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Blue Oak Plant Communities of Southern San Luis Obispo and Northern Santa Barbara Counties, California

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An ecological classification system has been developed for the Pacific Southwest Region of the Forest Service. As part of that classification effort, blue oak *(Quercus douglasii)* woodlands and forests of southern San Luis Obispo and northern Santa Barbara Counties in Los Padres National Forest were classified into 13 plant communities using vegetation collected from 208 plots, 0.1 acre each. Three distinct regions of vegetation were identified in the study area: Avenales, Miranda Pine Mountain and Branch Mountain. Communities were classified separately for plots in each region. Each region has a woodland community that occupies flat or gently sloping benches, toeslopes, and valley bottoms. These communities possess a relatively high proportion of large trees (≥ 18 in. d.b.h.) and appear to be heavily grazed. In each region an extensive woodland or forest community covers moderate slopes with low solar insolation. These communities have in common a relatively high density (>180 per acre) of small-diameter trees (2-6 in. d.b.h.). Xeric communities on moderate slopes with high solar insolation are present in each region. In general, however, blue oak is poorly represented in xeric topographic settings in the study area. Two rare communities occupy steep sites with low solar insolation in the Miranda Pine Mountain and Branch Mountain regions. Each community has high species richness and contains a distinctive set of high constancy species. Finally, upper elevation woodland and forest communities are present in Avenales and Branch Mountain regions, where both volume and tree density are high. Keys to the plant communities are included in an appendix. These communities will serve as a framework for gathering productivity and management information for further refinement.

Retrieval Terms: Quercus, Quercus douglasii, vegetation classification, California oaks, blue oak

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Cover: Blue oak woodlands and open annual grasslands in the Branch Mountain region, San Luis Obispo County, California.

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Introduction

Blue oak *(Quercus douglasii* H. & A.) is the most extensive hardwood cover type in California, covering nearly 3 million acres (Bolsinger 1988).[1] Despite its widespread distribution, ecologists and land managers have become increasingly concerned that this habitat is rapidly disappearing. Since 1945, 2 million acres of oak woodland in California have been converted to agricultural, residential, and commercial uses; more than 50 percent of this conversion has occurred in blue oak (Bolsinger 1988). Perhaps of even greater concern, however, is the apparent widespread absence of regeneration in the species. In nearly all parts of the State, recruitment of small trees is apparently inadequate to compensate for the mortality of older individuals (Bolsinger 1988; Muick and Bartolome 1987).

Vegetation classifications for blue oak generally have been broad. Some schemes recognize a blue oak woodland or phase (Barbour 1987, Griffin 1977), while others lump blue oak with other oak woodland types (Jepson 1925). Allen-Diaz and Holzman (1991) used tree, subshrub, and shrub data from the Vegetation Type Map survey (Allen and others 1990) to subdivide the blue oak type into 12 subseries. To date, however, the important herbaceous component has not been used to classify blue oak woodlands.

Bolsinger (1988) estimated that 14 percent of blue oak habitat is in National Forests. Of this 400,000 acres, about 30,000 acres are in Los Padres National Forest. On the central California coast, livestock grazing is the principal use of blue oak woodland. In this region blue oak cover is particularly important to grazing because forage production is considerably higher beneath oaks than in the surrounding grassland (Frost and McDougald 1989, Holland 1973, McClaran and Bartolome 1989).

The area encompassing southern San Luis Obispo and northern Santa Barbara Counties was selected for classification because it contains the most extensive areas of oak rangelands in Los Padres National Forest. The management and research applications of such a classification have been discussed at length (Hall 1989). In the case of blue oak, plant community classification can be used to do the following: (a) assess and predict wildlife habitat, (b) evaluate forage and cordwood production, (c) compare and suggest reasons for different rates of resprouting and regeneration, (d) rank stand susceptibility to insect defoliation and parasitism, and (e) measure fire effects.

Normally, vegetation is classified into plant associations that are late seral (climax) plant associations and their associated soils and geomorphology (Allen 1987). Because blue oak woodlands in the study area have been grazed by domestic livestock at least since the turn of the century, however, we have classified the vegetation into plant communities—a term used when successional status of a plant association is unknown.

This report classifies blue oak woodlands and forests of southern San Luis Obispo and northern Santa Barbara Counties into plant communities and describes the soils, vegetation, and stand structure of each community.

[1]To convert English measurements to metric, use this table

To Find	Multiply	By
Centimeters	inches	2.54
Meters	feet	0.3048
Kilometers	miles	1.609
Square meters	square feet	0.0929
Square meters/hectare	square feet/acre	0.0376
Hectares	acres	0.4048
°C	(°F-32)	0.556

Study Area

Topography

The headwaters of the Salinas River flow through the narrow valley that divides the La Panza Range to the northeast from Garcia Mountain and Los Machos Hills to the southwest *(fig. 1)*. Garcia Mountain rises abruptly (1200 ft per mile) from the Salinas River to a maximum elevation of approximately 3200 feet. In the vicinity of Branch Creek and Alamo Creek, however, Garcia Mountain gives way to Los Machos Hills—a series of dissected hills that seldom exceed 2200 feet in elevation. In contrast, the La Panza Range northeast of the Salinas River has a band of low foothills along its western boundary that create a gentler ascent to elevations of near 4000 feet.

South of the Cuyama River, the Sierra Madre ascend quickly (1000 ft per mile) along their eastern boundary with the Cuyama Valley. This southeast trending ridge reaches elevations of 4500 feet near Miranda Pine Mountain. Southwest of this ridge the mountains are rugged but gradually decrease in elevation toward the coast.

Geology

The northwest trending Rinconada fault marks a regional tectonic boundary between two terrains: the Coastal and Salinian blocks *(fig. 2)*. The Coastal block forms the southern extremity of the Santa Lucia Mountains. These mountains are composed of intensely deformed Franciscan rocks overlain by upper Cretaceous sedimentary rocks: marine sandstone, shale, and conglomerate (Dibblee 1976, Vedder and Brown 1968). Northeast of the fault is the Salinian block. Basement rock of this terrain is granite with overlying early Tertiary sedimentary rocks also composed of marine sandstone, shale and conglomerate.

All major mountain uplifting in the region took place in the Quaternary, primarily during the Pleistocene (Dibblee 1976). The Sierra Madre were elevated between the Rinconada fault and two southwest-dipping thrust or reverse faults, the South Cuyama and Ozena faults along the northeastern base of this mountain block. The La Panza Range uplift was formed by

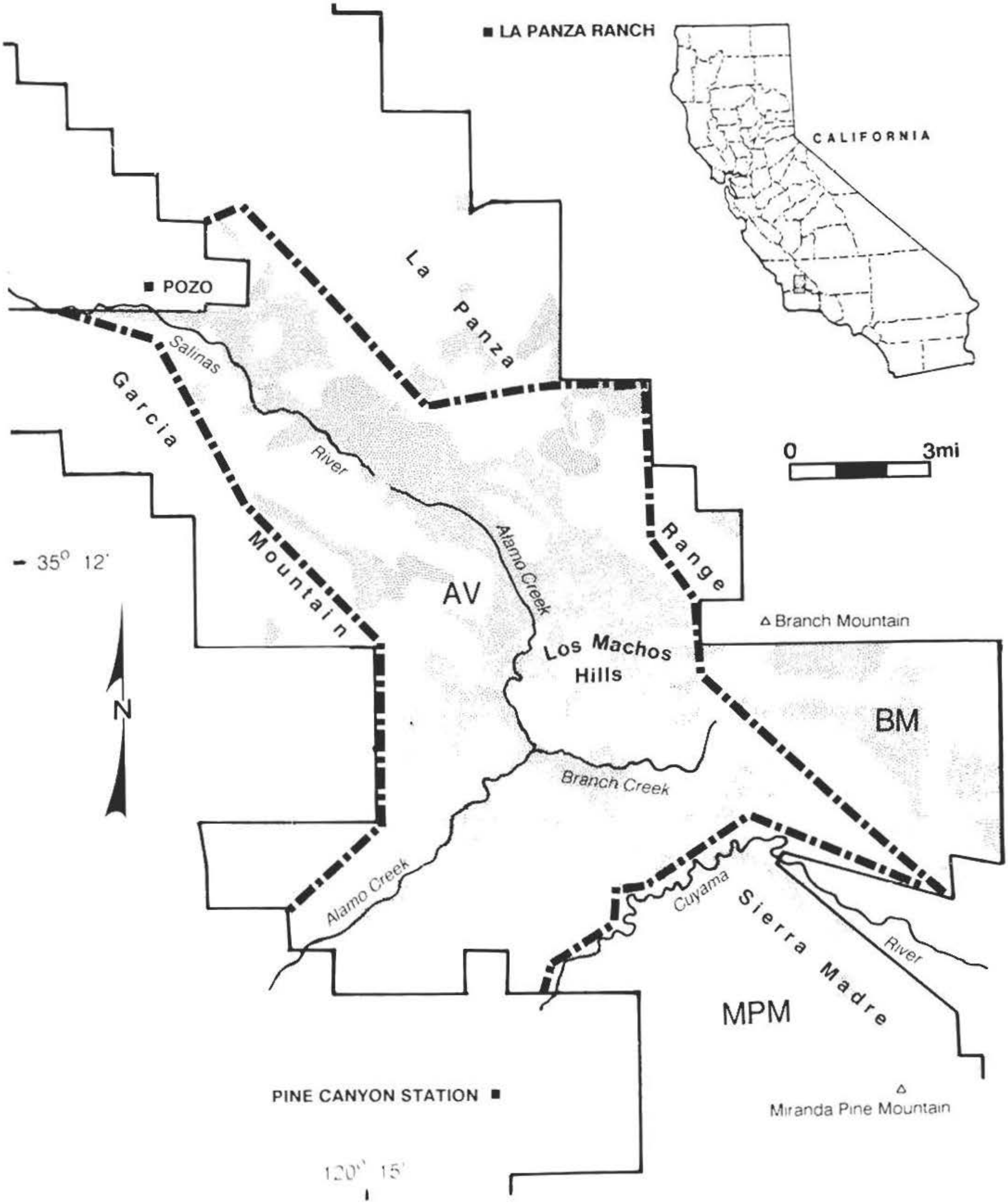

Figure 1—The study area encompasses southern San Luis Obispo and northern Santa Barbara Counties. Shaded areas are oak woodland and forest. Herbaceous vegetation regions are indicated by the dot-dashed lines: Avenales (AV), Miranda Pine Mountain (MPM), and Branch Mountain (BM). Solid line is the boundary of Los Padres National Forest.

arching and tilting northeastward on the northeast-dipping La Panza fault *(fig. 2)*.

Climate

Climate in the study area is characterized by cool, wet winters and warm, dry summers. Most precipitation falls as rain between November and March. Average annual precipitation declines steeply from west to east. For the relatively more coastal stations, average annual precipitation is 20.7 inches at Pozo and 18.5 inches at Pine Canyon Station. In contrast, average annual precipitation east of the La Panza Range is 8.7 inches at La Panza Ranch, and east of the Sierra Madre is 6.4 inches at Cuyama (34 miles east-southeast of Pine Canyon Station). In the southern part of its range, blue oak reaches its limit where average annual precipitation is 11-14 inches (Holland 1973). Average daily maximum temperatures in summer at Paso Robles, 37 miles northwest of Pozo, vary from 87 to 94 °F, while average daily minimums vary from 47 to 50 °F. In winter, average daily maximum temperatures range from 60 to 69 °F, and average daily minimum temperatures range from 31 to 36 °F.

Fog penetrates the Salinas River valley for much of the year but tends to be much less frequent in the inland portions of the La Panza Range and Sierra Madre.

Distribution of Blue Oak

Pure stands of blue oak forest, woodland and savanna dominate the study area and range in elevation from 1500 feet along the Salinas River to 3500 feet at Miranda Pine Mountain. Blue oak forests, woodlands, and savannas cover large continuous areas especially along the Salinas River, but more often stands occur as islands of varying sizes in a matrix of other vegetation types *(fig. 1)*. In the valleys, blue oak stands are usually patchily distributed in open grasslands with individual trees scattered between the clumps *(cover photo)*. With increasing elevation, blue oak woodlands usually abut chaparral or coastal sage scrub.

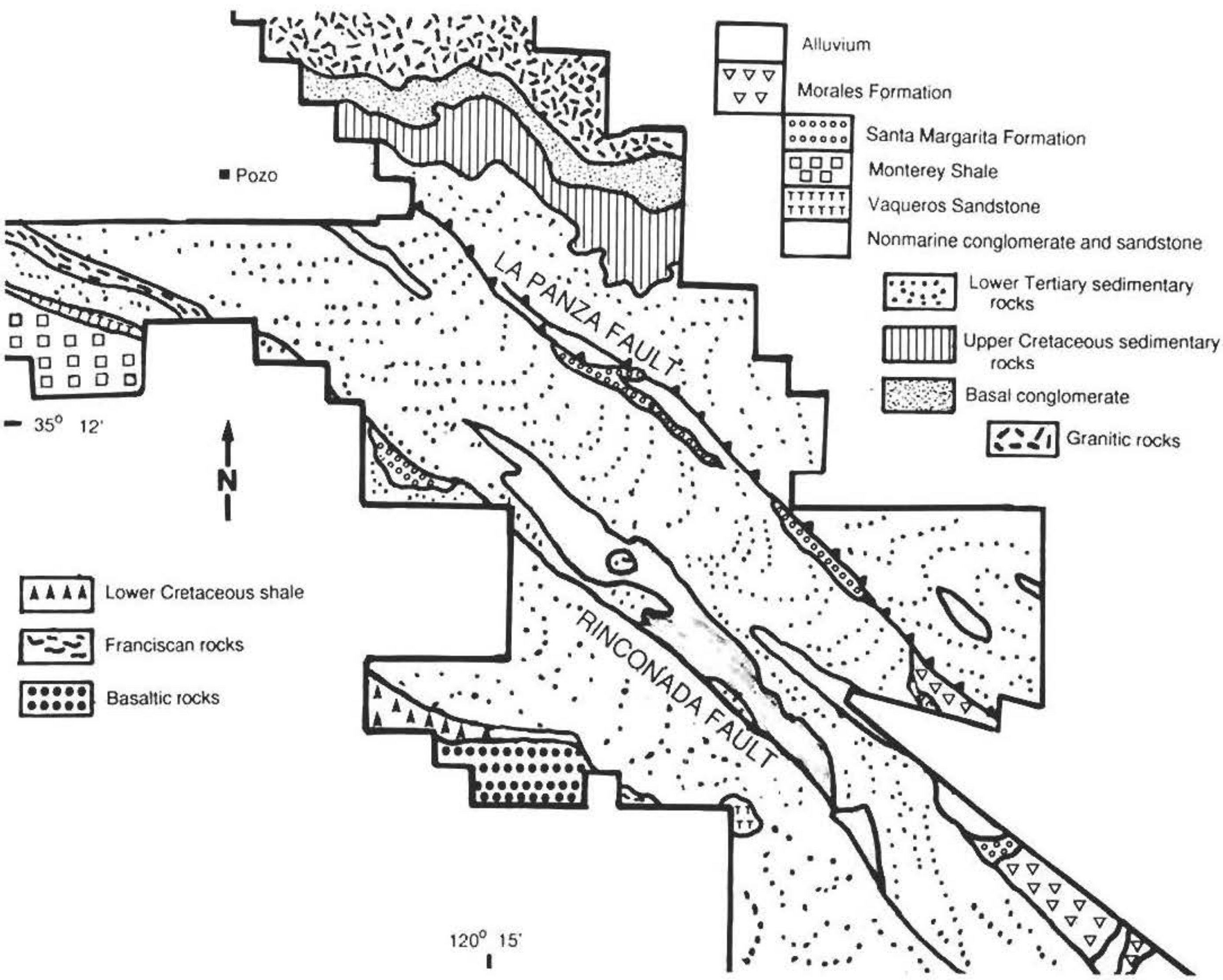

Figure 2—The study area is divided into the Coastal and Salinian blocks by the Rinconada fault (modified from Dibblee 1976).

At middle and upper elevations, the boundary between oak woodlands and chamise *(Adenostoma fasciculatum)* chaparral is often well defined.

Foothill pine *(Pinus sabiniana)*, an associate of blue oak over much of its range, is locally abundant on north-facing aspects only in the Pozo area. On lower-slope benches and north-facing aspects of Garcia Mountain, blue oak mixes occasionally with coast live oak *(Q. agrifolia)*. Valley oak *(Q. lobata)* is most prevalent on the Salinas valley floor and along stream courses where it intermingles with blue oak. Interior live oak *(Q. wislizenii)* is a minor associate of blue oak in the Sierra Madre.

Throughout the study area blue oak woodlands and forests are best developed on north-facing aspects. Along the Salinas River and upper Alamo Creek, stands frequently occupy east-, west-, and occasionally south-facing aspects. South of Branch Mountain and in the Sierra Madre, blue oak is increasingly confined to northern exposures with other exposures dominated by chaparral, coastal sage scrub, or—less frequently—annual grassland.

Methods

Sampling

In stands where blue oak overstory cover attained at least 20 percent and understory herbaceous cover exceeded 60 percent, 208 plots were established. A stand was sampled if oaks were relatively evenly distributed over the 0.1-acre plot on the same slope and aspect.

Slope angle, aspect, and elevation were recorded for each plot, as was landform, slope position, and within-plot vertical and horizontal microrelief. Slope classes were as follows: gentle, 30 percent or less; moderate, 31-45 percent; moderately steep, 46-60 percent; and steep, greater than 60 percent. Using slope and aspect we obtained an estimate of potential annual solar insolation for each plot using the tables of Frank and Lee (1966). In general, plots with high solar insolation are warm and dry, while those with low solar insolation are relatively cool and moist. Thus, solar insolation serves as a crude measure of topographic effects on the vegetation. Percent cover of moss and rocks also was noted. Height was measured for an average tree in each of the obvious canopy layers.

Percent foliar cover for all plant species was estimated visually and recorded into the following modified Braun-Blanquet percentage cover scale: 0-1, 2-5, 6-25, 26-50, 51-75, 76-100. Litter, thatch, and bare ground cover were placed in the same classes. Overstory cover was measured for trees with larger than 1-inch diameter at breast height (d.b.h.) with a concave gridded mirror (Lemmon 1956), by averaging five values taken in the plot: one near the plot center and the others 24 feet parallel and perpendicular to the contour from plot center. The d.b.h. of each tree in the plot was recorded in 2-inch increments. In addition, the d.b.h. was measured for the 25 nearest trees to plot center, as long as they were growing on the same slope and aspect as the plot. Height and diameter of snags taller than 3 feet were recorded, as were the bottom diameters (≥ 3 in.) and lengths (≥ 3 ft) of downed woody material.

A soil pit was excavated in each plot to a depth of 40 inches or bedrock, whichever was encountered first. Thickness of the A horizon was measured and its color, texture, percentage coarse fragment content, and pH were recorded. The same data were taken for the subsoil. Soil drainage, rootability, and lithology also were noted. Available water capacity (AWC) was calculated using soil horizon data for the entire profile and for the top 20 inches of soil (AWC20), where most herbaceous species are rooted.

Plot data were collected from the study area between late March and late May over a period of 3 years. In 1986 and 1987, 77 plots were sampled in the area from Pozo to the Cuyama River west of Branch Mountain *(fig. 1)*. In 1987, 53 plots were also sampled in the area from the Cuyama River to Miranda Pine Mountain and in 1987 and 1988, 78 plots were sampled in the area east of Branch Mountain.

