1949

California Plant Communities

Philip A. Munz

David D. Keck

Follow this and additional works at: <https://scholarship.claremont.edu/aliso>

Part of the [Botany Commons](#)

Recommended Citation

Munz, Philip A. and Keck, David D. (1949) "California Plant Communities," *Aliso: A Journal of Systematic and Floristic Botany*. Vol. 2: Iss. 1, Article 6.

Available at: <https://scholarship.claremont.edu/aliso/vol2/iss1/6>

CALIFORNIA PLANT COMMUNITIES

PHILIP A. MUNZ AND DAVID D. KECK*

INTRODUCTION

In order to discuss the California flora from the point of view of plant geography and distribution, it is desirable to bring its principal subdivisions into a utilitarian system of classification. Until the present time the majority of writers, in attempting to characterize the distribution of any given species, have employed the life zone concept of C. H. Merriam (1898). This concept, however, is now widely regarded to be inadequate for the purpose. A zone like the Upper Sonoran includes in California so many very definite and distinct plant communities as to be almost meaningless.

The writers are planning a manual of the plants of the state and propose to indicate for each species treated its plant community and habitat as well as its geographical and altitudinal ranges. For this purpose the life zone classification is too broad and inclusive. On the other hand, the common ecological classification into formation, association, consociation, society, etc., proves to be too elaborate and complex. The development of a suitable classification of the plant communities in California should rest upon a basis of ecological knowledge such as is not yet available for the flora of this state. Plant ecological studies have unfortunately lagged here, and, for the most part, only elementary facts are known about the ecology of the native plant communities. The present paper, accordingly, is but a pioneer statement in this direction. Its purpose is to present a classification of the vegetation that will aid in describing with some exactness the type of ecological niche in which a species belongs, where it is found, and with what other species it is associated.

In preparation of such a classification we have solicited aid and points of view from many friends and colleagues. We are especially indebted to John Thomas Howell of the California Academy of Sciences, G. Ledyard Stebbins, Jr. of the University of California, Jens Clausen and William M. Hiesey of the Carnegie Institution of Washington, Carl W. Sharsmith of Palo Alto, and to the members of the Biosystematists, a group of biologists of the San Francisco Bay region, for specific help given.

California is not only a large state but one of tremendous climatic and topographic diversity, with extreme differences in precipitation, temperature, drainage, and other pertinent factors. These extremes vary from lofty peaks to valley floors, from Sierran areas that have the greatest snowfall in the United States and those with active glaciers to the most arid and hottest desert areas, and from mild coastal climates to strongly continental ones. The vegetation responds in kind with all gradations from the gloomy luxuriance of the coast redwood forest to the glaring desolation of the extreme deserts.

*Carnegie Institution of Washington, Stanford, California.

For the most part, the diversity in California is duplicated elsewhere only over much wider areas, being comparable in extent to that found over the entire western half of Europe, or along the whole Atlantic seaboard of the United States, or throughout all the plains states from North Dakota to Michigan and Texas. Accordingly, it is natural that the corresponding diversity in California vegetation can better and more usefully be expressed for the purposes of a plant manual in a more refined classification than the customary life-zone concept affords.

California may be divided naturally into a few major biotic provinces, as determined by broad differences in climate. Its vegetation, in turn, is observed to be classifiable structurally in terms of vegetation types (forest, scrub, grassland, etc.), on the one hand, and floristically in terms of communities (on the basis of the presence of dominant species that give character to the flora), on the other. Since biotic provinces, vegetation types, and communities as here defined are all principally products of the climatic factors of the environment, their inclusion in one system of classification is reasonable.

BIOTIC PROVINCES

In a discussion of the California flora, it is worth considering the *biotic provinces* present in the state, since they reveal to some extent the relationship of the flora of one area to that of others both within and without the state. Dice (1943) says that a *biotic province* "covers a considerable and continuous geographic area and is characterized by the occurrence of one or more important ecological associations that differ, at least in proportional area covered, from the associations of adjacent provinces. In general, biotic provinces are characterized also by peculiarities of vegetation type, ecological climax, flora, fauna, climate, physiography, and soil." Such biotic provinces are the result of the interaction of past and present forces, those of the geological history as well as present climatic and edaphic influences. Each such province includes several vegetation types and plant communities.

Dice presents a series of such provinces for North America with five occurring in California: (1) *Oregonian*, the cool wet northwest portion of the state as far south as San Francisco Bay and for the most part heavily forested; (2) *Artemisian*, the sagebrush-covered northeastern counties of California; (3) *Californian*, most of California except for the two preceding provinces and the desert portions; (4) *Mohavian*, including the Mohave Desert and the Death Valley region; and (5) *Sonoran*, the Colorado Desert.

An earlier classification by Van Dyke (1919), based primarily on the study of insects, distinguished between two general groups of provinces: those with organisms of northern origin and those of southern origin. The former was divided into: (1) *Vancouverian* which included the *Pacific Maritime*, comparable to Dice's "Oregonian," and *Sierran*, largely the yellow pine belt; (2) *Canadian*, the fir zone; (3) *Hudsonian*, the forested zone above the red fir; and (4) *Arctic*, on the highest peaks. The provinces with organisms of southern origin were: (5) *Sonoran*, the deserts of southeastern California; (6) *Great Basin*, a derivative of the preceding and comparable to Dice's "Artemisian"; and (7) *Californian*, including southern California west of the mountains, then along

the coast to San Francisco, the South Coast Ranges, and most of the interior to Shasta County. Dice's "Californian" is more inclusive, since it contains also the montane belt of the Sierra Nevada.

