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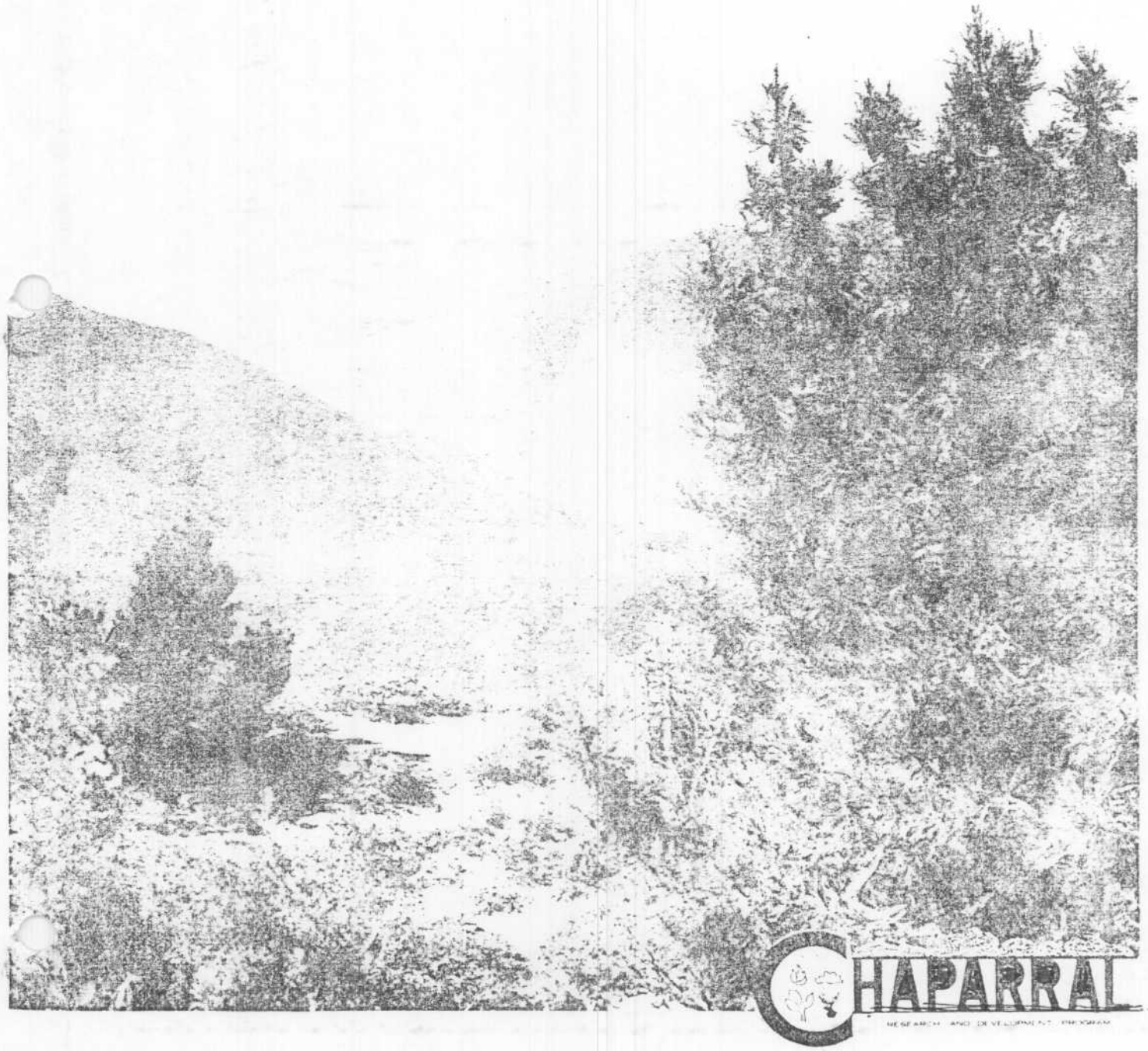
A Vegetation Classification System Applied to Southern California

Timothy E. Paysen Jeanine A. Derby Hugh Black, Jr. Vernon C. Bleich John W. Mincks



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Acknowledgments:

In 1977, the Forest Service, U.S. Department of Agriculture, established a research and development program at this Station titled "Vegetation Management Alternatives for Chaparral and Related Ecosystems." This 5-year program, with headquarters at Riverside, California, is an intensive effort to develop, test, and demonstrate a wide range of operations for maintaining or increasing the productivity of chaparral and related ecosystems in southern California.