Within the study area, 10 allotments have been grazed almost continuously by cattle since 1900. Data on stocking rates have been collected since 1945 and, typically, allotment grazing regimes have been highly variable. At the time of sampling, four allotments were grazed the entire year, and the others were grazed from 1 to 5 months. Although we are certain grazing has contributed to changes in the composition of blue oak vegetation in the study area, the quality of the stocking data did not permit their use in the analysis of vegetation-environment relationships.

Data Analysis

We analyzed species cover data using two-way indicator species analysis: TWINSPAN, which is a polythetic divisive classification technique (Hill 1979); and Detrended Correspondence Analysis (DCA), which is an indirect ordination technique (Hill and Gauch 1980). Midpoint values for each cover class were used in the analysis. Species with less than three occurrences in each region were omitted from the analysis.

The first division of TWINSPAN separated the plots into three distinct geographic regions *(figs. 1 and 3)*: Avenales (77 plots), Miranda Pine Mountain (53 plots), and Branch Mountain (78 plots) (Borchert and others 1991). Plots from each region were analyzed separately and classified into plant communities using progressive fragmentation (Bridgewater 1989, Peet 1980). Plots from a region first were ordinated with DCA, and correlations were calculated between environmental variables and first- and second-axis scores. Bivariate scattergrams for each significant correlation ($r \geq 0.50$; $p \leq 0.05$) were then examined for marked changes in DCA scores along the environmental gradient. A group of plots associated with a marked change in DCA scores suggested significant changes in composition. If significant differences in scores were detected, the group was removed from the analysis and retained as a potential community type.

The remaining plots were again run through TWINSPAN and, based on the first division, were separated into two groups. Each of the two groups were ordinated separately with DCA and, as before, scattergrams of DCA-environment correlations were examined for groups of plots with markedly different DCA scores. After removal of any grouped plots, remaining samples were subjected to TWINSPAN, and the process was repeated until we obtained plot groups with relatively homogeneous species composition that could not be further divided. An example of this analysis sequence for Avenales is presented in *figure 4*. In some instances, species presence-absence ordinations were used to clarify group membership of some plots.

Site index (SI), periodic annual increment (PAI), and volume (VOL) were calculated using equations developed by Standiford and Howitt (1988):

$$SI = \exp[\ln(HT) + 3.103 * (1/d.b.h.) - 3.103]$$

$$PAI = 0.00195 * VOL^{(0.61157)} * SI^{(1.2090)}$$

$$VOL = -510 + 30.9 * BASAL\ AREA$$

Site index was calculated using height attained by dominant trees at a d.b.h. of 10 inches. Based on measurements of 104 trees from four sites in the study area (Harvey 1989), a site index of 26 feet was used for the PAI equation.

The Shannon-Wiener index ($-\Sigma p_i \ln p_i$) was used to calculate a d.b.h. diversity index for the 25 trees in each stand, where p_i is the proportion of the 25 trees in the ith d.b.h. class.

Results and Discussion

Soils

Soils from the 208 plots were classified into 4 orders, 7 great groups, 25 subgroups, and 60 families. The most prevalent soil orders are Mollisols and Alfisols; Argixerolls and Haploxeralfs

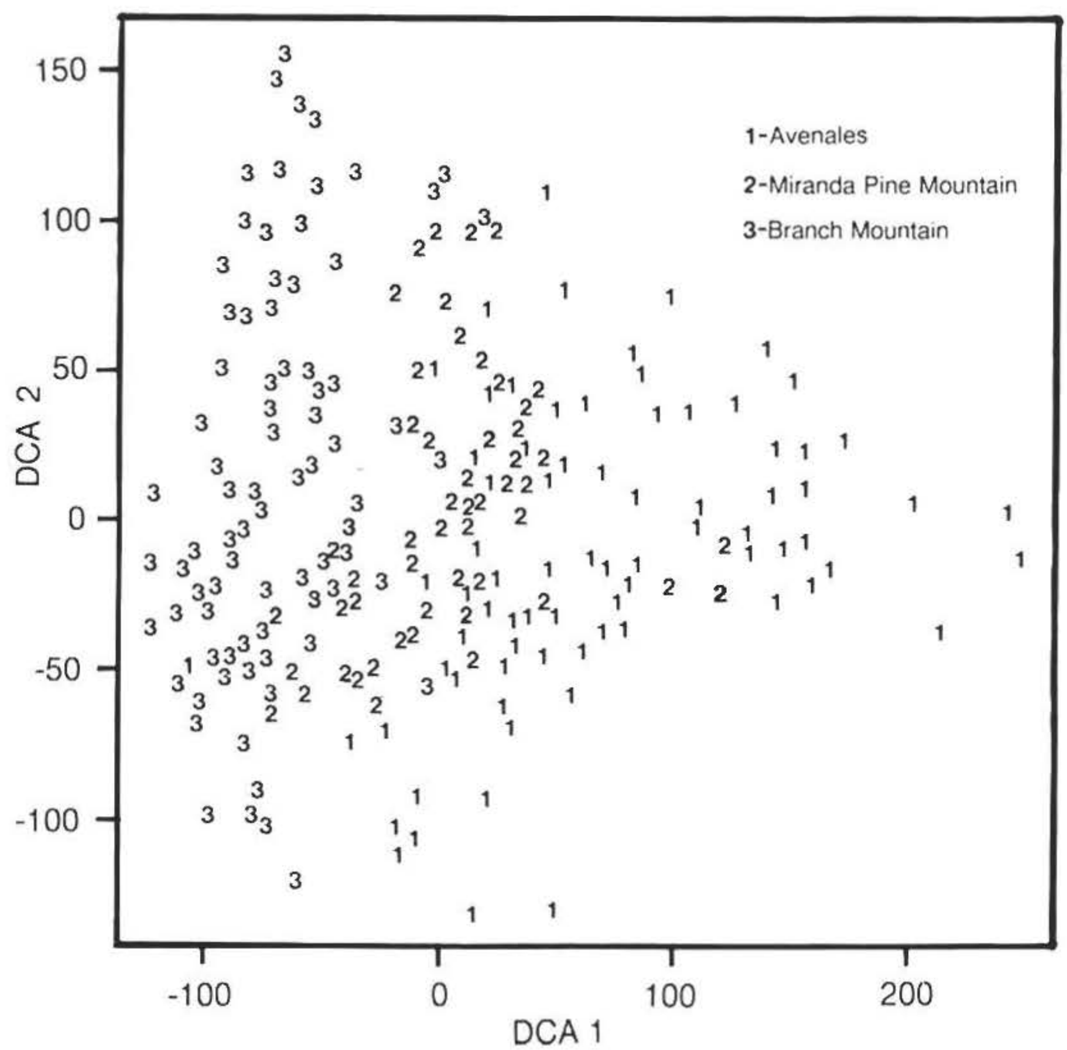

Figure 3—Detrended correspondence analysis (DCA) of the 208 study plots was used to identify potential communities.

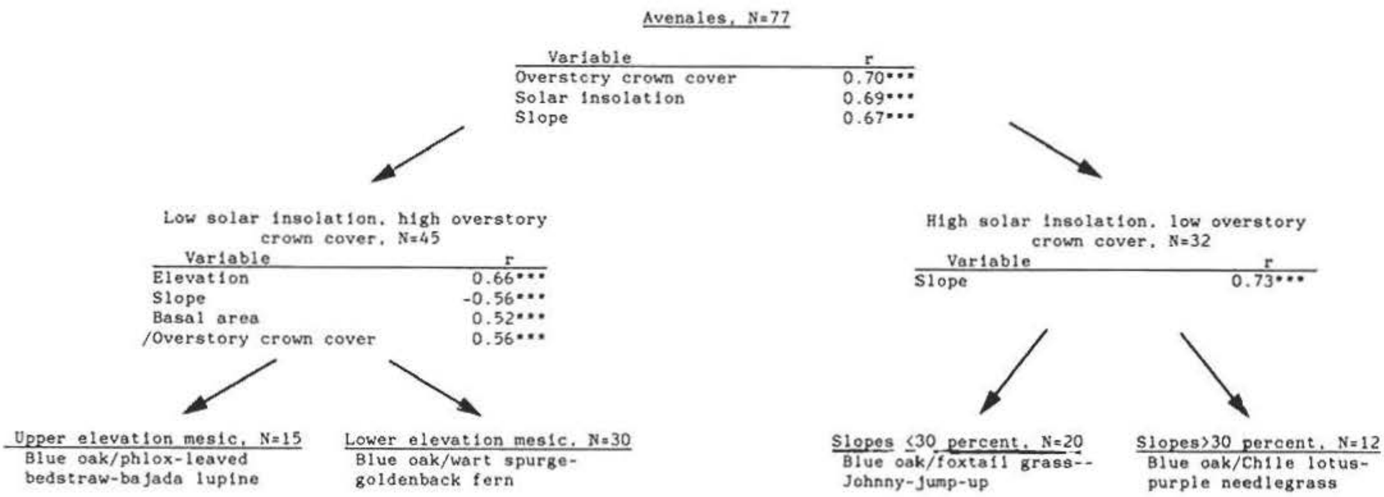

Figure 4—Steps used to classify the 77 Avenales plots show correlations between environmental variables and detrended correspondence analysis scores, where $r \geq 0.50$. Second-axis detrended correspondence analysis correlations are indicated by a "/" before the variable. *** indicates significance at the $p < 0.001$ level.

are the dominant great groups *(table 1)*. Soils were classified into 60 families of which the most abundant families were these: Chualar (41 plots), Modesto (16 plots), Botella (14 plots), and Ramona (14 plots).

The distribution of soil taxonomic groups in the three regions is similar *(table 1)*. Argixerolls, especially Pachic Argixerolls, are best represented in Avenales. Haploxeralfs, on the other hand, are most prevalent in Miranda Pine Mountain and Branch Mountain. The only other notable difference is that Xerocrepts are somewhat better represented in Miranda Pine Mountain than in the other regions.

In Sutter and Yuba Counties, blue oak volume was higher on moderately deep soils than on shallow soils, presumably because of lower AWCs in shallow soils (Lytle and Finch 1987). Also, moderately deep soils with a distinct clay layer (claypan) had lower mean volumes of blue oak than did moderately deep soils without this layer. Pillsbury and Stephens (1978) found a moderate correlation ($r = 0.50$) between average soil depth and gross volume of hardwoods on the Central Coast. In this study, however, we found no significant correlations between soil depth and volume, although in several regions herbaceous vegetation composition was significantly correlated with A-horizon coarse fragment content and AWC20 (Borchert and others 1991).

Table 1—*Percentage distribution of plots by Order and Great Group, within each region*

Order	Great Group	Avenales	Miranda Pine Mountain	Branch Mountain
		percent		
Alfisols				
	Haploxeralfs	19	34	38
	Palexeralfs	3	2	1
Subtotal		22	36	39
Entisols, Xerorthents		4	4	1
Inceptisols, Xerocrepts		1	8	3
Mollisols				
	Argixerolls	60	37	46
	Haploxerolls	12	11	11
	Palexerolls	1	4	—
Subtotal		73	52	57

Avenales Stand Classification

First-axis DCA scores for the 77 Avenales plots were significantly correlated with overstory crown cover, solar insolation, and slope angle *(fig. 4)*. Environmental variables and second-axis scores were not significantly correlated. Using the first division of TWINSPAN, plots were divided into two major groups: those with high solar insolation and low overstory crown cover (32 plots), and those with low solar insolation and high overstory cover (45 plots).

The 45 plots with low solar insolation and high overstory crown cover were divided into two groups: the first group of 15 plots appeared in a regression of second-axis DCA scores and elevation, and comprised the blue oak/phlox-leaved bedstraw-bajada lupine community *(fig. 5)*. The second group of 30 plots, the blue oak/goldenback fern-wart spurge community, showed considerable compositional variation but not enough to warrant further subdivisions.

DCA scores for the 32 reordinated plots with high solar insolation and low overstory cover were correlated with slope on the first DCA axis *(fig. 4)*. TWINSPAN divided these plots into two groups: those on slopes of 30 percent or less—blue oak/foxtail grass—Johnny-jump-up community (20 plots) and those on slopes of greater than 30 percent—blue oak/Chile lotus-purple needlegrass community (12 plots). A key to plant communities of the Avenales region is in *appendix A*.

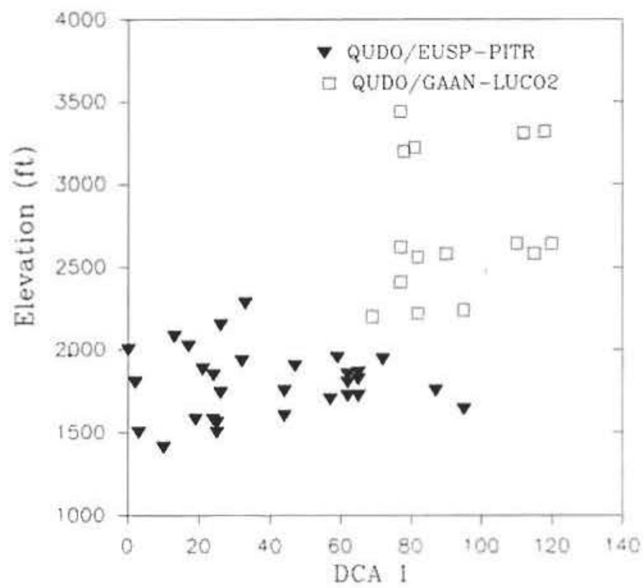

Figure 5—A bivariate scattergram for elevation and first-axis detrended correspondence analysis (DCA 1) scores for the 45 mesic plots in the Avenales region divides them into two communities: blue oak/goldenback fern-wart spurge (QUDO/EUSP-PITR) and blue oak/phlox-leaved bed-straw-bajada lupine (QUDO/GAAN-LUCO2).

Avenales Plant Community Descriptions

Blue Oak/Foxtail Grass—Johnny-Jump-Up *(Quercus douglasii/Hordeum leporinum-Viola pedunculata)* QUDO/HOLE-VIPE

Environmental Setting—The blue oak/foxtail grass—Johnny-jump-up community covers large continuous areas of private lands adjacent to Los Padres National Forest, especially in the valley bordering the Salinas River *(fig. 6)*. In the forest, however, stands of this type are widely scattered and typically occupy flat to gently sloping ($\leq$ 30 pct) toeslope benches, usually no more than 0.1-0.5 acre *(table 2)*.[2] Although this community is most prevalent at elevations below 2000 feet, it also occurs at higher elevations.

Soils—The majority of soils supporting this community are moderately deep to deep and develop equally from hard and soft sandstone *(table 3)*. Unlike soils of the other Avenales communities, sandy loams dominate the A horizon, and gravelly and coarse sandy loams dominate the subsoil. High A-horizon coarse fragment content is primarily responsible for the low average AWC20 of this community *(table 3)*.

[2] *Tables 2–5* follow the last plant community description for the Avenales region.

Figure 6—Typical stands of the blue oak/foxtail grass—Johnny-jump-up community in the Avenales region occupy toeslope benches. The signpost is marked in 1-foot segments.

Vegetative Characteristics—Compared with other Avenales communities, this one has a relatively high constancy and cover of cut-leaved geranium *(Geranium dissectum)*, foxtail grass *(Hordeum leporinum)*, bur clover *(Medicago polymorpha)*, hedge mustard *(Sisymbrium officinale)*, chickweed *(Stellaria media)*, Johnny-jump-up *(Viola pedunculata)*, and annual fescue *(Vulpia megalura)* *(table 4)*. Shrub cover is insignificant: toyon *(Heteromeles arbutifolia)* is the only species with a constancy greater than 5 percent.

Because of the high representation (18.6 pct) of trees in d.b.h. classes equal to or greater than 18 inches *(fig. 7)*, this community has the highest d.b.h. diversity index in the Avenales region *(table 2)*. Based on Harvey's (1989) d.b.h.-age regression for a stand in this community, trees 18 inches d.b.h. are at least 150 years old, indicating that a relatively high proportion of large, old trees inhabit this community. In addition, although average tree density in this community is the lowest in the Avenales region *(table 2)*, average basal area, volume, and PAI per tree are unusually high, suggesting that trees are not only long-lived but also are very productive in this environmental setting.

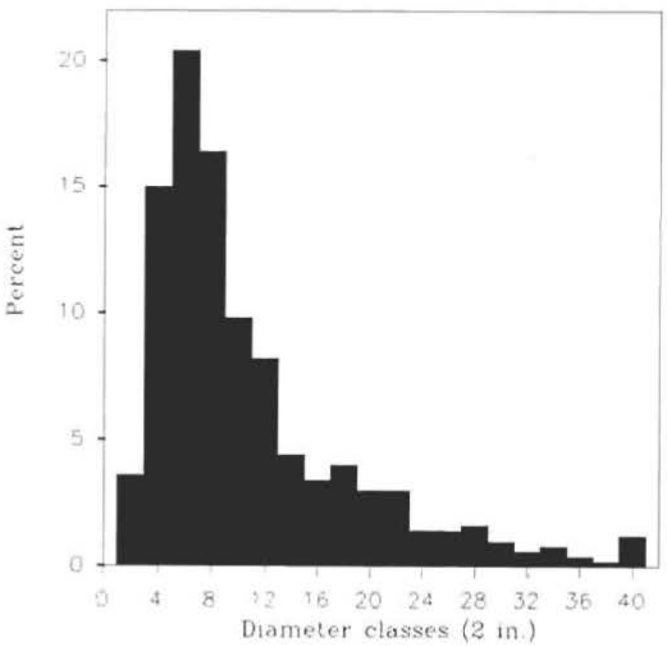

Figure 7—The diameter distribution for 500 trees (>1 in. d.b.h.) in the blue oak/foxtail grass—Johnny-jump-up community in the Avenales region shows the high percentage of trees with d.b.h. greater than or equal to 18 inches.

Blue Oak/Chile Lotus-Purple Needlegrass *(Quercus douglasii/Lotus subpinnatus-Stipa pulchra)* QUDO/LOSU-STPU

Environmental Setting—The low-elevation blue oak/Chile lotus-purple needlegrass community is rare in the study area. It occupies undulating, moderate and steep slopes that are equally distributed on east-, south- and west-facing slopes with high solar insolation *(fig. 8, table 2)*. Like the blue oak/foxtail grass—Johnny-jump-up community, stands of this community tend to be scattered and small, ranging from 0.1 to 2 acres.

Soils—This community has the highest percentage of shallow soils in the Avenales region *(table 3)*. Hard sandstone is the primary parent material. The prevalence of shallow soils may reflect the low rate of soil weathering in this xeric environment. Together, the Botella, Inks, and Ryers Families make up 50 percent of the plots *(table 5)*.

Vegetative Characteristics—Species with high constancy relative to other Avenales communities are blow wives *(Achyrachaena mollis)*, Mariposa lily *(Calochortus simulans)*, Chile lotus *(Lotus subpinnatus)*, and purple needlegrass *(Stipa pulchra)* *(table 4)*.

Blue Oak/Wart Spurge-Goldenback Fern *(Quercus douglasii/Euphorbia spathulata-Pityrogramma triangularis)* QUDO/EUSP-PITR

Environmental Setting—The blue oak/wart spurge-goldenback fern is the most widespread plant community in the Avenales region, occupying lower and middle concave slopes below 2000 feet elevation *(fig. 9)*. Slopes are moderately steep with low solar insolation, and most face west-northwest through east-northeast *(table 2)*.

Soils—Soils in this community are mostly moderately deep to deep and are derived primarily from hard sandstone *(table 3)*. Gravelly-clay and gravelly-clay loam textures are particularly well represented reflecting the high rate of soil weathering that takes place in these low-solar-insolation settings where soil moisture remains high for much of the year.

