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A Management-Oriented Classification of Pinyon-Juniper Woodlands of the Great Basin

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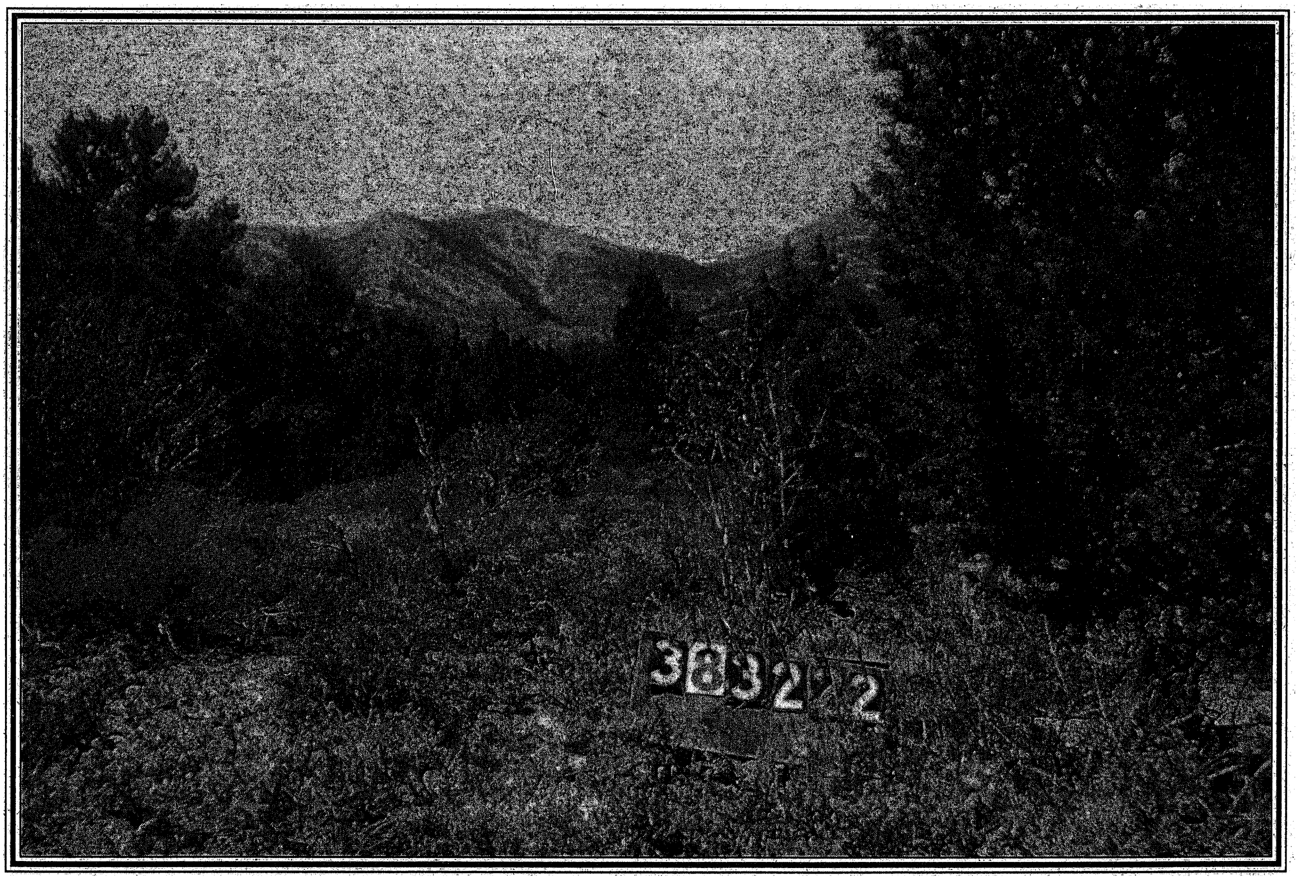

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Research Summary

Pinyon-juniper woodlands cover about 7.1 million ha (17.6 million acres), constituting about 18 percent of the land area of the Great Basin, yet no comprehensive ecological classification of them has been attempted before. To begin a classification, we sampled a random set of 66 of the approximately 110 mountain ranges within the Great Basin. Macroplots were systematically placed at 200 m elevation intervals up and down cardinal slopes. Data on tree age, vegetational cover, soils, and land form were collected from 1972 to 1975 within 463 stands used to either develop or test the classification presented here.

We used the already delineated National Hierarchical Framework of Ecological Units (ECOMAP 1993) down to the Section level to frame our classification to an intermediate coarseness. This subdivided the Great Basin into nine relatively environmentally homogenous Sections. Observable vegetational characteristics were used at lower layers because ECOMAP delineations are not yet available. Nine categories were recognized at the Series level based on variation in the relative cover contributions by the various junipers and pinyons. Subdividing the nine Sections by the nine possible Series gave 45 actual geographically distributed Series. The next lower level of the vegetation-based classification is the Association, identified by the dominant shrub species. Twenty-six species of dominant shrubs, combined with the Sections and Series, gave 183 Associations. The Sub-association level was based primarily on the 23 dominant native perennial grasses. When, rarely, a native, perennial grass was not present, the native perennial forb showing the greatest relative cover was used instead to name the Sub-association. This resulted in 326 Sub-associations distributed over the entire Great Basin. The manager needs only be concerned with the subset that occurs in their Section of interest, however.

With most Sub-associations found only once, our classification is only a beginning toward the desired end. It also reflects the complexity of the communities associated with Great Basin woodlands. Much more sampling redundancy will be required before we can begin to find out which Sub-associations are most common and how they relate to topographic and edaphic patterns. Our approach, however, provides a substantial beginning to a hierarchical classification of these woodlands and is easily modified and expanded. Using and building on our approach should allow the manager to better relate the results of previous as well as new studies and management experiences to each other.

Acknowledgments

We wish to thank Ken Rea, Roger Banner, and Dwight Beeson who were graduate research assistants and field crew leaders and their many undergraduate helpers too numerous to mention. Pat Johnson and Susan Durham provided valuable assistance in data coordination and analysis. Al Winward of the Forest Service's Intermountain Region is to be credited with keeping after us to finish this task.

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Introduction

Pinyon-juniper woodlands occupy about 18 percent (7.1 million ha, 17.6 million acres) of the land area of the Great Basin (Tueller and others 1979). The associated tree species are found over a wide range of environmental conditions extending from communities representative of the upper fringes of the Mohave Desert to communities found at the lower fringes of high mountain forests. Over this spatial and elevational range, communities associated with pinyon-juniper woodlands are highly variable, with complex distribution and compositional patterns. This variability is due to climatic changes occurring over the last 10,000 years and to variation in current environmental conditions (Nowak and others 1994a; Tausch and others 1993). While juniper has been present somewhere in the area for over 30,000 years (Nowak and others 1994a,b), pinyon is a relatively recent addition with a presence ranging from less than 2,000 to about 8,000 years depending on location. Over the last century many changes have occurred in these woodlands and both the types and the pace of change could potentially increase into the future.

In order to successfully inventory, plan, manage, and monitor complex wildlands like the pinyon-juniper woodlands, ecological classification is required. Ecological classifications result in several benefits. The resulting hierarchy of strata can provide guidelines for the collection and retrieval of both factual and interpretive information. Results and experiences from particular sites can be compared to other unstudied sites that are shown to be relatively similar by classification. This can increase the chances of the repetition of successful management actions and reduce the chances of failure. Research, particularly that research attempting to refine interpretations of factual data, can also be better focused if sites are related to an existing classification scheme. Creation of a hierarchy of ecological strata of increasing similarity enhances interpretation through both extrapolation and interpolation of survey data, research results, and management experiences.

How the Data Were Obtained

Despite their extensive area, the generally low levels of economic return from pinyon-juniper woodlands have resulted in relatively little scientific or management attention to them (Evans 1988). Previous inventory, monitoring, and research efforts have been largely limited to one or a few selected areas (St. Andre and others 1965). Some efforts have focused on the limited areas with potential for type conversion (Daniel and others 1966) while others collected data only on the trees (Smith and Schuler 1987). Resulting data are often summarized only by political subdivision, classes of tree density, or harvestable products (Born and others 1992; Van Hooser and Green 1983). Lack of regional and synthetic perspectives have limited our understanding of how the results of previous studies and management experiences relate to each other.

A cooperative research program designed to provide a synecological stratification of the pinyon-juniper woodlands of the Great Basin was initiated in 1972. The institutions originally involved were the Department of Rangeland Resources at Utah State University; the Department of Environmental and Resource Sciences at the University of Nevada, Reno; and the USDA Forest Service Intermountain Research Station (now known as the Rocky Mountain Research Station, RMRS). Region 4 of the USDA Forest Service and RMRS have more recently encouraged reactivation of this effort.

The study area (fig. 1), mainly the Great Basin and margins of other physiographic provinces directly adjacent to the Great Basin, was gridded into 1 minute subdivisions for both longitude and latitude. A random list of map intersections was then made, and the first 66 of the approximately 110 mountain ranges (fig. 2) that contacted the listed intersections were chosen for field study (Tueller and others 1979). These mountain ranges were then usually visited only once by one of several teams, and data on landforms, geology, soils, and vegetation gathered. A total of 463 macroplots were examined over the summers of 1972 through 1975, but only 426 were used to develop the

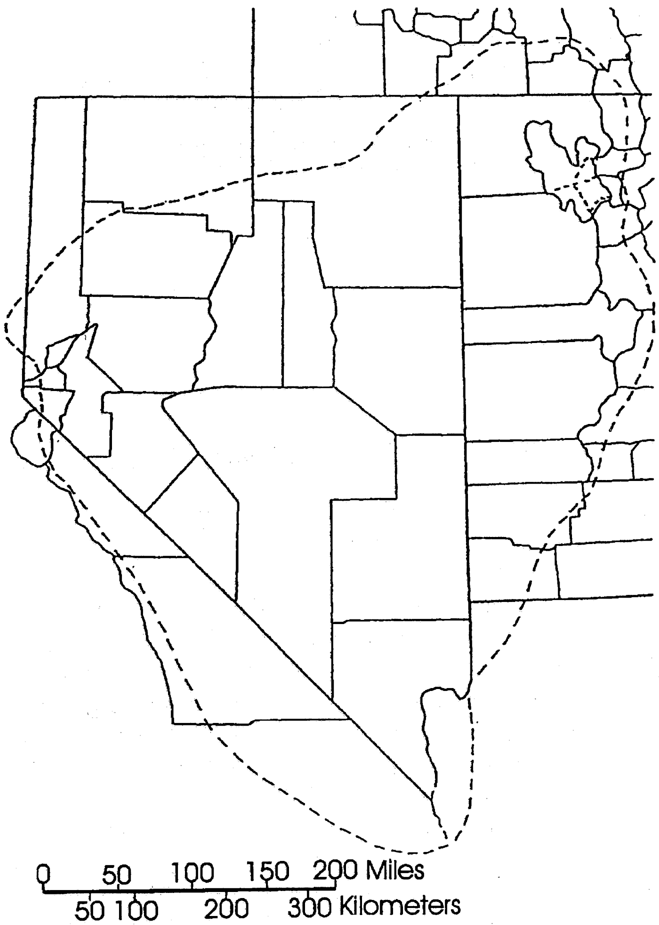

Figure 1—A political map showing, with the dashed line, the outer perimeter of the study area.

classification presented here. The remainder were reserved for testing the validity of the results.

Although some may be concerned about the age of the data used here, Austin (1987) and Yorks and others (1994) have shown that once trees dominate, very minor changes in understory vegetation take place over decades. Kent and Coker (1992) advise that minor variations in obtaining percentage cover do not greatly affect the results of subsequent community analysis because the several dominant species have substantial cover and the many associated species usually amount to minor cover either singly or collectively.

Budgets were not sufficient to take a large, randomized sample within mountain ranges. Sampling designs appropriate for large areas inevitably involve trade-offs between representativeness, bias, and practicality (Austin 1991). Accordingly, our sampling was consciously directed toward capturing the main variety of site conditions present on the cardinal slope aspects. Intermediate aspects and elevations are largely intermediate in ecological characteristics. We systematically located plots on broad, even slopes facing one of the cardinal directions (north, south, east, west) at regular contour intervals up and down the slope from a baseline of 2,000 m (6,560 feet). This is an elevation common to the pinyon-juniper woodland belts around mountain ranges over most of the Great Basin (Tueller and others 1979). Overall, the percentage of the macroplots that were sampled at 2,000 m was 37 percent, while 40 percent of them were above 2,000 m elevation and 23 percent were at elevations below 2,000 m.

The criteria used to determine the lowest and uppermost plots on each mountain side were that a plot had to contain at least 25 pinyon and/or juniper trees per hectare (about 10 per acre). Of these, at least one tree had to be of the "mature" size-age-form class (Blackburn and Tueller 1970). These criteria kept the samples from extending into grasslands, shrub steppes, or brushlands that have been invaded by small trees over only the past few decades. Our sampling was thus restricted to sites where woodland was clearly established at the time of sampling.

In order to reduce part of the variability due to secondary successional status, sampling was further

Figure 2—Map showing the major mountain ranges in the study area. The lower mountain boundaries are the same as those in Cronquist and others (1972). The 66 mountain ranges chosen for study are unshaded and numbered. See table 5 for the names of the studied mountain ranges associated with these numbers.

restricted to those sites showing no evidence of recent stand-replacing fires, tree cutting, chaining, or cabling. Nevertheless, nearly one-half of the macroplots sampled had an overstory cover dominated by trees established after the beginning of European settlement (Tausch and others 1981). The period of greatest tree establishment was apparently 1870 to 1920 (Tausch and others 1981). In the systematic sampling independently done by Born and others (1992), with a less restrictive definition of woodlands, about three-quarters of their locations involved establishment of all trees in the most recent 130 years (D. Born, personal communication).

Sampled northerly slopes were limited to the northern ends of mountain ranges or hill systems; southerly exposures were limited to the southern ends of mountain ranges. Eastern and western exposures were sampled near the center of the generally north-south oriented mountain ranges. The upper and lower boundaries of the pinyon-juniper woodland for the entire mountain slope were marked on topographic maps (of at least 1:25,000 scale) in order to check on the accuracy of the woodland distribution map made from LANDSAT-1 imagery over the entire study area (fig. 3).

Two levels of sampling on the 66 randomly selected mountain ranges were employed: "rapid" and "detailed." In the "rapid" approach, macroplots of approximately 20 by 50 m (66 by 165 feet) were paced off, with the long axes positioned perpendicularly to the slope contour. The macroplots were located at 200 m (660 ft) intervals up the broadest, most even slope available within 5 km (2 miles) of a road negotiable by 4-wheel-drive truck.

Physiographic features recorded at each macroplot location were: elevation, slope aspect, percent slope, length of slope, position on slope, landform, and macro- and micro-relief. Landforms and percent slope were aggregated into the classes listed in table 1. The percentage of bare soil, surface stone, gravel and litter covering the soil surface were estimated for the entire macroplot.

A soil profile in an interspace between trees was briefly examined with an auger. Features noted were depths to A, B, and C horizons, their color (both dry and wet), texture, structure, and boundary characteristics. The parent material or exposed rock was noted when possible. The objective was to classify these soils to at least Great Group (Soil Survey Staff 1994). Parent material was placed in a three-level hierarchical classification (table 2), where possible, after consulting the latest geologic maps of the area.

Within each "rapid" plot, all plant species were listed in one of five growth forms: trees, shrubs, grasses and grass-likes, forbs, or microphytes (mosses, lichens). With grasses and forbs combined, the resulting four

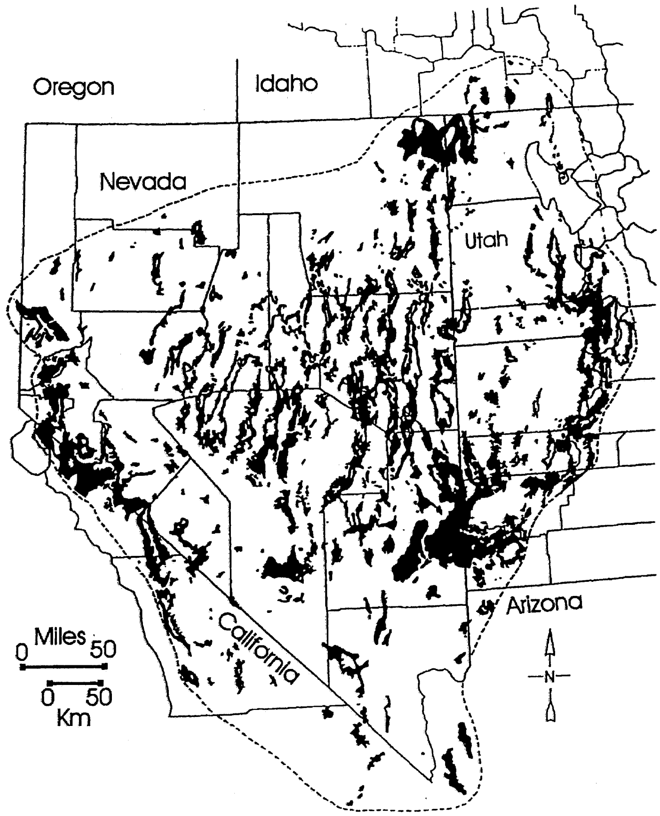

Figure 3—Map of the pinyon-juniper woodlands of the Great Basin derived from LANDSAT-1 color-infrared imagery and field checking (from Tueller and others 1979).

Table 1—Landform and slope class categories used in this study.

Name	Definition
Landform	
Foothill	Lower hills around the base of a main mountain mass.
Terrace	Relatively level remnant surface bordered by a steep escarpment on one to three sides, composed of alluvium or solid rock.
Bajada	Compound alluvial fan that merges with a valley floor.
Plateau	Elevated fairly flat surface bordered on all sides by steep escarpments.
Mountain	Large, central, upper elevational areas of a mount range above the foothills and bajadas.
Slope Class	
0 - 5%	
5 - 15%	
15 - 25%	
25 - 35%	
>35%	

Table 2—Three-level hierarchical classification used to describe surficially exposed rock or parent material at each macroplot.

Class	Supergroup	Clan	Abbreviation used in tables 12 and 14-19
A. Igneous			
	1. intrusive		
		a. granitoid	
		b. granitic	
		c. rhyolitid	Rh.
		d. porphyritic	Porph.
	2. extrusive		
		a. basaltic	
		b. andesitic/rhyolitic	Andesitic/Rh.
		c. tuff-welded tuff	Tuff-Weld.
	3. unspecifiec		
B. Sedimentary			
	1. terrestrial		
		a. alluvium	
		b. conglomerate	Conglom.
		c. siltstone/sandstone	Silt./Sand.
		d. siltstone/sandstone—alluvium	
	2. marine		
		a. limestone/dolomite	
Limest./Dolo.			
		b. limestone/dolomite-siltstone/sandstone	L./Dolo./Silt.
		c. shale	
		d. quartzite	Qu.
		e. quartzite-limestone/dolomite	Qu./Lime.
		f. phyllite/quartzite	Phyllite/Qu.
	3. unspecified		

Sources: Hintze, L. F. 1963; Ross, C. P. and J. D. Forrester, 1947; Stewart, J. H. and J. E. Carlson, 1974; Stokes, W. L., 1963; and Strand, R. G., 1967.

categories represented the four layers or synusia visible in the physiognomy of the stands of vegetation. A cover class rating was assigned to each plant species in the macroplot (Daubenmire 1959). Each of the original five growth form categories was then considered separately and the relative cover of each species within each of the four vertical layers of the vegetation was assessed. A size-age-form "maturity" class rating (Blackburn and Tueller 1970) was assigned to each individual tree within the macroplot and densities of each tree species estimated. A total of 257 plots on 48 mountain ranges were sampled at the "rapid" level.

At the "detailed" level of sampling, the same macroplot size was used, but data were obtained from direct measurements, using an expansion and intensification of the methods described for the "rapid" approach. That is, the macroplot boundaries were measured and permanently marked by a red steel post at the lower center point on the 20 m line there (fig. 4). Temporary markers were placed at the corners of the macroplots and at the ends of the five 20 m lines perpendicularly bisecting the center line at randomly located meter marks on the center tape.