Neither of these two systems is completely satisfactory for our purpose and we propose to recognize for California the following five *biotic provinces*:

(A) **Oregonian**, the "Vancouverian" proper of Van Dyke. We accept the name "Oregonian" since it has priority, having been proposed in 1859 by J. G. Cooper, since it is better known than Van Dyke's name, and since this province differs considerably between California, on the one hand, and Vancouver Island, whence it drew its name, on the other. It applies to the cool moist coastal strip extending southward to San Francisco Bay and with small elements in Monterey County. It is pretty much the same as the "Redwood Transition Zone" of Jepson (1925) and is the southern limit for many species of north coastal distribution.

(B) **Californian**, those portions of California west of the Sierra Nevada and the southern mountains, thus including the interior valleys and their surrounding hills in the central and northern parts of the state, as well as the southern coastal area and Coast Ranges south of San Francisco Bay. It reaches its southern limit in northern Baja California. There is much endemism, considerable Mexican influence, and a marked similarity in some genera and species to the temperate parts of Chile and Peru. There is much diversity in climate, but the rains are almost entirely in the winter, with a very long dry summer season.

(C) **Sierran**, the great montane area which runs interruptedly from southern Oregon through Mount Shasta, the Sierra Nevada, Tehachapi Mountains, San Gabriel, San Bernardino, San Jacinto and Cuyamaca ranges to the San Pedro Martir of Baja California. It begins with the yellow pine belt and extends to the summits of the mountains. In its lower and middle elevations there is a large floral element derived from the surrounding lowlands. There is also much endemism. Only at the higher altitudes are found the widespread boreal species that occur with greater frequency in other ranges like the Cascades and the Rocky Mountains. This is a region of winter snow and some summer rain.

(D) **Nevadan**, largely the "Great Basin" of Van Dyke and the "Artemisian" of Dice, occurring east of the Cascade-Sierran axis from Owens Valley northward. Some elements get into Siskiyou County. The lower plains are covered with *Artemisia tridentata*, but there are interrupted mountain ranges with some forest and woodland. Historically the general affinity is to the east and south. The winters are cold, the summers hot. Precipitation is relatively light, mostly coming as winter snow.

(E) **Southern Desert**, called "Sonoran" by Van Dyke, "Sonoran" and "Mohavian" by Dice, and "Mojave Desert" and "Sonoran Desert" by Shreve (1942a). Since the term "Sonoran" has had so different a meaning in the Merriam system of life zones, we are not employing it here. And, while we recognize the fact that the Mohave and Colorado deserts are very different in many respects, we are considering the two together, since the Creosote Bush Scrub occupies the largest single area in both. There is decided affinity with

the flora to the southeast. The deserts are known not only for their dryness, but also for the diurnal and seasonal temperature extremes.

VEGETATION TYPES

The vegetation of an area can be and almost automatically is thought of in terms of physiognomy, or the structural units into which it can be divided. The major *vegetation types* are fairly obvious, such as grassland, chaparral, woodland, coniferous forest, marsh, scrub, and the like. Such types are often referred to as "plant formations" or "climax formations," each of which is the "product of the complex of climatic factors effective in a region" (Oosting, 1948). We propose for California the following major *vegetation types*: I, Coastal Strand; II, Coastal Salt Marsh; III, Freshwater Marsh; IV, Coastal Scrub; V, Coastal Coniferous Forest; VI, Mixed Evergreen Forest; VII, Woodland-Savanna; VIII, Chaparral; IX, Valley Grassland; X, Montane Coniferous Forest; XI, Alpine Fell-fields; XII, Desert Woodland; XIII, Desert Scrub; and XIV, Alkali Sink. For the most part these have names that are self-explanatory, but any others will be made plain by the discussion under "Communities."

These *vegetation types*, such as grassland, are not necessarily uniform. The grasslands of the Great Plains east of the Rocky Mountains, for instance, with winter snow but maximum precipitation in summer, are very different from the grasslands of California, which receive all their precipitation in winter and in the form of rain. The grasslands of southeastern Washington, with major precipitation in winter but some in summer too, and with cooler year-round temperatures, differ from either. In each of these three areas the climatic conditions favor a grassland climax, but as they are not alike, the constituent species of grasses and other herbs also differ in the three areas. It is to such different phases of the vegetation type that the name "plant community" is applied in this paper.

PLANT COMMUNITIES

Oosting (1948) defines a *community* as "an aggregation of living organisms having mutual relationships among themselves and to their environment." Such a term can be more or less inclusive and agrees with the action of the Third International Botanical Congress at Brussels in 1910 (Shelford, 1932) in adopting the word community "to cover ecological units of every degree." We are using the term *plant community* for each regional element of the vegetation that is characterized by the presence of certain dominant species. In other words, the community is floristically determined. A vegetation type may consist of one to several communities.

The great majority of California plant communities have a climatic rather than a purely edaphic basis. Most of these can readily be divided into fairly distinct smaller groups. Take, for example, the Yellow Pine Forest. It is not at all a uniform community, but contains the plants of wet meadow, lake shore and stream bank, rocky outcrops, as well as open and pine-covered benches and slopes. In this paper such minor subdivisions are not named. The few communities that have an edaphic basis include the strand, marsh,

and saline groups. In these cases the vegetation type and community are commensurate.

In a state with the diversified topography of California and its exceedingly complex distribution of climates, the communities naturally must often be geographically discontinuous, with parts of one occurring as islands within another. A north-facing slope, for example, may be very different from one facing south; the former may have oak-woodland, the latter, chaparral. Thus a community may be much dissected, especially near its margins, and may dovetail in between adjacent communities so that lines of contact are irregular and transitional areas numerous and at times even rather extensive. The situation in some places is so complex as to be very difficult of interpretation and different observers may not agree as to treatment.