Vegetative Characteristics—Species with high constancy (>50 pct) in this community compared with other Avenales communities, include these: golden stars *(Bloomeria crocea)*, elegant clarkia *(Clarkia unguiculata)*, Chinese houses *(Collinsia heterophylla)*, wart spurge *(Euphorbia spathulata)*, slender cottonweed *(Micropus californicus)*, goldenback fern *(Pityrogramma triangularis)*, long-spurred plectritic *(Plectritus ciliosa)*, California buttercup *(Ranunculus californicus)*, and hairy-fruited buttercup *(R. hebecarpus)*. High constancy shrubs include honeysuckle *(Lonicera interrupta)* and poison oak *(Toxicodendron diversilobum)* *(table 4)*.

This community has the highest average species richness, overstory crown cover, and tree density in the Avenales region *(table 2)*. Fifty-eight percent of the trees are concentrated in the 2- to 6-inch d.b.h. classes *(fig. 10)*, resulting in the lowest d.b.h. diversity index. Using Harvey's (1989) d.b.h.-age regression in a stand of this type, most trees (74 pct) are likely less than 100 years old.

Figure 8—Stands of the blue oak/Chile lotus-purple needlegrass community in the Avenales region occupy slopes with high solar insolation. The signpost is marked in 1-foot segments.

Blue Oak/Phlox-Leaved Bedstraw-Bajada Lupine *(Quercus douglasii/Galium andrewsii-Lupinus concinnus)* QUDO/GAAN-LUCO2

Environmental Setting—The blue oak/phlox-leaved bedstraw-bajada lupine community occurs at elevations above 2000 ft on concave and undulating moderate slopes that are equally distributed on exposures facing west-northwest through east-northeast *(fig. 11)*. Most stands occupy middle and upper slopes.

Soils—Soils in this community have the highest average coarse fragment content and thickest A horizons in the Avenales region. Soils differ from soils in other communities by the high representation of loams and gravelly loams in the A horizon, and gravelly-clay loams in the subsoil *(table 3)*. This community also is distinguished from other communities by the relatively high percentage of Ultic and Pachic Ultic Argixerolls (33 pct) and Ultic Haploxeralfs (7 pct) *(table 5)*. The low base saturation in the upper 30 inches of the profile distinguishes these soils from the more common Typic Argixerolls. Low base saturation may have developed in this upper elevation environment as a result of the combination of comparatively high precipitation and coarse-textured soils, through which percolating water readily carries dissolved salts (basic cations). In addition, high organic carbon content of the A-horizon may contribute to the accumulation of humic acid, thus decreasing average pH and base saturation.

Vegetative Characteristics—Species with comparatively high constancies in this community include these: phlox-leaved bedstraw *(Galium andrewsii)*, whisker linanthus *(Linanthus ciliatus)*, bajada lupine *(Lupinus concinnus)*, and tomcat clover *(Trifolium tridentatum)* *(table 4)*. Tree density and basal area are both high resulting in the highest volume and PAI of the Avenales communities *(table 2)*.

Figure 9—Stands of the blue oak/goldenback fern-wart spurge community in the Avenales region occupy concave slopes with low solar insolation below 2000 feet. The signpost is marked in 1-foot segments.

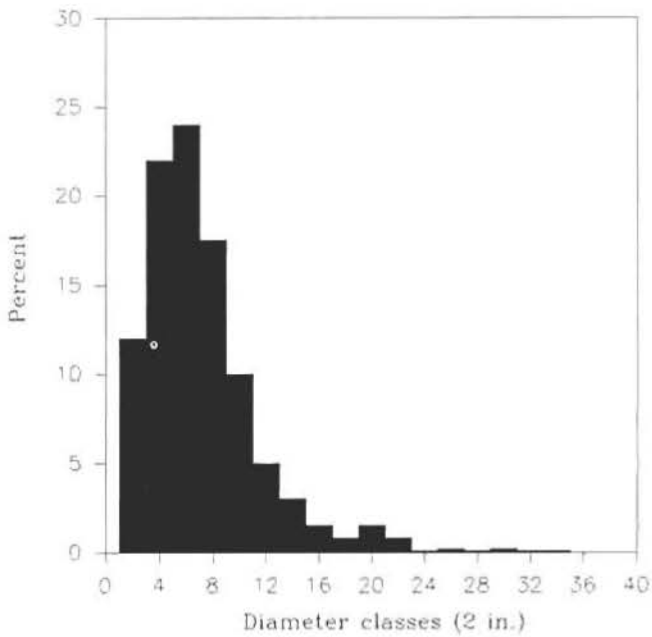

Figure 10—The diameter distribution for 750 trees (>1 in. d.b.h.) in the blue oak/goldenback fern-wart spurge community in the Avenales region shows that more than half have a d.b.h. of 2-6 inches.

Figure 11—Stands of the blue oak/phlox-leaved bedstraw-bajada lupine community in the Avenales region occupy slopes above 2000 feet. The signpost is marked in 1-foot segments.

***Table 2**—Topographic, stand structure, and vegetative characteristics of plant communities in the Avenales region. Values are means.*

Characteristic	QUDO/HOLE-VIPE[1]	QUDO/LOSU-STPU[2]	QUDO/EUSP-PITR[3]	QUDO/GAAN-LUCO2[4]
Elevation (feet)	1928	1916	1795	2738
Slope (percent)	16	41	44	39
Aspect	No preference	E to S to W	WNW to ENE	mostly W to WNW
Potential annual solar insolation (Kilogram cal/0.15 in^2/year)	268	285	227	240
Slope position	Lower, benches	Middle	Lower, middle	Middle, upper
Density (trees/acre)	33	210	248	228
Total basal area ($feet^2$/acre)	95	86	85	108
Volume ($feet^3$/acre)	2425	2147	2116	2827
Periodic annual increment ($feet^3$/acre/year)	11.7	10.9	10.8	12.9
Tall, middle and low tree heights (feet)	27.1, 18.8 12.2	23.8, 16.5 10.4	24.6, 17.1 10.3	22.5, 16.6 11.0
Overstory tree cover (percent)	68	69	83	79
Shrub cover (percent)	<1	<1	1	1
Mean species richness	47	49	58	45
D.b.h. diversity index	1.9701	1.7682	1.6993	1.7796

[1]Blue oak/foxtail grass—Johnny-jump-up.
[2]Blue oak/Chile lotus-purple needlegrass.
[3]Blue oak/wart spurge-goldenback fern.
[4]Blue oak/phlox-leaved bedstraw-bajada lupine.

Table 3*—Soil characteristics of plant communities in the Avenales region. Values are means.*

Characteristic	QUDO/HOLE-VIPE[1] (20 plots)	QUDO/LOSU-STPU[2] (12 plots)	QUDO/EUSP-PITR[3] (30 plots)	QUDO/GAAN-LUCO2[4] (15 plots)
A-horizon				
Thickness (inches)	5.4	6.3	5.8	10.3
Coarse fragment (percent)	11.2	7.9	6.3	12.9
Texture	Sandy loam; gravelly and gravelly coarse sandy loam; sandy clay loam	Mostly fine, gravelly and gravelly coarse sandy loam	Sandy loam and fine sandy loam; also gravelly clay loam	Sandy loam, gravelly sandy loam; loam and gravelly loam
Color	Dark brown; very dark grayish brown	Dark brown	Dark brown	Dark brown and very dark grayish brown
pH	6.8	6.6	6.7	6.6
Subsoil				
Coarse fragment (percent)	21.8	16.2	16.8	32.8
Texture	Sandy clay loam; gravelly, coarse, and cobbly sandy loam	Coarse and gravelly sandy clay loam; clay loam and coarse clay loam	Mostly clay and gravelly clay; clay loam and gravelly clay loam	Clay; gravelly clay loam; very gravelly sandy loam
Color	Dark brown; very dark grayish brown and dark brown	Brown and dark brown	Dark brown and brown	Variety of colors
pH	6.3	6.3	6.3	6.0
Available water capacity (inches/20 inches of soil)	2.20	2.34	2.50	2.36
Soil depth (inches)	20 pct <20 43 pct 21-40 37 pct >41	42 pct <20 33 pct 21-40 25 pct >41	20 pct <20 36 pct 21-40 44 pct >41	21 pct <20 22 pct 21-40 57 pct >41
Soil drainage	65 pct well drained 15 pct somewhat excessively drained 10 pct moderately well drained 10 pct excessively drained	58 pct well drained 25 pct moderately well drained 17 pct somewhat excessively drained	63 pct well drained 27 pct moderately well drained	47 pct well drained 20 pct moderately well drained 33 pct somewhat excessively drained
Parent material	Hard and soft sandstone	Primarily hard sandstone; also shale	Primarily hard sandstone; soft sandstone and conglomerate	Mostly hard sandstone; soft sandstone and shale
Rootability	Hard and fractured and soft and fractured	Mostly hard and fractured	Hard and fractured and soft and fractured	Mostly soft and fractured

[1]Blue oak/foxtail grass—Johnny-jump-up.
[2]Blue oak/Chile lotus-purple needlegrass.
[3]Blue oak/wart spurge-goldenback fern.
[4]Blue oak/phlox-leaved bedstraw-bajada lupine.

Table 4—Constancy and cover for species of blue oak communities in the Avenales region of southern San Luis Obispo County, California [1,2]

Cover type and species	QUDO/HOLE-VIPE[3] (20 plots)	QUDO/LOSU-STPU[4] (12 plots)	QUDO/EUSP-PITR[5] (30 plots)	QUDO/GAAN-LUCO2[6] (15 plots)
Overstory trees				
Quercus agrifolia	20/2	8/+	13/2	7/+
Quercus douglasii	100/68	100/69	100/83	100/79
Pinus sabiniana	—	—	13/+	—
Understory trees				
Quercus agrifolia	20/3	—	13/+	—
Quercus douglasii	25/+	50/3	53/+	73/2
Pinus sabiniana	5/+	—	7/+	—
Shrubs				
Arctostaphylos glauca	—	—	3/+	20/1
Artemisia californica	—	25/+	27/+	—
Cercocarpus betuloides	—	—	17/1	7/+
Heteromeles arbutifolia	5/+	—	—	7/+
Lonicera interrupta	15/+	17/+	50/+	13/+
Quercus dumosa	—	—	3/+	7/+
Rhamnus ilicifolia	20/+	—	43/+	7/+
Symphorocarpus sp.	20/+	17/+	50/+	40/+
Toxicodendron diversilobum	15/+	8/+	53/+	33/+
Subshrubs				
Corethrogyne filaginifolia	—	17/+	30/+	20/+
Eriophyllum confertiflorum	—	8/+	37/+	13/+
Herbs and grasses				
Achyrachaena mollis	10/+	50/+	27/+	7/+
Agoseris grandiflora	50/+	8/+	40/+	20/+
Agoseris heterophylla	10/+	17/+	13/+	7/+
Alchemilla arvensis	10/+	—	10/+	—
Amsinckia intermedia	50/3	67/5	47/+	80/1
Amsinckia menziesii	30/+	8/+	10/+	20/+
Anagallis arvensis	15/+	—	10/+	—
Astraglaus gambelianus	—	25/+	3/+	—
Avena barbata	100/21	83/28	90/7	93/18
Avena fatua	40/4	83/32	97/26	93/25
Bloomeria crocea	5/+	8/+	53/+	7/+
Bowlesia incana	40/+	—	23/+	7/+
Bromus arenarius	15/1	83/10	63/3	73/4
Bromus carinatus	15/+	8/+	40/+	13/+
Bromus diandrus	11/34	100/21	100/21	93/27
Bromus madritensis	20/+	75/3	87/5	40/+
Bromus mollis	100/37	100/18	97/14	100/11
Bromus rubens	10/+	42/+	13/+	27/+
Calandrinia ciliata	20/+	—	—	—
Calochortus simulans	20/+	58/+	20/+	7/+
Capsella bursa—pastoris	5/+	8/+	3/+	—
Centaurea melitensis	10/+	42/+	13/+	—
Cerastium glomeratum	65/+	83/+	93/+	40/+

continues

Table 4—Constancy and cover for species of blue oak communities in the Avenales region of southern San Luis Obispo County, California [1, 2] *continued*

Cover type and species	QUDO/HOLE-VIPE[3] (20 plots)	QUDO/LOSU-STPU[4] (12 plots)	QUDO/EUSP-PITR[5] (30 plots)	QUDO/GAAN-LUCO2[6] (15 plots)
Herbs and grasses, *continued*				
Chlorogalum pomeridianum	10/+	8/+	—	—
Cirsium vulgare	—	—	13/+	7/+
Clarkia affinis	90/2	92/+	83/+	93/+
Clarkia purpurea	90/1	92/+	83/+	93/+
Clarkia cylindrica	—	—	33/+	20/+
Clarkia unguiculata	15/+	17/+	67/1	60/+
Claytonia perfoliata	95/8	75/3	97/11	100/18
Clematus ligusticifolia	—	—	10/+	—
Collinsia heterophylla	—	—	67/4	40/2
Collinsia sparsiflora	25/+	—	37/+	27/+
Crassula erecta	—	—	7/+	7/+
Daucus pusillus	55/+	83/+	63/+	20/+
Delphinium parryi	20/+	—	7/+	7/+
Delphinium umbraculorum	—	—	10/+	—
Dichelostemma pulchellum	80/+	100/+	93/+	73/+
Dodecatheon clevelandii	70/+	33/+	60/+	80/+
Elymus glaucus	5/+	—	—	—
Erigeron foliosus	25/+	83/+	70/+	70/+
Erodium brachycarpum	85/9	75/11	13/+	—
Erodium cicutarium	100/7	100/5	73/+	80/3
Erodium moschatum	65/4	67/+	20/+	7/+
Euphorbia spathulata	30/1	25/+	100/2	7/+
Galium andrewsii	15/+	67/+	60/1	93/+
Galium angustifolium	5/+	—	3/+	—
Galium aparine	95/2	100/2	100/+	100/3
Galium murale	15/+	—	7/+	—
Galium nuttallii	25/+	25/+	53/+	27/+
Geranium dissectum	65/7	8/+	27/2	20/+
Gilia clivorum	85/+	83/3	63/+	80/3
Hordeum leporinum	85/12	42/6	10/+	7/+
Hypochoeris glabra	80/11	92/3	40/1	60/+
Koeleria cristata	5/+	33/+	40/+	40/+
Lactuca serriola	10/+	17/+	—	7/+
Lathyrus vestitus	—	—	30/+	40/+
Linanthus ciliatus	—	—	50/+	73/2
Lithophragma cymbalaria	—	—	3/+	—
Lolium multiflorum	—	8/+	10/+	—
Lomatium utriculatum	35/+	42/+	47/+	33/+
Lotus micranthus	25/+	8/+	17/+	—
Lotus purshianus	5/+	17/+	20/+	—
Lotus strigosus	5/+	25/+	—	—
Lotus subpinnatus	55/+	83/7	40/+	20/+
Lupinus bicolor	100/10	92/8	87/1	93/5
Lupinus concinnus	25/1	33/+	43/+	87/+
Lupinus densiflorus	—	25/+	3/+	—
Lupinus nanus	30/+	8/+	—	7/+
Madia gracilis	80/4	75/4	100/3	93/3

continues

Table 4—Constancy and cover for species of blue oak communities in the Avenales region of southern San Luis Obispo County, California [1, 2] *continued*

Cover type and species	QUDO/HOLE-VIPE[3] (20 plots)	QUDO/LOSU-STPU[4] (12 plots)	QUDO/EUSP-PITR[5] (30 plots)	QUDO/GAAN-LUCO2[6] (15 plots)
Herbs and grasses, *continued*				
Marah fabaceus	—	25/+	50/+	40/+
Medicago polymorpha	95/10	100/5	87/3	27/+
Melica californica	35/+	75/+	70/+	40/+
Melica imperfecta	—	—	17/+	7/+
Micropus californicus	30/+	33/+	67/+	13/+
Microseris elegans	5/+	17/+	3/+	—
Microseris heterocarpa	30/+	42/+	30/+	27/+
Microseris lindleyi	10/+	8/+	23/+	27/+
Microsteris gracilis	25/+	25/+	73/+	73/+
Nemophila pedunculata	35/+	—	37/+	—
Orthocarpus attenuatus	20/+	25/+	—	13/+
Orthocarpus purpurascens	25/+	33/+	10/+	13/+
Paeonia californica	—	25/+	23/+	—
Pellaea andromedaefolia	—	33/+	23/+	7/+
Phoradendron villosum	10/+	17/+	13/+	13/+
Pityrogramma triangularis	15/+	33/+	97/1	33/+
Plagiobothrys nothofulvus	55/+	58/2	—	7/+
Plantago erecta	5/+	8/+	3/+	—
Plectritus ciliosa	20/+	8/+	67/1	27/+
Poa scabrella	65/+	67/+	93/+	87/+
Pterostegia drymarioides	25/+	83/+	67/+	33/+
Ranunculus californicus	30/+	25/+	73/5	13/+
Ranunculus hebecarpus	60/+	58/+	97/2	27/+
Salvia spathacea	15/+	—	27/+	—
Sanicula bipinnata	95/3	83/2	97/6	100/3
Sanicula bipinnatifida	70/+	67/+	47/+	47/+
Sanicula crassicaulis	55/+	50/+	80/1	27/+
Sanicula tuberosa	15/+	—	20/+	20/+
Saxifraga californica	—	—	10/+	—
Senecio vulgaris	15/+	33/+	—	—
Silene gallica	70/+	83/1	17/+	33/+
Sisymbrium officinale	40/1	17/+	3/+	—
Sisyrinchium bellum	30/+	17/+	47/+	20/+
Sonchus oleraceus	—	33/+	3/+	13/+
Stellaria media	85/1	75/+	63/+	53/+
Stipa lepida	—	25/+	20/+	—
Stipa pulchra	35/+	100/1	20/+	33/+
Thysanocarpus curvipes	50/+	25/+	33/+	33/+
Thysanocarpus laciniatus	45/+	83/+	93/1	87/+
Torilis nodosa	20/+	8/+	30/+	—
Trifolium albopurpureum	65/+	83/+	60/+	73/3
Trifolium bifidum	45/1	—	60/1	—
Trifolium ciliolatum	90/6	83/5	93/6	87/11
Trifolium depauperatum	35/+	8/+	—	—
Trifolium gracilentum	40/+	58/+	23/+	13/+
Trifolium microcephalum	75/7	83/6	97/4	87/16
Trifolium oliganthum	35/+	17/+	73/3	67/5

continues

Table 4—Constancy and cover for species of blue oak communities in the Avenales region of southern San Luis Obispo County, California [1] [2] *continued*

Cover type and species	QUDO/HOLE-VIPE[3] (20 plots)	QUDO/LOSU-STPU[4] (12 plots)	QUDO/EUSP-PITR[5] (30 plots)	QUDO/GAAN-LUCO2[6] (15 plots)
Herbs and grasses, *continued*				
Trifolium tridentatum	45/+	25/+	67/+	73/12
Trifolium variegatum	25/+	17/+	3/+	20/+
Verbena lasiostachys	40/+	—	10/+	—
Vicia americana	5/+	—	13/+	7/+
Vicia ludoviciana	20/+	17/+	20/+	13/+
Vicia sativa	—	—	13/+	27/+
Vicia sp.	—	—	10/+	13/+
Viola pedunculata	90/9	33/2	47/3	73/7
Vulpia bromoides	50/+	8/+	57/+	33/5
Vulpia megalura	80/2	50/+	47/+	33/+
Vulpia microstachys	75/+	25/+	90/3	100/10
Vulpia myuros	35/+	8/+	33/+	27/+
Yabea microcarpa	75/1	33/+	87/1	80/+

[1] The following species were found in the plots but occurred less than three times: trees—*Quercus lobata, Quercus wislizenii;* shrubs and subshrubs—*Baccharis pilularis, Quercus dumosa, Rhamnus californica, Ribes speciosum, Salvia leucophylla, Sambucus mexicana,* and *Symphorocarpus albus;* herbs and grasses—*Achillea millefolium, Amsinckia lycopsoides, Allophyllum glutinosum, Athysanus pusillus, Bromus laevipes, Bromus sterilis, Bromus tectorum, Cardimine oligosperma, Castilleja affinis, Cheilanthes californica, Cirsium proteanum, Cryptantha flaccida, Dudleya lanceolata, Gilia minor, Githopsis specularioides, Gnaphalium californicum, Hedypnois cretica, Hesperocinde tenella, Layia platyglossa, Lasthenia chrysostoma, Linanthus androcaceus, Lithophragma cymbalaria, Lolium temulentum, Nemophila menziesii, Rafinesquia californica, Rigiopappus leptocladus, Scutellaria tuberosa, Stellaria nitens, Stipa cernua, Tropidocarpum gracile, Zigadenus brevibracteatus* and *Z. fremontii.*

[2] Constancy (percent of plots in which a species occurred) is given first followed by cover (average percent cover of a species in a plant community. The "+" symbol indicates that the average cover is less than 1 percent. The "—" indicates the species did not occur in the community.