All trees of each species were placed in appropriate size-age-form "maturity" classes (Blackburn and Tueller 1970). Four trees of each maturity class (if available), situated closest to two predetermined random points along the macroplot centerline, were measured for height and basal circumference. Crown spread of these trees in the widest and narrowest dimensions perpendicular to each other were also recorded. Tree cover for the plot was estimated by taking an average of tree crown dimensions, computing elliptical area on the measured trees, and multiplying by the number of trees of each size-age-form "maturity" class in the entire macroplot. Individuals of each "maturity" class category of each species nearest to the center line were cut down at about 10 cm above the ground and a cross-section of the stump taken for growth ring analysis in the laboratory. A total of 1,026 juniper (*Juniperus*) and 1,290 pine (*Pinus*) tree basal trunk cross-sections

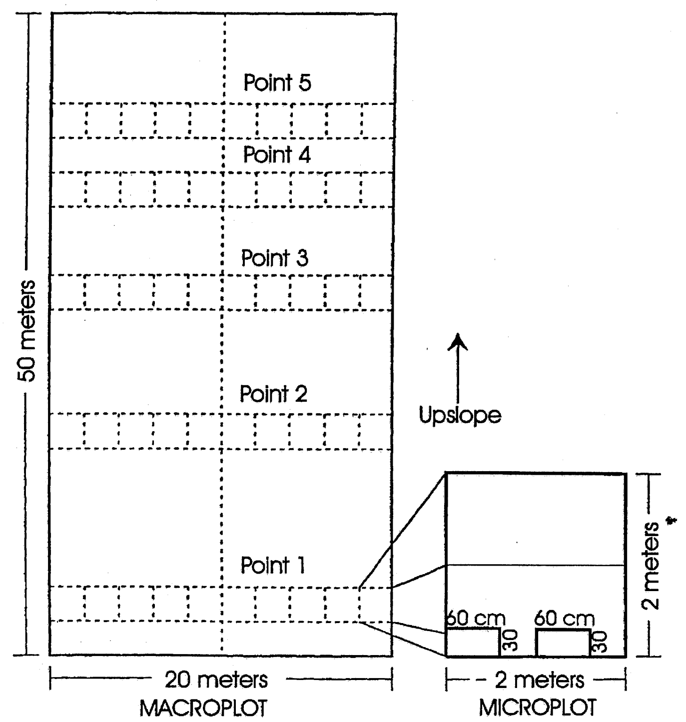

Figure 4—Plot layout for detailed sampling of vegetation, surface cover, and fecal density.

were sanded and their growth rings counted to estimate age.

Tree seedling and animal fecal pellet group density data were taken from ten contiguous 2 by 2 m microplots located on each 20 m line parallel to the slope. Shrub crown cover was estimated to the nearest 2 percent (Daubenmire 1959), in ten contiguous 1 by 2 m microplots also on each transect line. Forb and grass basal cover were similarly estimated in two 30 by 60 cm plots located within each 1 by 2 m microplot (fig. 4).

Slope, exposure, geologic parent material, and topographic class at the "detailed" sites were determined using the "rapid" sampling method. At the "detailed" sites, however, a soil pedon was exposed with a spade to pan or bedrock in an opening between trees (at least 1 m from any crown edges) near the center of each macroplot. A complete pedon description (Soil Survey Staff 1951, 1960) was written and half-liter samples of soil from each horizon and pieces of rock were usually collected for physical and chemical analyses in the laboratory necessary to describe the soil to at least the Sub-Group level (Soil Survey Staff 1975, 1994).

The 18 mountain ranges sampled with the "detailed" methods were randomly selected from the set of 66 mountain ranges randomly chosen from the 110 possibilities. A total of 207 stands were sampled in detail. However, only 169 were at even 200 m elevational increments and thus used for the classification developed here. Two mountain ranges (Needle in southwestern Utah, and Shoshone in west central Nevada) were sampled more intensively, at each 100 m contour interval, with additional procedures to be described later in other related publications. The samples at other than the 200 m intervals from these two mountain ranges were used to test the classification (see the "Validation" section). One mountain range (Mineral in southwestern Utah) was sampled by both "rapid" and "detailed" methods by two different teams to compare results.

Results of Previous Analyses of the Data

Previous analyses of some aspects of this data set (involving both "rapid" and "detailed" approaches) have already been published. For instance, Tueller and others (1979) using our fairly conservative definition of woodlands and appropriate LANDSAT-1 imagery, along with field checking of upper and lower boundaries of woodlands for about one-third of the mountain ranges, found that pinyon-juniper woodlands within our study area cover about 7.1 by 10^6 ha (17.6 million acres), or about 18 percent of the land surface of the study area (fig. 3). They also noticed that this vegetation type typically forms broad elevational belts encircling mountains in middle latitudes, but diminishes to progressively narrower southerly and westerly predominance towards the northern latitudinal extremes, and to northerly and easterly exposures in the south.

West and others (1978a) examined floristic patterns from the total data set involving 367 vascular plant species. The number of different vascular plant species in a macroplot was positively correlated with size and height of the mountain range on which it occurred, but negatively correlated with distance from adjacent mountains. The most outstanding features of the floristic patterns are: the relatively few species that were encountered over such a huge area, the lack of any vascular plant species restricted to pinyon-juniper woodlands (besides the trees and their parasites), and the lack of encounters with plant species on threatened, endangered, or sensitive lists. The latter is largely a consequence of avoiding concave topography and riparian areas, and not searching out unique kinds of parent material at appropriate times of the year so as to better record presence of ephemerals.

Floristic richness within a macroplot declined markedly with successional status (Everett and Koniak 1981; Tausch and others 1981). That is, as trees come to dominate, they outcompete herbaceous understory on a much stronger than 1:1 basis (Tausch and West 1995; West and others 1979).

Floristic richness for the entire woodland belt of a given mountain range was greatest on the higher mountain ranges on the southern end of the Central Plateau in south central Nevada (West and others 1978a). This is also where the elevational breadth of the woodland was greatest. This is the region where Great Basin and Mohave Desert floras merge and where the relative contribution of frontal storm systems moving inland from the Pacific and convectional storms associated with moist air from the Gulf of Mexico are most equivalent (Houghton 1979; Houghton and others 1975).

Woodland belts are narrow or nonexistent on northern exposures in the northern Great Basin where thermal belts can be disrupted easily in the spring (West and others 1978a). The woodland belt frequently retreats to northern exposures in the southeastern Great Basin, but also reaches its lowest elevations there. Where water from mountains eventually drains into the Colorado River, belts of air consistently warmer than the valleys below do not persist in winter (Beatley 1979/80). East- and west-facing woodland belts at similar latitude are not always at the same elevation or of the same width due largely to how mountain mass, directional orientation, and elevation of valley bottoms alter climate (West and others 1978a).

Total vascular plant cover in our samples varied from 9 to 80 percent, with an average of 35 percent. Greater average vascular plant cover is concentrated on the high plateau of central Nevada and the higher, larger mountain ranges elsewhere. Woodlands on mountain ranges with lower average elevation or lower latitudinal position, or both, have less average total vascular plant cover. The northernmost, largely juniper-dominated woodlands in southern Idaho, have greater average vascular plant cover than would be expected from the relatively low elevation of the woodlands there. In other words, latitude strongly compensates for elevation. Furthermore, because pinyon is largely absent in southern Idaho, it points to the strong possibility that pinyon is more competitive with understory than juniper. Total vascular plant cover generally increases with elevation in pinyon-juniper woodlands, correlating with increased precipitation as well as lower temperature, and thus greater effectiveness of precipitation (Houghton 1979). Understory cover and species richness is generally least in the middle elevational part of the belt (fig. 5), because tree cover most often dominates there (West and others 1978a).

The structurally dominant trees differ over latitude, longitude, and elevation. Utah juniper (*Juniperus osteosperma*) usually occurs as a sole dominant along the northern boundary of the study area and in a few places in the Bonneville Basin of western Utah. Single

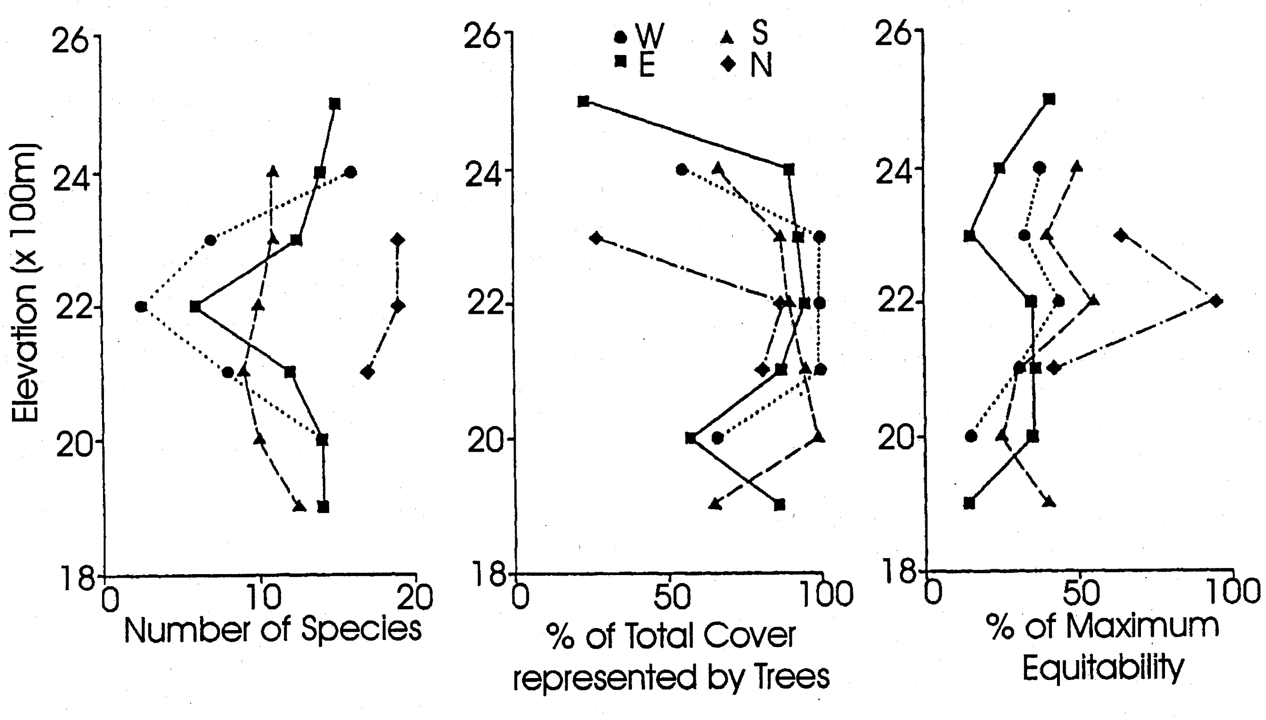

Figure 5—Species density (floristic richness), relative percent of total cover contributed by trees, and percent of maximum equitability calculated by the McIntosh (1967) index plotted by elevation and aspect, Needle Range, Beaver-Iron Cos., Utah (from West and others 1978a).

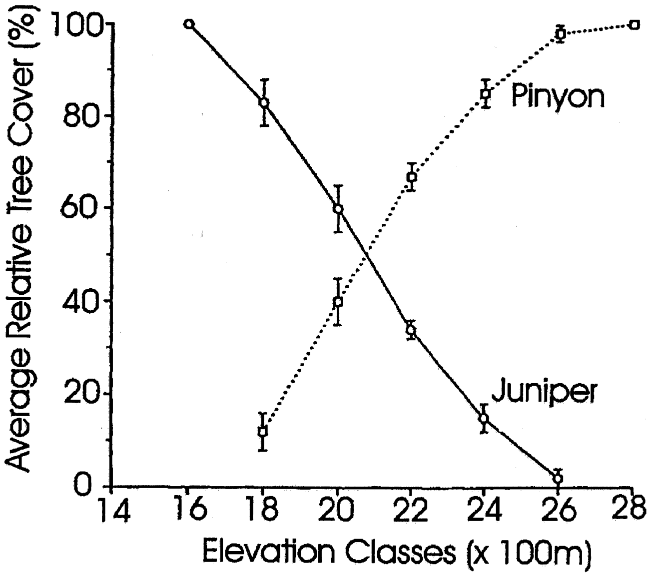

Figure 6—Average relative cover (percent) of pinyon (convex-solid line) and juniper (concave-dotted line) in relation to elevational interval. Vertical bars are equal to one standard error. Lack of bars indicates only one plot available (Tausch and others 1981).

needle pinyon (*Pinus monophylla*) occurs alone only on a few mountain ranges along the California-Nevada border. Colorado pinyon (*Pinus edulis*) replaces single needle pinyon in central to southwestern Utah where summer precipitation exceeds about 10 cm (3 inches). Hybridization of the two pinyons is most notable in southwestern Utah (Lanner 1974; Tausch and West 1987). The bulk of the sampled stands have various degrees of shared dominance by a pinyon and a juniper species.

There is also strong sorting of the mix of juniper and pinyon by elevation, with juniper often the lone dominant at sites around 1,600 m or lower elevations. As elevation increases, the relative percent cover of pinyon typically increases while that of juniper declines. The convexity of the pinyon curve and concavity of the juniper curve with elevation (fig. 6) also imply that pinyon is competitively superior (Tausch and others 1981; Tausch and West 1995).

Sorting the stands on the basis of slope exposure shows that on southerly and westerly exposures, the relative percent cover contributed by juniper is slightly higher than that on northerly and eastern exposures, particularly at higher elevations. This slight difference is probably due to relatively warmer temperatures and effectively drier soils on the southerly and westerly exposures receiving more solar radiation and thus heating of soil, air, and plants, than on northerly or easterly exposures (Tueller and others 1979).

We did not find strong latitudinal and longitudinal patterns in soil orders found under pinyon-juniper woodlands (West and others 1978b). Most of the consistent patterns in distribution of soil orders are related to elevation (fig. 7). We must conclude that contemporary climate is much more dominant than soils or topography in delimiting the basinwide and elevational extent of these woodlands. Present vegetation has also had an apparently minor effect on the development of soils in these woodlands. However, had we also sampled soils directly under the trees, we could have noted how acidic tree litter could be affecting those sites where the carbonate accumulations during previous grassland or shrub steppe occupation still persisted.

Vegetation of the Great Basin has been much more dynamic (Tausch and others 1993) than soil development. The current plant community is often not the one that was most important in the development of a given soil. This, along with more recent disturbance, secondary succession, and introduction of exotic species, makes use of soils in basin-wide synecological subdivision of limited value (Everett 1985). However, we agree with Brackley (1987), Hironaka (1987), Leonard and others (1987), and Summerfield and others (1986) in reconsidering soils in determination of finer-grained classifications of land.

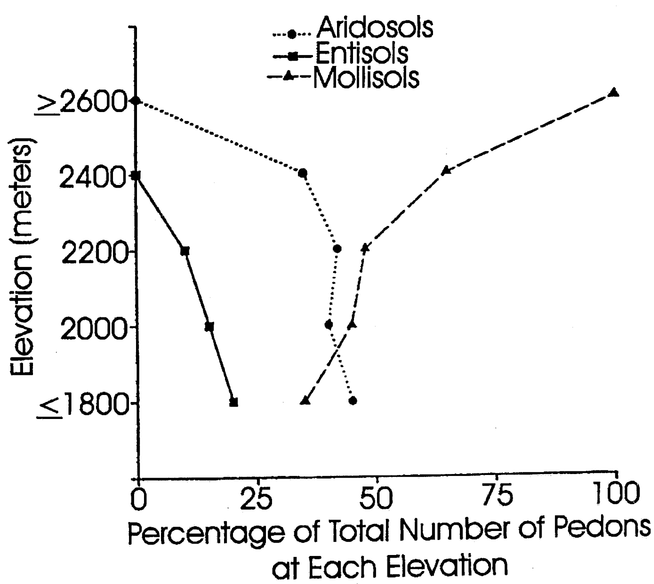

Figure 7—Percentage of the total number of pedons in each order at each elevational interval (West and others 1987b).

Previous Attempts at Woodland Classification

While the aforegoing is valuable in helping to understand basin-wide and some mountain range scale patterns, the manager's needs usually occur on a project, treatment, site, grazing allotment, pasture, or small watershed scale. The manager usually needs to know whether a planned management adjustment or unplanned alteration (for example, wildfire) is likely to lead to the expected changes or not. These interpretations involve either interpolation between or extrapolation of limited factual observations beyond the few other research or intensively managed and monitored sites. This begs the question of how similar or dissimilar is the new site to those where similar management has successfully or unsuccessfully taken place in the past? Managers are usually required to make these interpretations intuitively with limited reliance on factual information. Confidence in such decisionmaking comes from practice and long experience in a region. The newcomer is short on both. Might there be a way of making the process easier? We contend that a more formalized means of comparing appropriate factual similarities of sites would be a step in that direction.

The usual approach by the Forest Service in the Intermountain West during the past several decades has been to develop a hierarchical classification of land based on potential vegetation (Ferguson and others 1989; Hill and others 1992; Johnston 1987; Kennedy 1983; Moir and Carleton 1987; Wellner 1989; West 1982). Several problems intervene in easily doing this for pinyon-juniper woodlands in the Great Basin (Cooper 1978; Everett 1985; Everett and Bruner 1990; Hironaka 1987).

First, the dominant species of all Great Basin vegetation have very wide distributions, implying broad ecological amplitudes and thus broad indicator values. Pinyon and juniper trees range from the upper fringes of the Mohave Desert where they co-occur with joshua tree (*Yucca brevifolia*), cholla cactus (*Opuntia* sp.), and blackbrush (*Coleogyne ramossima*), to the lower fringes of high mountain forests in the Northern Great Basin where they co-occur with limber pine (*Pinus flexilis*), bristlecone pine (*P. longaeva*), and western juniper (*Juniperus occidentalis* ssp. *australis*). There is no easy source of unambiguous evidence of what environmental or biotic controls determine where one species enters and another drops out. Trees have become so dominant in recent decades that some have assumed that this has always been the case and, furthermore, that there is little ecological variation in the pinyon-juniper woodlands of the Great Basin. This is an illusion.

If one will search a site well, one can usually find openings where lower statured plants still exist. None, however, are species exclusively identified with tree-dominated situations as is more commonly the case for most forest types of more mesic environments. Instead, most of present understory remnants were part of the sagebrush steppe and sagebrush semi-desert vegetation types that occupied these sites up until about a century ago.

Unfortunately, these "understory" plants also have wide distributions and broad indicator values that can increase the difficulty of classification based on vegetation alone. Different combinations of controlling factors can, in different locations, result in the same apparent plant community type that may or may not respond similarly to management. Probably, only the most genetically variable species have survived the 20 or so glacial cooling and interglacial warming interludes in this region during the Pleistocene (Betancourt 1987; Brown 1995; Nowak and others 1994a,b; Tausch and others 1993). This genetic variation is, however, impossible to see with the naked eye, limiting the timely indicator value of particular species and species combinations in the field.

An additional complication to classifying vegetation in the Great Basin is the long and complex history of human uses in the region during the Holocene. These impacts started at least 11,000 years ago when the first wave of hunters helped drive to extinction about 32 genera of mammals (Grayson 1993; Owen-Smith 1989; Stuart 1991). Many of these were very large browsers who regularly consumed conifer foliage.

As these easy sources of human sustenance disappeared, the early peoples had to switch their diet to smaller animals and plants. Amerindians regularly used fire to manipulate the landscape to their benefit (Creque 1996). Seeds of perennial grasses were a mainstay of their diet. These grasses produced seed more abundantly and dependably with frequent intentional burning than with less frequent wildfires. Some annual and biennial forbs were even sown into the ash to provide foods and ceremonial needs (for example, tobaccos). Pinyon and juniper trees of all age classes remained on the steeper, rockier sites that wouldn't burn easily. The gentler slopes with deeper soils were actively managed by these aboriginal people to remain as a grassland mosaic with scattered trees. The region was thus far from an uninfluenced wilderness prior to Columbus (Denevan 1992).

The first itinerant Europeans (explorers, missionaries, trappers) who visited the region, beginning in 1776, remarked about the openness of the vegetation and abundance of fires (Gruell 1985). However, aboriginal influence already may have been waning because European diseases had preceded the appearance of the explorers by a century or so and reduced

Amerindian population densities to a small fraction of what they had been previously (Kay 1996). The cooler, wetter climate of the Little Ice Age may have also favored tree expansion from about 1400 to 1850 AD (Gottfried and others 1995).

The most widespread influence associated with permanent European settlement, beginning in the mid-nineteenth century in this region, was from livestock. Unrestrained levels of use of the palatable herbaceous fraction of the vegetation by livestock led to reduction in fine, continuous fuels for surface fires. Since fences and buildings were also built of wood then, there was also conscious fire control. While there was intensive harvesting of trees for charcoal, mine timbers, railroad ties, and domestic fuels around mining districts (Lanner 1981; Young and Budy 1987) for a few decades before the turn of the twentieth century, new trees established abundantly from about 1870 to 1920 (Tausch and others 1981).

