT-187. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station; 1985. 89 p.

A land-classification system based upon potential natural vegetation is presented for the coniferous forests of central and southern Utah. It is based on reconnaissance sampling of about 720 stands. A hierarchical taxonomic classification of forest sites was developed using the habitat type concept. Seven climax series, 37 habitat types, and six additional phases of habitat types are defined and described. A diagnostic key, using conspicuous indicator species, provides for field identification of the types.

KEYWORDS: forest vegetation, Utah, habitat types, plant communities, forest ecology, forest management, classification

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EXAMPLES OF CONIFEROUS FOREST HABITAT TYPES IN CENTRAL AND SOUTHERN UTAH

***Abies lasiocarpa/Aconitum columbianum* h.t.**

A gentle north slope in the LaSal Mountains east of Moab, UT (8,800 feet, 2 680 m). Both *Abies lasiocarpa* and *Picea engelmannii* are reproducing. Scattered *Populus tremuloides* remain in the overstory. A diverse undergrowth contains *Lonicera involucrata*, *Actaea rubra*, and *Geranium richardsonii*.

***Abies lasiocarpa/Vaccinium myrtillus* h.t.**

An undulating northwesterly slope near Mount Tukuhnikivatz in the LaSal Mountains east of Moab, UT (10,470 feet, 3 190 m). A mature stand of *Picea engelmannii* dominates the site, with many *Abies lasiocarpa* saplings in the understory. *Vaccinium myrtillus* comprises most of the undergrowth.

***Abies lasiocarpa/Berberis repens* h.t., *Pinus flexilis* phase**

A steep southeasterly slope along Table Cliff Plateau in the Escalante Mountains east of Escalante, UT (10,050 feet, 3 060 m). Large *Pseudotsuga menziesii* and *Pinus flexilis* dominate an understory of *Abies lasiocarpa*. The shrubby undergrowth is comprised of *Ribes cereum*, *Symphoricarpos oreophilus*, and *Berberis repens*.

***Abies lasiocarpa/Berberis repens* h.t., *Picea engelmannii* phase**

A moderately steep north slope near Posy Lake on the Aquarius Plateau north of Escalante, UT (9,200 feet, 2 800 m). The dense stand contains *Abies lasiocarpa* and *Picea engelmannii*. *Pachistima myrsinites* and *Berberis repens* dominate the depauperate undergrowth.

***Abies lasiocarpa/Ribes montigenum* h.t., *Mertensia arizonica* phase**

A moderately steep, northeasterly slope in the North Canyon drainage of the Abajo Mountains west of Monticello, UT (10,520 feet, 3 210 m). The stand is comprised of both *Abies lasiocarpa* and *Picea engelmannii*. The undergrowth contains small amounts of *Ribes montigenum*, and a lush herbaceous layer dominated by *Trautvetteria caroliniensis* and *Geranium richardsonii*.

***Abies lasiocarpa/Ribes montigenum* h.t., *Ribes montigenum* phase**

A steep northwesterly slope near Shelly Baldy Peak in the Tushar Mountains northeast of Beaver, UT (10 480 feet, 3 190 m). Large *Picea engelmannii* dominate an understory of scattered *Abies lasiocarpa*. The depauperate undergrowth consists of *Ribes montigenum* and *Lupinus argenteus*.

***Abies lasiocarpa/Juniperus communis* h.t.**

A moderately steep southern slope near Mount Holly in the Tushar Mountains northwest of Junction, UT (9,410 feet, 2 870 m). The mixed stand contains *Picea pungens* and *Populus tremuloides* in the overstory, with *Abies lasiocarpa* saplings and regeneration. *Juniperus communis* is conspicuous in the undergrowth.

***Abies lasiocarpa/Carex rossii* h.t.**

A moderately steep north slope near Flagstaff Peak on the Wasatch Plateau west of Ferron, UT (9,430 feet, 2 870 m). The stand is dominated by *Pseudotsuga menziesii* and contains scattered *Pinus flexilis* and *Abies lasiocarpa*. Only small amounts of *Carex rossii* and *Symphoricarpos oreophilus* are present in the undergrowth.