[3] Blue oak/foxtail grass—Johnny-jump-up.

[4] Blue oak/Chile lotus-purple needlegrass.

[5] Blue oak/wart spurge-goldenback fern.

[6] Blue oak/phlox-leaved bedstraw-bajada lupine.

Table 5—Frequency of soils by family for blue oak communities in the Avenales region

Common soil name and taxonomic class	QUDO/HOLE-VIPE[1] (20 plots)	QUDO/LOSU-STPU[2] (12 plots)	QUDO/EUSP-PITR[3] (30 plots)	QUDO/GAAN-LUCO2[4] (15 plots)	AWC[5]
	number of plots				
Agua Dulce (Loamy-skeletal, mixed, thermic Mollic Haploxeralfs)	1	—	—	—	3.0
Botella (Fine-loamy, mixed, thermic Pachic Argixerolls)	3	2	6	1	2.8-7.4
Chualar (Fine-loamy, mixed, thermic Typic Argixerolls)	1	1	3	2	1.9-7.1
Clayey-skeletal, mixed, thermic Mollic Haploxeralfs	—	1	—	—	5.1
Clayey-skeletal, mixed, thermic Ultic Palexerolls	—	—	1	—	4.3
Coarse-loamy, mixed, thermic Pachic Haploxerolls	1	—	1	—	3.5, 5.7
Coarse-loamy, mixed, thermic Typic Haploxeralfs	1	—	—	—	4.6
Coarse-loamy, mixed, thermic Typic Xerorthents	2	—	—	—	2.7, 3.2
Fine-loamy, mixed, thermic Pachic Ultic Argixerolls	1	—	—	—	5.2
Fine-loamy, mixed, thermic Ultic Argixerolls	—	—	—	3	3.9-5.2

continues

Table 5—Frequency of soils by family for blue oak communities in the Avenales region, continued

Common soil name and taxonomic class	QUDO/HOLE-VIPE[1] (20 plots)	QUDO/LOSU-STPU[2] (12 plots)	QUDO/EUSP-PITR[3] (30 plots)	QUDO/GAAN-LUCO2[4] (15 plots)	AWC[5]
	number of plots				
Fine-montmorillonitic, mixed, thermic Mollic Palexeralfs	—	—	1	—	4.2
Fine-montmorillonitic, mixed, thermic Typic Argixerolls	—	—	2	—	5.3, 7.1
Fine-montmorillonitic, thermic Mollic Palexeralfs	—	—	1	—	4.4
Fine-montmorillonitic, thermic Pachic Argixerolls	—	1	1	—	5.2, 5.8
Fine-montmorillonitic, thermic Ultic Argixerolls	—	—	—	1	4.9
Fine-montmorillonitic, thermic Ultic Haploxeralfs	—	—	—	1	5.9
Gazos (Fine-loamy, mixed, thermic Pachic Haploxerolls)	1	1	—	—	0.9-3.0
Hambright (Loamy-skeletal, mixed, thermic Lithic Haploxerolls)	—	—	—	1	2.8
Inks (Loamy-skeletal, mixed, thermic Lithic Argixerolls)	2	2	2	1	1.2-2.3
Livermore (Loamy-skeletal, mixed, thermic Typic Haploxerolls)	1	—			2.7
Loamy, mixed, thermic Ultic Lithic Argixerolls	—	—	1	—	2.3
Loamy-skeletal, mixed, thermic Lithic Haploxeralf	—	—	—	1	0.6
Loamy-skeletal, mixed, thermic Pachic Argixerolls	—	—	—	1	2.6
Loamy-skeletal, mixed, thermic Pachic Haploxerolls	2	—	—	—	1.5, 5.2
Loamy-skeletal, mixed, thermic Pachic Ultic Argixerolls	—	—	—	1	5.0
Loamy-skeletal, mixed, thermic Typic Argixerolls	1	—	1	—	1.9, 5.0
Loamy-skeletal, mixed, thermic Typic Xerorthents	—	—	—	1	2.2
Lodo (Loamy, mixed, thermic Lithic Haploxerolls)	1	1	—	—	1.4, 3.4
Los Osos (Fine-montmorillonitic, thermic Typic Argixerolls)	—	1	3	1	3.3-6.1
Modesto (Fine-loamy mixed, thermic Mollic Haploxeralfs)	1	—	3	—	1.4-5.1
Ramona (Fine-loamy, mixed, thermic Typic Haploxeralfs)	—	—	1	—	6.3
Ryer (Fine-montmorillonitic, thermic Typic Haploxeralfs)	1	2	—	—	3.2-5.8
Stonyford (Loamy, mixed, thermic Lithic Mollic Haploxeralfs)	—	—	1	—	2.5
Vista (Coarse-loamy, mixed, thermic Typic Xerochrepts)	—	—	1	—	6.3
Yorba (Loamy-skeletal, mixed, thermic Typic Haploxeralfs)	—	—	1	—	4.6

[1]Blue oak/foxtail grass—Johnny-jump-up.
[2]Blue oak/Chile lotus-purple needlegrass.
[3]Blue oak/wart spurge-goldenback fern.
[4]Blue oak/phlox-leaved bedstraw-bajada lupine.
[5]Range of available water capacity in inches per 40 inches of soil.

Miranda Pine Mountain Stand Classification

First-axis DCA scores for the 53 Miranda Pine Mountain plots were correlated with solar insolation, slope, density and overstory crown cover *(fig. 12)*. Correlations between site variables and second-axis scores were not significant. TWINSPAN divided the 53 plots into two groups: (1) those on moderate and steep slopes (>30 pct) with low solar insolation and high overstory crown cover (38 plots), and (2) those on gentle slopes ($\leq$30 pct) with high solar insolation and low overstory crown cover (15 plots) *(fig. 12)*.

The 38 plots on moderate and steep slopes with low solar insolation and high overstory crown cover were ordinated separately. TWINSPAN split these 38 mesic plots into two distinct communities: one on slopes between 30 and 60 percent (34 plots)—the blue oak/bajada lupine-tree clover community, and the other on slopes greater than 60 percent (4 plots)—the blue oak-interior live oak/mission star community *(fig. 12)*.

TWINSPAN divided the 15 xeric plots into two communities: one on slopes of 30 percent or less at low elevations (11 plots)—the blue oak/white-stemmed filaree-foxtail grass community, and the other on slopes greater than 30 percent at high elevations (4 plots)—the blue oak/blue larkspur-California phacelia community *(fig. 12)*. A key to plant communities of the Miranda Pine Mountain region is in *appendix B*.

Miranda Pine Mountain Plant Community Descriptions

Blue Oak/White-Stemmed Filaree-Foxtail Grass *(Quercus douglasii/Erodium moschatum-Hordeum leporinum)* QUDO/ERMO4-HOLE

Environmental Setting—The blue oak/white-stemmed filaree-foxtail grass community is uncommon and widely scattered. The community occupies toeslopes and benches and has a wide elevational range, although it tends to be more common at lower elevations of the Miranda Pine Mountain region *(fig. 13, table 6)*.[3] Stands seldom exceed 0.25 acre.

Soils—Soils are mostly moderately deep and form equally over hard sandstone and conglomerate *(table 7)*. Loams and sandy loams are the most prevalent A-horizon textures; a relatively high proportion (54 pct) of subsoil textures are clay and clay loams. A-horizon depth is considerably less than in the other Miranda Pine Mountain communities.

Vegetative Characteristics—Species with comparatively high constancy and cover in this community include these: dwarf athysanus *(Athysanus pusillus)*, mouse-eared chickweed *(Cerastium glomeratum)*, filaree *(Erodium brachycarpum)*, bur clover, rusty popcorn flower *(Plagiobothrys nothofulvus)*, purple sanicle *(Sanicula bipinnatifida)*, nodding needlegrass

[3] *Tables 6–9* follow the last plant community description for the Miranda Pine Mountain region.

Miranda Pine Mountain, N=53

Variable	r
Solar insolation	-0.81***
Slope	0.73***
Density	0.55***
Overstory crown cover	0.51***

Low solar insolation, high overstory crown cover, N=38

Variable	r
Solar insolation	0.74***
Slope	0.59***
/Overstory crown cover	0.51***

High solar insolation, low overstory crown cover, N=15

Variable	r
Slope	0.89**
Elevation	0.65**
Subsoil coarse fragment	0.58**
/Density	-0.73***
/Overstory crown cover	0.66**
/Solar insolation	0.60**

Slopes 30-60 percent, N=34
Blue oak/bajada lupine-tree clover

Slopes >60 percent, N=4
Blue oak-interior live oak/mission star

Slopes <30 percent, N=11
Blue oak/white-stemmed filaree-foxtail grass

Slopes >30 percent, N=4
Blue oak/blue larkspur-California phacelia

Figure 12—The steps used to classify the 53 Miranda Pine Mountain plots show correlations between environmental variables and detrended correspondence analysis scores, where r $\geq$ 0.50. Second-axis detrended correspondence analysis correlations are indicated by a "/" before the variable. Levels of significance are **, p < 0.01 and ***, p < 0.001.

Figure 13—Stands of the blue oak/white-stemmed filaree-foxtail grass community in the Miranda Pine Mountain region occupy toeslopes and benches across a wide range of elevations. The signpost is marked in 1-foot segments.

(Stipa cernua), small-headed clover *(Trifolium microcephalum)*, and Johnny-jump-up *(table 8)*. Tree density and overstory cover are low *(table 6)*. Large diameter trees (≤18 in.) are much less abundant (10 pct) in this community than in the similar blue oak/foxtail grass—Johnny-jump-up community in the Avenales region.

Blue Oak/Blue Larkspur-California Phacelia *(Quercus douglasii/Delphinium parryi-Phacelia imbricata)* QUDO/DEPA-PHIM

Environmental Setting—The blue oak/blue larkspur-California phacelia community is distinctive but highly localized. The community covers approximately 20 acres on west-northwest- and southwest-facing slopes near the crest of the Sierra Madre and on Miranda Pine Mountain *(fig. 14, table 6)*. It occupies moderately steep slopes at the upper elevations.

Soils—About 50 percent of the soils are shallow with very high coarse fragment content throughout the profile *(table 7)*. Textures are entirely cobbly and gravelly sandy loams. Average AWC20 is the lowest of the Miranda Pine Mountain communities. Low AWC20 combined with high solar insolation make this the most xeric of the Miranda Pine Mountain communities.

Vegetative Characteristics—In addition to blue larkspur *(Delphinium parryi)* and California phacelia *(Phacelia imbricata)*, other distinctive species in the herb layer include California gilia *(Gilia achilleaefolia)*, coffee fern *(Pellaea andromedaefolia)*, common groundsel *(Senecio vulgaris)*, and annual fescue *(table 8)*. There are relatively few shrub and subshrub species in this community.

Average tree density is low, but basal area is high primarily because of the abundance (23 pct) of trees with d.b.h. equal to or greater than 18 inches *(table 6)*.

Blue Oak/Bajada Lupine-Tree Clover *(Quercus douglasii/Lupinus concinnus-Trifolium ciliolatum)* QUDO/LUCO2-TRCI

Environmental Setting—The blue oak/bajada lupine-tree clover is a forest and woodland community that covers middle and upper, moderately steep, concave and convex slopes. It is the most prevalent community in the Miranda Pine Mountain region *(fig. 15, table 6)*. In its environmental setting it is similar to the blue oak/wart spurge-goldenback fern community in the Avenales region, except this one occurs at a higher average elevation and has a lower average solar insolation.

Soils—Soils are mostly moderately deep and form over hard sandstone and conglomerate *(table 7)*. Sandy loams, loams, and gravelly loams dominate A-horizon textures, while sandy loams and sandy-clay loams dominate the subsoil. AWC20 is the highest of the Miranda Pine Mountain communities. The Chualar and Ramona Families are well represented in this community (38 pct of the plots) *(table 9)*.

Vegetative Characteristics—In addition to bajada lupine and tree clover *(Trifolium ciliolatum)*, slender cottonweed, few-flowered clover *(Trifolium oliganthum)*, and reflex annual fescue *(Vulpia microstachys)* have high constancies relative to the other Miranda Pine Mountain communities *(table 8)*. Shrub and subshrub species richness are also high. In the Miranda Pine Mountain region this community has the highest average density, basal area, volume, and PAI *(table 6)*.

Blue Oak-Interior Live Oak/Mission Star *(Quercus douglasii-Quercus wislizenii/Lithophragma cymbalaria)* QUDO-QUWI/LICY

Environmental Setting—The blue oak-interior live oak/mission star forest community is rare and occupies steep (>60 pct) lower slopes and draws that face north through north-northwest *(fig. 16, table 6)*. These exposures explain why it has the lowest average solar insolation of the Miranda Pine Mountain communities.

Soils—The shallow soils of this type develop from conglomerate and have a relatively high coarse fragment content *(table 7)*. This is the only community in which gravelly sandy-clay loams are the dominant subsoil textures (75 pct of the plots).

Vegetative Characteristics—Interior live oak codominates with blue oak. Average species richness is high. Herb and grass species that have comparatively high constancies compared with other Miranda Pine Mountain communities include these: wild oats *(Avena fatua)*, speckled clarkia *(Clarkia cylindrica)*, elegant clarkia, Chinese houses, Coast Range melic *(Melica imperfecta)*, baby blue-eyes *(Nemophila menziesii)*, goldenback fern, hairy-fruited buttercup, and California saxafrage *(Saxafraga californica)* *(table 8)*.

Tree density is much higher than in the other Miranda Pine Mountain communities, but basal area, volume, and PAI are low *(table 6)*. The low d.b.h. diversity index results from the high percentage (95 pct) of trees that are 2-8 inches d.b.h. None of the trees exceeded 16 inches d.b.h.

Figure 14—Stands of the blue oak/blue larkspur-California phacelia community in the Miranda Pine region occupy moderately steep slopes at upper elevations. The signpost is marked in 1-foot segments.


LPNF
113


LPNF
114

Table 6—Topographic, stand structure, and vegetative characteristics of plant communities of the Miranda Pine Mountain region. Values are means.

Characteristic	QUDO/HOLE-ERMO4[1]	QUDO/DEPA-PHIM[2]	QUDO/LUCO2-TRCI[3]	QUDO-QUWI LICY[4]
Elevation (feet)	2106	3422	2470	1845
Slope (percent)	18	45	42	70
Aspect	NW to NE, SE to ESE	WNW to SSW	WNW to E	N to NW
Potential annual solar insolation (Kilogram cal/0.15 in^2/year)	261	272	224	166
Slope position	Toeslope, bench ridge	Ridge	Middle, upper	Lower
Density (trees/acre)	104	90	186	315
Total basal area (feet^2/acre)	64	66	68	49
Volume (feet^3/acre)	1467	1529	1591	1004
Periodic annual increment (feet^3/acre/year)	8.6	8.8	9.1	6.9
Tall, middle and low tree heights (feet)	31.1, 19.2 —	30.6, 24.9 11.3	26.9, 17.2 10.4	28.5, 21.1 12.0
Overstory tree cover (percent)	59	54	75	75
Shrub and subshrub cover (percent)	<1	<1	1	13
Mean species richness	44	41	54	60
D.b.h. diversity index	1.6912	2.0364	1.5654	0.8939

[1]Blue oak/white-stemmed filaree-foxtail grass.
[2]Blue oak/blue larkspur-California phacelia.
[3]Blue oak/bajada lupine-tree clover.
[4]Blue oak-interior live oak/mission star.

Figure 15—(Opposite, upper left) Stands of the blue oak/bajada lupine-tree clover community in the Miranda Pine Mountain region cover moderately steep slopes and are the most prevalent in the region. The signpost is marked in 1-foot segments.

Figure 16—(Opposite, left) Stands of the rare blue oak-interior live oak/mission star community in the Miranda Pine Mountain region have the lowest solar insolation in the region. The signpost is marked in 1-foot segments.

Table 7—Soil characteristics of plant communities in the Miranda Pine Mountain region. Values are means.

Characteristic	QUDO/ERMO4-HOLE[1] (11 plots)	QUDO/DEPA-PHIM[2] (4 plots)	QUDO/LUCO2-TRCI[3] (34 plots)	QUDO-QUWI/LICY[4] (4 plots)
A-horizon				
Thickness (inches)	5.6	8.7	8.6	8.3
Coarse fragment (percent)	14.7	28.5	12.5	17.5
Texture	Gravelly, coarse and fine sandy loam; loam	Gravelly and cobbly sandy loam; sandy loam	Sandy loam, very fine sandy loam; loam and gravelly	Coarse and gravelly sandy loam
Color	Dark brown	Dark yellowish brown	Dark brown	Dark brown
pH	6.1	6.1	6.1	6.0
Subsoil				
Coarse fragment (percent)	24.6	55.0	26.1	31.3
Texture	Clay loam; gravelly and very gravelly sandy loam	Very coarse, extremely gravelly and cobbly sandy loam	Sandy loam and fine sandy loam; clay loam; gravelly and cobbly clay loam	Gravelly sandy clay loam
Color	Dark brown; dark yellowish brown	Dark yellowish brown	Dark brown and dark yellowish brown	Dark yellowish brown
pH	5.7	6.2	5.8	5.6
Available water capacity (inches/20 inches of soil)	2.09	1.47	2.47	2.29
Soil depth (inches)	18 pct <20 73 pct 21-40 9 pct >41	50 pct <20 50 pct 21-40	17 pct <20 67 pct 21-40 16 pct >41	75 pct <20 25 pct 21-40
Soil drainage	27 pct well drained 55 pct moderately well drained 18 pct somewhat excessively drained	100 pct somewhat excessively drained	54 pct well drained 29 pct moderately well drained 9 pct excessively drained	100 pct well drained
Parent material	Hard sandstone and conglomerate	Primarily hard sandstone; conglomerate	Primarily hard sandstone and conglomerate; some shale and soft sandstone	Conglomerate
Rootability	Primarily hard and fractured	Soft and fractured	Hard and fractured and soft and fractured	Soft and fractured

[1]Blue oak/white-stemmed filaree-foxtail grass.
[2]Blue oak/blue larkspur-California phacelia.
[3]Blue oak/bajada lupine-tree clover.
[4]Blue oak-interior live oak/mission star.