Cattle and horses were the first domestic species introduced on these rangelands. They focused on the grasses. This probably first led to an expansion of shrubs. Sheep grazing dominated in the first half of this century. Sheep utilized steeper, rockier areas and more browse species further from water than cattle and horses. Deer populations exploded in the 1940-60's, probably in response to reduced sheep populations and more abundant and taller shrubs (Peek and Krausman 1996; Workman and Low 1976). Tree expansion became most noticeable in the 1950's and 60's. Grazing by feral horses, rabbits, and elk in recent decades may be focusing on the modicum of perennial herbs remaining (Yorks and others 1994). Even though livestock and deer grazing has generally been reduced on these mostly public lands in recent decades, the trees continue to grow and outcompete the understory over their very long lives (pinyons live for 500 to 800 years, junipers up to 2,000 years). Analysis of pollen deposited in sediments at selected sites in the northwestern Great Basin shows a greater abundance of juniper pollen during the Twentieth Century than at any other time in the past 5,000 years (Mehringer and Wigand 1990; Miller and Wigand 1994). When the paleo-information is combined with modern studies indicating major expansion in woodland extent and density, the implication is that we are currently dealing with a vastly greater amount of juniper and pinyon-dominated lands than any humans have encountered over the last 5,000 years.

The competitive powers of the herbaceous plants were and continue to be reduced by grazing, but more importantly, the fire return intervals have been greatly lengthened because of reduced fine, continuous fuel near the soil surface (Wright and others 1979). Climatic warming, the fertilizing effect of increasing atmospheric CO_2, increases in some bird, rodent, lagomorph, and wild ungulate (for example, elk) species, along with conscious fire control, led to an increase of both individual tree growth and stand densities (West 1984, 1988). Nevertheless, the relatively small differences in detectable growth rate of trees between sites has largely prevented the usual height-over-age approach to site classification from succeeding (Chojnacky 1987; Daniel and others 1966; Meeuwig and Cooper 1981; Smith and Schuler 1987, 1988), although one application has been useful (Tausch and Tueller 1990).

The tree-dominated woodlands of the present time with sparse understory are both structurally and functionally dissimilar to what probably prevailed before European occupation. Tree canopy dominance and a root system that extends three to five times beyond the crown diameter (Everett and Bruner 1990) has frequently led to mounds under the protection of trees and lower topography in the uncovered interspaces (Price 1993). Exposure of datable roots at many sites indicates accelerated soil erosion over about the past 120 years (Carrara and Carroll 1979). Soil degradation at many sites may have proceeded to the point where only partial recovery of site potential is now possible (Baxter 1977; McDaniel and Graham 1992).

With expected significant future changes from climate warming (Gates 1993; Kerr 1995) and increases in pollutants, including the fertilization effect of increased CO_2 (Graham and others 1990; Tinus 1995), it seems that these woodlands will continue to develop larger, more continuous tree canopies that facilitate summer firestorms. Indeed, such firestorms are becoming an increasingly common event. These hot fires result in loss of nearly all biotic reserves and in the invasion of vagile introduced species such as cheatgrass (*Bromus tectorum* L.) and red brome (*Bromus rubens* L.). Sites dominated by these winter annual grasses then re-burn about every 3 to 5 years. The result is a rapid, downward spiral of site degradation that only restabilizes when rock or other resistant soil layers dominate the surface. The total area affected by these summer crown fires is steadily increasing, particularly on the gentler topography that has easy access to livestock and vehicles. Few recognizable "climax" stands are left (West 1991).

Without reliable reference areas, reconstructing successional pathways through chronosequences (space-for-time substitutions) is highly speculative (Everett and Bruner 1990; Hironaka 1987; West and Van Pelt 1987). Remnant plants, soil seed reserves, seed rain, stage of succession, kind and timing of disturbance, subsequent climate and management, as well as landscape position and physical site variables, all determine trajectories of vegetation recovery. Thus, Everett (1985) suggests that the most probable plant community types at maximum understory expression be focused on in any classification effort.

Our Approach

The above problems have forced us to focus our classification on how we find pinyon-juniper woodlands now, rather than what they may have been or could be. Scientists and land managers in California have faced similar problems and yet developed a hierarchical approach (Paysen and others 1982). Everett and Bruner (1990) made a beginning toward adopting this approach, using data gathered from 350 stands in the extreme western Great Basin. We have modeled our approach on theirs, and on the example for California's hardwood rangelands (Allen and others 1991), but modified it to fit within the National Hierarchical Framework of Ecological Units (ECOMAP 1993).

The basic reason for adopting a hierarchical approach is that land managers can choose whatever level is appropriate for their particular focus. The higher-level, broader units are used when greater generality is needed. This classification also divides geographic subdivisions of the Great Basin into more localized areas that can be successfully used for management and research purposes. However, potentials for and responses to specific management alternatives differ greatly between project locales. Therefore, finer-grained levels will be needed when more detail and specificity are desired. Completion of the finer levels of classification are not possible with the data set used here because of the extensive nature of our sampling of woodlands and location-to-location variability. Much more redundancy of sampling of the stands representing Associations and Sub-associations will be needed in each local area to more firmly establish their identity, area occupied by those entities, their successional variation, and their relationships to the environment and to each other.

The first thing we did before we started the present synthesis was to truncate the data sets from the most intensively studied Shoshone and Needle Ranges such that the density of data was the same as for the other mountain ranges. Thus, only woodland stands at contours spaced at 200 m intervals from the 2,000 m elevation baseline were included in the construction of classified entities used here. The stands at 1,900, 2,100, 2,300, and 2,500 m on the Shoshone and Needle Ranges were reserved to test the extrapolatability and interpolatability of the classification scheme.

In a few macroplots, no understory whatsoever was encountered. This complicates the classification approach used here. In retrospect, we should have sampled beyond the 20 by 50 m macroplot boundaries when no understory was recorded within our plots. The actual boundaries of the represented stand irregularly extend beyond what occurs within the macroplot. If a larger area on the same ecological site is searched until less dense canopy is located, some understory will be encountered to make the following approach possible in nearly all instances.

Hierarchical Levels

The hierarchical levels proposed for this classification, the criteria used, their relationship to the size of polygons created, and the Ecoregion Classification of the United States (Bailey and others 1994; McNab and Avers 1994) are outlined in table 3. The Ecoregion approach is geographically explicit, whereas the vegetation units are abstract. The user should understand that only part of the information needed to construct the land classification hierarchy recommended by Bailey and others (1994) currently exists.

Vegetation classifications need not require geographic information to make them work. It is, however, easier to use a classification with at least some geographic delineations. Accordingly, we merged the two systems. We chose the particular vegetation-based hierarchical levels and variables that were already within the Ecoregion Classification so that land managers would, with the aid of this report, be able to see differences in the field, and move forward in applying the classification on the ground.

We agree with Hironaka (1987) that a usable classification must employ readily observable variables, be consistent, and be simple to work through. There are so many potential land type associations and land types, that only a few examples of vegetational proxies for these can possibly be covered here. Instead, we establish an open-ended system that can be expanded as needed.

We readily admit that the classification scheme that follows is more arbitrary and subjective than "natural." A completely "natural" approach is impossible (Kent and Coker 1992) and inadequate anyway (Nolet and others 1995). Our approach has value only if it simplifies and enhances human understanding by identifying factual information that can be effectively applied in interpretations by land managers.

The Classification

The hierarchical approaches suggested by Hunter and Paysen (1986) were merged with the National Hierarchical Framework of Ecological Units (ECOMAP 1993). Bailey and others (1994) have already defined the higher levels of this geographic subdivising.

For this classification, pinyon and juniper woodlands are placed in the Dry Domain of the Ecoregion Hierarchy (Bailey and others 1994). The Woodland Formation is added between the Dry Domain and the Desert Division (table 3). Following the Desert Division from Bailey and others (1994), we have inserted

Table 3—Hierarchical levels of classification used for pinyon-juniper woodlands of the Great Basin. ECOMAP (1993) ecological units are capitalized. Vegetational units are in lower case. Numbers used are from Bailey and others (1994).

	Criteria	Polygon size	Name of unit	Map number in Mohave	Map number in Great Basin	Map number in Mountains
				- - - - - - - -Lowlands	- - - - - - - -	
DOMAIN	Broad climatic zones	millions of mi^2	Dry Domain	300	300	300
Formation	Structurally dominant plant life forms		Woodland			
DIVISION	Köppen-Trewartha regional climatic types Broad vegetational affinities Dominant soil order	hundreds of thousands of mi^2	Desert	Sub-tropical 320	- - -Temperate 340	- - - M340
Subformation	Further division of dominant lifeforms		Conifer Woodland			
PROVINCE	Dominant potential natural vegetation (Küchler 1970)	tens of thousands mi^2	American Desert and Semi-Desert	322		
			Intermountain Desert and Semi-Desert		341	
			Nevada-Utah Mountains Semi-Desert-Coniferous Forest-Alpine Meadow			M341
SECTION	Geologic age, stratigraphy, lithology, morphology	thousands of mi^2	Northern Mohave Desert	322A		
			Bonneville Basin		341A	
	Regional climate		Mono-Walker-Owens Basins		341D	
	Soil sub-orders and great groups		Lahontan Basin		341E	
	Potential natural communities		Southeastern Great Basin		341F	
			Humboldt Basin		341G	
			Northern Great Basin		342B	
			Central Great Basin			M341A
			South Central Utah Highlands			M341C
SUBSECTION	Geomorphic process, surficial geology Soil sub-orders and great groups Sub-regional climate Vegetational series	tens to low thousands of mi^2	Only mountainous Forest Service areas yet covered (see Nelson 1994)			
Series	Relative dominance of largest species		*Pinus monophylla* *P. edulis* *Juniperus osteosperma*		(see table 6)	
LANDTYPE ASSOCIATION	geomorphic process and surficial geology Elevation Soil sub-groups, families or series Potential natural communities	high hundreds to about 1,000 acres				
LANDTYPE	Elevation, aspect, slope gradient and position Soil families and series Rock type Plant associations	tens to hundreds of acres				
Association	Dominant shrub				(see table 10)	
LANDTYPE PHASE	Land form and slope position Soil families and series Phase of plant association	less than 100 acres				
Subassociation	Dominant native perennial grass/forbs				(see table 10)	
Stand	Uniform vegetation due to uniform environment and disturbance history					
Macroplot	Area of stand sampled	0.1 ha				

the Conifer Woodland Subformation. At these levels and above, the highest proportion of the land area considered (fig. 1) is desert. The mountain masses, around which most of the Great Basin's pinyon-juniper woodlands are centered (fig. 2), are like islands in a "sea" of desert.

Great Basin vegetation is characterized by very low floristic species richness considering the huge area involved. Many of the plant species we encountered, particularly the cover dominants, have such wide ecological tolerances that they have only coarse indicator value. That is, the same species mean different things in different places. We suspect that the rapidly changing environments of the past fostered much natural selection, but at the intraspecific rather than specific level (Tausch and others 1993). Except for sagebrush sub-species (West and others 1978c), intraspecific differences are difficult to discern in the field. Thus, we found it useful to employ "Sections" from Bailey and others (1994) (table 4). Only coarse-textured maps designating locations to the Section level of ECOMAP (McNab and Bailey 1994) are currently available for the entire study area. Accordingly, decisions about what Section a given borderline mountain range should be placed in was difficult in some cases. Thus, when ECOMAP is done for finer-textured levels in the Great Basin, the boundaries of higher levels will change as well.

Because these Sections constitute nine coarsely different kinds of effective environments across the Great Basin (fig. 8), the populations of plant species and sub-species of sagebrush within Sections should have relatively homogeneous responses compared to everywhere else they occur. We have used the recommendations of Kartesz (1994) for Latin names of plants. We have used the recommendations of Anonymous (1988) for common names, linking the two names through the synonymy given in Kartesz (1994).

Sub-sections have not yet been formalized, except in California (Goudey and Smith 1994), and only tentatively for the National Forest lands of the Intermountain Region (Nelson 1994). The Interior Columbia River Basin Ecosystem Management group has taken watershed boundaries as the basis of Sub-sections of the Pacific Northwest (Anonymous 1996). Hydrological boundaries do not appear in the criteria of ECOMAP (1993). Thus, there are some issues to be sorted out at this level.

Series are based on the relative cover contributions by the various tree species to total tree cover. Use of relative cover allows us to compare stands regardless of year of data collection, successional status, or site potential. Furthermore, the differences in the methods used to assess cover by the different teams using the "rapid" and "detailed" methods should be minimized because we are concerned at this level with dominance ranking rather than absolute amounts of tree cover. This ranking is also easy to do in the field by laying out a tape and adding up canopy intercepts.

The arbitrarily determined Series (table 5) were pure stands of *Pinus monophylla* (designated by the acronym, PIMO), strongly (80 to 99 percent relative cover) dominated by *P. monophylla* (designated by the acronym, PiMo), weakly (50 to 79 percent) dominated by *P. monophylla* (designated by the acronym, Pimo); pure stands of *Juniperus osteosperma* (100 percent relative tree cover, designated by the acronym, JUOS), strongly (80 to 99 percent relative cover) dominated by *J. osteosperma* (designated by the acronym, JuOs), and weakly (50 to 79 percent relative tree cover) dominated by *J. osteosperma* (designated by the acronym, Juos); and stands strongly (80 to 99 percent) dominated by *Pinus edulis* (designated by the acronym, PiEd), or weakly (50 to 79 percent relative cover) dominated by *P. edulis* (designated by the acronym, Pied). Pure stands of *P. edulis* were not encountered in this study, apparently because we did not sample into eastern Utah where this species is common and *P. monophylla* is not found. Only two stands in which Rocky Mountain Juniper (*Juniperus scopulorum*) dominates were encountered in south central Utah.

PIMO, PiMo, and Pimo Series (about 55 percent of the stands sampled) were primarily found in central and western Nevada. PiEd and Pied Series (about 2 percent of the stands) were found only in southwestern Utah. JUOS, JuOs, and Juos series (about 44 percent of the stands) dominate geographically in western Utah and central and eastern Nevada, but also occur locally in western Nevada, and extend to lower elevations at the northern and other margins of the Great Basin.

Landtype Associations (LTAs), according to ECOMAP (1993), are to be based on geomorphic process and surficial geology, elevation, soil sub-groups, families or series, local climate, and potential natural communities. No one, to our knowledge, has yet determined how to consistently apply combinations of these disparate pieces of factual information and make rules for identifying boundaries between LTAs. We await examples, particularly for this region.

The same concern exists for Landtypes and Landtype Phases. Until these matters are resolved in a consensual way between the land management, advisory, and scientific institutions, we suggest that our simpler, vegetation-based land classification be used.

The next level of the vegetation-based classificational hierarchy, the Associations, are designated by the dominant shrub present. An alphabetical listing of the acronym for each of the 26 shrub taxa used to designate Associations, along with its corresponding Latin and common name is found in table 6.

In order to further differentiate various kinds of pinyon-juniper woodlands, we designated Sub-associations, based primarily on the dominant native

Table 4—Relationships between ECOMAP sections and mountain ranges.

Section		Mountain	Map Code
Number	Name	ranges (States)	in fig. 2
322A	Northern Mohave Desert	Beaver Dam (UT)	46
		McCullough (NV)	21
		Panamint (CA)	1
		Sheep (NV)	29
		Spring (NV)	33
341A	Bonneville Basin	Burbank Hills (UT)	47
		Canyon (UT)	48
		Confusion (UT)	49
		Cricket (UT)	50
		East Tintic (UT)	52
		House (UT)	54
		Mineral (UT)	55
		Oquirrh (UT)	57
		Pavant (UT)	58
		Pilot (UT-NV)	59
		San Francisco (UT)	61
		Sheeprock (UT)	62
		Stansbury (UT)	63
		Wah Wah (UT)	65
		West Tintic (UT)	66
341D	Mono-Walker-Owens Basins	Excelsior (NV)	12
		Pine Nut (NV)	24
		Virginia (NV)	41
		Wassuk (NV)	42
		White (CA-NV)	2
341E	Lahontan Basin	Silver Peak (NV)	31
		West Humboldt (NV)	43
341F	Southeastern Great Basin	Beryl-Enterprise Hills (UT)	53
		Fortification (NV)	14
		Grant (NV)	16
		Highland (NV)	17
		Kawich (NV)	18
		Needle (UT)	56
		Pine Valley (UT)	60
		Quinn Canyon (NV)	25
		South Egan (NV)	19
		Wilson Creek (NV)	45
341G	Humboldt Basin	Cherry Creek (NV)	7
		East Humboldt (NV)	11
		Pequop (NV)	23
		Spruce (NV)	34
		Toana (NV)	36
342B	Northern Great Basin	Albion (ID)	3
		Black Pine (ID)	4
		Goose Creeks (NV-UT)	15
		Sublette (ID)	5
M341A	Central Great Basin	Bald (NV)	6
		Clan Alpine (NV)	8
		Deep Creek (NV-UT)	51
		Desayota (NV)	9
		Diamond (NV)	10
		Fish Creek (NV)	13
		Southern Snake (NV)	20
		Monitor (NV)	22
		North Egan (NV)	39
		Northern Snake (NV)	40
		Roberts Creek (NV)	26
		Ruby (NV)	27
		Schell Creek (NV)	28
		Shoshone (NV)	30
		Simpson Park (NV)	32
M341A	Central Great Basin	Sulphur Springs (NV)	35
		Toiyabe (NV)	37
		Toquima (NV)	38
		White Pine (NV)	44
M341C	South-Central Utah Highlands	Tushar (UT)	64

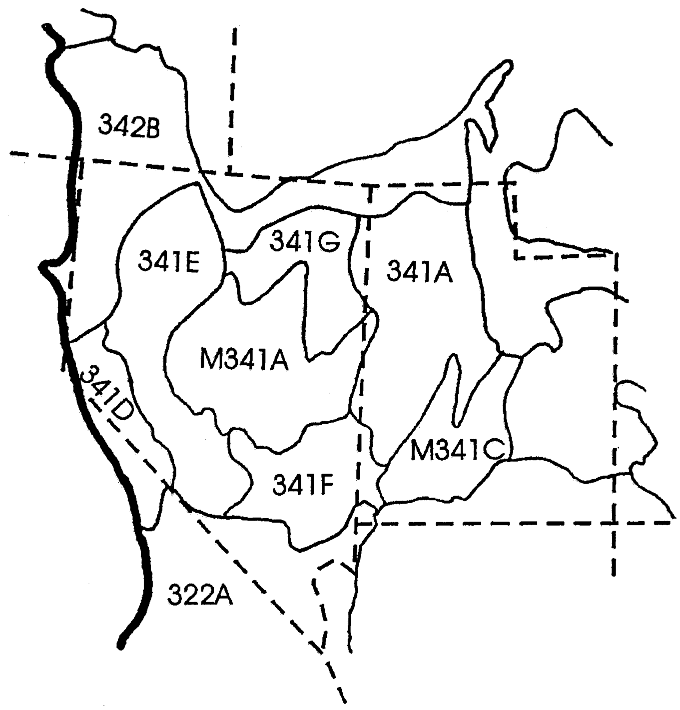

Figure 8—Map of Sections used in this study from Bailey and others (1994).

perennial grasses, and secondarily, when a native perennial grass was not present, on the most abundant native perennial forb. Most of the introduced species are annuals. Annuals were ignored because their abundance fluctuates greatly from year to year (Treshow and Allen 1979) and we sampled over several years (1972 through1975) with drastically varying weather. Annuals are also usually increased by disturbance. We tried to avoid sampling areas of recent disturbance.

An alphabetical listing of the acronyms for each species of native perennial grass used to primarily designate Sub-associations, along with its corresponding Latin and common name is found in table 7. An alphabetical listing of the acronyms for each species of perennial forbs that were secondarily used to help designate Sub-associations appears in table 8. When native perennial forbs are used in the absence of a native perennial grass to designate a Sub-association, the four letter code is surrounded by parentheses to alert the user that this has been done.

Table 9 outlines the hierarchical structure we ended up using in the classification presented here. The number of units found at each level across the entire Great Basin and an example of a named unit are also given there.

Combining the nine Sections with the nine possible levels of tree dominance (table 5) creates 81 possible

Table 5—Categorization of stands sampled into Series, based on relative cover dominance by tree species.

Acronym	Latin name	Common name	Relative cover	Number of stands
			Percent	
PIMO	*Pinus monophylla*	Singleleaf pinyon	100	48
PiMo	*Pinus monophylla*	Singleleaf pinyon	80-99	96
Pimo	*Pinus monophylla*	Singleleaf pinyon	50-79	95
JUOS	*Juniperus osteosperma*	Utah juniper	100	84
JuOs	*Juniperus osteosperma*	Utah juniper	80-99	59
Juos	*Juniperus osteosperma*	Utah juniper	50-79	37
PiEd	*Pinus edulis*	Colorado pinyon	80-99	3
Pied	*Pinus edulis*	Colorado pinyon	50-79	2
Jusc	*Juniperus scopulorum*	Rocky Mountain juniper	50-79	2
Total				426

Table 6—Shrubs used to designate Associations. The order is alphabetical by acronyms (first two letters of genus and first two letters of the species names, except for sagebrushes). Corresponding Latin names are those recommended by Kartesz (1994), and common names are those recommended by Anonymous (1988).