The present classification is an essentially practical one and defines twenty-four communities within the fourteen vegetation types and five biotic provinces (see Tables I and II). The number of communities was arrived at by attempting to recognize each one that is rather easily distinguishable from the others in having a number of species more or less restricted to it, including at least a few dominants or characteristic indicator species.

TABLE I. A SYSTEM OF CLASSIFICATION FOR THE CALIFORNIA VEGETATION.

Biotic Province	Vegetation Type	Plant Community
A. <i>Oregonian</i>	I. Coastal Strand	1. Coastal Strand
	II. Coastal Salt Marsh	2. Coastal Salt Marsh
	III. Freshwater Marsh	3. Freshwater Marsh
	IV. Coastal Scrub	4. Northern Coastal Scrub
	V. Coastal Coniferous Forest....	{ 6. Closed-cone Pine Forest 7. Redwood Forest
	VI. Mixed Evergreen Forest	
B. <i>Californian</i>	I. Coastal Strand	1. Coastal Strand
	II. Coastal Salt Marsh	2. Coastal Salt Marsh
	III. Freshwater Marsh	3. Freshwater Marsh
	IV. Coastal Scrub	5. Coastal Sage Scrub
	VII. Woodland-Savanna	{ 9. Foothill Woodland 10. Southern Oak Woodland
	VIII. Chaparral	
C. <i>Sierran</i>	IX. Valley Grassland	12. Valley Grassland
	X. Montane Coniferous Forest..	{ 13. Yellow Pine Forest
		{ 14. Red Fir Forest
		{ 15. Lodgepole Forest
		{ 16. Subalpine Forest
D. <i>Nevadan</i>	XI. Alpine Fell-fields	17. Alpine Fell-fields
	XII. Desert Woodland	{ 18. Northern Juniper Woodland
		{ 19. Pinyon-Juniper Woodland
	XIII. Desert Scrub	{ 21. Sagebrush Scrub
		{ 22. Shadscale Scrub

E. <i>Southern Desert</i>	XII. Desert Woodland	{ 19. Pinyon-Juniper Woodland
		20. Joshua Tree Woodland
	XIII. Desert Scrub	{ 22. Shadscale Scrub
		23. Creosote Bush Scrub
	XIV. Alkali Sink	24. Alkali Sink

TABLE II. MAJOR VEGETATION TYPES AND PLANT COMMUNITIES OF CALIFORNIA

Vegetation Type	Plant Community
I. Coastal Strand	1. Coastal Strand
II. Coastal Salt Marsh	2. Coastal Salt Marsh
III. Freshwater Marsh	3. Freshwater Marsh
IV. Coastal Scrub	{ 4. Northern Coastal Scrub
	5. Coastal Sage Scrub
V. Coastal Coniferous Forest	{ 6. Closed-cone Pine Forest
	7. Redwood Forest
VI. Mixed Evergreen Forest	8. Mixed Evergreen Forest
VII. Woodland-Savanna	{ 9. Foothill Woodland
	10. Southern Oak Woodland
VIII. Chaparral	11. Chaparral
IX. Valley Grassland	12. Valley Grassland
	{ 13. Yellow Pine Forest
X. Montane Coniferous Forest	14. Red Fir Forest
	15. Lodgepole Forest
	16. Subalpine Forest
XI. Alpine Fell-fields	17. Alpine Fell-fields
	{ 18. Northern Juniper Woodland
XII. Desert Woodland	19. Pinyon-Juniper Woodland
	20. Joshua Tree Woodland
XIII. Desert Scrub	21. Sagebrush Scrub
	22. Shadscale Scrub
	23. Creosote Bush Scrub
XIV. Alkali Sink	24. Alkali Sink

Many species of widespread distribution occupy a number of climatic zones and have correspondingly a number of climatic races or ecotypes, each fitting into its own environmental niche. In the classification herewith proposed, it is hoped that pointing out the various communities in which the species occur will give some indication of the number of ecotypes to be expected. The fact that one species may be restricted to a single community and another may occupy several, in which quite different conditions exist, should be suggestive as to ecotypic constitution and as to where various ecotypes may be sought, if they do occur.

Plates XIV-XVII represent an attempt to present pictorially by means of graphs some of the principal differences in climate between representative plant communities as shown by records of temperature, precipitation, and

length of growing season. These graphs sample the principal climates found in California excepting that of the Alpine Fell-fields. They show the mean maximum and mean minimum temperatures by months, the average length of growing season, the average annual precipitation, and the average snow-fall, if any. The data employed were obtained from the "Climatic Summary of the United States" issued by the United States Weather Bureau in 1930. The mean maximum temperature curve is derived from the average of the highest daily temperatures of a given month over a period of usually many years. Similarly, the mean minimum temperature curve is derived from the average of the lowest daily temperatures. The amount of separation between the two curves is a measure of the average diurnal variation in temperature of a given station. In Plate XV for the purposes of illustration curves are added for the highest and lowest recorded temperatures, respectively, for each month at Fresno, but these figures are not repeated elsewhere, as the average maxima and minima are thought to be of greater significance in the delimitation of plant communities. The growing season is determined by the average number of days between the last killing frost in spring and the first killing frost in fall. The progression from the equitable coast climate at Point Reyes, with its slight seasonal and diurnal variations in temperature, to the much more variable continental climate of the desert at the other end of the series is indeed striking.