Table 8—Constancy and cover for species of the blue oak communities in the Miranda Pine Mountain region of northern Santa Barbara County, California[1,2]

Cover type and species	QUDO/ERMO4-HOLE[3] (11 plots)	QUDO/DEPA-PHIM[4] (4 plots)	QUDO/LUCO2-TRCI[5] (34 plots)	QUDO-QUWI/LICY[6] (4 plots)
Overstory trees				
Quercus douglasii	100/64	100/66	100/68	100/49
Quercus wislizenii	—	—	6/+	75/19
Understory trees				
Quercus douglasii	55/+	100/1	94/+	100/2
Quercus wislizenii	—	—	12/+	50/+
Shrubs				
Amorpha californica	9/+	—	6/+	25/+
Arctostaphylos glauca	—	—	12/+	50/10
Artemisia californica	9/+	—	6/+	—
Cercocarpus betuloides	9/+	—	18/+	50/+
Haplopappus linnearifolia	9/+	—	21/+	50/+
Heteromeles arbutifolia	—	—	18/+	25/+
Lonicera interrupta	18/+	—	56/+	75/+
Rhamnus crocea	27/+	25/+	71/+	100/2
Rhus trilobata	9/+	—	—	50/+
Sambucus mexicana	9/+	—	6/+	25/+
Symphorocarpus sp.	—	—	6/+	—
Toxicodendron diversilobum	—	—	24/+	75/+
Yucca whipplei	—	50/+	3/+	25/+
Subshrubs				
Corethrogyne filaginifolia	18/+	25/+	50/+	75/+
Eriogonum elongatum	18/+	75/+	9/+	—
Eriophyllum confertiflorum	—	25/+	50/+	100/2
Lotus scoparius	—	25/+	9/+	50/+
Herbs and grasses				
Achillea millefolium	9/+	—	18/+	50/+
Achyrachaena mollis	9/+	—	21/+	—
Agoseris heterophylla	27/+	—	32/+	50/+
Allophyllum gilioides	9/+	—	21/+	—
Amsinckia intermedia	100/3	100/5	97/1	75/+
Androsace elongata	—	—	3/+	50/+
Athysanus pusillus	73/+	25/+	58/+	—
Avena barbata	100/7	100/32	100/28	75/+
Avena fatua	9/+	25/+	50/4	75/+
Bloomeria crocea	—	25/+	6/+	25/+
Bromus arenarius	90/4	75/5	91/9	100/2
Bromus carinatus	—	—	9/+	—
Bromus diandrus	100/13	100/38	94/18	100/5
Bromus madritensis	55/2	25/+	94/3	100/2
Bromus mollis	100/35	100/11	97/17	100/2
Bromus rubens	73/2	50/1	79/+	50/+
Bromus trinii	—	—	12/+	—
Calandrinia ciliata	27/+	50/1	3/+	—
Calochortus simulans	9/+	—	12/+	—
Calochortus venustus	9/+	—	21/+	50/+
Capsella bursa-pastoris	64/+	—	12/+	—
Cerastium glomeratum	100/2	—	62/+	50/+
Cirsium vulgare	—	25/+	12/+	25/+

continues

Table 8—Constancy and cover for species of the blue oak communities in the Miranda Pine Mountain region of northern Santa Barbara County, California.[1, 2] *continued*

Cover type and species	QUDO/ERMO4-HOLE[3] (11 plots)	QUDO/DEPA-PHIM[4] (4 plots)	QUDO/LUCO2-TRCI[5] (34 plots)	QUDO-QUWI/LICY[6] (4 plots)
Herbs and grasses				
Clarkia affinis	82/+	100/+	100/+	100/+
Clarkia purpurea	82/+	100/+	100/+	100/+
Clarkia cylindrica	—	—	29/+	75/+
Clarkia unguiculata	—	—	29/+	100/+
Claytonia perfoliata	91/5	100/26	100/15	100/8
Clematus ligusticifolia	—	—	3/+	50/+
Collinsia heterophylla	—	—	12/+	100/1
Daucus pusillus	27/+	—	12/+	—
Delphinium parryi	—	75/+	—	—
Dichelostemma pulchellum	100/1	50/+	82/+	75/+
Dodecatheon clevelandii	82/+	50/+	82/+	50/+
Dudleya lanceolata	—	50/+	9/+	—
Erigeron foliosus	73/+	100/+	94/+	100/1
Erodium brachycarpum	82/1	—	12/+	—
Erodium cicutarium	100/22	100/11	97/5	25/+
Erodium moschatum	91/6	—	35/+	—
Euphorbia spathulata	—	—	18/+	—
Galium andrewsii	45/+	50/+	94/+	100/1
Galuim aparine	73/+	75/+	100/+	100/2
Galium nuttallii	36/+	—	85/+	100/2
Gilia achilleaefolia	—	75/+	—	—
Gilia clivorum	100/1	25/+	91/+	25/+
Githopsis specularioides	—	—	3/+	50/+
Grindelia sp.	—	—	9/+	—
Hordeum leporinum	100/28	—	44/+	—
Hypochoeris glabra	55/+	50/+	50/+	—
Koeleria cristata	36/+	—	65/+	100/1
Lactuca serriola	9/+	25/+	3/+	—
Lagophylla ramosissima	8/+	—	29/+	25/+
Lathyrus vestitus	—	25/+	12/+	25/+
Lepidium lasiocarpum	45/+	—	6/+	—
Linanthus ciliatus	27/+	50/+	91/+	100/1
Lithophragma cymbalaria	—	—	—	100/1
Lomatium utriculatum	55/+	—	97/+	100/1
Lotus subpinnatus	9/+	—	44/+	—
Lupinus bicolor	100/3	100/1	100/1	25/+
Lupinus concinnus	36/+	—	74/+	—
Lupinus densiflorus	—	25/+	9/+	25/+
Madia gracilis	36/+	—	79/+	100/+
Marah fabaceus	—	—	44/+	50/+
Medicago polymorpha	82/+	—	41/+	—
Melica californica	18/+	—	50/+	75/+
Melica imperfecta	—	50/1	6/+	100/+
Micropus californicus	27/+	25/+	68/+	—
Microseris heterocarpa	27/+	—	29/+	—
Microseris linnearifolia	18/+	50/+	53/+	75/+
Microsteris gracilis	55/+	25/+	94/+	100/+
Monardella villosa	9/+	25/+	3/+	50/+
Nemophila menziesii	—	50/+	24/+	100/1
Orthocarpus purpurascens	9/+	—	9/+	—
Paeonia californica	27/+	—	6/+	—

continues

Table 8—Constancy and cover for species of the blue oak communities in the Miranda Pine Mountain region of northern Santa Barbara County, California,[1, 2] *continued*

Cover type and species	QUDO/ERMO4-HOLE[3] (11 plots)	QUDO/DEPA-PHIM[4] (4 plots)	QUDO/LUCO2-TRCI[5] (34 plots)	QUDO-QUWI/LICY[6] (4 plots)
Herbs and Grasses				
Pellaea andromedaefolia	—	75/+	32/+	25/+
Phacelia imbricata	—	100/+	3/+	25/+
Phoradendron villosum	36/+	50/+	44/+	36/+
Pityrogramma triangularis	—	25/+	68/+	100/4
Plagiobothrys nothofulvus	55/+	25/+	21/+	—
Plantago erecta	18/+	—	24/+	—
Plectritus ciliosa	9/+	—	44/+	50/+
Poa scabrella	91/+	100/+	94/1	100/1
Pterostegia drymarioides	55/+	50/+	71/+	100/1
Ranunculus hebecarpus	27/+	—	38/+	100/1
Sanicula bipinnata	83/1	—	100/5	100/3
Sanicula bipinnatifida	73/+	25/+	53/+	50/+
Sanicula crassicaulis	9/+	—	18/+	50/1
Saxifraga californica	—	—	12/+	75/+
Senecio vulgaris	18/+	75/+	9/+	—
Silene gallica	55/+	75/+	24/+	—
Sitanion hystrix	—	—	6/+	50/+
Stellaria media	100/9	—	88/1	75/+
Stellaria nitens	45/+	—	18/+	—
Stipa cernua	55/2	—	18/+	25/+
Stipa lepida	—	25/+	3/+	—
Stipa pulchra	9/+	—	12/+	—
Thysanocarpus curvipes	82/+	75/+	88/+	50/+
Thysanocarpus laciniatus	73/+	25/+	79/+	100/1
Trifolium albopurpureum	91/+	75/1	97/+	50/+
Trifolium ciliolatum	27/+	50/+	79/+	—
Trifolium gracilentum	18/+	50/+	9/+	—
Trifolium microcephalum	55/+	25/+	29/+	—
Trifolium oliganthum	9/+	—	50/+	—
Trifolium tridentatum	18/+	100/1	88/+	50/+
Viola pedunculata	64/3	—	38/3	—
Vulpia megalura	36/5	75/5	—	—
Vulpia microstachys	55/+	25/+	91/+	75/+
Vulpia myuros	64/+	25/+	91/+	100/1
Yabea microcarpa	45/+	—	76/+	100/+

[1]The following species were found in the plots but occurred less than three times: trees—*Pinus coulteri;* subshrubs and shrubs—*Adenostoma fasciculatum, Baccharis pillularis, Eriodictyon crassifolium, Eriogonum fasciculatum, Haplopappus squarossus, Rhamnus ilicifolia, Ribes speciosum;* herbs and grasses—*Agoseris grandiflora, Amsinckia menziesii, Arenaria douglasii, Asclepius eriocapra, Astragalus gambelianus, Bowlesia incana, Bromus laevipes, Bromus sterilis, Bromus tectorum, Calystegia malacophylla, Chlorogalum pomeridianum, Cirsium californicum, Crassula erecta, Cryptantha corollata, Cryptantha flaccida, Cryptantha intermedia, Delphinium umbraculorum, Elymus glaucus, Eriogonum nudum, Erodium botrys, Filago californica, Galium angustifolium, Gastridium ventricosum, Hordeum geniculatum, Lamarckia aurea, Lasthenia californica, Linanthus androcaceus, Lomatium macrocarpum, Lotus strigosus, Lupinus sparsiflorus, Malacothrix californica, Muilla maritima, Nemophila pedunculata, Phacelia distans, Phacelia douglasii, Plagiobothrys canescens, Plagiobothrys tenellus, Sagina decumbens, Sanicula tuberosa, Scutellaria tuberosa, Senecio breweri, Sitanion jubatum, Stipa coronata, Stipa lepida, Trifolium variegatum, Tropidocarpum gracile, Verbena lasiostachys, Vulpia bromoides,* and *Zigadenus fremontii.*

[2]Constancy (percent of plots in which a species occurred) is given first followed by cover (average percent cover of a species in a plant community). The "+" symbol indicates that average cover is less than 1 percent. The "—" indicates the species did not occur in the community.

[3]Blue oak/white-stemmed filaree-foxtail grass.

[4]Blue oak/blue larkspur-California phacelia.

[5]Blue oak/bajada lupine-tree clover.

[6]Blue oak-interior live oak/mission star.

Table 9—Frequency of soils by family for blue oak communities in the Miranda Pine Mountain region

Common soil name and taxonomic class	QUDO/ERMO—HOLE[1] (11 plots)	QUDO/DEPA—PHIM[2] (4 plots)	QUDO/LUCO—TRCI[3] (34 plots)	QUDO—QUWI/LICY—COHE[4] (4 plots)	AWC[5]
	number of plots				
Agua Dulce (Loamy-skeletal, mixed, thermic Mollic Haploxeralfs)	—	—	2	1	2.3—3.3
Botella (Fine-loamy, mixed, thermic Pachic Argixerolls)	—	—	1	—	5.2
Chualar (Fine-loamy, mixed, thermic Typic Argixerolls)	3	—	8	1	3.2—5.9
Clayey-skeletal, mixed, thermic Ultic Palexeralfs	1	—	—	—	1.0
Coarse-loamy, mixed, thermic Pachic Haploxerolls	—	—	1	—	7.3
Coarse-loamy, mixed, thermic Typic Haploxeralfs	—	—	1	—	3.7
Coarse-loamy, thermic Typic Haploxerolls	1	—	—	—	6.8
Fine-loamy, montmorillonitic, mixed, thermic Typic Palexerolls	—	—	1	—	5.5
Fine-montmorillonitic, mixed, thermic Palexerolls	1	—	—	—	2.6
Hambright (Loamy-skeletal, mixed, thermic Lithic Haploxerolls)	1	—	1	—	1.3, 2.8
Inks (Loamy-skeletal, mixed, thermic Lithic Argixerolls)	—	—	1	—	1.5
Loamy-skeletal, mixed, thermic Lithic Entic Haploxerolls	—	—	1	—	0.4
Loamy-skeletal, mixed, thermic Lithic Xerorthents	—	2	—	—	0.6, 1.1
Loamy-skeletal, mixed, thermic Pachic Argixerolls	—	—	1	—	2.6
Loamy-skeletal, mixed, thermic Pachic Haploxerolls	—	—	1	—	3.5
Loamy-skeletal, mixed, thermic Typic Argixerolls	—	1	2	—	1.6-4.5
Loamy-skeletal, thermic Typic Argixerolls	—	—	1	—	5.6
Los Osos (Fine-montmorillonitic, mixed, thermic Typic Argixerolls)	—	—	1	—	3.6
Millsholm (Loamy, mixed, thermic Lithic Xerocrepts)	—	—	1	—	2.2
Modesto (Fine-loamy mixed, thermic Mollic Haploxeralfs)	1	—	2	1	3.5—4.7
Ramona (Fine-loamy, mixed, thermic Typic Haploxeralfs)	—	—	5	1	2.1—5.7
Rincon (Fine-montmorillonitic, thermic Mollic Haploxeralf)	—	—	1	—	4.4
Stonyford (Loamy, mixed, thermic Lithic Mollic Haploxeralfs)	1	—	—	—	1.5
Vista (Coarse-loamy, mixed, thermic Typic Xerocrepts)	1	1	1	—	4.2—6.1
Yorba (Loamy-skeletal, mixed, thermic Typic Haploxeralfs)	1	—	1	—	2.6, 3.4

[1]Blue oak/white-stemmed filaree-foxtail grass.
[2]Blue oak/blue larkspur-California phacelia.
[3]Blue oak/bajada lupine-tree clover.
[4]Blue oak-interior live oak/mission star.
[5]Range of available water capacity in inches per 40 inches of soil.

Branch Mountain Stand Classification

First-axis DCA scores for the 78 plots in the Branch Mountain region were correlated with solar insolation and slope angle, while second-axis scores were correlated with elevation *(fig. 17)*. When second-axis DCA scores were regressed with elevation, 18 plots were clustered above 3000 feet *(fig. 18)*. After these plots were removed from the analysis, TWINSPAN was used to divide the 60 remaining low-elevation plots into two groups: mesic plots with low solar insolation (27 plots), and xeric plots with high solar insolation (33 plots).

The first-axis DCA scores for the 27 plots with low solar insolation was correlated with slope, solar insolation, elevation, and A-horizon coarse fragment content *(fig. 17)*. TWINSPAN

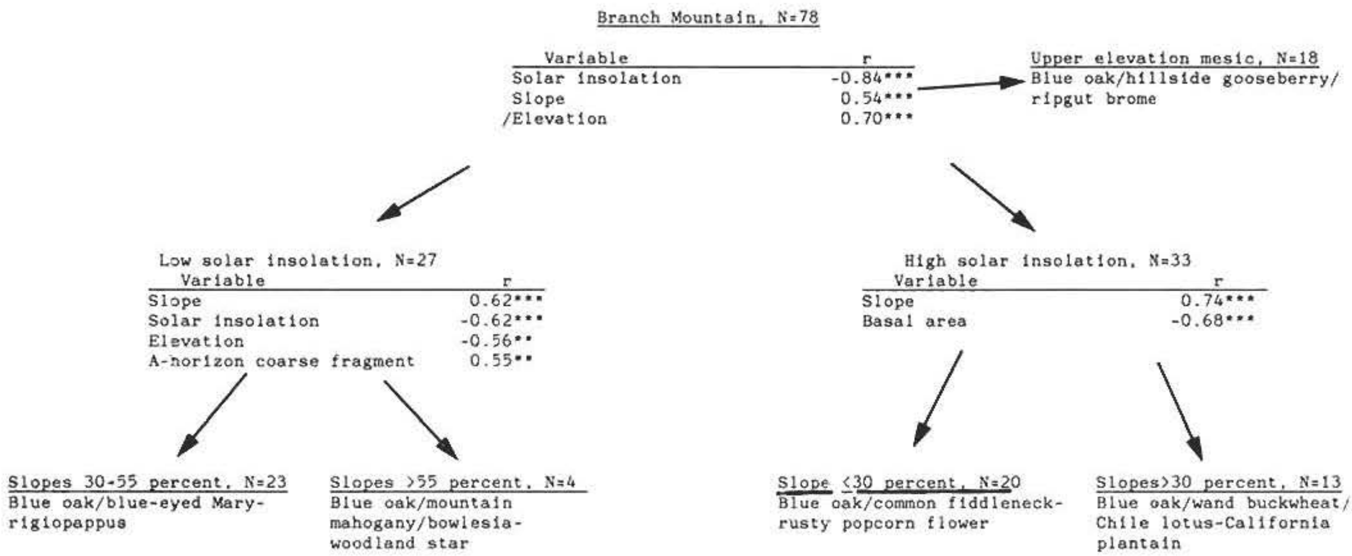

Figure 17—Steps used to classify the 78 Branch Mountain plots show correlations between environmental variables and detrended correspondence analysis scores, where r ≥ 0.50. Second-axis detrended correspondence analysis correlations are indicated by a "/" before the variable. Significance levels are **, p < 0.01 and ***, p < 0.001.

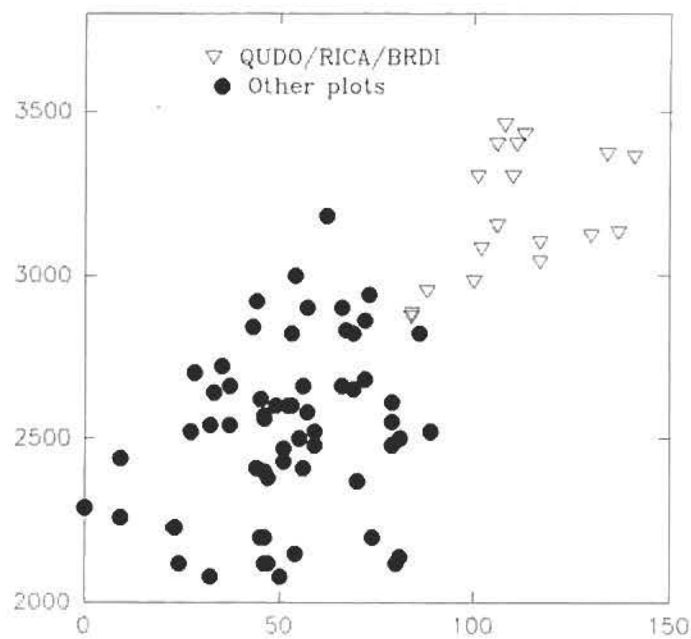

Figure 18—Detrended correspondence analysis used for ordination of the 78 Branch Mountain plots. The 18 plots of the blue oak/hillside gooseberry/ripgut brome community (QUDO/RICA/BRDI) were clustered above 3000 feet.

split these plots into two groups: (1) those 23 plots on slopes equal to or less than 55 percent with generally low A-horizon coarse fragment content—blue oak/blue-eyed Mary-rigiopappus community, and (2) those 4 plots on slopes greater than 55 percent with high A-horizon coarse fragment content—blue oak/mountain mahagony/bowlesia-woodland star community.

When the 33 xeric plots with high solar insolation were ordinated, first-axis DCA scores were correlated with slope and basal area. TWINSPAN divided these 33 plots into two groups: those 20 plots on gentle slopes of 30 percent or less with generally high basal area—blue oak/common fiddleneck-rusty popcorn flower community, and those 13 plots on slopes greater than 30 percent with low basal area—blue oak/wand buckwheat/ Chile lotus-California plantain community. A key to the plant communities of the Branch Mountain region is in *appendix C*.