Code	Latin name	Common name
Amal	*Amelanchier alnifolia*	Saskatoon serviceberry
AA	*Artemisia arbuscula*	Gray low sagebrush
AN	*Artemisia nova*	Black low sagebrush
Atca	*Atriplex canescens*	Fourwing saltbush
AT	*Artemisia tridentata* ssp. *tridentata*	Basin big sagebrush
AV	*Artemisia tridentata* ssp. *vaseyana*	Mountain big sagebrush
AW	*Artemisia tridentata* ssp. *wyomigensis*	Wyoming big sagebrush
Cele	*Cercocarpus ledifolius*	Curlleaf mountain mahogany
Cemo	*Cercocarpus montanus*	True mountain mahogany
Chna	*Chrysothamnus nauseousus*	Rubber rabbitbrush
Chvi	*Chrysothamnus viscidiflorus*	Stickyleaf low rabbitbrush
Chpa	*Chrysothamnus paniculatus*	Desert rabbitbrush
Cora	*Coleogyne ramosissima*	Blackbrush
Epne	*Ephedra nevadensis*	Nevada Mormon-tea
Epvi	*Ephedra viridis*	Green Mormon-tea
Ermi	*Eriogonum microthecum*	Slender buckwheat
Gusa	*Gutierrezia sarothrae*	Broom snakeweed
Mare	*Mahonia repens*	Oregon-grape
Pera	*Peraphyllum ramosissimum*	Squaw-apple
Pugl	*Purshia glandulosa*	Desert bitterbrush
Pume	*Purshia mexicana*	Mexican cliffrose
Putr	*Purshia tridentata*	Antelope bitterbrush
Quga	*Quercus gambelii*	Gambel oak
Rive	*Ribes velutinum*	Desert currant
Syal	*Symphoricarpos albus*	Common snowberry
Sylo	*Symphoricarpos longiflorus*	Longflower snowberry

Table 7—Native, perennial grasses used to designate Sub-associations. The order is alphabetical by acronyms (first two letters of the genus and first two letters of the species names). Latin names are those recommended by Kartesz (1994), and common names are those recommended by Anonymous (1988).

Code	Latin name	Common name
Arpu	*Aristida purpurea*	Purple threeawn
Bogr	*Bouteloua gracilis*	Blue grama
Brca	*Bromus carinatus*	Mountain brome
Elel	*Elymus elymoides*	Bottlebrush squirreltail
Ella	*Elymus lanceolatus*	Thick spike wheatgrass
Eltr	*Elymus trachycaulus*	Slender wheatgrass
Feid	*Festuca idahoensis*	Idaho fescue
Hija	*Hilaria jamesii*	Galleta
Leci	*Leymus cinereus*	Basin wildrye
Lesa	*Leymus salinus*	Salina wildrye
Lesi	*Leymus simplex*	Bullgrass
Mumo	*Muhlenbergia montana*	Mountain muhly
Orhy	*Oryzopsis hymenoides*	Indian ricegrass
Pasm	*Pascopyrum smithii*	Western wheatgrass
Pofe	*Poa fendleriana*	Muttongrass
Pose	*Poa secunda*	Sandberg's bluegrass
PsXsa	*Pseudoelymus* X *saxicola*	Foxtail wheatgrass
Pssp	*Pseudoroegneria spicata*	Bluebunch wheatgrass
Star	*Stipa arida*	Mormon needlegrass
Stco	*Stipa comata*	Needle and thread
Stoc	*Stipa occidentalis*	Western needlegrass
Stsp	*Stipa speciosa*	Desert needlegrass
Stth	*Stipa thurberiana*	Thurber needlegrass

Table 8—Native perennial forbs used to designate Sub-associations when native perennial grasses were lacking. The order is alphabetical by acronyms (first two letters of the genus and first two letters of the species names). Latin names are those recommended by Kartesz (1994), and common names according to Anonymous (1988).

Code	Latin name	Common name
Basa	*Balsamorhiza saggitata*	Arrowleaf balsamroot
Cach	*Castelleja chromosa*	Desert Indian paintbrush
Cacr	*Caulanthus crassicaulis*	Thickstem wild cabbage
Canu	*Calochorthus nuttallii*	Sego lily
Crfl	*Cryptantha flavoculata*	Roughseed cryptantha
Erov	*Eriogonum ovalifolium*	Cushion eriogonum
Erum	*Eriogonum umbellatum*	Sulphur eriogonum
Luse	*Lupinus sericeus*	Silky lupine
Pede	*Penstemon deustus*	Scobland penstemon
Pepa	*Penstemon pachyphyllus*	Thickleaf penstemon
Phdi	*Phlox diffusa*	Diffuse phlox
Stco	*Strepthanthus cordatus*	Heartshape twist flower

Series. However, some Series were not found in some Sections yielding 45 actual Series. Twenty-six species of dominant shrubs were identified (table 6) that when combined with the Sections and Series resulted in 183 Associations. The addition of the 23 dominant grass species (not including "no grass") (table 7) resulted in a total of 326 Sub-associations. This level of variation within such an extensive sample illustrates the large variation in the understory communities associated with these woodlands over the Great Basin.

While the level of complexity may superficially seem to be more than any manager can consider, please keep in mind that at the maximum level of detail presented here, the user needs to already know or be able to key out only 4 trees, 26 shrubs, and 23 species of perennial grasses to use this first level of classification anywhere in the Great Basin. Someone working out of a particular District Office of the USDI Bureau of Land Management (BLM) or a Ranger District of the USDA Forest Service will only need to know or find out the identity of less than about half of this list of common species.

Table 9—Outline of the hierarchical classification used for Great Basin pinyon-juniper woodlands. Gradual indenting of each level signifies progressively lower entities in the hierarchy.

Level	Number of units	Example
Formation	1	Woodland
Subformation	1	Conifer Woodland
Sections	9	Bonneville Basin
Series	45	PIMO in Section III
Associations	183	PIMO/Arno
Subassociations	326	PIMO/Arno/Elel
Stands	426	
Macroplots	426	

A summary of all the Series, Associations, and Sub-associations discovered from field sampling so far (table 10) indicates how many stands of each Series, Association, and Sub-association were sampled in each Section.

While it would be desirable to further subdivide pinyon-juniper woodlands beyond Sub-associations and relate these lower units to elevation, slope, exposure, topography, soils, ecological site, and so forth, this study is not based on a sample that is adequate for this level of site specific detail. Thus, indicative, not definitive, correlates are listed (when available) (tables 11 through 19) as part of the discussion of the individual Sections that follow. This information is to be regarded as only a starting point for managers and scientists to build their own ecological site and stand classifications in a local area.

A stand occupies an area of sufficient homogeneity with regard to soils, topography, microclimate, and past disturbance history so as to have resulted in uniform enough vegetation to be treated as a single unit. Although each macroplot used here was sampled within a single stand, the spatial extent of those stands was not mapped.

Our data do not make it possible to identify where on the landscape finer-textured vegetational classification entities will reliably occur. We also do not identify all the environmental factors correlating on a landscape basis. Across a region, differing combinations of environmental characteristics can be important in explaining vegetational behavior. The data used here also are not close to representing all the possible Associations and Sub-associations probably present, nor does it adequately portray their relative abundances and areal extent. Many of the rarer combinations are probably missing altogether.

The classification presented here also does not necessarily represent an ecological hierarchy. A collection of stands now aggregated into particular Associations and Sub-associations could represent different degrees of successional status or disturbance over several ecological sites. The same classification could also represent different community types and different responses to management in different Sections. For example, moderately disturbed sites that were not detected as such might thus be sampled. They could then be initially classified in the same Association, but through successional time, may change as to both the Association and Sub-association in which they would be classified.

Table 10—Summary of occurrences of Series, Associations, and Sub-associations by geographic unit. Numbers indicate stands of pinyon-juniper woodland sampled within each category. Sub-associations in parentheses indicate that native perennial forbs are used in the absence of a native perennial grass.

			Sections									
Series[a]	Assoc.[b]	Sub-assoc.[c]	322A	341A	341D	341E	341F	341G	342B	M341A	M341C	Total
PIMO	AA	Feid								1		1
"	AN	Orhy			1							1
"	"	Pssp								1		1
"	AT	Pose			1					1		2
"	AV	Bogr					1					1
"	"	Elel			1							1
"	"	Feid								1		1
"	"	Leci								1		1
"	"	Orhy					1					1
"	"	Pose			2		3			6		11
"	"	Pssp			1		1					2
"	"	Stco			2							2
"	"	Stoc			1							1
"	AW	Elel				1						1
"	"	Hija			1							1
"	"	Orhy			1							1
"	AW	Pose			1							1
"	"	Stoc			1					1		2
"	Amal	Brca								1		1
"	"	Pssp								1		1
"	Cele	Elel								1		1
"	"	Orhy								1		1
"	"	Pofe					1					1
"	"	Pose					1			3		4
"	"	Stoc								1		1
"	Chvi	Elel					1					1
"	"	Pose			1							1
"	Epvi	Pose								1		1
"	Putr	Orhy			1							1
"	"	Stth			1							1
"	Rive	Pose			1							1
PiMo	AA	Elel								1		1
"	"	Feid								1		1
"	AN	Bogr	1									1
"	"	Elel				1						1
"	"	N.G./N.F.[d]						1		1		2
"	"	Orhy				1	3	1		2		7
"	"	Pofe	1									1
"	"	Pose								3		3
"	"	Stco		1								1
"	"	Stoc								1		1
"	AT	Hija					1					1
"	"	Orhy				1				1		2
"	"	(Pepa)								1		1
"	"	Pose					2			5		7
"	"	Stco		1								1
"	AV	Elel			1		2			2		5
"	"	Feid								4		4
"	"	Leci			2							2
"	"	(Luse)			1							1
"	"	Orhy					2			2		4
"	"	Pofe	1									1
"	"	Pose			6		1			9		16

(con.)

Table 10 (Con.)

			Sections									
Series[a]	**Assoc.**[b]	**Sub-assoc.**[c]	**322A**	**341A**	**341D**	**341E**	**341F**	**341G**	**342B**	**M341A**	**M341C**	**Total**
PiMo	AV	Pssp					2	1		2		5
"	"	Stoc								1		1
"	AW	Elel			1							1
"	"	Hija					1			1		2
"	"	Pose								2		2
"	"	Stoc								1		1
"	Amal	Pose					2					2
"	"	Pssp					1					1
"	Cele	Elel								2		2
"	"	Pofe					2					2
"	"	Pose								1		1
"	"	Pssp						1				1
"	Gusa	Pssp		1								1
"	Mare	Elel					1					1
"	Pugl	Elel								1		1
"	Putr	Elel								1		1
"	"	Pofe		1								1
"	"	Pose						1				1
"	Sylo	Brca					1					1
"	"	Elel					1					1
"	"	Feid								1		1
"	"	Pose			1					1		2
Pimo	AA	Orhy				1						1
"	AN	Arpu		1								1
"	"	Bogr					1					1
"	"	Elel	1	1	1		1			1		5
"	"	Hija	1									1
"	"	Orhy				1				1		2
"	"	(Pepa)		1								1
"	"	Pofe		1			1					2
"	"	Pose					1			3		4
"	"	Pssp						1				1
"	"	Stoc								1		1
"	AT	Elel								3		3
"	"	Leci								1		1
"	"	Orhy		1	1		2	2				6
"	"	Pasm		1						5		6
"	"	Pofe					1					1
"	"	Pose								2		2
"	"	Stco			1			1				2
"	"	(Stco)								1		1
"	AV	(Crfl)								1		1
"	"	Elel					2					2
"	"	(Erum)	1									1
"	"	Orhy					1			1		2
"	"	(Pede)								1		1
"	"	Pofe								1		1
"	"	Pose					1			1		2
"	"	Pssp		1				2		2		5
"	"	Stoc								1		1
"	AW	Bogr	2									2
"	"	Elel	1				2			1		4
"	"	(Erum)					1					1
"	"	Hija					2					2
"	"	Orhy		1								1

(con.)

Table 10 (Con.)

Series[a]	Assoc.[b]	Sub-assoc.[c]	322A	341A	341D	341E	341F	341G	342B	M341A	M341C	Total
			Sections									
Pimo	AW	Pose						1		1		2
"	"	Star	1									1
"	Amal	N.G./N.F.[d]					1					1
"	"	Pose								1		1
"	Cele	(Basa)		1								1
"	"	Elel								1		1
"	"	(Erum)	1									1
"	"	N.G./N.F.[d]		1								1
"	"	Orhy					2					2
"	"	PsXsa					1					1
"	Cora	Bogr	2									2
"	"	(Cach)	1									1
"	"	(Pose)	1									1
"	Gusa	Lesa		1								1
"	"	Orhy					1					1
"	N.S.[d]	N.G./N.F.[d]					1					1
"	N.S.	Pose						1				1
"	Pera	Pofe					1					1
"	Pugl	PsXsa					1					1
"	"	Stco		1								1
"	Pume	Arpu					1					1
"	"	Pose					1					1
"	Putr	Pose						2				2
JUOS	AA	Brca				1						1
"	"	Leci				2						2
"	"	Orhy		1								1
"	"	Pasm		1								1
"	"	Pssp							1			1
"	AN	(Cacr)						1				1
"	"	(Canu)		1								1
"	"	Elel		1								1
"	"	Orhy		1			1			2		4
"	"	Pasm		2								2
"	"	Pose							1	1		2
"	"	Pssp							2			2
"	AT	Bogr		1								1
"	"	(Cacr)								1		1
"	"	Elel				2						2
"	"	Ella		2								2
"	"	Eltr							1			1
"	"	Hija		2								2
"	"	Leci								3		3
"	"	Mumo		1								1
"	"	N.G./N.F.[d]		1								1
"	"	Orhy		3				1				4
"	"	Pasm		1								1
"	"	Pose		1			1		2			4
"	"	Pssp		2					1			3
"	AV	Ella					1			1		2
"	"	Leci								1		1
"	"	N.G./N.F.[d]		1								1
"	"	Orhy	1							1		2
"	AV	Pasm		3								3
"	"	Pose		1		1			1	1		4
"	"	Pssp		2					2			4

(con.)

Table 10 (Con.)

			Sections									
Series[a]	Assoc.[b]	Sub-assoc.[c]	322A	341A	341D	341E	341F	341G	342B	M341A	M341C	Total
JUOS	AW	Bogr					1					1
"	"	Elel	1									1
"	"	Hija					1					1
"	"	Leci								1		1
"	"	Pose	1									1
"	"	Pssp								1		1
"	Chna	Pssp		1								1
"	Chpa	Arpu					1					1
"	Chvi	Pose						1				1
"	"	Pssp					1	1				2
"	Cora	Bogr	1									1
"	"	Elel					1					1
"	"	Orhy	1									1
"	Gusa	Hija		1								1
"	"	Pssp							1			1
"	"	Stco		1								1
"	Quga	Elel		1								1
"	Pume	Lesi					1					1
"	"	Pasm		1								1
"	"	PsXel		1								1
"	Putr	Pssp							1			1
JuOs	AA	Hija					1					1
"	"	Pasm		1								1
"	AN	Eltr					1					1
"	"	Orhy		2			3			1		6
"	"	Pasm		2								2
"	"	Pose								2		2
"	"	Pssp								1		1
"	"	Stco					1					1
"	AT	Ella		1								1
"	"	Hija		2			1					3
"	"	Orhy		2			1			1	1	5
"	"	Pose								1		1
"	"	Pssp		1				2		2		5
"	AV	Elel		2						1		3
"	"	Orhy					1					1
"	"	Pose								1		1
"	AW	Elel		1								1
"	"	Hija					3					3
"	"	Pose					1					1
"	"	Pssp		1				2				3
"	"	Stco					1					1
"	Amal	Ella		1								1
"	Atca	Orhy		1								1
"	Cele	Elel		1								1
"	"	Lesi		1								1
"	Chpa	Bogr	1									1
"	Cora	Pofe	1									1
"	"	Stsp	1									1
"	Epvi	Elel								1		1
"	Pume	Hija					1					1
"	Putr	Pose						2				2
"	Quga	Elel									1	1
"	"	Eltr		1								1
"	"	(Erum)		1								1
"	"	N.G./N.F.[d]		1								1
"	"	Orhy		1								1
Juos	AN	Elel					1					1
"	"	(Erov)					1					1
"	"	Orhy		1						1		2

(con.)

Table 10 (Con.)

Series[a]	Assoc.[b]	Sub-assoc.[c]	322A	341A	341D	341E	341F	341G	342B	M341A	M341C	Total
			Sections									
Juos	AN	Pose								1		1
"	"	Pssp		2				1				3
"	"	Star	1									1
"	AT	Orhy								1	1	2
"	"	Stco					1					1
"	AV	Elel								1	1	2
"	"	N.G./N.F.[d]					1					1
"	"	Orhy					1				1	2
"	"	Pose								1		1
"	"	Pssp								1		1
"	"	Stth			1							1
"	AW	Hija		1								1
"	"	Pofe					1					1
"	Cele	N.G./N.F.[d]		1								1
"	"	Orhy								1		1
"	"	Pose		1						1		2
"	Chvi	Pose								1		1
"	"	Stoc					1					1
"	Epvi	(Pepa)					1					1
"	"	Pssp								1		1
"	Ermi	N.G./N.F.[d]					1					1
"	N.S.[d]	(Erov)					1					1
"	"	Pose						1				1
"	Putr	Elel					1					1
"	"	Hija					1					1
"	"	Orhy		1						1		2
JUSC	AV	Bogr									1	1
Jusc	Amal	Pofe					1					1
PiEd	AV	Bogr									1	1
"	Cemo	(Phdi)					1					1
"	Epne	Orhy		1								1
Pied	Cemo	Orhy									1	1
"	Gusa	Orhy		1								1
Totals												
	Series		5	7	4	4	8	5	1	6	5	45
	Associations		13	34	13	8	47	18	6	38	6	183
	Sub-associations		22	67	25	10	76	21	10	88	7	326
Number of stands			24	82	33	12	95	27	13	133	7	426

[a]See table 5 for key to Series acronyms.
[b]See table 6 for key to Association acronyms.
[c]See tables 7 and 8 for key to Sub-association acronyms.
[d]N.G. = no grass; N.F. = no forb; N.S. = no shrub.

Using This Classification

Now that we have defined all of the hierarchical levels within our classification and outlined what we have already found, we can begin to illustrate the structure and utility of this classification using our sampled stands. Since the Sections used are approximately equal in size to Ranger Districts of the USDA Forest Service and Resource Areas of the USDI Bureau of Land Management, the administrative levels where most land management decisions are made, we begin by illustrating how to use the classification from the view of someone working out of one of those offices. This report provides the initial classification of the Series, Sub-series, Associations, and Sub-associations we found present in each Section. The users may well find new combinations as they attempt to use this material.

The users need not read all the following text and tabular material sequentially. Instead they should match up their area of interest with the appropriate Section depicted in the map (fig. 8). The mountain ranges within each Section are listed in table 4. Their geographic locations are shown in figure 2. The reader who has determined an area of interest should turn to figure 8 to find what Section is involved, and then find the following appropriate pages discussing pinyon-juniper woodlands in that Section. We have tried to simplify this process by staggering marginal tabs for the Sections depicted in figure 8 using the same order as they are discussed in the following text. The Sections are covered in a sequential order matching the numbering sequence of Bailey and others (1994).

Note that the first two letters of the generic and species Latin name (except for sagebrushes which have been further shortened—see table 6) are combined into a four letter acronym in order to shorten the text. A complete list of the acronyms, Latin names, and common names are given of trees (table 5), of shrubs (table 6), of grasses (table 7), and of forbs (table 8).

Occasionally either no shrub, native perennial grass, or native perennial forb were encountered in the sample. In such cases, 'N.S.' for "no shrub," 'N.G.' for "no grass," and 'N.F.' for "no forb" were designated. These absences were probably a function of our incomplete sampling of all the individual plants within the area of the rectangular 0.1 ha macroplot (fig. 4). The user is advised to search throughout the actual stand to find the occasional shrub or grass to correct these problems. In other words, we don't place significance in classifying by absence of understory.

In the absence of a native perennial grass, a native perennial forb has been used, if possible. When this has been done, the forb's acronym is placed within parentheses. In a few cases, no vascular plant understory was observed at all and thus the stand could not be classified beyond Series.

The Series within each Section are ordered with *Pinus monophylla* Series first (if present) followed by *Juniperus osteosperma* Series and then *Pinus edulis* Series.

The discussions for each Section are presented as stand alone entities. Thus, a manager may read only the treatment for each Section in which they are interested.