The most significant indicator species of the various communities are those most closely restricted in their ecological requirements—that is, those species of only one or very few ecotypes. Tree indicators, when present, are stressed above the herbs because they have more effect on the microhabitat or microclimate, and they are more widely known and more readily identified. In the following classification there are presented for each community a list of characteristic species, a statement as to distribution and type of area covered, pertinent climatic data, and a brief word as to the general appearance of the vegetation.

1. Coastal Strand

Plate XIV

Artemisia pycnocephala, *Franseria bipinnatifida*, *F. Chamissonis*, *Lathyrus littoralis*, *Lupinus arboreus*, *L. Chamissonis*, *Abronia maritima*, *A. umbellata*, *Oenothera cheiranthifolia*, *Atriplex leucophylla*, *Fragaria chiloensis*, *Poa Douglasii*, *Haplopappus ericoides*, *Mesembryanthemum nodiflorum*, *M. crystallinum*, *Convolvulus Soldanella*.

Sandy beaches and dunes scattered along the entire coast.

Annual rainfall 15 to 70 inches, with much fog and wind; growing season 12 months, with 350 to 365 frost-free days; small seasonal and diurnal fluctuations in temperature; mean summer maxima 61°-72°, mean winter minima 39°-47° F.

Vegetation low or prostrate, often succulent, late flowering. The constitution of this community varies considerably from north to south, some species reaching their southern limit at Cape Mendocino, some at Monterey Peninsula, and some at Point Conception. A number of others,

Plate XIV. Graphs presenting data on climates for four stations in the Coast Ranges, Oregonian and Californian provinces.

however, show the continuity of the community by extending the entire length of the state and beyond.

The data for Point Reyes (Plate XIV) are equally typical of Coastal Strand and Northern Coastal Scrub.

2. Coastal Salt Marsh

Salicornia virginica, *S. subterminalis*, *Suaeda californica* and var. *pubescens*, *Distichlis spicata*, *Spartina leiantha*, *Limonium californicum*, *Frankenia grandifolia*, *Triglochin maritima*.

Salt marshes along the coast, from sea level to 10 feet.

Average rainfall 15 to 40 inches; growing season 12 months, with 330 to 365 frost-free days; small seasonal and diurnal fluctuations in temperature; temperature range about as in Coastal Strand.

Most extensive on tidelands.

3. Freshwater Marsh

Scirpus Olneyi, *S. validus*, *S. acutus*, *S. californicus*, *Typha latifolia*, *T. domingensis* (*T. angustifolia*), *Eleocharis palustris*, *Carex senta*, *C. obnupta*.

Marshes of interior valleys such as near Tulare Lake, river-bottom lagoons, and near coast back of immediate salty areas, from sea level to about 500 feet.

Climatic conditions variable, but growing season long and physical conditions relatively constant.

4. Northern Coastal Scrub

Baccharis pilularis, *Mimulus aurantiacus*, *Castilleja latifolia*, *Rubus vitifolius*, *Lupinus variicolor*, *Heracleum lanatum*, *Eriophyllum staechadifolium*, *Gaultheria Shallon*, *Anaphalis margaritacea*, *Artemisia Suksdorfii*, *Erigeron glaucus*.

Narrow coastal strip from southern Oregon to San Mateo County and from Pacific Grove to Point Sur, lying between the Coastal Strand and the Redwood Forest at elevations mostly below 500 feet.

Annual rainfall 25 to 75 inches, with much fog and wind; growing season 10 to 12 months, with 300 to 350 frost-free days; little fluctuation in temperature, mean summer maxima 63°-75°, mean winter minima 35°-40° F.

Rather low plants rarely over 6 feet in height, sometimes dense, but often with extensive areas of grass (*Danthonia californica*, *Deschampsia caespitosa* ssp. *holciformis*, *Calamagrostis nutkaensis*, *Holcus lanatus*, etc.) between.

5. Coastal Sage Scrub

Artemisia californica, *Salvia apiana*, *S. mellifera*, *S. leucophylla*, *Eriogonum fasciculatum*, *Rhus integrifolia*, *Encelia californica*, *Horkelia cuneata*, *Haplopappus squarrosus*, *H. venetus*, *Eriophyllum confertiflorum*.

Usually dry rocky or gravelly slopes, South Coast Ranges to Baja California, mostly below 3,000 feet and below the Chaparral.

Annual rainfall 10 to 20 inches; growing season 8 to 12 months, with 230 to 350 frost-free days; mean summer maximum temperatures 68°-90°, mean winter minima 37°-48° F.

Plants half-shrubs, 1 to 5 feet tall or somewhat woodier and larger, forming a more open community than Chaparral.

6. Closed-cone Pine Forest

Pinus muricata, *P. contorta*, *P. radiata*, *P. remorata*, *Cupressus macrocarpa*, *C. pygmaea*, *C. Goveniana*.

Interrupted forest from Mendocino plains southward near the immediate coast to Santa Barbara County, from near sea level to 1,200 feet. Northward it is on the seaward side of the redwoods in barren soils.

Average rainfall 20 to 60 inches, much fog; growing season 9 to 12 months, with 270 to 360 frost-free days; climate cool with temperatures comparable with those in the Redwood Forest.

Trees 30 to nearly 100 feet tall, in a relatively dense forest.

7. Redwood Forest

Plate XIV

Sequoia sempervirens, *Pseudotsuga taxifolia*, *Myrica californica*, *Lithocarpus densiflora*, *Vaccinium ovatum*, *Gaultheria Shallon*, *Rhododendron californicum*, *Oxalis oregona*, *Vancouveria parviflora*, *Polystichum munitum*, *Whipplea modesta*.