Branch Mountain Plant Community Descriptions

Blue Oak/Common Fiddleneck-Rusty Popcorn Flower *(Quercus douglasii/Amsinckia intermedia-Plagiobothrys nothofulvus)* QUDO/AMIN-PLNO

Environmental Setting—Blue oak/common fiddleneck-rusty popcorn flower is the dominant woodland community in the gently rolling valley just east of Branch Mountain *(cover photo)*. Here stands of varying size (0.1-3 acres) are scattered in open grasslands. Invariably, this community occupies gentle, north-through east-northeast-facing lower slopes and benches *(fig. 19, table 10)*.[4]

Soils—Soils are shallow to moderately deep and form over hard sandstone or mixed hard and soft sandstone *(table 11)*. Fine sandy loams and loams dominate the A horizons, but subsoil textures vary among sandy loams, loams, sandy-clay loams, and clay or clay loams. AWC20 in this community is rather low, primarily because of the shallow soils.

[4]*Tables 10-13* follow the last plant community description for the Branch Mountain region.

Figure 19—Stands of the blue oak/common fiddleneck-rusty popcorn flower community in the Branch Mountain region occupy gentle lower slopes and benches. The signpost is marked in 1-foot segments.

Vegetative Characteristics—In addition to rusty popcorn flower and common fiddleneck *(Amsinckia intermedia)*, lady's mantle *(Alchemilla arvensis)*, goldfields *(Lasthenia californica)*, chickweed *(Stellaria media)*, pinpoint clover *(Trifolium gracilentum)*, and small-headed clover have high constancies compared with other Branch Mountain communities *(table 12)*. Tree density is low, but volume, PAI, and basal area per tree are much higher than in other communities in the Branch Mountain region *(table 10)*. The high d.b.h. diversity index is the result of the comparatively high proportion of trees (29 pct) that are 18 inches d.b.h. or larger.

Blue Oak/Wand Buckwheat/Chile Lotus-California Plantain
(Quercus douglasii/Eriogonum elongatum/Lotus subpinnatus-Plantago erecta)
QUDO/EREL/LOSU-PLER

Environmental Setting—The woodland community of blue oak/wand buckwheat/Chile lotus-California plantain is occasionally encountered on moderate slopes facing east-northeast and east *(fig. 20)*, but rarely does it occupy entire slopes *(table 10)*. Instead, stands tend to be patchily distributed midslope within large areas of annual grassland.

Soils—Soils are mostly moderately deep and form over soft sandstone. Loam is the dominant A-horizon texture *(table 11)*. AWC20 is high but its positive effect on plant growth likely is offset by high insolation in this topographic setting. The Chualar and Ramona Families have relatively high frequencies (62 pct together) in this community *(table 13)*.

Vegetative Characteristics—Other species with high constancies relative to other Branch Mountain communities include white microseris *(Microseris lindleyi)* and purple needlegrass *(table 12)*. This community has the lowest average tree cover in the Branch Mountain region. Basal area, volume, and PAI are also low *(table 10)*.

Blue Oak/Blue-Eyed Mary-Rigiopappus
(Quercus douglasii/Collinsia sparsiflora-Rigiopappus leptocladus)
QUDO/COSP-RILE

Environmental Setting—Blue oak/blue-eyed Mary-rigiopappus is the most prevalent low-elevation mesic community in the Branch Mountain region. It covers concave, middle,

Figure 20—Stands of the blue oak/wand buckwheat/Chile lotus-California plantain community in the Branch Mountain region cover moderate slopes with high solar insolation. The signpost is marked in 1-foot segments.

and lower slopes that are oriented north through northwest *(fig. 21, table 10)*.

Soils—Soils are moderately deep and form over soft sandstone. Loam is the dominant texture in the A horizon, and clay loams are well represented in the subsoil *(table 11)*. Soil depth and moderately fine textures are largely responsible for the high average AWC20 of this community.

Vegetative Characteristics—This community has the highest average tree density but the lowest d.b.h. diversity index in the Branch Mountain region *(table 10)*, due to the high proportion (75 pct) of trees in the 2- to 6-inch size classes. Species with relatively high constancies are these: shooting stars *(Dodecatheon clevelandii)*, common lomatium *(Lomatium utriculatum)*, gumweed *(Madia gracilis)*, and mitre-fruited navarettia *(Navarettia mitracarpa) (table 12)*.

Blue Oak/Mountain Mahogany/Bowlesia-Woodland Star
(Quercus douglasii/Cercocarpus betuloides/Bowlesia incana-Lithophragma affine)
QUDO/CEBE2/BOIN-LIAF

Environmental Setting—The blue oak/mountain mahogany/bowlesia-woodland star community is rare and covers moderately steep, north-facing lower slopes and draws *(fig. 22, table 10)*. In its topographic setting it is most similar to the blue oak-interior live oak/mission star community of Miranda Pine Mountain.

Soils—Soils in this community are derived from soft sandstone and are moderately deep to deep. A-horizon textures are entirely loams; subsoil textures are almost entirely clay loams *(table 11)*. Deep soils, high AWC20, and low solar insolation combine to make this the most mesic of the Branch Mountain communities.

Figure 21—Stands of the blue oak/blue-eyed Mary-rigiopappus community in the Branch Mountain region cover moderate slopes with low solar insolation. The signpost is marked in 1-foot segments.

Vegetative Characteristics—Like the blue oak-interior live oak/mission star community of Miranda Pine Mountain, this community has a suite of high constancy species: bowlesia *(Bowlesia incana)*, speckled clarkia, elegant clarkia, Chinese houses, common blue-cup *(Githopsis specularioides)*, small-rayed baeria *(Lasthenia microglossa)*, baby blue-eyes, and hairy-fruited buttercup *(table 12)*. Shrub cover is unusually high *(table 10)*. Although this is clearly the most mesic community in the Branch Mountain region, basal area and density are unexpectedly low.

Blue Oak/Hillside Gooseberry/Ripgut Brome *(Quercus douglasii/Ribes californica/Bromus diandrus)* QUDO/RICA/BRDI

Environmental Setting—The blue oak/hillside gooseberry/ripgut brome community is concentrated on moderate, middle, and upper slopes above 3000 feet *(fig. 23)*. Community orientation is north-facing on linear and convex slopes *(table 10)*.

Soils—Soils are shallow to moderately deep. Loams and sandy loams are the most prevalent textures in the profile, and coarse fragment is high throughout the profile *(table 11)*. This community has a relatively high percentage (22 pct) of Lithic Argixerolls *(table 13)*.

Vegetative Characteristics—Distinctive high constancy species are notably absent in this community. Several rather common species like slender oats *(Avena barbata)*, Spanish brome *(Bromus madritensis)*, and red-stemmed filaree-foxtail grass *(Erodium cicutarium)* have particularly high cover *(table 12)* perhaps because these upper elevation sites have not been heavily grazed. Basal area, volume, PAI, and overstory cover are all high indicating that productivity may be enhanced by relatively higher precipitation in these upper elevation sites *(table 10)*.

Figure 22—Stands of the rare blue oak/mountain mahogany/bowlesia-woodland star community in the Branch Mountain region cover moderately steep slopes and draws with low solar insolation. The signpost is marked in 1-foot segments.

Table 10—Topographic, stand structure, and vegetative characteristics of plant communities in the Branch Mountain region. Values are means.

Characteristic	QUDO/AMIN-PLNO[1]	QUDO/EREL/LOSU-PLER[2]	QUDO/COSP-RILE[3]	QUDO/CEBE2/BOIN-LIAF[4]	QUDO/RICA/BRDI[5]
Elevation (feet)	2568	2462	2603	2100	3186
Slope (percent)	17	48	46	65	36
Aspect	Primarily N to ENE	ENE and E	N to NW	N	NNE to NNW
Potential annual solar insolation (Kilogram cal/0.15 in^2/year)	253	253	201	161	213
Slope position	Lower, benches	Middle	Lower, middle	Draw, lower	Middle, upper
Density (trees/acre)	144	161	269	107	216
Total basal area (feet^2/acre)	106	47	66	31	99
Volume (feet^3/acre)	2765	942	1529	448	2549
Periodic annual increment (feet^3/acre/year)	12.7	6.6	8.9	4.2	12.1
Upper, middle and low tree heights (feet)	30.1, 19.7 —	25.3, 18.1 11.4	26.7, 17.7 10.3	36.4, 27.0 11.0	31.2, 20.9 12.7
Overstory tree cover (percent)	63	54	63	61	69
Shrub cover (percent)	<1	<1	2	8	4
Mean species richness	57	56	59	60	51
D.b.h. diversity index	1.9069	1.8226	1.4923	1.9434	1.7002

[1]Blue oak/common fiddleneck-rusty popcorn flower.
[2]Blue oak/wand buckwheat/Chile lotus-California plantain.
[3]Blue oak/blue-eyed Mary-rigiopappus.
[4]Blue oak/mountain mahogany/bowlesia-woodland star.
[5]Blue oak/hillside gooseberry/ripgut brome.

Figure 23—Stands of the blue oak/hillside gooseberry/ripgut brome community in the Branch Mountain region are concentrated on moderate slopes above 3000 feet. The signpost is marked in 1-foot segments.

Table 11—Soil characteristics of plant communities in the Branch Mountain region. Values are means.

Characteristic	QUDO/AMIN-PLNO[1] (20 plots)	QUDO/EREL/LOSU-PLER[2] (13 plots)	QUDO/COSP-RILE[3] (23 plots)	QUDO/CEBE2/BIOC-LIAF[4] (4 plots)	QUDO/RICA/BRDI[5] (18 plots)
A-horizon					
Thickness (inches)	7.5	6.5	7.1	7.5	7.3
Coarse fragment (percent)	5.1	6.2	4.5	11.3	9.6
Texture	Primarily loam; fine sandy loam	Primarily loam	Primarily loam; some silt loam	Loam	Primarily loam; fine sandy loam, clay loam
Color	Dark yellowish brown and dark brown	Primarily dark brown; also dark yellowish brown	Dark yellowish brown	Dark yellowish brown	Dark brown
pH	6.0	6.1	6.0	6.0	6.1
Subsoil					
Coarse fragment (percent)	10.3	11.0	11.9	15.0	14.7
Texture	Sandy clay loam; fine sandy loam; loam	Mostly loam; also clay loam and sandy clay loam	Primarily clay loam; also clay and loam	Clay loam and gravelly clay loam	Loam; gravelly fine sandy loam; clay loam
Color	Dark yellowish brown; also dark brown	Brown, dark brown, dark yellowish brown	Dark yellowish brown; dark brown	Dark yellowish brown	Dark yellowish brown and dark brown
pH	6.2	6.3	6.3	6.0	6.2
Available water capacity (inches/20 inches of soil)	2.59	2.94	2.93	2.79	2.49
Soil depth (inches)	40 pct <20 60 pct 21-40	15 pct <20 77 pct 21-40 8 pct >41	10 pct <20 81 pct 21-40 9 pct >41	75 pct 21-40 25 pct >41	28 pct <20 72 pct 21-40
Soil drainage	85 pct well drained	85 pct well drained	96 pct well drained	100 pct well drained	94 pct well drained
Parent material	Hard sandstone; some soft sandstone	Primarily soft sandstone; also hard sandstone	Hard and soft sandstone	Mostly soft sandstone	Hard and soft sandstone
Rootability	Equally hard and fractured and soft and fractured	Primarily soft and fractured	Equally soft and fractured and hard and fractured	Soft and fractured	Equally hard and fractured and soft and fractured

[1]Blue oak/common fiddleneck-rusty popcorn flower.
[2]Blue oak/wand buckwheat/Chile lotus-California plantain.
[3]Blue oak/blue-eyed Mary-rigiopappus.
[4]Blue oak/mountain mahogany/bowlesia-woodland star.
[5]Blue oak/hillside gooseberry/ripgut brome.

Table 12—*Constancy and cover for species of the blue oak communities in the Branch Mountain region of southern San Luis Obispo County, California*[1,2]

Cover type and species	QUDO/AMIN PLNO[3] (20 plots)	QUDO/EREL/ LOSU-PLER[4] (13 plots)	QUDO/COSP-RILE[5] (23 plots)	QUDO/CEBE2/ BOIN-LIAF[6] (4 plots)	QUDO/RICA/ BRDI[7] (18 plots)
Overstory trees					
Quercus douglasii	100/63	100/54	100/63	100/61	100/69
Understory trees					
Quercus douglasii	75/+	100/1	96/1	100/1	94/+
Shrubs					
Amorpha californica	—	—	—	—	17/+
Arctostaphylos glauca	—	—	22/+	25/+	—
Cercocarpus betuloides	—	23/+	48/+	100/5	11/+
Ericameria linnearifolia	5/+	15/+	35/2	50/+	—
Eriogonum fasciculatum	—	31/+	9/+	—	—
Juniperus californica	5/+	—	13/+	—	28/1
Lonicera interrupta	50/+	62/+	91/+	100/2	83/+
Rhamnus ilicifolia	15/+	46/+	74/+	100/1	56/1
Ribes californicum	—	—	4/+	—	50/2
Ribes quercetorum	5/+	—	4/+	—	22/+
Subshrubs					
Corethrogyne filaginifolia	5/+	46/+	13/+	—	17/+
Eriogonum elongatum	—	62/+	4/+	—	—
Eriogonum nudum	5/+	38/+	4/+	—	6/+
Eriophyllum confertiflorum	—	23/+	48/+	50/+	11/+
Herbs and grasses					
Achillea millefolium	20/+	46/+	26/+	—	—
Achyrachaena mollis	—	—	—	25/+	22/+
Agoseris grandiflora	—	—	9/+	—	28/
Agoseris heterophylla	45/+	54/+	22/+	—	50/+
Alchemilla arvensis	75/+	38/+	48/+	50/+	11/+
Allophyllum gilioides	10/+	—	4/+	—	—
Amsinckia intermedia	95/3	69/+	52/+	50/+	61/+
Amsinckia menziesii	10/+	—	—	—	17/+
Androsace elongata	20/+	23/+	70/+	100/1	33/+
Athysanus pusillus	100/+	46/+	83/+	100/1	28/+
Avena barbata	80/1	92/2	83/+	—	100/11
Avena fatua	5/+	15/+	13/+	—	17/+
Arenaria douglasii	30/+	8/+	17/+	50/+	6/+
Astragalus trichopodus	10/+	15/+	13/+	—	—
Bloomeria crocea	15/+	23/+	78/+	75/+	44/+
Bowlesia incana	5/+	—	—	100/5	—
Bromus arenarius	45/+	62/4	43/+	75/+	72/+
Bromus diandrus	85/+	38/+	48/+	25/+	100/26
Bromus madritensis	65/+	62/+	48/4	100/5	67/2
Bromus mollis	100/46	100/27	100/37	100/23	100/13
Bromus rubens	100/7	100/6	100/3	100/15	94/1
Bromus trinii	25/+	38/+	70/+	100/1	33/+
Calandrinia ciliata	45/+	15/+	—	25/+	—
Calochortus simulans	—	38/+	4/+	—	—
Capsella bursa-pastoris	65/+	31/+	13/+	75/+	17/+
Cerastium glomeratum	90/+	85/+	78/+	100/+	72/+
Cirsium californicum	5/+	—	—	65/+	61/+
Clarkia affinis	95/+	100/+	100/+	100/1	100/+
Clarkia purpurea	95/+	100/+	100/+	100/1	100/+

continues

Table 12—Constancy and cover for species of the blue oak communities in the Branch Mountain region of southern San Luis Obispo County, California[1 2] continued

Cover type and species	QUDO/AMIN PLNO[3] (20 plots)	QUDO/EREL/ LOSU-PLER[4] (13 plots)	QUDO/COSP-RILE[5] (23 plots)	QUDO/CEBE2/ BOIN-LIAF[6] (4 plots)	QUDO/RICA/ BRDI[7] (18 plots)
Herbs and Grasses, *continued*					
Clarkia cylindrica	—	8/+	39/+	100/1	17/+
Clarkia unguiculata	—	15/+	4/+	100/+	11/+
Claytonia perfoliata	100/8	77/5	100/36	100/81	100/40
Collinsia heterophylla	5/+	8/+	52/+	100/1	22/+
Collinsia sparsiflora	70/+	38/+	91/+	25/+	39/+
Crassula erecta	20/+	15/+	9/+	25/+	6/+
Daucus pusillus	60/2	77/5	17/+	—	14/+
Delphinium parryi	—	8/+	—	25/+	11/+
Dichelostemma pulchellum	100/1	92/+	100/+	100/+	83/+
Dodecatheon clevelandii	60/+	69/2	87/+	50/+	77/+
Erigeron foliosus	80/+	85/+	83/+	100/1	72/+
Erodium brachycarpum	70/3	69/+	17/+	—	—
Erodium cicutarium	95/24	100/17	96/10	100/1	100/30
Erodium moschatum	10/2	8/+	—	—	—
Galium andrewsii	65/+	69/+	96/1	75/+	90/+
Galuim aparine	70/+	85/+	100/1	100/1	79/+
Galium nuttallii	25/+	62/+	83/+	100/1	44/+
Gilia clivorum	100/1	100/1	9/+	—	28/
Githopsis specularioides	—	8/+	13/+	100/1	22/+
Hordeum leporinum	95/3	69/+	43/+	—	83/2
Hypochoeris glabra	10/+	38/+	9/+	—	28/+
Koeleria cristata	60/+	31/+	52/+	—	50/+
Lactuca serriola	50/+	31/+	30/+	50/+	22/+
Lagophylla ramosissima	35/+	92/+	87/+	50/+	33/+
Lasthenia californica	80/+	62/+	26/+	25/+	11/+
Lasthenia microglossa	—	—	9/+	100/1	—
Lepidium lasiocarpum	50/+	62/+	22/+	—	6/+
Linanthus androsaceus	15/+	15/+	13/+	—	6/+
Linanthus ciliatus	55/+	85/+	87/+	—	72/+
Linanthus liniflorus	35/+	—	—	—	—
Lithophragma affine	—	—	—	100/1	6/+
Lithophragma cymbalaria	—	—	13/+	50/+	6/+
Lomatium macrocarpum	65/+	31/+	78/+	75/+	61/+
Lomatium utriculatum	60/+	62/+	91/+	75/+	56/+
Lotus subpinnatus	75/+	92/17	22/+	—	6/+
Lupinus bicolor	100/7	92/14	83/3	—	100/1
Lupinus concinnus	10/+	23/+	9/+	—	17/+
Lupinus subvexus	40/+	100/1	100/2	25/+	—
Madia gracilis	15/+	31/+	57/+	25/+	33/+
Marah fabaceus	—	8/+	39/+	50/+	6/+
Melica californica	65/+	85/+	83/+	25/+	11/
Micropus californicus	90/+	100/1	91/+	50/+	56/+
Microseris heterocarpa	40/+	38/+	61/+	25/+	61/+
Microseris lindleyi	75/+	92/+	70/+	50/+	67/+
Microsteris gracilis	50/+	23/+	91/+	100/1	76/+
Navarettia atractyloides	15/+	—	4/+	—	—
Navarettia mitracarpa	20/+	23/+	57/+	25/+	6/+
Nemophila menziesii	20/+	31/+	52/+	100/1	28/+
Orobanche uniflora	—	—	43/+	25/+	17/+
Orthocarpus attenuatus	80/+	69/+	—	—	—
Orthocarpus purpurascens	25/+	38/+	—	—	—
Pellaea andromedaefolia	5/+	8/+	9/+	—	11/+

continues

Table 12—Constancy and cover for species of the blue oak communities in the Branch Mountain region of southern San Luis Obispo County, California[1,2] *continued*