Section 322A: Pinyon-Juniper Woodlands of the Northern Mohave Desert

The first geographic grouping of pinyon-juniper woodlands that was considered occurs in the northernmost portion of Section 322A (fig. 8), commonly known as the Mohave Desert. We sampled woodlands on only five mountain ranges there: McCullough, Sheep, and Spring in Nevada, the Panamint Range in California, and the Beaver Dam Mountains of extreme southwestern Utah (table 5). Only "rapid" sampling was done on these mountain ranges. The field teams working this area did not obtain adequate soil descriptions to reliably classify to Great Group level at all stands, hence the missing information in the two far right columns of table 11. Because our coverage of this Section is spatially limited, the land manager or scientist should expect to encounter many other kinds of pinyon-juniper woodlands when working in that section.

Section 322A had five Series (table 11); PiMo, Pimo, JUOS, JuOs, and Juos.

The PiMo Series in this Section has two Associations and three Sub-associations (table 11). The Associations are PiMo/AN and PiMo/AV. The PiMo/AN Association is represented by the PiMo/AN/Bogr and PiMo/AN/Pofe Sub-associations. The PiMo/AV Association had only a PiMo/AV/Pofe Sub-association.

The Pimo Series in this Section is divided among five Associations. The Pimo/AN Association had Pimo/AN/Elel and Pimo/AN/Hija Sub-associations. The Pimo/AV Association had but the Pimo/AV/(Erum) Sub-association. The Pimo/AW Association had three Sub-associations: Pimo/AW/Bogr, Pimo/AW/Elel, and Pimo/AW/Star. The Pimo/Cele Association had but one Sub-association, Pimo/Cele/(Erum). The Pimo/Cora Association had the Pimo/Cora/Bogr, Pimo/Cora/(Cach), and Pimo/Cora/Pose Sub-associations (table 11).

The JUOS Series in this Section was represented by five stands divided into three Associations (table 11). The Associations are JUOS/AV, JUOS/AW, and JUOS/Cora. The JUOS/AV Association had the JUOS/AV/Orhy Sub-association. The JUOS/AW Association was divided into JUOS/AW/Elel and JUOS/AW/Pose Sub-associations. The JUOS/Cora Association was split between JUOS/Cora/Bogr and JUOS/Cora/Orhy Sub-associations.

The JuOs Series in Section 322A has two Associations (table 11), so far. These are JuOs/Chpa and JuOs/Cora represented by JuOs/Chpa/Bogr, JuOs/Cora/Pofe, and JuOs/Cora/Stsp Sub-associations, respectively.

The Juos Series in this Section is represented by only one stand of the Juos/AN/Star Sub-association.

Table 11—Summary of Pinyon-Juniper Woodland Series, Associations, and Sub-associations in Section 322A. Parentheses indicate that native perennial forbs are used to designate a Sub-association in the absence of a native perennial grass.

Series[a]	Assoc.[b]	Sub-assoc.[c]	Mtn. range	Elev. (m)	Aspect	Slope	Geol. form.	Soils (great group)	Soils (subgroup)
PiMo	AN	Bogr	Spring	2,200	E	08	Granitic		
"	"	Pofe	Panamint	2,000	N	62	Granitic	Haploxerolls	
"	AV	"	Panamint	2,200	W	38	Granitic		
Pimo	AN	Elel	Sheep	1,800	E	16	Granitic	Haploxerolls	
"	"	Hija	Panamint	2,000	S	24	Granitic	Haploxerolls	
"	AV	(Erum)	Spring	2,000	W	28	Granitic		
"	AW	Bogr	Spring	2,000	E	05	Granitic		
"	"	"	Sheep	1,800	S	10	Shale		
"	"	Elel	Sheep	1,600	N	32	Basaltic	Haploxerolls	
"	"	Star	Spring	1,800	S	32	Granitic		
"	Cele	(Erum)	Spring	2,200	W	21	Granitic		
"	Cora	Bogr	Beaver Dam	1,400	S	27	Quartzite		
"	"	"	McCullough	1,600	E	16	Granitic		
"	"	(Cach)	Spring	1,800	N	10	Granitic		
"	"	Pose	Beaver Dam	1,400	W	38	Quartzite		
JUOS	AV	Orhy	Beaver Dam	1,400	E	14	Quartzite		
"	AW	Elel	Beaver Dam	1,400	N	21	Quartzite		
"	"	Pose	Beaver Dam	1,200	N	21	Quartzite	Haploxerolls	
"	Cora	Bogr	Spring	1,800	E	10	Granitic		
"	"	Orhy	Spring	1,600	S	16	Granitic		
JuOs	Chpa	Bogr	McCullough	1,600	N	10	Granitic	Haploxerolls	
"	Cora	Pofe	Panamint	1,800	W	20	Granitic		
"	"	Stsp	McCullough	1,600	S	09	Granitic		
Juos	AN	Star	Sheep	2,000	W	14	Granitic	Haploxerolls	

[a]See table 5 for key to Series acronyms.
[b]See table 6 for key to Association acronyms.
[c]See tables 7 and 8 for key to Sub-association acronyms.

Section 341A: Pinyon-Juniper Woodlands of the Bonneville Basin

This Section comprises a large area of land in western Utah and extreme eastern Nevada (fig. 8). This area does not drain to the ocean and was covered by a large freshwater lake (Bonneville) during the Pleistocene. The remnants are the Great Salt Lake, Utah Lake, Sevier Dry Lake, and numerous salt pans in all the low spots. Pinyon-juniper woodlands, however, occupy intermediate elevations on most of the mountains within and bordering this basin.

Fifteen mountain ranges were sampled from Section 341A in this study (tables 5 and 12). Since some of the Associations and Sub-associations were found on more than one mountain range (table 12), some redundancy was encountered and accordingly more confidence can be placed in these classificational entities than in other Sections where given Associations or Sub-associations are found only once.

Section 341A had seven Series (table 12); PiMo, Pimo, JUOS, JuOs, Juos, PiEd, and Pied.

The PiMo Series in this Section had four Associations (table 12). The PiMo/AN Association had but the PiMo/AN/Stco Sub-association. The PiMo/AT Association also had only the PiMo/AT/Stco Sub-association. The PiMo/Gusa Association had only the PiMo/Gusa/Pssp Sub-association. The PiMo/Putr Association had but the PiMo/Putr/Pofe Sub-association.

The Pimo Series in Section 341A had seven Associations (table 12). The Pimo/AN Association had four Sub-associations. These were the Pimo/AN/Arpu, Pimo/AN/Elel, Pimo/AN/(Pepa), and Pimo/AN/Pofe. The Pimo/AT Association had two Sub-associations. These were the Pimo/AT/Orhy and Pimo/AT/Pasm Sub-associations (table 12). The Pimo/AV Association had only the Pimo/AV/Pssp Sub-association. The Pimo/AW Association had but the Pimo/AW/Orhy Sub-association. The Pimo/Cele Association had two Sub-associations, the Pimo/Cele/(Basa) and Pimo/Cele/N.G./N.F. The Pimo/Gusa Association had but the Pimo/Gusa/Lesa Sub-association. The Pimo/Pugl Association had but the Pimo/Pugl/Stco Sub-association.

The JUOS Series in Section 341A had eight Associations (table 12). The JUOS/AA Association had two Sub-associations; JUOS/AA/Orhy and JUOS/AA/Pasm. The JUOS/AN Association had four Sub-associations; JUOS/AN/(Canu), JUOS/AN/Elel, JUOS/AN/Orhy, and JUOS/AN/Pasm. The JUOS/AT Association had nine Sub-associations; JUOS/AT/Bogr, JUOS/AT/Ella, JUOS/AT/Hija, JUOS/AT/Mumo, JUOS/AT/N.G./N.F., JUOS/AT/Orhy, JUOS/AT/Pasm, JUOS/AT/Pose, and JUOS/AT/Pssp. The JUOS/AV Association had four Sub-associations; JUOS/AV/N.G./N.F., JUOS/AV/Pasm, JUOS/AV/Pose, and JUOS/AV/Pssp. The JUOS/Chna Association had only the JUOS/Chna/Pssp Sub-association. The JUOS/Gusa Association had two Sub-associations; JUOS/Gusa/Hija and JUOS/Gusa/Stco. The JUOS/Pume Association had two Sub-associations; JUOS/Pume/Pasm and JUOS/Pume/PsXsa. The JUOS/Quga Association had but the JUOS/Quga/Elel Sub-association.

The JuOs Series in this Section had nine Associations (table 12). The JuOs/AA Association had but the JuOs/AA/Pasm Sub-association. The JuOs/AN Association had the JuOs/AN/Orhy and JuOs/AN/Pasm Sub-associations. The JuOs/AT Association had four Sub-associations; the JuOs/AT/Ella, JuOs/AT/Hija, JuOs/AT/Orhy, and JuOs/AT/Pssp. The JuOs/AV Association had but the JuOs/AT/Elel Sub-association. The JuOs/AW Association had the JuOs/AW/Elel and JuOs/AW/Pssp Sub-associations. The JuOs/Amal Association had only the JuOs/Amal/Ella Sub-association. The JuOs/Atca Association had but the JuOs/Atca/Orhy Sub-association. The JuOs/Cele Association had two Sub-associations; the JuOs/Cele/Elel and JuOs/Cele/Lesi. The JuOs/Quga Association had the JuOs/Quga/Eltr, JuOs/Quga/(Erum), JuOs/Quga/N.G./N.F., and JuOs/Quga/Orhy Sub-associations.

The Juos Series in Section 341A had four Associations (table 12). The Juos/AN Association had Juos/AN/Orhy and Juos/AN/Pssp Sub-associations. The Juos/AW Association had but the Juos/AW/Hija Sub-association. The Juos/Cele Association had the Juos/Cele/N.G./N.F. and Juos/Cele/Pose Sub-associations. The Juos/Putr Association had only the Juos/Putr/Orhy Sub-association (table 12).

The PiEd Series in this Section had but the PiEd/Epne/Orhy Sub-association.

The Pied Series in Section 341A had but the Pied/Gusa/Orhy Sub-association.

Table 12—Summary of Pinyon-Juniper Woodland Series, Associations, and Sub-associations in Section 341A. Parentheses indicate that native perennial forbs are used in the absence of a native perennial grass to designate Sub-Association. See table 2 for key to abbreviations for geological formations.

Series[a]	Assoc.[b]	Sub-assoc.[c]	Mtn. range	Elev. (m)	Aspect	Slope	Geol. form.	Soils (great group)	Soils (subgroup)
PiMo	AN	Stco	Pilot	2,000	W	11	Limest./Dolo.	Calcixerolls	
"	AT	"	Pilot	2,000	S	36	Phyllite/Qu.	Haploxerolls	aridic
"	Gusa	Pssp	Wah Wah	2,000	N	21			
"	Putr	Pofe	Pilot	2,000	E	40	Granitoid	Haplargids	xerollic
Pimo	AN	Arpu	Wah Wah	1,800	S	31			
"	"	Elel	House	2,000	S	05	Limestone		
"	"	(Pepa)	House	2,200	S	03	Limestone		
"	"	Pofe	Confusion	2,200	E	21	Limest./Dolo.		
"	AT	Orhy	San Francisco	2,000	S	21			
"	"	Pasm	Oquirrh	1,800	W	25			
"	AV	Pssp	San Francisco	2,200	N	23			
"	AW	Orhy	Confusion	2,200	W	18	Limest./Dolo.	Calciorthids	lithic xerollic
"	Cele	(Basa)	Pilot	2,200	W	53	Limest./Dolo.	Argixerolls	lithic
"	"	N.G./N.F.[d]	Mineral	2,200	E	31	Haploxerolls		lithic
"	Gusa	Lesa	Confusion	2,000	W	49	Limest./Dolo.		
"	Pugl	Stco	Pilot	1,800	N	49	Tuff-Weld.	Haploxerolls	lithic
JUOS	AA	Orhy	Stansbury	2,000	N	06			
"	"	Pasm	East Tintic	2,000	E	25	Tuff		
"	AN	(Canu)	Sheeprock	2,000	W	11	Quartzite		
"	"	Elel	Pavant	1,600	W	19			
"	"	Orhy	Burbank Hills	2,000	E	05	Shale	Calciorthids	xerollic
"	"	Pasm	West Tintic	1,800	S	04	Alluvium		
"	"	"	Canyon	1,600	N	09			
"	AT	Bogr	Mineral	2,000	W	16	Haploxerolls		aridic
"	"	Ella	West Tintic	1,800	E	09	Alluvium		
"	"	"	Mineral	1,800	N	12	Alluvium		
"	"	Hija	Cricket	1,800	N	09	Quartzite		
"	"	"	Cricket	1,800	E	12			
"	"	Mumo	Mineral	1,800	S	09	Haplargids		xerollic
"	"	N.G./N.F.[d]	Mineral	1,800	E	07	Alluvium		
"	"	Orhy	Stansbury	1,800	E	05			
"	"	"	East Tintic	1,800	W	09	Tuff		
"	"	"	Wah Wah	1,800	W	07			
"	"	Pasm	West Tintic	1,800	W	25	Alluvium		
"	"	Pose	Canyon	1,600	W	11			
"	"	Pssp	Cricket	1,800	S	21			
"	"	"	Cricket	1,800	W	09			
"	AV	N.G./N.F.[d]	Mineral	1,800	W	05	Alluvium		
"	"	Pasm	East Tintic	1,800	S	18	Limestone		
"	"	"	East Tintic	2,000	W	21	Tuff		
"	"	"	Canyon	1,800	E	25			
"	"	Pose	Stansbury	2,000	E	14	Limestone		
"	"	Pssp	Mineral	1,800	S	31	Alluvium		
"	"	"	Mineral	2,000	N	21	Granitoid		
JUOS	Chna	"	House	1,800	E	0	Limestone		
"	Gusa	Hija	San Francisco	1,800	W	12			
"	"	Stco	Wah Wah	1,800	N	21			
"	Pume	Pasm	Stansbury	1,800	S	45			
"	"	PsXsa	Sheeprock	2,000	E	18	Quartzite		
"	Quga	Elel	Pavant	1,800	N	14	Alluvium		
JuOs	AA	Pasm	East Tintic	1,800	N	17	Tuff		
"	AN	Orhy	Pilot	1,800	W	07	Tuff-Weld.	Haploxerolls	
"	"	"	Oquirrh	1,600	E	07			
"	"	Pasm	Oquirrh	1,600	N	25			
"	"	"	Oquirrh	1,800	S	16			
"	AT	Ella	West Tintic	2,000	N	09	Alluvium		
"	"	Hija	Wah Wah	1,800	E	18			
"	"	"	Wah Wah	2,000	S	04			
"	"	Orhy	San Francisco	2,000	N	18			

(con.)

Table 12 (Con.)

Series[a]	Assoc.[b]	Sub-assoc.[c]	Mtn. range	Elev. (m)	Aspect	Slope	Geol. form.	Soils (great group)	Soils (subgroup)
JuOs	AT	Orhy	San Francisco	2,000	E	09			
"	"	Pssp	Pilot	1,800	E	25	Quartzite	Calcixerolls	aridic
"	AV	Elel	Mineral	1,800	N	05	Argixerolls		aridic calcic
"	"	"	Mineral	1,800	E	07	Calciorthids		xerollic
"	AW	"	Mineral	1,800	W	11	Torrifluvents		xeric
"	"	Pssp	Mineral	2,000	W	34	Alluvium		
"	Amal	Ella	West Tintic	2,000	E	16	Alluvium		
"	Atca	Orhy	Pavant	1,800	E	18	Tuff		
"	Cele	Elel	Mineral	2,000	S	23	Silt/Sand		
"	"	Lesi	Confusion	2,000	E	58	Limest./Dolo.	Calciorthids	lithic xerollic
"	Quga	Eltr	Mineral	2,000	N	12	Haploxerolls		aridic
"	"	(Erum)	Pavant	2,000	S	33	Alluvium		
"	"	N.G./N.F.[d]	Mineral	2,000	S	47	Haploxerolls		aridic
"	"	Orhy	Canyon	1,800	S	12			
Juos	AN	"	Burbank Hills	2,000	N	27	L./Dolo.-Silt	Calciorthids	xerollic
"	"	Pssp	Mineral	2,000	E	23	Silt/Sand		
"	"	"	House	2,000	E	27	Limestone		
"	AW	Hija	Wah Wah	2,000	E	09			
"	Cele	N.G./N.F.[d]	Pilot	2,200	S	40	Limest./Dolo.	Haploxerolls	lithic
"	"	Pose	Pilot	2,000	N	53	Limest./Dolo.	Calcixerolls	aridic
"	Putr	Orhy	Mineral	2,000	E	11	Calciorthids		xerollic
PiEd	Epne	"	Pavant	2,000	E	18			
Pied	Gusa	"	Wah Wah	2,000	W	05			

[a]See table 5 for key to Series acronyms.
[b]See table 6 for key to Association acronyms.
[c]See tables 7 and 8 for key to Sub-association acronyms.
[d]N.G. = no grass; N.F. = no forb; N.S. = no shrub encountered.

Section 341D: Pinyon-Juniper Woodlands of the Mono-Walker-Owens Basins of Extreme Western Nevada and Adjacent California

Section 341D is the smallest of the nine Sections sampled in this study (fig. 8). The Washoe, Mason, Owens, and Deep Springs Valleys are involved, but most of the pinyon-juniper woodlands are found on the mountains directly next to the eastern slope of the Sierra Nevada. The mountain ranges sampled in this study were the Pine Nut, Wassuk, Excelsior, and Virginia Ranges wholly in Nevada and the White Mountains that straddle the border with California (table 4, fig. 2).

This Section had four Series (table 13); PIMO, PiMo, Pimo, and Juos.

The PIMO Series in Section 341D had seven Associations and 15 Sub-associations (table 13). The PIMO/AN Association had but the PIMO/AN/Orhy Sub-association. The PIMO/AT Association had but the PIMO/AT/Pose Sub-association. The PIMO/AV Association had the PIMO/AV/Elel, PIMO/AV/Pose, PIMO/AV/Pssp, PIMO/AV/Stco, and PIMO/AV/Stoc Sub-associations. The PIMO/AW Association had the PIMO/AW/Hija, PIMO/AW/Orhy, PIMO/AW/Pose, and the PIMO/AW/Stco Sub-associations. The PIMO/Chvi/Pose Sub-association was the only one found for the PIMO/Chvi Association. The PIMO/Putr Association had the PIMO/Putr/Orhy and PIMO/Putr/Stth Sub-associations. The PIMO/Rive/Pose Sub-association was the sole Sub-association within the PIMO/Rive Association.

The PiMo Series had PiMo/AV, PiMo/AW, and PiMo/Sylo Associations. The PiMo AV Association had PiMo/AV/Elel, PiMo/AV/Leci, PiMo/AV/(Luse), and PiMo/AV/Pose Sub-associations. The PiMo/AW Association had but the PiMo/AW/Elel Sub-association. The PiMo/Sylo Association had only the PiMo/Sylo/Pose Sub-association.

The Pimo/AN Association had a lone Pimo/AN/Elel Sub-association. The Pimo/AT Association had the Pimo/AT/Orhy and the Pimo/AT/Stoc Sub-associations (table 13).

The Juos Series had only a Juos/AV/Stth Sub-association on a 33 percent southerly slope at 1,800 m on the Pine Nut Mountains, indicating how rare juniper-dominated woodlands are in this Section.

Table 13—Summary of Pinyon-Juniper Woodland Series, Associations, and Sub-associations in Section 341D. Parentheses indicate that native perennial forbs are used in the absence of a native perennial grass to designate Sub-Association.