Seaward slopes of outer Coast Ranges, 10 to 2,000 feet (even to 3,000 feet in Santa Lucia Mountains), from Del Norte County and adjacent Oregon to Santa Cruz County, with outliers along the coast of central Monterey County.

Average rainfall 35 to 100 inches, with dense dripping fog in dry season; growing season 6 to 12 months, with 200 to 350 frost-free days; not much change in temperature diurnally or seasonally, the mean summer maxima 68°-84°, the mean winter minima 33°-40° F. The data for Branscomb, Mendocino County (Plate XIV), which are the best obtainable to represent this community, indicate a greater seasonal and diurnal variation in temperature, a greater average precipitation, and a considerably shorter growing season than average for the Redwood Forest as a whole.

Trees very tall, even to 350 feet, in a heavy, dense forest.

8. Mixed Evergreen Forest

Plate XIV

Lithocarpus densiflora, *Arbutus Menziesii*, *Pseudotsuga taxifolia*, *Umbellularia californica*, *Acer macrophyllum*, *Castanopsis chrysophylla*, *Quercus chrysolepis*, *Q. Kelloggii*, *Q. agrifolia*, *Q. Garryana*, *Aesculus californica*, *Alnus rubra*, *Rubus spectabilis*, *Ceanothus thyrsiflorus*, *Rhododendron occidentale*.

Along inner edge of the Redwood Forest and on higher hills within, mostly in the North Coast Ranges, but as far south as the Santa Cruz Mountains and north side of the Santa Lucia Mountains, at elevations of 200 to 2,500 feet.

Average rainfall 25 to 65 inches, with some fog; growing season 7 to 11 months, with 200 to 300 frost-free days; mean summer maximum temperatures 75°–90°, mean winter minima 29°–39° F.

Trees to 100 feet tall or more, in rather close stands, often with brush beneath and with grassland islands.

9. Foothill Woodland

Plate XVI

Pinus Sabiniana, *P. Coulteri* in upper parts, *Quercus Douglasii*, *Q. chrysolepis*, *Q. agrifolia*, *Q. Wislizenii*, *Q. lobata*, *Umbellularia californica*, *Aesculus californica*, *Rhamnus californica* ssp. *tomentella*, *Ceanothus cuneatus*, *Cercis occidentalis*, *Ribes quercetorum*, *Eriodictyon californicum*.

Foothills and valley borders, 400 to 3,000 feet, fingering upward on warm slopes to 5,000 feet; Inner Coast Ranges, Trinity County to Santa Barbara County; western foothills of the Sierra Nevada, reaching southern limit in northwestern Los Angeles County.

Average rainfall 15 to 40 inches, little or no fog; growing season 6 to 10 months, with 175 to 310 frost-free days; hot dry summers, with mean maximum temperatures 75°–96°, and mean winter minima 29°–42° F.

Trees 15 to 70 feet tall, in dense or open woodland, with scattered brush and grassland between the trees. This composite community contains both the oak parklands of the valley floors and the digger pine woodland of the surrounding slopes.

10. Southern Oak Woodland

Plate XIV

Quercus agrifolia, *Q. Engelmannii*, *Juglans californica*, *Rhus integrifolia*, *R. ovata*, *R. trilobata*.

Valleys of interior southern California from Los Angeles County to San Diego County and ascending to about 5,000 feet at Vandeventer Flat in the San Jacinto Mountains.

Average rainfall 15 to 25 inches, often of torrential type with rapid runoff; growing season 7 to 10 months, with 200 to 350 frost-free days; mean summer maximum temperatures 84°–92°, mean winter minima 32°–44° F.

Trees 20 to 60 feet tall, with grassland or few soft shrubs between them.

11. Chaparral

Adenostoma fasciculatum, *Photinia arbutifolia*, *Rhamnus californica*, *R. crocea*, *Quercus dumosa*, *Cercocarpus betuloides*, *Yucca Whipplei*, *Fremontia californica*, *Prunus ilicifolia*, *Ceanothus* spp., *Arctostaphylos* spp., *Pickeringia montana*, *Trichostema lanatum*.

Dry slopes and ridges in Coast Ranges from Shasta County south, and below the Yellow Pine Forest on the western slopes of the Sierra Nevada and more southern mountains. Rocky, gravelly, or fairly heavy soils.

Average rainfall 14 to 25 inches; hot dry summers and cool but not cold winters; growing season 8 to 12 months, with 250 to 360 frost-free days; mean summer maximum temperatures 82°–94°, mean winter minima 29°–45° F.

A broad-leaved sclerophyll type of vegetation, 3 to 6 or 10 feet high and dense, often nearly impenetrable. Very subject to fire, following which many of the shrubs tend to stump-sprout.

12. Valley Grassland

Plate XV

Originally with various bunch grasses such as *Stipa pulchra*, *S. cernua*, *Poa scabrella*, and *Aristida divaricata*; now because of overgrazing largely replaced by annual species of *Bromus*, *Festuca*, *Avena*, etc.

Great Central Valley and low hot valleys of Inner Coast Ranges, such as Salinas and San Benito valleys, Antelope Valley; ascending to about 4,000 feet in Tehachapi Mountains and eastern San Diego County; along the coast from San Luis Obispo County south.

Plate XV. Graphs for data on climate in the Great Valley, Californian province.

Average rainfall 6 to 20 inches; growing season 7 to 11 months, with 205 to 325 frost-free days; mean maximum summer temperatures 88°–102°, mean winter minima 32°–38° F.

Subtropical type of open treeless grassland, with winter rain and hot dry summers; rich display of flowers in wet springs. Local habitats, such as "hog-wallows," with distinctive floras.