Cover type and species	QUDO/AMIN PLNO[3] (20 plots)	QUDO/EREL/ LOSU-PLER[4] (13 plots)	QUDO/COSP-RILE[5] (23 plots)	QUDO/CEBE2/ BOIN-LIAF[6] (4 plots)	QUDO/RICA/ BRDI[7] (18 plots)
Herbs and Grasses, *continued*					
Phacelia distans	15/+	—	4/+	25/+	—
Phacelia imbricata	—	23/+	—	—	—
Phoradendron villosum	70/+	62/+	30/+	—	78/+
Pityrogramma triangularis	20/+	15/+	74/+	100/1	28/+
Plagiobothrys canescens	15/+	—	—	—	—
Plagiobothrys nothofulvus	70/+	23/+	—	—	11/+
Plagiobothrys tenellus	30/+	15/+	—	—	—
Plantago erecta	30/+	62/+	4/+	—	—
Plectritus ciliosa	60/+	31/+	96/+	100/1	56/+
Poa scabrella	100/2	100/1	100/7	100/4	100/1
Polypogon monospeliensis	10/+	15/+	—	—	17/+
Pterostegia drymarioides	45/+	54/+	—	50/+	11/+
Ranunculus hebecarpus	5/+	—	43/+	100/1	22/+
Rigiopappus leptocladus	15/+	23/+	65/+	25/+	39/+
Sanicula bipinnata	80/+	92/1	100/3	75/+	100/1
Sanicula bipinnatifida	60/+	46/+	48/+	—	61/+
Sanicula tuberosa	—	—	17/+	75/+	33/+
Saxifraga californica	5/+	8/+	96/+	100/1	33/+
Senecio vulgaris	40/+	31/+	30/+	25/+	17/+
Silene gallica	20/+	15/+	—	—	—
Sitanion jubatum	85/+	46/+	83/+	—	22/+
Stellaria media	90/10	31/+	57/+	75/1	56/6
Stipa pulchra	45/+	69/+	4/+	—	—
Thysanocarpus curvipes	80/+	85/+	83/+	100/1	56/+
Thysanocarpus laciniatus	85/+	54/+	96/+	50/+	56/+
Trifolium albopurpureum	100/1	100/4	96/1	25/+	67/+
Trifolium depauperatum	35/+	15/+	9/+	—	—
Trifolium ciliolatum	5/+	31/+	—	—	44/+
Trifolium gracilentum	90/4	62/+	17/+	—	65/+
Trifolium microcephalum	95/3	69/+	30/+	—	67/+
Trifolium oliganthum	55/+	15/+	87/+	—	94/+
Trifolium tridentatum	100/1	62/+	100/1	75/+	100/4
Tropidocarpum gracile	40/+	—	—	25/+	—
Verbena lasiostachys	15/+	8/+	17/+	75/+	50/+
Viola quercetorum	—	—	—	25/+	33/+
Vulpia bromoides	70/+	54/+	87/+	25/+	83/+
Vulpia megalura	100/19	100/15	100/12	100/12	100/8
Vulpia microstachys	80/+	92/1	100/+	50/+	94/1
Vulpia myuros	95/3	92/3	87/+	50/1	44/+
Yabea microcarpa	20/+	8/+	48/+	100/1	72/+

[1]The following species were found in the plots but occurred less than three times: trees—*Quercus agrifolia, Quercus wislizenii*; subshrubs and shrubs—*Ceanothus cuneatus, Heteromeles arbutifolia, Haplopappus squarossus, Prunus ilicifolia, Salvia leucophylla*; herbs and grasses—*Apiastrum angustifolium, Astragalus gambelianus, Bromus carinatus, Bromus tectorum, Centaurea melitensis, Chlorogalum pomeridianum, Cirsium proteanum, Claytonia spatulata, Clematis linguisticifolia, Cryptantha coronata, Cryptantha intermedia, Delphinium umbraculorum, Descurainia pinnata, Dudleya lanceolata, Eschscholzia californica, Euphorbia spatulata, Filago californica, Filago gallica, Gastridium ventricosum, Hesperomecon linearis, Lathrys jepsonii, Layia platygossa, Linanthus dichotomus, Lotus purshianus, Medicago polymorpha, Melica imperfecta, Microseris elegans, Orthocarpus micranthus, Penstemon heterophyllus, Poa annua, Sanicula crassicaulus, Senecio breweri, Sisymbrium officinale, Sitanion hystrix, Stipa cernua, Stylomecon heterophylla, Taushia hartwegii*, and *Trifolium variegatum*.

[2]Constancy (percent of plots in which a species occurred) is given first followed by cover (average percent cover of a species in a plant community). The "+" symbol indicates that the average cover is less than 1 percent. The "—" indicates the species did not occur in the community.

[3]Blue oak/common fiddleneck-rusty popcorn flower.

[4]Blue oak/wand buckwheat/Chile lotus-California plantain.

[5]Blue oak/blue-eyed Mary-rigiopappus.

[6]Blue oak/mountain mahogany/bowlesia-woodland star.

[7]Blue oak/hillside gooseberry/ripgut brome.

Table 13—Frequency of soils by family for blue oak communities in the Branch Mountain region

Common soil name and taxonomic class	QUDO/AMIN-PLNO[1] (20 plots)	QUDO/EREL/LOSU-PLER[2] (13 plots)	QUDO/COSP-RILE[3] (23 plots)	QUDO/CEBU/BIOC-LIAF[4] (4 plots)	QUDO/RICA/BRDI[5] (18 plots)	AWC[6]
	number of plots					
Agua Dulce (Loamy-skeletal, mixed, thermic Mollic Haploxeralfs)	—	—	2	—	—	3.0, 3.2
Argonaut (Fine, mixed, thermic Mollic Haploxeralfs)	—	—	—	1	1	4.2, 4.8
Botella (Fine-loamy, mixed, thermic Pachic Argixerolls)	—	—	1	—	—	6.4
Chualar (Fine-loamy, mixed, thermic Typic Argixerolls)	2	4	6	1	4	2.7—6.1
Coarse-loamy, thermic Typic Haploxerolls	—	—	—	—	1	3.7
Hambright (Loamy-skeletal, mixed, thermic Lithic Haploxerolls)	1	—	—	—	—	2.2
Inks (Loamy-skeletal, mixed, thermic Lithic Argixerolls)	3	—	—	—	3	1.9—2.7
Livermore (Loamy-skeletal, mixed, thermic Typic Haploxerolls)	—	—	—	—	1	1.6
Loamy, mixed, thermic Lithic Haploxeralfs	1	1	1	—	—	1.7—2.8
Loamy-skeletal, mixed, thermic Typic Argixerolls	—	—	—	1	1	2.8, 3.2
Loamy-skeletal, thermic Typic Argixerolls	—	—	—	—	1	2.8
Loamy, mixed, thermic Lithic Xerorthents	1	—	—	—	—	1.2
Lodo (Loamy, mixed, thermic Lithic Haploxerolls)	—	—	—	—	2	1.3, 1.4
Los Osos (Fine-montmorillonitic, thermic Typic Argixerolls)	3	—	5	1	2	3.4—6.6
Los Robles (Fine-loamy, mixed, thermic Typic Xerochrepts)	1	1	—	—	—	3.8, 4.0
Millsap (Fine, mixed, thermic Typic Palexeralfs)	1	—	—	—	—	2.1
Modesto (Fine-loamy, mixed, thermic Mollic Haploxeralfs)	3	2	6	—	—	3.1—6.3
Ramona (Fine-loamy, mixed, thermic, Typic Haploxeralfs)	2	4	1	—	—	3.0—6.2

continues

Table 13—Frequency of soils by family for blue oak communities in the Branch Mountain region, continued

Common soil name and taxonomic class	QUDO/AMIN-PLNO[1] (20 plots)	QUDO/EREL/LOSU-PLER[2] (13 plots)	QUDO/COSP-RILE[3] (23 plots)	QUDO/CEBU/BIOC-LIAF[4] (4 plots)	QUDO/RICA/BRDI[5] (18 plots)	AWC[6]
	number of plots					
Rincon (Fine-montmorillonitic, thermic Mollic Haploxeralfs)	—	—	1	—	1	3.9, 6.2
San Andreas (Coarse-loamy, mixed, thermic Typic Haploxerolls)	1	—	—	—	1	3.9, 4.5
Stonyford (Loamy, mixed, thermic Lithic Mollic Haploxeralfs)	1	1	—	—	—	2.5

[1]Blue oak/common fiddleneck-rusty popcorn flower.
[2]Blue oak/wand buckwheat/Chile lotus-California plantain.
[3]Blue oak/blue-eyed Mary-rigiopappus.
[4]Blue oak/mountain mahogany/bowlesia—woodland star.
[5]Blue oak/hillside gooseberry/ripgut brome.
[6]Range of available water capacity in inches per 40 inches of soil.

Comparable Communities Across Regions

Open Stands on Gentle Slopes

The blue oak/foxtail grass—Johnny-jump-up (Avenales region), blue oak/white-stemmed filaree (Miranda Pine Mountain region), and blue oak/common fiddleneck-rusty popcorn flower (Branch Mountain region) communities are similar in topographic setting and stand structure. All occupy gentle slopes and have a relatively high proportion of large trees. Although they share a number of indicator species, such as foxtail grass, rusty popcorn flower, chickweed, and filaree (*Erodium* sp.), these communities differ markedly in vegetation. A DCA ordination shows no overlap among the three communities (*fig. 24*). Of the blue oak types described by others, these communities are most similar to the "open type," which occupies gentle slopes and has tree densities of less than 100 per acre (White 1966a).

Species composition suggests that these communities with open stands on gentle slopes are heavily grazed by livestock. Grazing generally increases with decreasing slope (Cook 1966, Mueggler 1965, Yeo and others 1990). Species encouraged by heavy grazing of open types are well represented in these communities: smooth cat's ear *(Hypochoeris glabra)* (White 1966a, Rosiere 1987, Rossiter 1966), foxtail grass (Heady and Pitt 1979, Rosiere 1987), and annual fescue (Rossiter 1966, White 1966b). Based on the density of cow droppings, use of the open stand type was high (White 1966a). Nevertheless, it is difficult to isolate the effects of grazing on community composition because grazing patterns are confounded by solar insolation and other factors. For example, soil disturbance by pocket gophers *(Thomomys bottae)* and ground squirrels *(Spermophilus beecheyi)* may increase the abundance of rusty popcorn flower and fiddleneck in the absence of livestock grazing (White 1966b).

Research on cavity-nesting birds in Mendocino County, California, indicates that communities with a high proportion of large trees may be especially important to cavity-nesting birds.

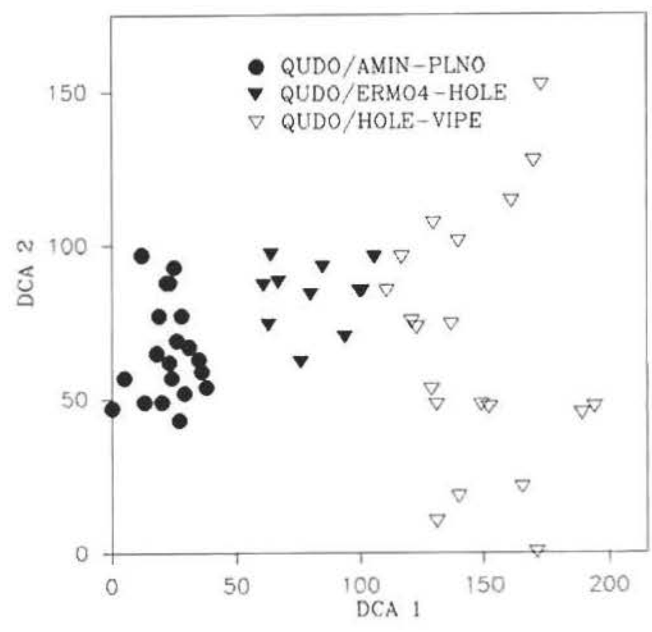

Figure 24—Detrended correspondence analysis ordination of the communities on gentle (≤ 30 pct) slopes shows the following communities: blue oak/common fiddleneck-rusty popcorn flower (QUDO/AMIN-PLNO) from the Branch Mountain region; the blue oak/white-stemmed filaree-foxtail grass (QUDO/ERMO4-HOLE) from the Miranda Pine Mountain region; and the blue oak/foxtail grass—Johnny-jump-up (QUDO/HOLE-VIPE) from the Avenales region.

Compared with valley oak, black oak *(Q. kelloggii)*, and interior live oak, blue oaks 20 inches d.b.h. or larger had a high number of natural and excavated cavities (Wilson and others 1990). Five of the seven common bird species that nest in cavities were particularly abundant in low-density stands (<40 trees/acre) that also had an abundance of blue oaks 20 inches d.b.h. or larger. In these three woodland communities, trees this size make up 17.2 percent of the trees—the highest proportion in the study area. In addition, these communities have the highest percentage (4 pct) of trees 30 inches d.b.h. or larger, which are preferred by acorn woodpeckers *(Melanerpes formicivorus)* for storage trees (Wilson and others 1990).

Open Stands on Moderate Slopes

In this portion of its range, blue oak is poorly represented on slopes of 30 percent or greater with high solar insolation. The blue oak/Chile lotus-purple needlegrass (Avenales region), blue oak/blue larkspur-California phacelia (Miranda Pine Mountain region) and blue oak/wand buckwheat/Chile lotus-California plantain (Branch Mountain region) communities occupy this setting in the study area. In ungrazed grasslands two high constancy species in these communities, purple needlegrass and Chile lotus, occupied only the driest end of the moisture gradient on sandstone (McNaughton 1968). That finding agrees with the distribution of those species observed in this study. Purple needlegrass, however, also tends to occupy sites where annual cover is reduced by fire, grazing or disturbance (Bartolome and Gemmill 1981). Other species with relatively high constancies in these communities that also are associated with heavy grazing include these: red brome *(Bromus rubens)* (Rosiere 1987), rattlesnake weed *(Daucus pusillus)* (Heady and Pitt 1979), and smooth cat's ear (Bentley and Talbot 1951). Even though they occupy steeper slopes, these high insolation communities produce forage earlier in the growing season than do dense stands in low insolation settings (Chiariello 1989), and may be heavily grazed.

Dense Stands

The most prevalent woodland and forest communities in each region are blue oak/wart spurge-goldenback fern (Avenales region), blue oak/bajada lupine-tree clover (Miranda Pine Mountain region) and blue oak/blue-eyed Mary-rigiopappus (Branch Mountain region). These communities cover moderate, north-facing concave slopes. Vegetation, however, is quite different among the three communities *(fig. 25)*. All three have relatively high densities of smaller trees (2-6 in. d.b.h.) and are the equivalent of White's (1966a) "dense stand" type (>300 trees/acre, north-facing slopes). Griffin (1977) described two extremely dense stands of this type with 425 and 538 trees per acre. The abundance of small-diameter trees easily places these communities in the Blue oak/Understory oak/Grass subseries (Allen-Diaz and Holzman 1991), which occurs in the Coast Ranges and Sierra Nevada. In oak woodlands on similar sites (north-facing slopes, >30 pct slope) within a similar elevational range (1000-3000 ft) in the southern Sierra Nevada, densities of blue oak were extremely low (4 trees/acre) (Frost and McDougald 1989). Densities of blue oak were highest on south-facing slopes, in sharp contrast to the study reported here.

Dense blue oak stands in Mendocino County harbor few cavity-nesting birds, in part because of the small numbers of trees 20 inches d.b.h. or larger (Wilson and others 1990). On the other hand, high-density stands provide habitat for less abundant species such as pygmy owl *(Glaucidium gnoma)*, brown creeper *(Certhia familiaris)*, barn owl *(Tyto alba)*, and turkey *(Meleagris gallopavo)*.

Upper Elevations

Of the two upper elevation communities, blue oak/hillside gooseberry ripgut brome (Branch Mountain region) is found on sites with lower solar insolation and at a higher average elevation than blue oak/phlox-leaved bedstraw-bajada lupine community (Avenales region). The reason is perhaps because the blue oak/hillside gooseberry ripgut brome community is located farther inland where precipitation is lower. Although they differ in vegetation, these upper elevation communities share many stand structure characteristics: both have high basal areas, volumes, and PAI. Although tree density is somewhat lower in the blue oak/hillside gooseberry ripgut brome community than in blue oak/phlox-leaved bedstraw-bajada lupine community, trees in the less dense community are taller, especially in the tall-tree layer *(table 10)*. In the Miranda Pine Mountain region, chaparral replaces an upper elevation north-slope blue oak community.

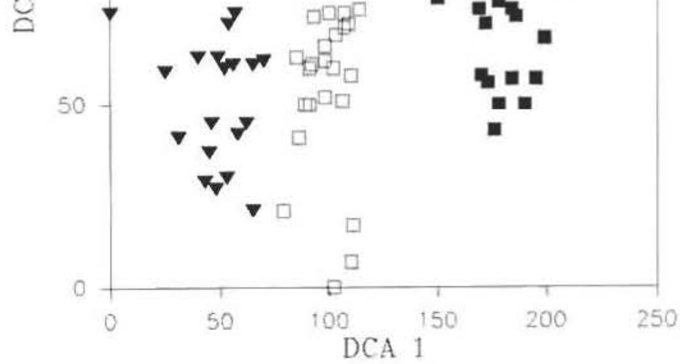

Figure 25—Detrended correspondence analysis ordination shows the forest/woodland communities with low solar insolation on slopes of 30-55 percent: blue oak/goldenback fern-wart spurge (QUDO/EUSP-PITR) from the Avenales region; blue oak/bajada lupine-tree clover (QUDO/LUCO2-TRCI) from the Miranda Pine Mountain region; and blue oak/blue-eyed Mary-rigiopappus (QUDO/COSP-RILE) from the Branch Mountain region.

Steep Slopes

Two other ecologically similar communities are blue oak-interior live oak/mission star (Miranda Pine Mountain region) and blue oak/mountain mahogany/bowlesia-woodland star (Branch Mountain region). Both occupy steep environments with low solar insolation, and both are rare in the landscape. Species richness and shrub cover in these communities are high; but they differ markedly in vegetation from each other, and from communities in their respective regions. The distinctive composition of these communities may be a consequence of two factors: light grazing on these steep slopes and the mesic environmental setting. Stand structure of the two communities also differs. Compared with blue oak/mountain mahogany/bowlesia-woodland star community, the blue oak-interior live oak/mission star community has a much higher tree density, and as a consequence, a much lower basal area and d.b.h. diversity index.

Regeneration

A study on the Hastings Reservation provided the first quantitative data to suggest that blue oak was not producing enough recruits to maintain stand numbers. White (1966a) based this conclusion on the unusually low numbers of seedlings and saplings, and on the fact that smaller d.b.h. trees (4-12 in.) were quite old (70-90 yr). Since White's study, others (Bolsinger 1988, Muick and Bartolome 1987) have used size-class distributions to assess blue oak regeneration locally and Statewide. The use of stand size-class structure alone has been criticized, however, as presenting only a partial picture of blue oak regeneration (McClaran 1986, McClaran and Bartolome 1990). Understanding mortality and reproduction—the production of seed and seedlings—is equally important (Bartolome and others 1987).

Harvey (1989) examined historic recruitment of four stands in the study area by analyzing stand-age structure in conjunction with empirical seedling and sapling mortality curves. In the Avenales region, recruitment of individuals into two stands, one each in the blue oak/wart spurge-goldenback fern and blue oak/foxtail grass—Johnny-jump-up communities, had not occurred since 1940. In the Miranda Pine Mountain region, recruitment of seedlings had taken place in a dense stand of blue oak/bajada lupine-tree clover but not in an open-ridge stand of the same community.