Series[a]	Assoc.[b]	Sub-assoc.[c]	Mtn. range	Elev. (m)	Aspect	Slope	Geol. form.	Soils (great group)	Soils (subgroup)
PIMO	AN	Orhy	White	2,400	W	33		Haploborolls	aridic
"	AT	Pose	Wassuk	1,800	N	19	Granitic		
"	AV	Elel	White	2,800	W	31		Haploborolls	aridic
"	"	Pose	White	2,600	W	40		Haploborolls	aridic
"	"	"	Excelsior	2,200	E	18	Granitic	Cambiorthids	lithic xerollic
"	"	Pssp	Wassuk	2,400	N	44	Granitic		
"	"	Stco	White	2,400	N	09	Rhyolitic		
"	"	"	Excelsior	2,200	S	07	Granitic	Cambiorthids	xerollic
"	"	Stoc	White	2,600	N	12	Rhyolitic	Argiborolls	aridic
"	AW	Hija	Wassuk	2,000	S	31	Granitic		
"	"	Orhy	Wassuk	2,200	E	18	Granitic		
"	"	Pose	Wassuk	2,000	N	24	Granitic		
"	"	Stco	Wassuk	2,200	E	08	Granitic		
"	Chvi	Pose	Excelsior	2,200	W	11	Granitic	Cambiorthids	lithic xerollic
"	Putr	Orhy	Wassuk	2,400	S	44	Granitic		
PIMO	Putr	Stth	Pine Nut	2,000	S	38	Granitic		
"	Rive	Pose	Excelsior	2,200	N	23	Granitic	Cambiorthids	lithic xerollic
PiMo	AV	Elel	Pine Nut	2,000	E	23	Basaltic		
"	"	Leci	Virginia Range	1,800	N	22	Granitic		
"	"	"	Virginia Range	1,800	E	40	Granitic		
"	"	(Luse)	Pine Nut	2,200	N	20	Basaltic		
"	"	Pose	Pine Nut	1,800	N	42	Basaltic		
"	"	"	Pine Nut	1,800	E	06	Basaltic		
"	"	"	Pine Nut	2,000	W	16	Granitic		
"	"	"	Virginia Range	2,000	N	47	Granitic		
"	"	"	Virginia Range	1,800	S	19	Granitic		
"	"	"	Virginia Range	2,000	S	14	Granitic		
"	AW	Elel	Wassuk	2,200	W	32	Granitic		
"	Sylo	Pose	White	2,200	N	55	Basaltic	Cambiorthids	xerollic
Pimo	AN	Elel	White	2,200	S	02		Paleorthids	xerollic
"	AT	Orhy	Wassuk	2,200	S	20	Granitic		
"	"	Stoc	Pine Nut	1,800	W	13	Granitic		
Juos	AV	Stth	Pine Nut	1,800	S	33	Granitic		

[a]See table 5 for key to Series acronyms.
[b]See table 6 for key to Association acronyms.
[c]See tables 7 and 8 for key to Sub-association acronyms.

Section 341E: Pinyon-Juniper Woodlands of the Lahontan Basin of Western Nevada

Section 341E occupies most of western Nevada from the Santa Rosa Mountains near the Oregon border to Pahute Mesa on the border of the Mohave Desert (fig. 8). The lowlands of the central part of this unit were once occupied by glacial Lake Lahontan. Of the approximately 20 separate mountain ranges in this "sea" of desert terrain, our random sample draw only led to two; the West Humboldt and Silver Peak Ranges (table 5). The mountains in the north largely lack pinyon juniper woodlands (fig. 3). The southernmost mountains have considerable woodland acreage that was not sampled in this effort. The team working this set of mountains was too sparing in their efforts at soil descriptions for us to be able to conclude much about soils there. We thus must caution that the classification presented here is only a beginning.

Section 341E had four Series; PIMO, PiMo, Pimo, and JUOS (table 14).

The PIMO Series is represented by but one stand in the PIMO/AW/Elel Sub-association.

The PiMo Series had two Associations; PiMo/AN and PiMo/AT. PiMo/AN/Elel and PiMo/AN/Orhy were the two Sub-associations representing the PiMo/AN Association. The only Sub-association in the PiMo/AT Association was PiMo/AT/Orhy.

The Pimo Series had Pimo/AA and Pimo/AN Associations, both with Orhy as their leading understory perennial grass and thus only Sub-associations.

The JUOS Series in this Section had JUOS/AA, JUOS/AT, and JUOS/AV Associations. JUOS/AA/Brca and JUOS/AA/Leci Sub-associations were sampled here. JUOS/AT/Elel was the only Sub-association found within the JUOS/AT Association. The JUOS/AV/Pose Sub-association was the only one found within the JUOS/AV Association.

Table 14—Summary of Pinyon-Juniper Woodland Series, Associations, and Sub-associations in Section 341E. See table 2 for key to abbreviations of geological formations.

Series[a]	Assoc.[b]	Sub-assoc.[c]	Mtn. range	Elev. (m)	Aspect	Slope	Geol. form.	Soils (great group)	Soils (subgroup)
PIMO	AW	Elel	Silver Peak	2,400	W	09			
PiMo	AN	Elel	Silver Peak	2,400	S	05			
"	"	Orhy	Silver Peak	2,200	W	05			
"	AT	Orhy	Silver Peak	2,200	E	40			
Pimo	AA	Orhy	Silver Peak	2,200	N	07			
"	AN	Orhy	Silver Peak	2,200	S	21	Limestone		
JUOS	AA	Brca	West Humboldt	2,000	E	36			
"	"	Leci	West Humboldt	2,000	W	45	Limest./Dolo.	Calcixerolls	
"	"	"	West Humboldt	1,800	E	51	Limest./Dolo.	Calcixerolls	
"	AT	Elel	West Humboldt	2,000	S	36	Quartzite		
"	"	"	West Humboldt	1,800	S	05	Quartzite		
"	AV	Pose	West Humboldt	1,800	W	36	Limest./Dolo.	Calcixerolls	

[a]See table 5 for key to Series acronyms.
[b]See table 6 for key to Association acronyms.
[c]See tables 7 and 8 for key to Sub-association acronyms.

Section 341F: Pinyon-Juniper Woodlands of the Southeastern Great Basin

Section 341F occurs in southeastern Nevada and a smaller portion in adjacent southwestern Utah (fig. 8). Even though this Section is smaller than Section 341E, it was sampled more thoroughly because of the random selection of mountain ranges used. Ten mountain ranges were visited in this study (tables 5 and 15). Data from the South Egan, Quinn Canyon, Highland, Wilson Creek, Grant, Fortification, and Kawich Ranges of Nevada are used here, as is data from the Needle and Pine Valley Mountains and Beryl-Enterprise Hills of Utah. The elevations of the valleys between the mountains in this Section are often high enough that pinyon-juniper woodlands cover much mid-valley terrain as well as the lower hill systems and lower flanks of the mountains.

Section 341F had eight Series; PIMO, PiMo, Pimo, JUOS, JuOs, Juos, Jusc (*Juniperus scopulorum*), and PiEd (table 15).

There were three Associations in the PIMO Series; PIMO/AV, PIMO/Cele, and PIMO/Chvi. The PIMO/AV Association had PIMO/AV/Bogr, PIMO/AV/Orhy, PIMO/AV/Pose, and PIMO/AV/Pssp Sub-associations. The PIMO/Cele/Pofe and PIMO/Cele/Pose were the two Sub-associations in the PIMO/Cele Association. The PIMO/Chvi Association had but the PIMO/Chvi/Elel Sub-association.

The PiMo Series had eight Associations; PiMo/AN, PiMo/AT, PiMo/AV, PiMo/AW, PiMo/Amal, PiMo/Cele, PiMo/Mare, and PiMo/Sylo. The PiMo/AN/Orhy Sub-association was the only such unit in PiMo/AN. The PiMo/AT Association was divided into PiMo/AT/Hija and PiMo/AT/Pose Sub-associations. The PiMo/AV Association was divided into PiMo/AV/Elel, PiMo/AV/Orhy, PiMo/AV/Pose, and PiMo/AV/Pssp Sub-associations. There was only the PiMo/AW/Hija Sub-association within the PiMo/AW Association (table 15). The PiMo/Amal Association was divided into PiMo/Amal/Pose and PiMo/Amal/Pssp Sub-associations. The PiMo/Cele Association was only represented by the PiMo/Cele/Pofe Sub-association. The PiMo/Mare Association had but the PiMo/Mare/Elel Sub-association. The PiMo/Sylo Association was split into the PiMo/Sylo/Brca and PiMo/Sylo/Elel Sub-associations.

The Pimo Series in Section 341F had Pimo/AN, Pimo/AT, Pimo/AV, Pimo/AW, Pimo/Amal, Pimo/Cele, Pimo/Gusa, Pimo/N.S., Pimo/Pera, Pimo/Pugl, and Pimo/Pume Associations. The Pimo/AN Association had Pimo/AN/Bogr, Pimo/AN/Elel, Pimo/AN/Pofe, and Pimo/AN/Pose Sub-associations. The Pimo/AT Association had Pimo/AT/Orhy and Pimo/AT/Pofe Sub-associations. The Pimo/AV Association had the Pimo/AV/Elel, Pimo/AV/Orhy, and Pimo/AV/Pose Sub-associations. The Pimo/AW Association had representation in Pimo/AW/Elel, Pimo/AW/(Erum), and Pimo/AW/Hija Sub-associations. The Pimo/Amal Association had but the Pimo/Amal/N.G./N.F. Sub-association.

The Pimo/Cele Association was divided into Pimo/Cele/Orhy and Pimo/Cele/PsXsa Sub-associations. The Pimo/Gusa Association had but the Pimo/Gusa/Orhy Sub-association. There was also a Pimo/N.S./N.G./N.F. Sub-association. The Pimo/Pera Association had but the Pimo/Pera/Pofe Sub-association. The Pimo/Pugl Association had but the Pimo/Pugl/PsXsa Sub-association. The Pimo/Pume Association had Pimo/Pume/Arpu and Pimo/Pume/Pose Sub-associations.

The JUOS Series in Section 341F had eight Associations; JUOS/AN, JUOS/AT, JUOS/AV, JUOS/AW, JUOS/Chpa, JUOS/Chvi, JUOS/Cora, and JUOS/Pume (table 15). The JUOS/AN Association had but the JUOS/AN/Orhy Sub-association. The JUOS/AT Association had but the JUOS/AT/Pose Sub-association. The JUOS/AV Association had but the JUOS/AV/Ella Sub-association, whereas the JUOS/AW Association had JUOS/AW/Bogr and JUOS/AW/Hija Sub-associations. The JUOS/Chpa Association had only the JUOS/Chpa/Arpu Sub-association. The JUOS/Chvi Association had only the JUOS/Chvi/Pssp Sub-association. The JUOS/Cora Association was represented by only the JUOS/Cora/Elel Sub-association. The JUOS/Pume Association had but the JUOS/Pume/Lesi Sub-association (table 15).

The JuOs Series in this Section had six Associations (table 15); the JuOs/AA, JuOs/AN, JuOs/AT, JuOs/AV, JuOs/AW, and JuOs/Pume. The JuOs/AA Association had only the JuOs/AA/Hija Sub-association. The JuOs/AN Association was split into JuOs/AN/Eltr, JuOs/AN/Orhy, and JuOs/AN/Stco Sub-associations. The JuOs/AT Association had the JuOs/AT/Hija and JuOs/AT/Orhy Sub-associations. The JuOs/AV Association had only the JuOs/AV/Orhy Sub-association. The JuOs/AW Association was divided between JuOs/AW/Hija, JuOs/AW/Pose, and JuOs/AW/Stco Sub-associations. The JuOs/Pume Association had only the JuOs/Pume/Hija Sub-association.

The Juos Series in Section 341F had nine Associations; Juos/AN, Juos/AT, Juos/AV, Juos/AW, Juos/Chvi, Juos/Epvi, Juos/Ermi, Juos/N.S., and Juos/Putr, each represented by only one Sub-association except the Juos/AN Association that was split into Juos/AN/Elel and Juos/AN/(Erov) Sub-associations. The Juos/AV Association was divided into Juos/AV/N.G./N.F. and Juos/AV/Orhy Sub-associations; and Juos/Putr which had Juos/Putr/Elel and Juos/Putr/Hija Sub-associations (table 15).

The PiEd Series in this Section was represented only once as a PiEd/Cemo/(Phdi) Sub-association at 1,800 m elevation on a 25 percent northerly slope on the Pine Valley Mountains.

The only place in Section 341F where we encountered woodland dominated by the Jusc Series was at 2,000 m elevation on a 2 percent N slope of the Pine Valley mountains. In this instance the dominant understory shrub was Amal and the dominant grass was Pofe.

Table 15—Summary of Pinyon-Juniper Woodland Series, Associations, and Sub-associations in Section 341F. Parentheses indicate that native perennial forbs are used in the absence of a native perennial grass to designate a Sub-association. See table 2 for key to abbreviations for geological formations.

Series[a]	Assoc.[b]	Sub-assoc.[c]	Mtn. range	Elev. (m)	Aspect	Slope	Geol. form.	Soils (great group)	Soils (subgroup)
PIMO	AV	Bogr	Needle	2,400	W	25			
"	"	Orhy	Needle	2,400	W	11		Haploborolls	lithic
"	"	Pose	Quinn Canyon	2,000	N	48	Granitic		
"	"	"	Needle	2,400	N	16		Haploborolls	aridic
"	"	"	Quinn Canyon	2,200	W	35	Granitic		
"	"	Pssp	Kawich	2,200	E	56	Granitic		
"	Cele	Pofe	Highland	2,400	E	25	Limest./Dolo.	Haploborolls	lithic
"	"	Pose	Needle	2,400	E	27	Andesitic/Rh.	Agriborolls	lithic
"	Chvi	Elel	Needle	2,400	N	18		Haploborolls	lithic
PiMo	AN	Orhy	Needle	2,200	E	04	Basaltic		
"	"	"	Grant	2,000	N	11			
"	"	"	Grant	2,000	W	27			
"	AT	Hija	Kawich	2,000	S	14	Granitic		
"	"	Pose	Enterprise-Beryl Hills	2,200	N	07	Andesitic/Rh.	Haploxerolls	aridic
"	"	"	Quinn Canyon	2,000	S	13	Granitic		
"	AV	Elel	Needle	2,200	N	21		Haploxerolls	lithic
"	"	"	Needle	2,400	E	42		Haploborolls	lithic
"	"	Orhy	Needle	2,200	S	16	Andesitic/Rh.	Haploxerolls	aridic
"	"	"	Needle	2,200	W	09	Andesitic/Rh.	Haploxerolls	aridic
"	"	Pose	Quinn Canyon	2,200	E	42	Granitic		
"	"	Pssp	Quinn Canyon	2,000	W	09	Granitic		
"	AV	Pssp	Kawich	2,000	E	11	Granitic		
"	AW	Hija	Grant	2,000	S	35			
"	Amal	Pose	Needle	2,200	N	36		Haploxerolls	lithic
"	"	"	Quinn Canyon	2,200	S	11	Granitic		
"	"	Pssp	Quinn Canyon	2,200	N	45	Granitic		
"	Cele	Pofe	Highland	2,400	N	31	Limest./Dolo.	Haploxerolls	lithic
"	"	"	Highland	2,400	W	31	Limest./Dolo.	Haploborolls	lithic
"	Mare	Elel	Needle	2,200	N	21		Haploxerolls	lithic
"	Sylo	Brca	Quinn Canyon	2,200	W	35	Granitic		
"	"	Elel	Highland	2,600	E	107	Limest./Dolo.	Argiborolls	lithic
Pimo	AN	Bogr	Wilson Creek	2,000	W	13	Granitic		
"	"	Elel	South Egan	2,200	E	07			
"	"	Pofe	Highland	2,200	W	55	Limest./Dolo.	Haploxerolls	lithic
"	"	Pose	Quinn Canyon	2,000	E	34	Granitic		
"	AT	Orhy	Needle	2,200	N	25		Haploxerolls	lithic
"	"	"	Quinn Canyon	1,800	E	28	Granitic		
"	"	Pofe	Highland	2,200	N	21	Limest./Dolo.	Haploxerolls	lithic
"	AV	Elel	Needle	2,400	E	49		Haploborolls	aridic
"	"	"	Needle	2,400	E	51		Argiborolls	lithic
"	"	Orhy	Needle	2,200	S	32		Haplargids	lithic xerollic
"	"	Pose	Kawich	2,000	N	47	Granitic		
"	AW	Elel	Wilson Creek	2,000	S	02	Granitic		
"	"	Elel	Fortification	2,000	E	11			
"	"	(Erum)	Fortification	2,000	W	05			
"	"	Hija	Highland	2,000	S	38	Alluvium	Calciorthids	xerollic
"	"	"	Highland	1,800	W	05	Alluvium	Calciorthids	xerollic
"	Amal	N.G./N.F.[d]	Needle	2,200	E	18		Argixerolls	aridic
"	Cele	Orhy	Needle	2,400	S	60		Cambiorthids	lithic xerollic
"	"	"	Highland	2,400	S	36	Alluvium	Camborthids	lithic xerollic
"	"	PsXsa	Highland	2,200	S	40	Alluvium	Cambiorthids	lithic xerollic
"	Gusa	Orhy	Needle	2,400	S	62		Cambiorthids	lithic xerollic
"	N.S.[d]	N.G./N.F.[d]	Needle	2,200	W	05		Haplargids	xerollic
"	Pera	Pofe	Highland	2,200	E	27	Limest./Dolo.	Calcixerolls	aridic
"	Pugl	PsXsa	South Egan	2,200	W	12			
"	Pume	Arpu	Needle	2,000	S	16		Argixerolls	aridic calcic

(con.)

Table 15 (Con.)

Series[a]	Assoc.[b]	Sub-assoc.[c]	Mtn. range	Elev. (m)	Aspect	Slope	Geol. form.	Soils (great group)	Soils (subgroup)
Pimo	Pume	Pose	Enterprise-Beryl Hills	2,200	E	07			
JUOS	AN	Orhy	South Egan	2,000	W	02			
"	AT	Pose	Pine Valley	1,800	S	14			
"	AV	Ella	Pine Valley	2,000	W	19			
"	AW	Bogr	Pine Valley	1,800	W	12			
"	"	Hija	Pine Valley	2,000	S	14			
"	Chpa	Arpu	Highland	1,800	S	23	Alluvium		
"	Chvi	Pssp	Needle	2,000	N	11	Shale		
"	Cora	Elel	Pine Valley	1,200	E	0			
"	Pume	Lesi	Pine Valley	2,000	E	16			
JuOs	AA	Hija	Needle	2,000	W	05		Haploxerolls	aridic
"	AN	Eltr	Highland	2,000	E	05	Alluvium	Paleorthids	xerollic
"	"	Orhy	Needle	2,000	W	04	Alluvium	Argixerolls	aridic calcic
"	"	"	Wilson Creek	2,000	N	05	Rhyolitic		
"	"	"	Grant	2,000	E	11			
"	"	Stco	Fortification	2,000	N	02			
"	AT	Hija	Kawich	2,000	W	14	Granitic		
"	"	Orhy	Needle	1,800	S	02	Alluvium	Paleorthids	xerollic
"	AV	Orhy	Quinn Canyon	2,000	S	23	Granitic		
"	AW	Hija	Enterprise-Beryl Hills	1,800	N	04	Andesitic/Rh.	Calcixerolls	aridic
"	"	"	Enterprise-Beryl Hills	2,000	S	29	Andesitic/Rh.	Haplargids	xerollic
"	"	"	Fortification	2,000	S	13			
"	"	Pose	Enterprise-Beryl Hills	1,800	W	05	Andesitic/Rh.		
"	"	Stco	Wilson Creek	2,000	E	08	Rhyolitic		
"	Pume	Hija	Enterprise-Beryl Hills	2,000	E	21	Andesitic/Rh.	Haploxerolls	aridic
Juos	AN	Elel	Needle	2,000	E	05		Cambiorthids	xerollic
"	"	(Erov)	Needle	2,000	S	21		Argixerolls	aridic
"	AT	Stco	Highland	2,000	W	07	Alluvium		
"	AV	N.G./N.F.[d]	Needle	2,200	W	18		Calcixerolls	aridic
"	"	Orhy	Needle	2,200	S	45		Cambiorthids	lithic xerollic
"	AW	Pofe	Highland	2,000	N	09	Alluvium	Calcixerolls	aridic
"	Chvi	Stoc	Needle	2,200	E	21		Argixerolls	aridic
"	Epvi	(Pepa)	Needle	2,000	S	27	Andesitic/Rh.	Argixerolls	aridic
"	Ermi	N.G./N.F.[d]	Needle	2,000	N	11		Cambiorthids	xerollic
"	N.S.[d]	(Erov)	Needle	2,000	S	16		Argixerolls	aridic
"	Putr	Elel	Needle	2,200	W	16		Cambiorthids	lithic xerollic
"	"	Hija	Enterprise-Beryl Hills	2,000	N	18	Andesitic/Rh.		
Jusc	Amal	Pofe	Pine Valley	2,000	N	02			
PiEd	Cemo	(Phdi)	Pine Valley	1,800	N	25			

[a]See table 5 for key to Series acronyms.
[b]See table 6 for key to Association acronyms.
[c]See tables 7 and 8 for key to Sub-association acronyms.
[d]N.G. = no grass; N.F. = no forb; N.S. = no shrubs encountered.

Section 341G: Humboldt Basin of Northeastern Nevada

Section 341G corresponds to most of the lower elevations within the drainage of the Humboldt River situated in northeastern Nevada and a small part of Utah north of the Deep Creek Range. Even though this is smaller than Section 341E, we randomly drew five mountain ranges; the Cherry Creek, East Humboldt, Spruce, Pequop, and Toana, all in Nevada. Most of the sampling was, however, "rapid" and some of the soils and geological information was inadequate for reporting here.

Five Series are represented in this Section; PiMo, Pimo, JUOS, JuOs, and Juos (table 16).