13. Yellow Pine Forest

Plate XVI

Pinus ponderosa, *P. Lambertiana*, *Libocedrus decurrens*, *Abies concolor*, *Pseudotsuga taxifolia*, *Quercus Kelloggii*, *Ribes nevadense*, *R. Roezlii*, *Rubus parviflorus*, *Chamaebatia foliolosa*, *Arctostaphylos patula*, *A. Mariposa*, *Ceanothus integerrimus*.

North Coast Ranges, 3,000 to 6,000 feet; northern California, 1,200 to 5,500 feet; Sierra Nevada, 2,000 to 6,500 or 7,000 feet; southern California, 5,000 to 8,000 feet.

Average precipitation 25 to 80 inches, partly as snow; growing season 4 to 7 months, with 90 to 210 frost-free days; mean summer maximum temperatures 80°–93°, mean winter minima 22°–34° F.

Trees 75 to 200 feet tall, in extensive, continuous forests.

14. Red Fir Forest

Plate XVI

Abies magnifica, *Pinus Murrayana*, *P. monticola*, *P. Jeffreyi*, *Castanopsis sempervirens*, *Ceanothus cordulatus*, *Gilia aggregata*, *Populus tremuloides*.

Above 6,000 feet in North Coast Ranges; northern California, 5,500 to 7,500 feet; Sierra Nevada, 6,000 to 9,000 feet; southern California, 8,000 to about 9,500 feet.

Average precipitation 35 to 65 inches, with heavy winter snow; growing season 3 to 4.5 months, with 40 to 70 frost-free days; mean summer maximum temperatures 73°–85°, mean winter minima 16°–26° F. The data for Huntington Lake (Plate XVI) are somewhat atypical in that they come from a station on the lower border of this community, toward the dry end of the range.

Trees to 100 feet tall or more, in dense forests.

15. Lodgepole Forest

Plate XVI

Pinus Murrayana, *Tsuga Mertensiana*, *Artemisia Rothrockii*, *Potentilla Breweri*, *Castilleja Culbertsonii*, *Pedicularis attolens*, *Haplopappus apargioides*, *Senecio lugens*.

Northernmost California to central Sierra Nevada, where it grows from about 8,300 to 9,500 feet.

Average precipitation about 30 to 60 inches, mostly as snow; growing season 9 to 14 weeks, with frost-free days as many as 40; mean summer maximum temperatures 67°–75°, mean winter minima 10°–18° F.

Trees to 50 or 60 feet tall, in rather open forest with extensive meadows scattered through it.

16. Subalpine Forest

Pinus albicaulis, *P. Balfouriana*, *P. flexilis*, *P. Murrayana*, *Tsuga Mertensiana*, *Salix petrophila*, *Eriogonum incanum*, *Ribes cereum*, *R. montigenum*, *Aquilegia pubescens*, *Sedum obtusatum*, *Potentilla fruticosa*, *Cassiope Mertensiana*, *Phyllodoce Breweri*, *Penstemon heterodoxus*.

The most boreal forest in California; in northern California from about 8,000 to 9,500 feet; Sierra Nevada, 9,500 to 11,000 feet; poorly represented in southern California and above 9,500 feet.

Plate XVI. Graphs for data on weather at four stations in the Sierra Nevada, *Californian* and *Sierran* provinces.

Average precipitation about 30 to 50 inches, dropping as low as 15 inches on the east side of the crest, mostly as snow, with heavy snow cover in winter; growing season 7 to 9 weeks, and killing frost possible in every month; mean summer maximum temperatures probably not over 65° F., winter minima unknown.

Trees from elfin wood (Krummholz) to 40 feet tall or more, usually rather scattered.

17. Alpine Fell-fields.

Carex Helleri, *C. Breweri*, *Festuca ovina*, *Poa rupicola*, *P. Suksdorfii*, *Luzula spicata*, *Eriogonum ovalifolium*, *Oxyria digyna*, *Draba densifolia*, *D. Breweri*, *D. Lemmonii*, *D. oligosperma*, *Anelsonia eurycarpa*, *Ivesia Shockleyi*, *Potentilla diversifolia*, *Astragalus tegetarius*, *Epilobium obcordatum*, *Podistera nevadensis*, *Polemonium eximium*, *Cryptantha nubigena*, *Castilleja nana*, *Penstemon Menziesii* ssp. *Davidsonii*, *Haplopappus Macronema*, *Hulsea algida*.

Above tree growth; northern California mostly above 9,500 feet; Sierra Nevada mostly above 10,500 feet; San Bernardino and San Jacinto mountains with bare suggestion on highest peaks.

Average precipitation about 25 to 35 inches, predominantly as snow; swept by gales in winter with deep drifts of snow accumulating locally; growing season 4 to 7 weeks and killing frost possible at any time; intense illumination; mean summer maximum temperatures probably not over 55°–60° F., winter minima unknown.

Almost entirely perennial herbs, scattered or forming low turf, or among rocks; many cushion plants.

18. Northern Juniper Woodland

Plate XVII

Juniperus occidentalis, *Pinus Jeffreyi*, *P. monophylla*, *Artemisia tridentata*, *Penstemon speciosus*.

Great Basin Plateau to the base of the Sierra Nevada from Modoc County to southern Mono County, 4,200 to 5,600 feet in the north, 6,000 to 7,000 feet in the south.

Average precipitation 10 to 30 inches, largely as snow; growing season 2 to 5 months, with 70 to 140 frost-free days; mean summer maximum temperatures 82°–89°, mean winter minima 10°–20° F.

Open forest of trees 10 to 60 feet tall, on brush-covered slopes and flats.