***Abies concolor/Arctostaphylos patula* h.t.**

A gentle southwest slope on North Elk Ridge in the Abajo Mountains northwest of Blanding, UT (8,690 feet, 2 650 m). *Pinus ponderosa* dominates in the overstory, with *Abies concolor* present as saplings. *Arctostaphylos patula* and *Symphoricarpos oreophilus* are conspicuous in the undergrowth.

***Abies concolor/Berberis repens* h.t., *Berberis repens* phase**

[illegible] slope near Canaan Peak southwest of Escalante, UT [illegible] *Abies concolor* and *Pseudotsuga menziesii* codominate in the [illegible] and *Symphoricarpos oreophilus* are the most prominent undergrowth [illegible]

***Abies concolor/Berberis repens* h.t., *Juniperus communis* phase**

A gently undulating westerly slope west of Bryce Canyon National Park on the [illegible] Plateau (8,900 feet, 2 710 m). *Abies concolor* dominates an open stand that [illegible] *Pseudotsuga menziesii* and *Populus tremuloides*. *Juniperus communis* and *Berberis repens* are conspicuous in the undergrowth.

***Abies concolor/Symphoricarpos oreophilus* h.t.**

A gentle east slope below Table Cliff Plateau in the Escalante Mountains southwest of Escalante, UT (8,680 feet, 2 650 m). *Abies concolor* is present as saplings in a stand dominated by *Pseudotsuga menziesii* and *Pinus ponderosa*. *Symphoricarpos oreophilus* is the most prominent undergrowth species.

***Picea engelmannii/Ribes montigenum* h.t.**

A gentle southeast slope near Meeks Lake in the Boulder Mountains south of Teasdale, UT (10,880 feet, 3 320 m). *Picea engelmannii* is the only tree on the site. The depauperate undergrowth is primarily *Ribes montigenum* and *Lupinus argenteus*.

***Picea pungens/Juniperus communis* h.t.**

A toeslope bench near Pine Lake in the Escalante Mountains north of Tropic, UT (8 460 feet, 2 580 m). A mixture of *Picea pungens* and *Pinus ponderosa* comprise the even aged overstory. *Arctostaphylos uva ursi* and *Juniperus communis* dominate the open undergrowth.

***Pseudotsuga menziesii/Berberis repens* h.t., *Pinus ponderosa* phase**

[illegible] steep ridgetop near Thousand Lake Mountain on the Fish Lake Plateau [illegible] UT (8 600 feet, 2 620 m). A mixed stand of *Pseudotsuga menziesii* and [illegible]

***Pseudotsuga menziesii/Symphoricarpos oreophilus* h.t.**

A gentle west slope near Barker Reservoir in the Escalante Mountains northwest of Escalante, UT (8,000 feet, 2 440 m). *Pseudotsuga menziesii* is gradually replacing an overstory dominated by *Pinus ponderosa*. *Symphoricarpos oreophilus* is the most prominent undergrowth species.

***Pinus ponderosa/Arctostaphylos patula* h.t.**

A gentle southeast slope above Tropic Reservoir on the Paunsaugunt Plateau west of Bryce Canyon National Park (7,800 feet, 2 380 m). *Pinus ponderosa* dominates the site. *Arctostaphylos patula* and *Purshia tridentata* are conspicuous in the undergrowth.

***Pinus ponderosa/Purshia tridentata* h.t.**

A gentle north slope near Lion Mountain in the Boulder Mountains south of Teasdale, UT (8,080 feet, 2 460 m). *Pinus ponderosa* is the only tree on the site. The undergrowth is dominated by *Purshia tridentata*.

***Pinus ponderosa/Quercus gambelii* h.t., *Symphoricarpos oreophilus* phase**

A gentle southeast slope near Polar Mesa in the LaSal Mountains east of Moab, UT (8,060 feet, 2 460 m). *Pinus ponderosa* is the only tree on the site. A dense shrub layer is dominated by *Quercus gambelii*, *Symphoricarpos oreophilus*, and *Rosa woodsii*.

***Pinus ponderosa/Muhlenbergia montana* h.t.**

A gentle southeast slope above Alvey Creek in the Escalante Mountains west of Escalante, UT (7 450 feet, 2 270 m). *Pinus ponderosa* is present in two age classes. The undergrowth is dominated by *Artemisia tridentata* and *Bouteloua gracilis*.

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