The PiMo Series in Section 341G has four Associations; PiMo/AN, PiMo/AV, PiMo/Cele, and PiMo/Putr. The PiMo/AN Association was split into PiMo/AN/N.G./N.F. and PiMo/AN/Orhy. The PiMo/AV Association had only the PiMo/AV/Pssp Sub-association. The PiMo/Cele Association had only the PiMo/Cele/Pssp Sub-association. The PiMo/Putr Association had only the PiMo/Putr/Pose Sub-association.

The Pimo Series in this Section had six Associations; Pimo/AN, Pimo/AT, Pimo/AV, Pimo/AW, Pimo/N.S., and Pimo/Putr. The Pimo/AN Association had but the Pimo/AN/Pssp Sub-association. The Pimo/AT Association had the Pimo/AT/Orhy and Pimo/AT/Stco Sub-associations. The Pimo/AV Association had only the Pimo/AV/Pssp Sub-association. The Pimo/AW Association had only the Pimo/AW/Pose Sub-association. The Pimo/N.S. Association had only the Pimo/N.S./Pose Sub-association. Pimo/Putr Association had only the Pimo/Putr/Pose Sub-association.

The JUOS Series in Section 341G had three Associations; JUOS/AN, JUOS/AT, and JUOS/Chvi. The JUOS/AN Association was represented only by the JUOS/AN/(Cacr) Sub-association. The JUOS/AT Association had only the JUOS/AT/Orhy Sub-association. The JUOS/Chvi Association was split into JUOS/Chvi/Pose and JUOS/Chvi/Pssp Sub-associations.

The JuOs Series in this Section had three Associations; JuOs/AT, JuOs/AW, and JuOs/Putr. The JuOs/AT Association had only the JuOs/AT/Pssp Sub-association. The JuOs/AW Association had but the JuOs/AW/Pssp Sub-association. The JuOs/Putr Association had only the JuOs/Putr/Pose Sub-association.

The Juos Series in Section 341G had two Associations; Juos/AN, and Juos/N.S. (table 16). The Juos/AN Association had only the Juos/AN/Pssp Sub-association. Only the Juos/N.S./Pose Sub-association was found in the Juos/N.S. Association in this Section (table 16).

Table 16—Summary of Pinyon-Juniper Woodland Series, Associations, and Sub-associations in Section 341G. Parentheses indicate that native perennial forbs are used in the absence of a native perennial grass to designate Sub-association. Also see table 2 for key to abbreviations for geological formations.

Series[a]	Assoc.[b]	Sub-assoc.[c]	Mtn. range	Elev. (m)	Aspect	Slope	Geol. form.	Soils (great group)	Soils (subgroup)
PiMo	AN	N.G./N.F.[d]	Pequop	2,000	W	26			
"	"	Orhy	Cherry Creek	2,000	N	31			
"	AV	Pssp	Spruce Mountain	2,200	E	16			
"	Cele	Pssp	Cherry Creek	2,200	W	49			
"	Putr	Pose	East Humboldt	2,200	E	25	Granitic	Cambiorthids	lithic xerollic
Pimo	AN	Pssp	Cherry Creek	2,200	E	25			
"	AT	Orhy	Cherry Creek	2,000	W	33			
"	"	"	Pequop	2,000	S	11			
"	"	Stco	Toana	1,800	E	09	Limest./Dolo.	Calciorthids	xerollic
"	AV	Pssp	Spruce Mountain	2,200	S	36			
"	"	"	Spruce Mountain	2,200	W	18			
"	AW	Pose	Toana	2,000	E	21	Limest./Dolo.		
"	N.S.[d]	Pose	Pequop	2,000	E	38			
"	Putr	Pose	East Humboldt	2,200	S	18	Granitic		
"	"	"	Toana	2,000	S	40	Limest./Dolo. silt	Silt.Haploxerolls	lithic
JUOS	AN	(Cacr)	Spruce Mountain	2,000	S	09			
"	AT	Orhy	Cherry Creek	2,000	E	08			
"	Chvi	Pose	East Humboldt	2,000	W	07	Alluvium	Paleoxerolls	aridic
"	"	Pssp	Toana	1,800	N	11	Silt/Sand.		
JuOs	AT	Pssp	East Humboldt	2,200	W	51	Granitic	Cambiorthids	lithic xerollic
"	"	"	Pequop	2,000	N	11			
"	AW	Pssp	Spruce Mountain	2,000	N	09			
"	"	"	Spruce Mountain	2,000	E	40			
"	Putr	Pose	East Humboldt	2,000	E	07	Limest./Dolo. Silt.	Paleorthids	xerollic
"	"	"	East Humboldt	2,000	S	11	Limest./Dolo. Silt.	Cambiorthids	xerollic
Juos	AN	Pssp	Cherry Creek	2,200	S	15			
"	N.S.[d]	Pose	Toana	2,000	W	04	Tuff-Weld.	Calcixerolls	aridic

[a]See table 5 for key to Series acronyms.
[b]See table 6 for key to Association acronyms.
[c]See tables 7 and 8 for key to Sub-association acronyms.
[d]N.G. = no grass; N.F. = no forb; N.S. = no shrub encountered.

Section 342B: Pinyon-Juniper Woodlands of the Northern Great Basin in Northern Nevada, Extreme northwestern Utah, and Adjacent Idaho and Oregon

Section 342B is a unit that has a western lobe extending from the flanks of the Sierra Nevada across the northern part of the Lahontan Basin of Nevada and independent lake basins of southeastern Oregon to a restricted corridor across the Leonard Creek and Trout Creek Mountains near the Nevada-Oregon border to an elongated easterly lobe across extreme northeastern Nevada, extreme northwestern Utah, and part of southern Idaho (fig. 8). The northwestern lobe holds only western juniper (*Juniperus occidentalis*), a sub-type not within our study area boundaries (fig. 1). We randomly drew no mountain ranges in the southwestern part of this Section. Therefore, our information only derives from the four mountain ranges sampled in the eastern lobe; the Goose Creeks along the Nevada-Utah border, and the Albion, Black Pine, and Sublette Ranges in southern Idaho.

Only one Series was found in this Section; JUOS (table 17). That is, only woodlands dominated solely by Utah juniper were sampled. We know that *Pinus monophylla* extends northward to the Cache Peak Range, near the Silent City of Rocks in southern Idaho, and also on the north, south, and easterly slopes of the Raft River Mountains in the extreme northwestern Utah. However, our random selections did not lead us there. If other work expands our efforts, other Series are expected to emerge.

The JUOS Series in Section 342B had six Associations; JUOS/AA, JUOS/AN, JUOS/AT, JUOS/AV, JUOS/Gusa, and JUOS/Putr (table 17). The JUOS/AA Association had but the JUOS/AA/Pssp Sub-association. The JUOS/AN Association was split into JUOS/AN/Pose and JUOS/AN/Pssp Sub-associations. The JUOS/AT Association was divided into the JUOS/AT/Eltr, JUOS/AT/Pose, and JUOS/AT/Pssp Sub-associations. The JUOS/AV Association was split into JUOS/AV/Pose and JUOS/AV/Pssp Sub-associations. The JUOS/Gusa Association had but the JUOS/Gusa/Pssp Sub-association. The JUOS/Putr Association had only the JUOS/Putr/Pssp Sub-association (table 17).

Table 17—Summary of Pinyon-Juniper Woodland Series, Associations, and Sub-associations in Section 342B. See table 2 for key to abbreviations for geological formations.

Series[a]	Assoc.[b]	Sub-assoc.[c]	Mtn. range	Elev. (m)	Aspect	Slope	Geol. form.	Soils (great group)	Soils (subgroup)
JUOS	AA	Pssp	Goose Creek	1,800	W	25	Andesitic/Rh.	Calciorthids	xerollic
"	AN	Pose	Albion	1,600	S	05			
"	"	Pssp	Black Pine	1,800	E	07	Qu./Lime.	Calciorthids	xerollic
"	"	"	Black Pine	1,800	S	11	Qu./Lime.	Calciorthids	xerollic
"	AT	Eltr	Goose Creek	1,800	E	19	Alluvium	Haploxerolls	aridic
"	"	Pose	Albion	1,600	W	07			
"	"	"	Black Pine	1,800	W	09	Silt/Sand.	Haploxerolls	Calciorthidic
"	"	Pssp	Black Pine	1,600	S	05	Qu./Lime.	Calciorthids	xerollic
	AV	Pose	Sublett	1,600	N				
"	"	Pssp	Goose Creek	1,800	S	49	Andesitic/Rh.	Cambiorthids	xerollic
"	"	"	Goose Creek	2,000	S	18	Andesitic/Rh.	Haploxerolls	aridic
"	Gusa	Pssp	Black Pine	1,600	E	05	Qu./Lime.	Calcixerolls	aridic
"	Putr	Pssp	Sublett	1,600	W				

[a]See table 5 for key to Series acronyms.
[b]See table 6 for key to Association acronyms.
[c]See tables 7 and 8 for key to Sub-association acronyms.

Section M341A: Pinyon-Juniper Woodlands of the Central Great Basin

Most of Section M341A occurs in central Nevada, with a lobe extending easterly to the Deep Creek Mountains along the Nevada-Utah border about 100 miles south of Wendover (fig. 8). This is the region of highest average elevation within the Great Basin. Although there are higher points elsewhere in our study area (for example, White Mountains), even the valley bottoms in this Section have elevations generally exceeding 5,000 feet. Because this Section, on average, is higher and thus wetter and cooler (and has mostly calcareous parent materials, Cronquist and others 1972), it has much actual and potential woodland habitat.

Our random selection of 19 mountain ranges in this Section (table 5) yielded the densest set of data (table 18) we have for any Section. Even so, we do not pretend that we encountered all possibilities here; however, we did have greater redundancies and thus have more confidence in discussing the woodlands of this Section than any other (table 18).

Six woodland Series were found in Section M341A; PIMO, PiMo, Pimo, JUOS, JuOs, and Juos (table 18).

The PIMO Series was represented by eight Associations; PIMO/AA, PIMO/AN, PIMO/AT, PIMO/AV, PIMO/AW, PIMO/Amal, PIMO/Cele, and PIMO/Epvi. The PIMO/AA Association had only the PIMO/AA/Feid Sub-association. The PIMO/AN Association also had solely the PIMO/AN/Pssp Sub-association. The PIMO/AT Association had the single PIMO/AT/Pose Sub-association. The PIMO/AV Association, however, had PIMO/AV/Feid, PIMO/AV/Leci, and PIMO/AV/Pose Sub-associations. The PIMO/AW Association had only the PIMO/AW/Stoc Sub-association. The PIMO/Amal Association had the PIMO/Amal/Brca and PIMO/Amal/Pssp Sub-associations. The PIMO/Cele Association had the PIMO/Cele/Elel, PIMO/Cele/Orhy, PIMO/Cele/Pose, and PIMO/Cele/Stoc Sub-associations. The PIMO/Epvi Association had only the PIMO/Epvi/Pose Sub-association.

The PiMo Series in Section M341A had nine Associations; PiMo/AA, PiMo/AN, PiMO/AT, PiMo/AV, PiMo/AW, PiMo/Cele, PiMo/Pugl, PiMo/Putr, and PiMo/Sylo. The PiMo/AA Association was split into the PiMo/AA/Elel and PiMo/AA/Feid Sub-associations. The PiMo/AN Association was divided into the PiMo/AN/N.G./N.F., PiMo/AN/Orhy, PiMo/AN/Pose, and PiMo/AN/Stoc Sub-associations. The PiMo/AT Association was sorted into the PiMo/AT/Orhy, PiMo/AT/(Pepa), and PiMo/AT/Pose Sub-associations. The PiMo/AV Association was further segregated into PiMo/AV/Elel, PiMo/AV/Feid, PiMo/AV/Orhy, PiMo/AV/Pose, PiMo/AV/Pssp, and PiMo/AV/Stoc Sub-associations. The PiMo/AW Association was split into the PiMo/AW/Hija, PiMo/AW/Pose, and PiMo/AW/Stoc Sub-associations. The PiMo/Cele Association was divided into the PiMo/Cele/Elel and PiMo/Cele/Pose Sub-associations. The PiMo/Pugl Association had but the PiMo/Pugl/Elel Sub-association. The PiMo/Putr Association also had only the PiMo/Putr/Elel Sub-association. The PiMo/Sylo Association was split into the PiMo/Sylo/Feid and PiMo/Sylo/Pose Sub-associations.

The Pimo Series in Section M341A had six Associations (table 18); Pimo/AN, Pimo/AT, Pimo/AV, Pimo/AW, Pimo/Amal, and Pimo/Cele. The Pimo/AN Association had the Pimo/AN/Elel, Pimo/AN/Orhy, Pimo/AN/Pose, and Pimo/AN/Stoc Sub-associations. The Pimo/AT Association was divided into the Pimo/AT/Elel, Pimo/AT/Leci, Pimo/AT/Pasm, Pimo/AT/Pose, and Pimo/AT/(Stco) Sub-associations. The Pimo/AV Association was divided into Pimo/AV/(Crfl), Pimo/AV/Orhy, Pimo/AV/(Pede), Pimo/AV/Pofe, Pimo/AV/Pose, Pimo/AV/Pssp, and Pimo/AV/Stoc Sub-associations. The Pimo/AW Association was divided into the Pimo/AW/Elel and Pimo/AW/Pose Sub-associations. The Pimo/Amal Association had but a single Pimo/Amal/Pose Sub-association. The Pimo/Cele Association had only the Pimo/Cele/Elel Sub-association.

The JUOS Series in this Section had four Associations; JUOS/AN, JUOS/AT, JUOS/AV, and JUOS/AW. The JUOS/AN Association was divided into the JUOS/AN/Orhy and JUOS/AN/Pose Sub-associations. The JUOS/AT Association had JUOS/AT/(Cacr) and the JUOS/AT/Leci Sub-associations. The JUOS/AV Association was split into the JUOS/AV/Ella, JUOS/AV/Leci, JUOS/AV/Orhy, and JUOS/AV/Pose Sub-associations. The JUOS/AW Association was divided into the JUOS/AW/Leci and the JUOS/AW/Pssp Sub-associations.

The JuOs Series in Section M341A was divided into four Associations; JuOs/AN, JuOs/AT, JuOs/AV, and JuOs/Epvi. The JuOs/AN Association was split among the JuOs/AN/Orhy, JuOs/AN/Pose, and the JuOs/AN/Pssp Sub-associations. The JuOs/AT Association had the JuOs/AT/Orhy, JuOs/AT/Pose, and JuOs/AT/Pssp Sub-associations. The JuOs/AV Association was divided between the JuOs/AV/Elel and JuOs/AV/Pose Sub-associations. The JuOs/Epvi Association had but the JuOs/Epvi/Elel Sub-association (table 18).

The Juos Series in Section M341A had seven Associations; Juos/AN, Juos/AT, Juos/AV, Juos/Cele, Juos/Chvi, Juos/Epvi, and Juos/Putr. The Juos/AN Association was divided into the Juos/AN/Orhy and the Juos/AN/Pose Sub-associations. The Juos/AT Association had only the Juos/AT/Orhy Sub-association. The Juos/AV Association was split between the Juos/AV/Elel, Juos/AV/Pose and the Juos/AV/Pssp Sub-associations. The Juos/Cele Association was divided between the Juos/Cele/Orhy and the Juos/Cele/Pose Sub-associations. The Juos/Chvi Association had but the Juos/Chvi/Pose Sub-association. The Juos/Epvi Association had only the Juos/Epvi/Pssp Sub-association. The Juos/Putr Association had only the Juos/Putr/Orhy Sub-association (table 18).

Table 18—Summary of Pinyon-Juniper Woodland Series, Associations, and Sub-associations in Section M341A. Parentheses indicate that native perennial forbs are used in the absence of a native perennial grass to designate Sub-association. Also see table 2 for key to abbreviations of geological formations.

Series[a]	Assoc.[b]	Sub-assoc.[c]	Mtn. range	Elev. (m)	Aspect	Slope	Geol. form.	Soils (great group)	Soils (subgroup)
PIMO	AA	Feid	Shoshone	2,400	N	55	Tuff-Weld.	Haploborolls	aridic
"	AN	Pssp	White Pine	2,200	E	16			
"	AT	Pose	Desayota	2,000	W	36			
"	AV	Feid	Shoshone	2,400	N	49	Tuff-Weld.	Haploborolls	aridic
"	"	Leci	Shoshone	2,600	E	45	Rhyolitic	Haploborolls	aridic
"	"	Pose	Shoshone	2,200	N	36	Alluvium	Argixerolls	aridic
"	"	"	Shoshone	2,600	N	42	Tuff-Weld.	Haploborolls	aridic
"	"	"	Shoshone	2,400	S	40	Conglom.	Cambiorthids	xerollic
"	"	"	Shoshone	2,400	S	51	Conglom	Argiborolls	aridic
"	"	"	Shoshone	2,600	S	53	Rhyolitic	Argiborolls	aridic
"	"	"	Shoshone	2,400	W	49	Conglom	Durargids	xerollic
"	AW	Stoc	North Egan	2,400	W	73			
"	Amal	Brca	Southern Snake	2,200	E	03	Granitic		
"	"	Pssp	Ruby	2,000	N	52			
"	Cele	Elel	Monitor	2,600	S	31	Tuff-Weld.	Haploborolls	aridic
"	"	Orhy	Toiyabe	2,400	S	27	Andesitic/Rh.	Haploborolls	aridic
"	"	Pose	Shoshone	2,600	E	32	Tuff-Weld.	Argiborolls	aridic
"	"	"	Shoshone	2,600	S	60	Tuff-Weld.	Argiborolls	aridic
"	"	"	Shoshone	2,600	W	60	Tuff-Weld.	Haploborolls	aridic
"	"	Stoc	Monitor	2,600	W	40	Tuff-Weld.	Haploborolls	lithic
"	Epvi	Pose	Shoshone	2,400	E	70	Tuff-Weld.	Haploborolls	aridic
PiMo	AA	Elel	North Egan	2,400	N	14			
"	"	Feid	Shoshone	2,200	N	47	Tuff-Weld.	Argixerolls	aridic
"	AN	N.G./N.F.[d]	Northern Snake	2,200	W	40			
"	"	Orhy	Simpson Park	2,000	E	17			
"	"	"	Simpson Park	2,000	W	30			
"	"	Pose	Toiyabe	2,000	E	29	Granitic	Paleorthids	xerollic
"	"	"	Toiyabe	2,000	W	25	Alluvium	Paleorthids	xerollic
"	"	"	Desayota	2,000	N	18			
"	"	Stoc	Schell Creek	2,000	N	14	Rhyolitic	Cambiorthids	xerollic
"	AT	Orhy	Deep Creek	2,000	S	21			
"	"	(Pepa)	Northern Snake	2,400	W	60			
"	"	Pose	Shoshone	2,200	W	45	Tuff-Weld.	Haplargids	lithic xerollic
"	"	"	Southern Snake	2,000	N	09	Granitic		
"	"	"	Clan Alpine	1,800	N	56			
"	"	"	Clan Alpine	1,800	N	28			
"	"	"	Clan Alpine	2,000	E	19			
"	AV	Elel	Schell Creek	2,400	E	51	Shale	Haploborolls	aridic
"	"	"	North Egan	2,200	S	05			
"	"	Feid	Toiyabe	2,400	W	51	Limest./Dolo.		
"	"	"	Simpson Park	2,000	N	39			
"	"	"	Desayota	2,200	E	49			
"	"	Feid	Sulphur Springs	2,200	N	55	Granitic		
"	"	Orhy	Desayota	2,200	S	19			
"	"	"	Fish Creek	2,200	W	07			
"	"	Pose	Shoshone	2,200	N	27	Basaltic	Argixerolls	aridic
"	"	"	Shoshone	2,200	E	14	Alluvium	Argixerolls	aridic
"	"	"	Shoshone	2,200	E		Tuff-Weld.		
"	"	"	Shoshone	2,400	E	60	Tuff-Weld.	Argiborolls	aridic
"	"	"	Shoshone	2,200	S	21	Tuff-Weld.	Haploxerolls	aridic
"	"	"	Shoshone	2,200	W	55	Tuff-Weld.	Haploxerolls	aridic
"	"	"	Monitor	2,400	N	29	Tuff-Weld.		
"	"	"	Desayota	2,000	S	32			
"	"	"	Desayota	2,200	W	30			
"	"	Pssp	Southern Snake	2,200	W	19	Basaltic		
"	"	"	White Pine	2,400	S				
"	"	Stoc	North Egan	2,400	E	36			
"	AW	Hija	Simpson Park	2,000	S	28			
"	"	Pose	Deep Creek	2,200	S	34			
"	"	"	Shoshone	2,200	E	07	Alluvium	Haploxerolls	aridic
"	"	Stoc	Northern Snake	2,000	E	18			
"	Cele	Elel	Monitor	2,400	E	12	Tuff-Weld.	Durargids	xerollic
"	"	"	Monitor	2,600	E	38	Tuff-Weld.	Haploborolls	aridic
"	"	Pose	Toiyabe	2,400	E	70	Limest./Dolo.	Cambiorthids	xerollic
"	Pugl	Elel	Toiyabe	2,200	S	21	Tuff-Weld.	Haploxerolls	aridic
"	Putr	Elel	Monitor	2,200	E	04	Tuff-Weld.	Argixerolls	aridic
"	Sylo	Feid	Toiyabe	2,200	W	40	Limest./Dolo.	Haploxerolls	aridic
"	"	Pose	Monitor	2,200	N	02	Tuff-Weld.	Haploxerolls	lithic

(con.)