19. Pinyon-Juniper Woodland

Pinus monophylla, *Juniperus californica* or *J. osteosperma* (*J. utahensis*), *Quercus dumosa* var. *turbinella*, *Purshia glandulosa*, *Cowania Stansburiana*, *Fallugia paradoxa*, *Cercocarpus ledifolius*, *Yucca schidigera*, *Y. baccata*.

East base of Sierra Nevada, White-Inyo ranges southward through higher mountains of Mohave Desert, mostly at elevations of 5,000 to 8,000 feet, and between Yellow Pine Forest and Joshua Tree Woodland or Sage-brush Scrub.

Plate XVII. Graphs for climate at four stations east of the Sierra Nevada. *Nevadan* and *Southern Desert* provinces.

Average precipitation 12 to 20 inches, with some snow and some summer showers; growing season 5 to 8 months, with 150 to 250 frost-free days; mean summer maximum temperatures about 88°–95°, mean winter minima about 20°–30° F.

Trees 10 to 30 feet tall, in open stands with shrubs between.

20. Joshua Tree Woodland

Yucca brevifolia and var. *Jaegeriana*, *Juniperus californica* or *J. osteosperma* (*J. utahensis*), *Salazaria mexicana*, *Lycium Andersonii*, *L. Cooperi*, *Eriogonum fasciculatum* var. *polifolium*, *Tetradymia spinosa*.

Well-drained mesas and slopes, 2,500 to 4,000 feet or higher, from southern Owens Valley to Little San Bernardino Mountains and southern Nevada and Utah.

Average rainfall about 6 to 15 inches, with summer showers; growing season on the deserts limited by water rather than by temperature; frost-free days 200 to 250; mean summer maximum temperatures 95°–100°, mean winter minima 22°–32° F.

Trees 10 to 30 feet high, scattered, with shrubs and herbs between.

21. Sagebrush Scrub

Plate XVII

Artemisia tridentata, *A. nova*, *A. cana*, *Coleogyne ramosissima*, *Chrysothamnus nauseosus* ssp. *speciosus* and *mohavensis*, *C. viscidiflorus*, *Atriplex confertifolia*, *A. canescens*, *Tetradymia spinosa*, *Purshia tridentata*, *P. glandulosa*.

Deep pervious soil along the east base of the Sierra Nevada from Modoc County south to the San Bernardino Mountains, mostly at elevations of 4,000 to 7,500 feet; occasional in Siskiyou and San Diego counties.

Average precipitation 8 to 15 inches mostly as winter snow; growing season 3.5 to 6 months, with 70 to 130 frost-free days; mean summer maximum temperatures 83°–95°, mean winter minima 8°–27° F.

Low, silvery gray shrubs 2 to 7 feet tall, interspersed with greener plants.

22. Shadscale Scrub

Atriplex confertifolia, *Grayia spinosa*, *Eurotia lanata*, *Kochia californica*, *Artemisia spinescens*, *Menodora spinescens*, *Gutierrezia Sarothrae*, *Coleogyne ramosissima*.

In heavy soil, often with underlying hardpan, of mesas and flats at 3,000 to 6,000 feet, about the Mohave Desert, Owens Valley, etc.

Average rainfall 3 to 7 inches; growing season limited by water; frost-free days 150 to 250; temperatures similar to those in Joshua Tree Woodland.

Plants largely 1 to 1.5 feet tall, shallow-rooted, and covering large monotonous areas between Creosote Bush Scrub and Joshua Tree Woodland.

23. Creosote Bush Scrub

Plate XVII

Larrea divaricata, *Franseria dumosa*, *Fouquieria splendens*, *Dalea californica*, *D. Schottii*, *D. spinosa*, *Lycium brevipes*, *L. Andersonii*, *Hy-menoclea Salsola*, *Encelia farinosa*, *E. frutescens*, *Sphaeralcea ambigua*, *Baccharis sergiloides*, *Echinocereus Engelmannii*, *Opuntia Bigelovii*,

O. echinocarpa, *O. basilaris*; *Prosopis juliflora* var. *glandulosa*, *Olneya Tesota*, *Pluchea sericea*, and *Chilopsis linearis* along the water courses. Well-drained soil of slopes, fans, and valleys, usually below 3,500 feet, in deserts from southern end of Owens Valley to Mexico.

Average rainfall mostly 2 to 8 inches, some as summer showers; frost-free days 180 to 345; highly variable seasonal and diurnal temperatures, mean summer maxima 100°–110°, mean winter minima 30°–42° F.

Shrubs 2 to 10 feet tall, widely spaced, largely dormant between rainy periods.

24. Alkali Sink

Plate XVII

Atriplex polycarpa, *A. lentiformis*, *A. Breweri*, *A. spinifera*, *A. Parryi*, *Sarcobatus vermiculatus*, *Allenrolfea occidentalis*, *Suaeda Torreyana* var. *ramosissima*, *Salicornia virginica*, *Frankenia grandifolia* var. *campestris*.

Poorly drained alkaline flats and playas in floor of Great Central Valley and of arid regions east of the Sierra Nevada, and in such sinks as Panamint and Death valleys, mostly at less than 4,000 feet elevation.

Average rainfall 1.5 to 7 inches; frost-free days 200 to 335; highly variable seasonal and diurnal temperatures, mean summer maxima 106°–116°, mean winter minima 28°–37° F.

Low scattered gray or fleshy halophytes where there is poor or no drainage, as about dry lakes; under this community there are grouped several associations which are perhaps more distinct and cover larger areas in the deserts of Nevada and Utah.