Production of small trees—in this case trees that are 1 inch or less at breast height—can be used as an indicator of recruitment from the sapling to small-tree stage (Bartolome and Muick 1987). The vast majority of saplings in the study reported here had not reached breast height (5 ft). Instead, they ranged from multistemmed plants of more than 4 inches high to shrubby plants less than 4 feet high, many with basal stem diameters greater than 1 inch (*fig. 26*). Age of individuals in this height class varied from less than 5 to 100 years (Harvey 1989).

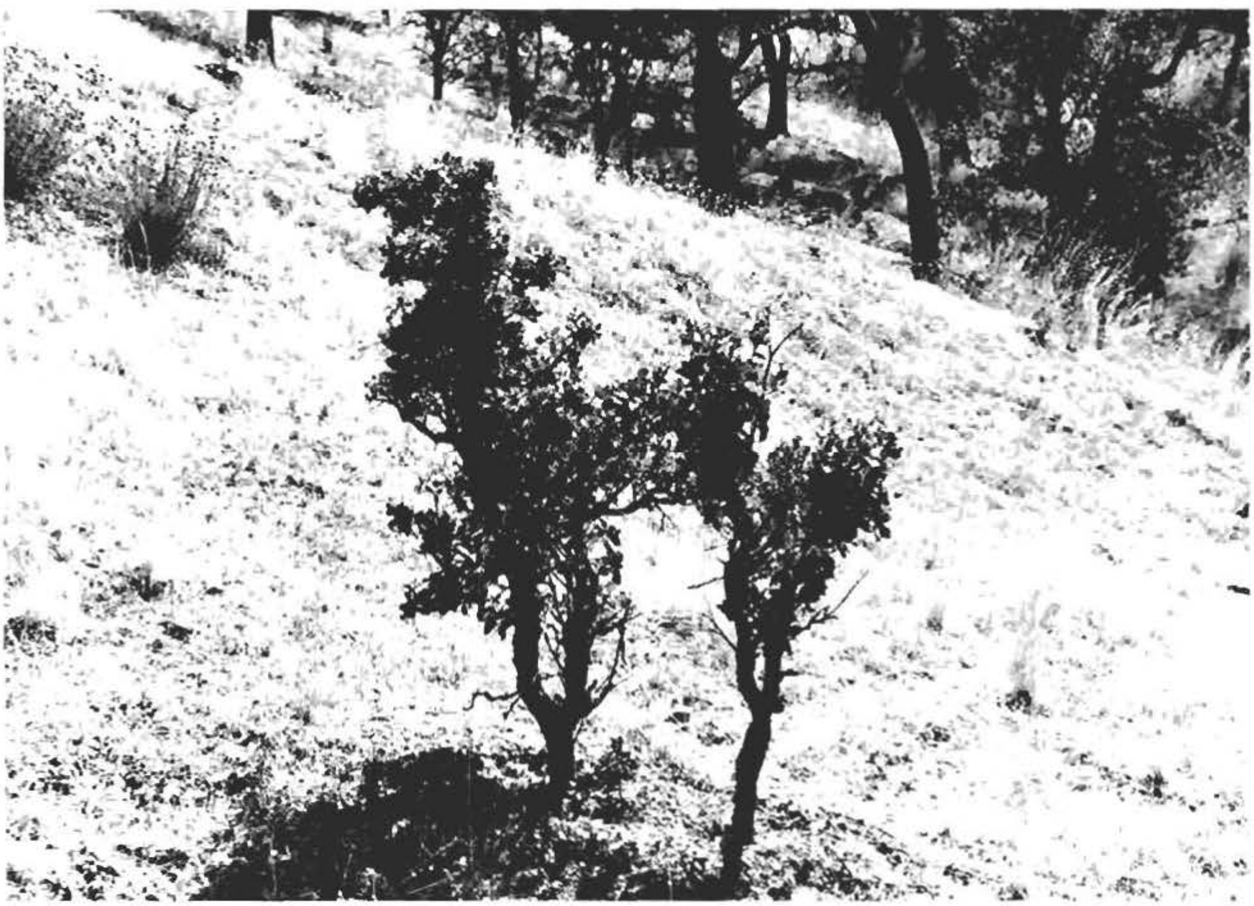

Figure 26—Hedged blue oak saplings have yet to reach breast height.

A mortality estimate of 2 percent per year in the tree class (Bolsinger 1988) clearly shows a shortfall of recruitment in the Avenales region *(table 14)*. Although we do not know the rate at which individuals reach d.b.h., field observations suggest that it is well below expected tree losses in each region. Thus, small-tree recruitment apparently is inadequate to replace tree mortality in the study area, and, given this constant rate over time, numbers of blue oak will slowly decline.

Snags and Downed Logs

Sample sizes of snags and logs were too small for us to examine differences among plant communities. Even at the regional level, sample sizes are small *(table 15)*, but a regional overview is still possible.

In general, small and large snags occur at low densities in the study area. Given the abundance of trees 8 inches or less d.b.h. in all the stands, the density of small snags seems unusually low, suggesting either that mortality is low in this size class or that small-diameter dead trees deteriorate more rapidly than large snags. Of the two classes, large snags are probably most important to wildlife species. Acorn woodpeckers, for example, select blue oak snags that average 25.6 inches d.b.h. and 53.8 feet high for acorn storage (McRoberts and McRoberts 1976).

Compared with snags, large and small downed logs are more abundant *(table 15)*. Logs are generated from two sources: (a) individual branches on living oaks that die and fall to the ground, and (b) trunks and branches of dead trees. Extensive herpetological field observations and collections in the study area indicate that many reptiles and at least two amphibians depend heavily on downed woody material, especially large logs and stumps, in blue oak (Sam Sweet, University of California, Santa Barbara; *table 16*). Indeed, 60 percent of the captures of small ground-dwelling vertebrates in blue oak were reptiles (Block and others 1988). Since large-diameter trees that become large logs are differentially distributed among the plant communities, future surveys of small vertebrates may show that these animals are also unequally distributed among the types.

Table 14*—Numbers of trees, saplings, and expected tree losses by region*

Region	Trees [1]	Saplings [2]	Yearly expected tree losses [3]
Avenales	1607	0	3.2
Miranda Pine Mountain	1156	27	2.3
Branch Mountain	1519	28	3.0

[1]Trees are greater than 1 inch in d.b.h.

[2]Saplings are individuals 1 inch or less in d.b.h.

[3]Yearly expected tree losses are estimated at 2 percent per year (Bolsinger 1988).

Table 15*—Densities of snags and downed logs for the three regions*

Snags and logs	Avenales	Miranda Pine Mountain	Branch Mountain
Snags ≤8 in. d.b.h.			
Sample size	8	8	8
Average d.b.h. (inches)	5.7	4.1	3.8
Average height (feet)	11.7	11.0	11.0
Density (number/acre)	1.0	1.5	1.0
Snags >8 in. d.b.h.			
Sample size	6	2	10
Average d.b.h. (inches)	26.0	19.0	19.8
Average height (feet)	19.3	17.0	20.7
Density (number/acre)	0.8	0.4	1.3
Small downed logs, bottom diameter 3-8 in., length ≥3 ft			
Sample size	—	13	11
Average diameter (inches)	—	6.4	6.7
Average length (feet)	—	10.8	9.8
Density (number/acre)	—	2.5	1.4
Large downed logs, bottom diameter >8 in., length ≥3 ft			
Sample size	—	4	11
Average diameter (inches)	—	11.7	16.0
Average length (feet)	—	15.7	14.0
Density (number/acre)	—	0.8	1.4

***Table 16**—Use of microhabitat by amphibians and reptiles in the study area*

Species	Microhabitat[1]					
	Live trees	Snags	Hollow stumps	Small downed woody material[2]	Large downed woody material[3]	Abundance[4]
Salamanders						
Arboreal salamander *(Aneides lugubris)*	f	fr*tc	ftc	(fc)	f*tc*	3
California slender salamander *(Batrachoseps nigriventris)*	—	—	(ftc)	f*t*c*	f*c*t*r*	60
Eschscholtz's salamander *(Ensatina eschscholtzi)*	—	—	ftc	ftc	f*c*t*r*	15
Lizards						
California legless lizard *(Anniella pulchra)*	—	—	ftcg*	f*tc(g)	f*t*c*g*	40
Western whiptail *(Cnemidophorus tigris)*	—	—	(fc)	(f)	fc	3
Gilbert's skink *(Eumeces gilberti)*	—	(f)	f*t*c*g	fc	f*t*c* g*	10
Western skink *(E. skiltonianus)*	—	—	ftcg*r	ftc	f*t*c*g*r*	30
Foothill alligator lizard *(Gerrhonotus multicarinatus)*	(f)	f	f*tcg	ftc*g	f*t*c*g*r*	20
Western fence lizard *(Sceloporus occidentalis)*	f*t*(c)	ftcg	f*t*cg*	(ftr)	f*t*c*g*	150
Side-blotched lizard *(Uta stansburiana)*	—	(ft)	ftcg	(ftc)	ftc*g	10
Snakes						
Racer *(Coluber constrictor)*	—	—	ftc*g*r	ft(c)	ftc*g*r*	5
Western rattlesnake *(Crotalus viridis)*	—	—	f*t*c*g*r*	(fc)	f*t*c*g*r*	10
Eastern ring-necked snake *(Diadophis punctatus)*	—	—	ftc*g*r	f*tc*(g)	f*t*c*g*r*	12
Spotted night snake *(Hypsiglena torquata)*	—	—	f*t*c*g*r	ftc	f*t*c*g*(r)	3
Common king snake *(Lampropeltis getulus)*	(f)	—	f*tc*g*r*	(fc)	f*t*c*g*r*	2
California striped racer *(Masticophis lateralis)*	f	—	ftc*g*(r)	f	f*t*c*g*r	5
Gopher snake *(Pituophis melanoleucus)*	(f)	(f)	f*t*c*g*r*	f(c)	f*t*c*g*(r)	5

[1]Categories of use are as follows:
- f—foraging
- g—thermal refugium
- r—reproduction
- t—territories
- c—cover

Use ratings from most to least important are as follows: f*, f, (f).
[2]Less than or equal to 3 in. d.b.h. and less than or equal to 3 ft long.
[3]Greater than 3 in. d.b.h. and greater than 3 ft long.
[4]Number of individuals an experienced collector could find in 3 hr, in 5 acres, under good weather conditions.

Appendix—Keys to Plant Communities

Because plant identification is possible for just 3 months of the year, the keys use slope, elevation, and solar insolation, which are highly correlated with the vegetation (Borchert and others 1991). Nevertheless, the final choice of a plant community should be based on the supplementary information contained in the community descriptions and accompanying tables. Also, because the keys are based on samples taken within the study area, their utility in other parts of the range of blue oak are unknown.

The presence of a species in the name of a plant community does not imply that the species occurs only in that community, or even that it is present in all its stands. Instead, a species is included in a name if it has a high constancy or cover in one community relative to the others. For example, in the Avenales region, Chile lotus *(Lotus subpinnatus)* is present in all four communities, but its constancy and cover are particularly high in the Blue Oak/Chile Lotus-Purple Needlegrass community *(table 4)*.

Scientific names conform to Kartesz and Kartesz (1980), but species were identified using Hoover (1970). Recent taxonomic changes in Hickman (1993) are given in *appendix D*. Species codes are from Reed and others (1963), and common names are from Abrams (1975) and McAuley (1985).

The steps in using these keys are as follows:

1. Select an area of about 0.1 acre with uniform slope and aspect. Oak overstory cover should be at least 20 percent. The plot should be representative of a larger area.
2. Be able to recognize the diagnostic species used in the key and estimate their foliar cover. Remember, 1 percent foliar cover is equivalent to 44 square feet.
3. A compass, clinometer, and altimeter or topographic map are essential for using the key. Slope and aspect can be coverted to solar insolation using *table 17*.
4. Work carefully through the plant community key to a preliminary identification.
5. Read the description of the plant community to verify your identification.

***Table 17**—Values of potential annual solar insolation (kilogram calories/0.15 in^2/year) for 34° latitude*

Aspect	Slope							
	0	10	20	30	40	50	60	70
N.	272	254	236	216	196	176	158	143
NNE.(W.)	272	256	238	220	202	185	168	153
NE.(W.)	272	259	246	233	219	207	195	184
E.(W.)	272	271	270	268	265	262	259	256
ENE.(WNW.)	272	265	258	250	242	235	228	221
ESE.(WSW.)	272	277	281	284	286	286	285	284
SE.(SW.)	272	282	290	297	301	303	304	303
SSE.(SSW.)	272	285	296	304	310	313	314	314
S.	272	286	298	307	313	316	318	317

Source: Frank and Lee (1966)

A. Avenales Region

1 Occurs at elevations below 2200 feet.

2 Occurs on slopes equal to or less than 30 percent. Foxtail grass *(Hordeum leporinum)* is almost always present. Spanish grass *(Bromus madritensis)* and fleabane aster *(Erigeron foliosus)* are rarely present. **Blue oak/foxtail grass—Johnny-jump-up community**.

2 Occurs on slopes greater than 30 percent. Foxtail grass sometimes is present. Spanish grass and fleabane aster are usually present.

3 Solar insolation is greater than 260 *(table 17)*. Purple needlegrass *(Stipa pulchra)* is present. Either windmill pink *(Silene gallica)* or filaree *(Erodium brachycarpum)* are present together or individually. Goldenback fern *(Pitryogramma triangularis)* and wart spurge *(Euphorbia spathulata)* are occasionally present. **Blue oak/Chile lotus-purple needlegrass community**.

3 Solar insolation is equal to or less than 260. Purple needlegrass, windmill pink, and filaree are rarely present. Wart spurge is always present, and goldenback fern is nearly always present. **Blue oak/wart spurge-goldenback fern community**.

1 Occurs at elevations above 2200 feet 4

4 Occurs on slopes of less than or equal to 30 percent. Phlox-leaved bedstraw is absent. Whisker linanthus is rarely present. Foxtail grass is almost always present. **Blue oak/foxtail grass—Johnny-jump-up community.**

4 Occurs on slopes greater than 30 percent. Phlox-leaved bedstraw *(Galium andrewsii)* is present, and whisker linanthus *(Linanthus ciliatus)* is frequently present. Foxtail grass is rarely present. **Blue oak/phlox-leaved bedstraw-bajada lupine community**.

B. Miranda Pine Mountain Region

1 Occurs on slopes equal to or less than 30 percent. Foxtail grass is always present; white-stemmed filaree *(Erodium moschatum)* and filaree *(Erodium brachycarpum)* are almost always present individually or together. **Blue oak/white-stemmed filaree-foxtail grass community**.

1 Occurs on slopes greater than 30 percent. Foxtail grass is often present, white-stemmed filaree and filaree are sometimes present 2

2 Occurs on north- to northwest-facing slopes greater than 60 percent. Mission star *(Lithophragma cymbalaria)* and Chinese houses *(Collinsia heterophylla)* are always present. Interior live oak *(Quercus wislizenii)* is frequently present. **Blue oak-interior live oak/mission star community**.

2 Occurs on a variety of aspects; slopes vary from 30 to 60 percent. Mission star is absent. Interior live oak and Chinese houses are rarely present 3

3 Occurs on northwest- to east-facing slopes. Gum weed *(Madia gracilis)*, bajada lupine *(Lupinus concinnus)*, and redberry *(Rhamnus crocea)* are frequently present. California phacelia *(Phacelia imbricata)* and blue larkspur *(Delphinium parryi)* are absent. **Blue oak/bajada lupine-tree clover community**.

3 Occurs on west- to south-facing slopes. Gum weed, bajada lupine, and redberry are absent. California phacelia and blue larkspur are present. **Blue oak/blue larkspur-California phacelia community**.

C. Branch Mountain Region

1 Occurs at elevations below 2900 feet.

2 Occurs on slopes equal to or less than 30 percent. Rusty popcorn flower *(Plagiobothrys nothofulvus)* is usually present. **Blue oak/common fiddleneck-rusty popcorn flower community**.

2 Occurs on slopes greater than 30 percent. Rusty popcorn flower is occasionally present.

3 Solar insolation is greater than 240 *(table 17)*. Many-stemmed gilia *(Gilia clivorum)* is always present. Narrow-leaved orthocarpus *(Orthocarpus attenuatus)*, California plantain *(Plantago erecta)*, and purple needlegrass *(Stipa pulchra)* are usually present. Slender phlox *(Microsteris gracilis)* is occasionally present. **Blue oak/wand buckwheat/Chile lotus-California plantain community**.

3 Solar insolation is equal to or less than 240. Many-stemmed gilia, narrow-leaved orthocarpus, California plantain, wand buckwheat, and purple needlegrass are rarely present. Slender phlox is usually present 4

4 Occurs at elevations below 2150 feet on slopes greater than 55 percent. Solar insolation is equal to or less than 180. Bowlesia *(Bowlesia incana)*, elegant clarkia *(Clarkia unguiculata)*, common blue cup *(Githopsis specularioides)*, small-rayed baeria *(Lasthenia microglossa)*, and woodland star *(Lithophragma affine)* are always present. Slender oat *(Avena barbata)*, dove lupine *(Lupinus bicolor)*, and few-flowered clover *(Trifolium oliganthum)* are absent. **Blue oak/mountain mahagony/bowlesia-woodland star community**.

4 Occurs at elevations between 2150 and 2900 feet on slopes of less than 55 percent. Solar insolation is greater than 180. Bowlesia, elegant clarkia, common blue cup, small-rayed baeria, and woodland star are rare or absent. Slender oat, dove lupine, and few-flowered clover are usually present. **Blue oak/blue-eyed Mary-rigiopappus community**.

1 Occurs at elevations above 2900 feet. **Blue oak/hillside gooseberry/ripgut brome community**.

D. Recent Changes in Taxonomic Names

At the time this report went to press, a new manual to the higher plants of California (Hickman 1993) was published, but it was too late to incorporate taxonomic changes into the text of this report. The following is a list of species names that have been revised in the manual.

Species in this report	Corresponding names in the new manual
Shrubs	
Corethrogyne filaginifolia	*Lessingia filaginifolia*
Haplopappus linnearifolia	*Ericameria laricifolia*
Herbs and grasses	
Alchemilla arvensis	*Aphanes occidentales*
Amsinckia intermedia	*Amsinckia menziesii*
Arenaria douglasii	*Minuartia douglasii*
Bromus mollis	*Bromus hordeaceus*
Bromus rubens	*Bromus madritensis*
Cirsium californicum	*Cirsium occidentale*
Cirsium proteanum	*Cirsium occidentale*
Crassula erecta	*Crassula connata*
Dichelostemma pulchellum	*Dichelostemma capitatum*
Galium nuttalii	*Galium porregens*
Hesperomecon linearis	*Meconella linearis*
Hordeum geniculatum	*Hordeum marinum*
Hordeum leporinum	*Hordeum murinum*
Koeleria cristata	*Koeleria macrantha*
Lotus subpinnatus	*Lotus wrangelianus*
Lupinus densiflorum	*Lupinus microcarpus*
Lupinus subvexus	*Lupinus microcarpus*
Microseris heterocarpa	*Stebbinoseris heterocarpa*
Microseris lindleyi	*Uropappus lindleyi*
Orthocarpus attenuatus	*Castilleja attenuatus*
Orthocarpus purpurascens	*Castilleja exserta*
Pityrogramma triangularis	*Pentagramma triangularis*
Poa scrabella	*Poa secunda*
Sitanion hystrix	*Elymus elymoides*
Sitanion jubatum	*Elymus multisetus*
Stipa cernua	*Nasella cernua*
Stipa lepida	*Nasella cernua*
Stipa pulchra	*Nasella pulchra*
Viola quecetorum	*Viola purpurea*

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