Table 18 (Con.)

Series[a]	Assoc.[b]	Sub-assoc.[c]	Mtn. range	Elev. (m)	Aspect	Slope	Geol. form.	Soils (great group)	Soils (subgroup)
Pimo	AN	Elel	Northern Snake	2,200	E	05			
"	"	Orhy	Southern Snake	2,000	S	09	Basaltic		
"	"	Pose	Deep Creek	2,000	W	09			
"	"	"	Sulphur Spring	1,800	N	54	Granitic		
"	"	"	Fish Creek	2,200	E	05			
"	"	Stoc	Northern Snake	2,200	N	09			
"	AT	Elel	Schell Creek	2,200	N	11	Andesitic/Rh.	Haploxerolls	aridic
"	"	"	Monitor	2,200	S	14	Tuff-Weld.	Haplargids	xerollic
"	"	"	Roberts Creek	2,200	S	11			
"	"	Leci	White Pine	2,000	W	02			
"	"	Pasm	Deep Creek	1,800	E	38			
"	"	"	Deep Creek	2,000	E	29			
"	"	"	Schell Creek	2,200	E	29	Shale	Haploxerolls	aridic
"	"	"	Ruby	2,000	W	25			
"	"	"	Bald	2,200	W	40			
"	"	Pose	Shoshone	2,200	S	36	Tuff-Weld.	Argixerolls	aridic
"	"	"	Shoshone	2,200	S	21	Alluvium	Durargids	xerollic
"	"	(Stco)	Toquima	2,000	S	27			
"	AV	(Crfl)	North Egan	2,200	W	31			
"	"	Orhy	Toquima	2,000	E	47			
"	"	(Pede)	White Pine	2,200	S	32			
"	"	Pofe	Northern Snake	2,200	S	05			
"	"	Pose	Roberts Creek	2,200	W	12			
"	"	Pssp	Toquima	2,200	N	18			
"	"	"	Toquima	2,200	W	27			
"	"	Stoc	Monitor	2,400	W	23	Tuff-Weld.	Cambiorthids	xerollic
"	AW	Elel	Shoshone	2,200	S	32	Basaltic	Haplargids	xerollic
"	"	Pose	Southern Snake	2,000	N	02	Granitic		
"	Amal	Pose	Roberts Creek	2,200	E	13			
"	Cele	Elel	Monitor	2,400	S	25	Tuff-Weld.	Argiborolls	aridic
JUOS	AN	Orhy	Diamond	2,000	S	08			
"	"	"	Diamond	2,200	S	25			
"	"	Pose	Sulphur Springs	1,800	E	10	Granitic		
"	AT	(Cacr)	Roberts Creek	2,000	S	09			
"	"	Leci	Ruby	2,000	E	04			
"	"	"	Diamond	2,000	N	11			
"	"	"	Diamond	2,000	E	04			
"	AV	Ella	Shoshone	2,200	E	09	Basaltic	Haploxerolls	aridic
"	"	Leci	Bald	2,000	N	18			
"	"	Orhy	Fish Creek	2,000	W	04			
"	"	Pose	Diamond	2,000	W	09			
"	AW	Leci	Fish Creek	2,000	N	04			
"	"	Pssp	White Pine	2,200	N	14			
JuOs	AN	Orhy	Ruby	2,000	S	12			
"	"	Pose	Roberts Creek	2,000	N	24			
"	"	"	Sulphur Springs	2,000	W	06	Granitic		
"	"	Pssp	Deep Creek	1,800	W	07			
"	AT	Orhy	Schell Creek	2,000	E	07	Quartzite		
"	"	Pose	Sulphur Springs	2,000	E	22	Granitic		
"	"	Pssp	Deep Creek	1,800	N	16			
"	"	"	Deep Creek	2,000	N	25			
"	AV	Elel	Schell Creek	2,000	S	07	Limest./Dolo.	Haploxerolls	aridic
"	"	Pose	Toiyabe	2,000	N	09	Alluvium	Cambiorthids	lithic xerollic
"	Epvi	Elel	Southern Snake	2,000	W	15	Basaltic		
Juos	AN	Orhy	Fish Creek	2,000	E	33			
"	"	Pose	Sulphur Springs	2,000	S	41	Granitic		
"	AT	Orhy	Bald	2,000	E	21			
"	AV	Elel	Fish Creek	2,200	S	12			
"	"	Pose	North Egan	2,200	N	18			
"	"	Pssp	Bald	2,200	E	11			
"	Cele	Orhy	Schell Creek	2,200	S	18	Limest./Dolo.		
"	Cele	Pssp	Bald	2,200	E	11			
"	Cele	Orhy	Schell Creek	2,200	S	18	Limest./Dolo.		
"	"	Pose	Toiyabe	2,200	E	19	Tuff-Weld.	Haplargids	xerollic
"	Chvi	Pose	Shoshone	2,200	S	02	Tuff-Weld.	Argixerolls	aridic
"	Epvi	Pssp	Schell Creek	2,200	W	45	Limest./Dolo.		
"	Putr	Orhy	Bald	2,000	W	09			

[a]See table 5 for key to Series acronyms.
[b]See table 6 for key to Association acronyms.
[c]See tables 7 and 8 for key to Sub-association acronyms.
[d]N.G. = no grass; N.F. = no forb; N.S. = no shrub encountered.

Section M341C: Pinyon-Juniper Woodlands in the High Plateaus and Mountains of South Central Utah

Our study area (fig. 1) overlapped slightly with Section M341C (fig. 8). We did not sample the Wasatch, Markagunt, and Paunsagunt Plateaus that make up most of this unit, but only randomly drew only the Tushar Range (table 19). We encountered five Series there; JuOs, Juos, PiEd, Pied, and JUSC.

The JuOs Series in Section M341C had only the JuOs/Quga Association and JuOs/Quga/Elel Sub-association (table 19).

The Juos Series in this Section had the Juos/AT and Juos/AV Associations. The Juos/AT Association had only the Juos/AT/Orhy Sub-association. The Juos/AV Association was divided into Juos/AV/Elel and Juos/AV/Orhy Sub-associations.

The PiEd Series in Section M341C was represented by only the PiEd/AV Association and PiEd/AV/Bogr Sub-association.

The Pied Series in this Section had only the Pied/Cemo Association and Pied/Cemo/Orhy Sub-association.

The JUSC Series appeared only when sampling Sections M341C and M341F. It was represented only by the JUSC/AV Association and JUSC/AV/Bogr Sub-association (table 19) in Section M341C.

Table 19—Summary of Pinyon-Juniper Woodland Series, Associations, and Sub-associations in Section M341C. See table 2 for key to abbreviations of geological formations.

Series[a]	Assoc.[b]	Sub-assoc.[c]	Mtn. range	Elev. (m)	Aspect	Slope	Geol. form.	Soils (great group)	Soils (subgroup)
JuOs	Quga	Elel	Tushar	2,000	W	04	Andesitic/Rh.	Argixerolls	aridic calcic
Juos	AT	Orhy	Tushar	2,000	E	27	Conglom	Calcixerolls	aridic
"	AV	Elel	Tushar	2,200	N	16	Andesitic/Rh.	Durorthids	typic
"	"	Orhy	Tushar	2,000	N	18	Conglom	Argixerolls	aridic
PiEd	AV	Bogr	Tushar	2,000	S	31	Andesitic/Rh.	Haploxerolls	aridic
Pied	Cemo	Orhy	Tushar	2,200	E	27	Conglom	Haploxerolls	aridic
JUSC	AV	Bogr	Tushar	2,200	S	21	Andesitic/Rh.	Haploxerolls	lithic

[a]See table 5 for key to Series acronyms.
[b]See table 6 for key to Association acronyms.
[c]See tables 7 and 8 for key to Sub-association acronyms.

Comparison of Groupings Between Sections

This completes the presentation of findings at the Section level. We now turn to comparison of Series, Associations, and Sub-Associations between Sections to see where overlaps occur and whether any larger generalizations are possible. To do this, consult table 10 where we have listed all of the Series, Associations, and Sub-Associations identified in this initial classification along the three far left columns. Into the columns to the right, we have listed the number of stands sampled in each of the nine Sections and totals for the samples in each. On the last few lines of table 10 are the total numbers of sampled stands for each Series, Association, and Sub-association in each Section and for the total study.

Plant species within the Great Basin pinyon-juniper woodlands are not randomly intermingled; there are definite latitudinal, longitudinal, and elevational patterns. For instance, *Pinus monophylla* dominates in the west and south and occurs mostly at the higher elevations there. The leading understory shrubs under *Pinus monophylla* dominated woodlands are more often those associated with more mesic environments than occurs with juniper (table 10). The PiMo Series is the only one that was found in eight out of nine Sections, while the PIMO Series is found in four Sections (table 10). *Juniperus osteosperma* is much more widespread than the two pinyon species and thus has a much wider array of leading understory shrubs (table 10). A few grasses are very widespread (table 7). For instance, Indian ricegrass (*Oryzopsis hymenoides*) is a dominant found in every Section and Series (table 10). Blue grama (*Bouteloua gracilis*), while found as an understory dominant in nearly all the Series, is found only in the more southerly or lower elevation Sections (table 10). Thus, *Bouteloua gracilis* (Bogr) and the other major warm season perennial grass, *Hilaria jamesii* (Hija), are indicators of relatively warmer and drier conditions wherever they are found.

Putting the indicator value of shrubs together with the indicator value of the leading dominant grasses (table 8) shows that cool season grasses are definitely more common under the tall sagebrushes and other shrubs associated with generally higher elevations, more northerly latitudes, northerly slopes in the south, or otherwise more mesic conditions. Warm season grasses have an affinity for low sagebrushes and other shrubs that are associated with more desert-like conditions.

There are some general relationships between vegetational Series and soil Orders related to elevation and temperature (fig. 7). Argiborolls and Haploborolls are confined to the pinyon dominated vegetational Series, and Calciorthids and Calcixerolls are found predominately with Utah juniper dominated Series. Camborthids and Haploxerolls are found in all Series (table 20).

Topographic and soils influences within the Sections cannot be reliably identified from this initial attempt at classification. We found the landform descriptors used in the field were too vague to be consistently applied by field crews not trained in geomorphology. More detailed analysis within the Shoshone and Needle Ranges incorporating topography and soils will be reported on in subsequent publications.

Table 20—Relationship of vegetational series to soil orders. Numbers in cells indicate number of stands where adequate soil descriptions were made to allow the correspondence to be expressed here.

	Vegetational Series[a]								
Soil order	PIMO	PiMo	Pimo	JUOS	JuOs	Juos	JUSC	PiEd	Pied
Argiboroll	6	2	2						
Argixeroll	1	4	4		3	6			
Calciorthid			4	5	2	2			
Calcixeroll		1	1	4	2	6			
Camborthid	5	4	5	1	3	4			
Durargid	1	1	1						
Durorthid						1			
Haplargid		2	4	1	1	1			
Haploboroll	16	4	1						
Haploxeroll		15	11	6	6	2	1	1	1
Palorthid		2	1		3				
Palexeroll				1					
Torrifluvent					1				

[a]See table 5 for key to Series acronyms.

Validation

We now need to consider how complete the classification presented herein is, as well as its reliability. The ultimate answers to these questions require practical attempts to use our classification. We can, however, report some preliminary testing.

Because we sampled the Shoshone and Needle Ranges more intensively, yet excluded the data from intervening elevations and exposures in developing the classification presented here, we can now bring those data forward and see how much overlap there is with the initial identifications within the hierarchy of the classification and speculate on how many new Associations and Sub-associations need to be identified.

Basin-wide classification identified only about half (28 out of 45) of the Sub-associations sampled on the Shoshone Range (table 21). Only three out of 31 Sub-associations were identified elsewhere in Section 341E. This again illustrates the great variability in dominant plant species combinations within pinyon-juniper woodlands.

Sampling of woodlands on the Needle Range by the two teams involved greatly different intensities of sampling (table 22). Team A looked at 48 stands whereas Team B looked at only 10 stands. It was, therefore, inevitable that their work would differ in the resulting classification categories. In fact, only one (PiMo/Artrva/Orhy) out of 46 Sub-associations was sampled by both teams. This points out the degree to which initial sample size and the guidelines used, plus

Table 21—Comparison of pinyon-juniper woodland stand placement on the Shoshone Range, Nevada, using abbreviated (200 m elevation increments) versus full (each 100 m elevation) sampling. Numbers are the number of stands observed in each hierarchial level.

Series[a]	Association[b]	Sub-association[c]	Number of stands: Abbreviated	Full	Total	Predicted
PIMO	AA	Feid	1	0	1	No
"	"	Pose	0	2	2	No
"	AV	Pose	6	3	9	Yes
"	Cele	Pose	3	2	5	Yes
"	Epvi	Pose	1	0	1	No
"	Pugl	Pose	0	1	1	No
PiMo	AA	Feid	1	2	3	No
"	"	Pose	0	1	1	No
"	AN	Pose	0	1	1	Yes
"	AT	Pose	1	0	1	Yes
"	AV	Feid	0	1	1	Yes
"	"	Pose	6	4	10	Yes
"	AW	Elel	0	1	1	No
"	"	Pose	1	1	2	Yes
"	Cele	Pose	0	1	1	Yes
"	Epvi	Pose	0	1	1	Yes
"	Pugl	Pose	0	2	2	No
"	Putr	Pose	0	1	1	No
"	Sylo	Feid	0	1	1	Yes
Pimo	AA	Pose	0	1	1	No
"	AT	Pose	2	0	2	No
"	AV	Pose	0	1	1	No
"	AW	Elel	1	0	1	Yes
"	"	Pose	1	0	1	Yes
"	Pugl	Elel	0	1	1	No
"	Putr	Pose	0	1	1	Yes
JUOS	AV	PsXsa	1	0	1	Yes
JuOs	AW	Pose	0	1	1	Yes
Juos	AW	Pose	0	1	1	No
"	Cele	Leci	0	1	1	No
"	Chvi	Elel	1	0	1	Yes
Total			26	30	56	16 yes 15 no

[a]See table 5 for key to Series acronyms.
[b]See table 6 for key to Associations acronyms.
[c]See tables 7 and 8 for key to Sub-associations acronyms.

Table 22—Comparison of pinyon-juniper woodland stand placement on the Needle Range, Utah, using abbreviated (200 m elevation increments) vs. full (each 100 m elevation) sampling. The findings of the two teams are designated A or B. Numbers are of stands sampled within that hierarchial level. Y = yes, was predicted, N = not predicted, I = Sub-association that was identified in Section 341A.

Series[a]	Association[b]	Sub-association[c]	Abbreviated	Full	Total	Team	Predicted
PIMO	AA	Elel	0	1	1	A	N
"	AN	Bogr	0	1	1	A	N
"	AV	Bogr	1	0	1	A	Y/I
"	"	Pose	1	0	1	B	Y/I
"	"	Pssp	0	1	1	A	Y/O
"	Cele	Pose	1	0	1	B	Y/I
"	Chvi	Elel	1	0	1	A	Y/I
PiMo	AN	Orhy	1	0	1	B	Y/I
"	AT	N.G.[4]	0	1	1	A	Y/I
"	AV	Elel	2	1	3	A	Y/I
"	"	N.G.	0	1	1	A	Y/O
"	"	Orhy	1	0	1	A	Y/I
"	"	Orhy	2	0	2	B	Y/I
"	Amal	Pose	0	1	1	A	Y/I
"	"	Pssp	1	0	1	A	Y/I
"	Mare	Elel	1	0	1	A	N
"	Syor	N.G./N.F.[d]	0	1	1		A
Pimo	AN	Bogr	0	1	1	A	Y/I
"	"	Elel	0	1	1	A	Y/I
"	"	Pose	0	1	1	A	Y/I
"	AV	Elel	2	0	2	A	Y/I
"	"	Orhy	2	0	2	A	Y/I
"	"	Stco	0	1	1	A	N
"	AW	Orhy	1	0	1	B	Y/I
"	Amal	N.G.	1	1	2	A	N
"	Cele	Orhy	1	0	1	A	Y/I
"	Chvi	Elel	0	1	1	A	N
"	Gusa	Orhy	1	0	1	A	N
"	Mare	Elel	0	1	0	A	N
"	N.S.	N.G./N.F.[d]	2	0	2	A	N
"	Pume	Arpu	1	0	1	A	N
JUOS	Chvi	Pssp	1	0	1	B	Y/I
JuOs	AA	Hija	1	0	1	A	Y/I
"	AN	Orhy	1	0	1	B	Y/I
"	AW	Orhy	1	0	1	B	Y/I
"	Chvi	Elel	0	1	1	A	N
"	Gusa	Hija	0	1	1	A	
Juos	AN	Arpu	1	0	1	A	N
"	"	Elel	1	1	2	A	Y/I
"	"	N.G./N.F.[d]	1	1	2	A	Y/I
"	AV	Elel	1	0	1	A	Y/I
"	"	N.G./N.F.[d]	1	0	1	A	N
"	"	Orhy	1	0	1	A	Y/O
"	Cele	Arpu	0	1	1	A	N
"	Chvi	Stoc	1	0	1	A	Y/I
"	Epvi	N.G./N.F.[d]	1	0	1	B	N
"	Erum	N.G./N.F.[d]	1	0	1	A	N
"	Putr	Elel	1	0	1	A	N
Totals						A = 48 B = 10	Y = 28 N = 17 I = 26 O = 3

[a]See table 5 for key to Series acronyms.
[b]See table 6 for key to Associations acronyms.
[c]See tables 7 and 8 for key to Sub-associations acronyms.
[d]N.G. = no grass; N.F. = no forbs encountered.

Table 23—Comparison of classification of the pinyon-juniper woodlands of the Mineral Range, Utah, by two teams using the "rapid" approach.

Series[a]	Association[b]	Sub-association[c]	Number of stands	Team
Pimo	Cele	N.G./N.F.[d]	1	B
JUOS	AT	Ella	1	A
		Mumo	1	B
		N.G./N.F.[d]	1	A
	AV	Bogr	1	B
		N.G./N.F.[d]	1	A
		Pssp	2	A
JuOs	AV	Elel	2	B
	AW	Elel	1	B
		Pssp	1	A
	Cele	Elel	1	A
	Quga	Eltr	1	B
		N.G./N.F.[d]	1	B
Juos	AN	Pssp	1	A
	Putr	Orhy	1	B

[a]See table 5 for key to Series acronyms.
[b]See table 6 for key to Associations acronyms.
[c]See tables 7 and 8 for key to Sub-associations acronyms.
[d]N.G. = no grass; N.F. = no forbs encountered.

the choices made by different crews for locating sampling sites influence the outcome. It also illustrates the requirement for a classification hierarchy to be simple, open-ended, and adaptable to be useable in Great Basin woodlands.

The sampling of the Mineral Range by two different teams, both working in the "rapid" mode had no overlap at the Sub-association level (table 23). Even at the Association level, there was only three out of nine Associations in common (table 23). Only three of the four Series were even sampled by both teams.

The above should demonstrate that the classification presented constitutes only the first outline, a skeleton on which to build. Users should be prepared to at least add their own additional units at the Association, Sub-association, and finer grained (local) levels. Everywhere this classification is used, it will need to be expanded to the more site specific Landtype Association and Landtype levels. Between the Association and Sub-association levels, and possibly between other levels as well, additional environmental factors will possibly need to be included. This is probably most true where Landtype Association and Landtype levels are involved. Nevertheless, the methods proposed to expand this classification are easy and open ended enough so that adding to the system should be routine. The authors would appreciate receiving feedback from readers on additions and modifications they find necessary in practice.

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A hierarchical framework for the classification of Great Basin pinyon-juniper woodlands was based on a systematic sample of 426 stands from a random selection of 66 of the 110 mountain ranges in the region. That is, mountain ranges were randomly selected, but stands were systematically located on mountain ranges. The National Hierarchical Framework of Ecological Units (ECOMAP) was used for the highest levels of classification, subdividing the Great Basin into nine relatively environmentally homogeneous Sections. The remaining levels are vegetation-based, focusing on the relative composition and dominance of pinyon and juniper and the dominant shrub and perennial grass species present. This approach will allow managers to better relate the results of previous, as well as new studies and management experiences.

Keywords: pinyon, juniper, vegetation classification, ECOMAP, Ecoregions, management

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