BIBLIOGRAPHY

- ABRAMS, L. R. 1910 A phytogeographic and taxonomic study of the Southern California trees and shrubs. Bull. N. Y. Bot. Gard. 6: 300-485.
- BAKER, F. S., and COMMITTEE. 1945. Forest cover types of western North America. Pamphlet of Soc. Amer. Foresters, 1-35.
- BAUER, H. L. 1930. Vegetation of the Tehachapi Mountains. Ecology 11: 263-280.
- BENSON, L., and R. A. DARROW. 1944. A manual of southwestern desert trees and shrubs. Univ. Ariz. Bull. 15; no 2: 1-411.
- BILLINGS, W. D. 1945. The plant associations of the Carson Desert region, western Nevada. Butler Univ. Studies 7: 89-123.
- BOWERMAN, MARY L. 1944. The flowering plants and ferns of Mount Diablo, California. pp. 1-290. Gillick Press, Berkeley, California.
- CLARK, H. W. 1937. Association types in the North Coast Ranges of California. Ecology 18: 214-230.
- CLAUSEN, J., KECK, D. D., and W. M. HIESEY. Experimental studies on the nature of species.
- I. 1940. Effect of varied environments on western North American plants. Carnegie Inst. Wash. Pub. 520: 1-452.
- III. 1948. Environmental responses of climatic races of *Achillea*. op. cit. 581: 1-129.
- CLEMENTS, F. E. 1920. Plant indicators. Carnegie Inst. Wash. Pub. 290: 1-388.
- COOKE, W. B. 1940. Flora of Mount Shasta. Amer. Midl. Nat. 23: 497-572.
- COOPER, W. S. 1922. The broad-sclerophyll vegetation of California. Carnegie Inst. Wash. Pub. 319: 1-124.

- COOPER, W. S. 1936. The strand and dune flora of the Pacific Coast of North America. *In* Essays in Geobotany, T. H. Goodspeed, editor; pp. 141-187.
- DICE, L. R. 1943. The biotic provinces of North America. pp. 1-73. Univ. Mich. Press.
- HALL, H. M., and J. GRINNELL. 1919. Life-zone indicators in California. *Proc. Calif. Acad. Sci.* IV, 9: 37-67.
- JENSEN, H. A. 1947. A system for classifying vegetation in California. *Calif. Fish and Game* 33: 199-266.
- JEPSON, W. L. 1910. The silva of California. *Memoirs Univ. Calif.* 2: 1-480.
- JEPSON, W. L. 1923-1925. A manual of the flowering plants of California. pp. 1-1238. Assoc. Students Store, Univ. Calif., Berkeley.
- KLYVER, F. D. 1931. Major plant communities in a transect of the Sierra Nevada Mountains of California. *Ecology* 12: 1-17.
- KÜCHLER, A. W. 1947. A geographic system of vegetation. *Geogr. Rev.* 37: 233-240.
- MASON, H. L. 1946. The edaphic factor in narrow endemism. *Madroño* 8: 241-257.
- MASON, H. L. 1947. Evolution of certain floristic associations in western North America. *Ecol. Mon.* 17: 201-210.
- MERRIAM, C. H. 1898. Life zones and crop zones of the United States. U. S. Dept. Agric., Div. Biol. Surv., *Bull.* 10: 1-79.
- MUNZ, P. A. 1935. A manual of Southern California botany. pp. i-xxxix, 1-642. J. W. Stacey, Distributor, San Francisco.
- OOSTING, H. J. 1948. The study of plant communities. pp. 1-389. W. H. Freeman and Co., San Francisco.
- OOSTING, H. J., and W. D. BILLINGS. 1943. The red fir forest of the Sierra Nevada. *Ecol. Mon.* 13: 259-274.
- PECK, M. E. 1941. A manual of the higher plants of Oregon. pp. 1-866. Binford and Mort, Portland.
- PIEMEISEL, R. L., and F. R. LAWSON. 1937. Types of vegetation in the San Joaquin Valley of California and their relation to the beet leafhopper. U.S.D.A. Tech. *Bull.* 557: 1-28.
- RUSSELL, R. J. 1926. Climates of California. Univ. Calif. Pub. Geogr. 2: 73-84.
- SHANTZ, H. L. 1925. Plant communities in Utah and Nevada. pp. 15-23 *in* Tidestrom, I., Flora of Utah and Nevada. *Contr. U. S. Nat. Herb.* 25: 1-565.
- SHANTZ, H. L., and R. ZON. 1924. The natural vegetation of the United States. *In* U. S. Dept. Agric. Atlas of Amer. Agric. 1-29.
- SHARSMITH, HELEN K. 1945. Flora of the Mount Hamilton Range of California. *Amer. Midl. Nat.* 34: 289-367.
- SHELFORD, V. E. 1932. Basic principles of the classification of communities and habitats and the use of terms. *Ecology* 13: 105-120.
- SHREVE, F. 1942a. The desert vegetation of North America. *Bot. Rev.* 8: 195-246.
- SHREVE, F. 1942b. The vegetation of Arizona. pp. 10-23 *in* Kearney, T. H., and R. H. Peebles, Flowering plants and ferns of Arizona. U.S.D.A. Misc. Pub. 423: 1-1069.
- SMILEY, F. J. 1921. A report upon the boreal flora of the Sierra Nevada of California. Univ. Calif. Pub. Bot. 9: 1-423.
- VAN DYKE, E. C. 1919. The distribution of insects in western North America. *Ann. Entom. Soc. Amer.* 12: 1-12.
- WEAVER, J. E., and F. E. CLEMENTS. 1938. Plant ecology, ed. 2. pp. 1-601. McGraw-Hill Co.