Work toward the development of the Vegetation Classification System described in this report was facilitated through the efforts of many persons. Ike Parker, ecologist, Tahoe National Forest, Forest Service, U.S. Department of Agriculture, made available the experience he obtained while working on the Forest Service's Pacific Southwest Region (R-5) pilot ecology program. William Harvey, range conservationist, Inyo National Forest, served as an advisor in matters pertaining to range management during the initial development of the system. Mona Myatt and Terry Yonkers, both ecologists, of the Southern California Edison Company, were a source of valuable advice, and graciously provided plant community information from their Coastal Resources Inventory. Constructive comments based on field tests of the system were received from Waldo Burford and John Sully, biologists, both of the California Department of Transportation; Jan Zabriskie of the University of California, Riverside, Deep Canyon Desert Research Station; and Bruce Smith, Maureen Hales, and John Hall, biologists, all of the Riverside office, Bureau of Land Management, U.S. Department of Interior.

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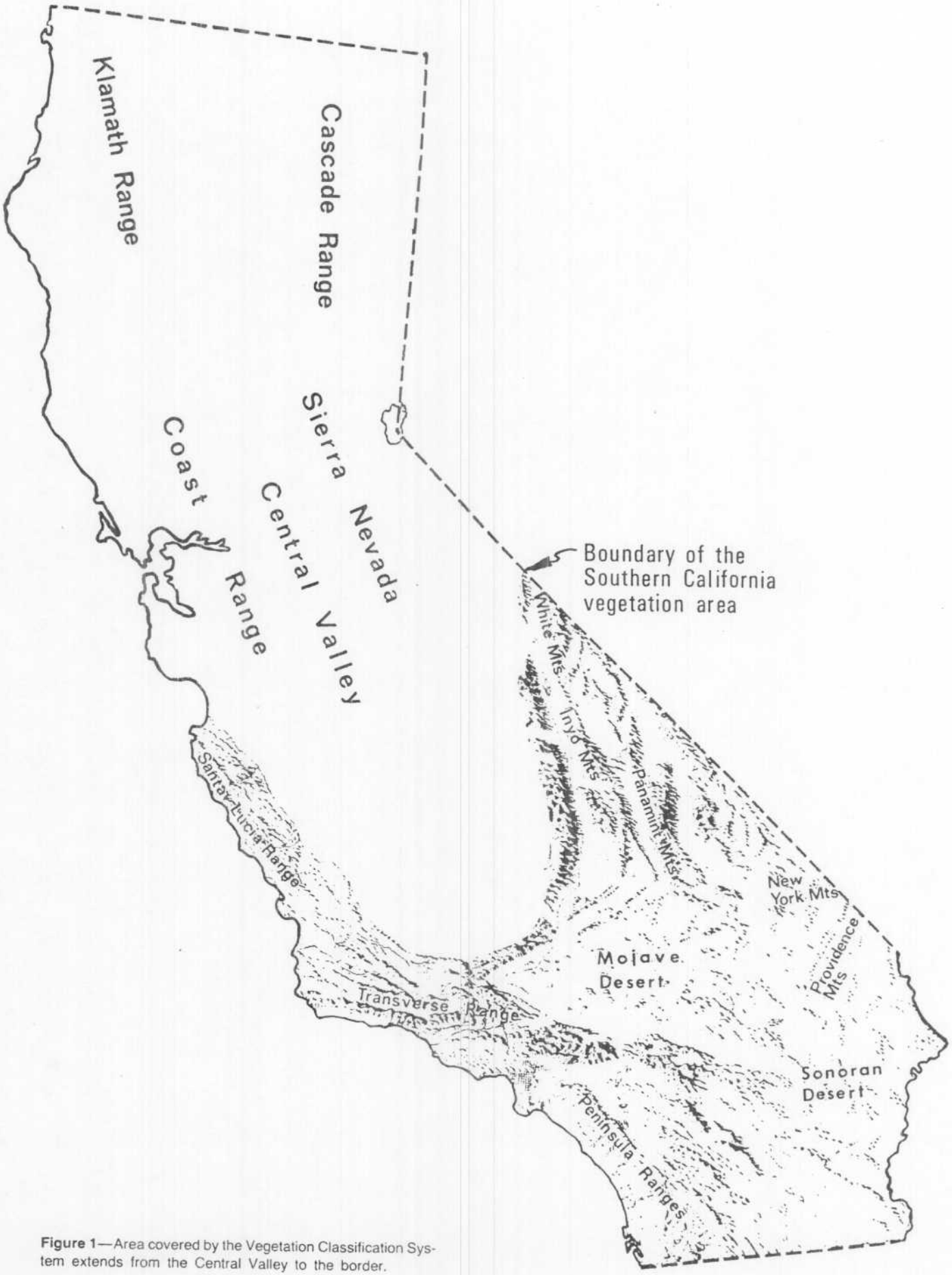


Figure 1—Area covered by the Vegetation Classification System extends from the Central Valley to the border.

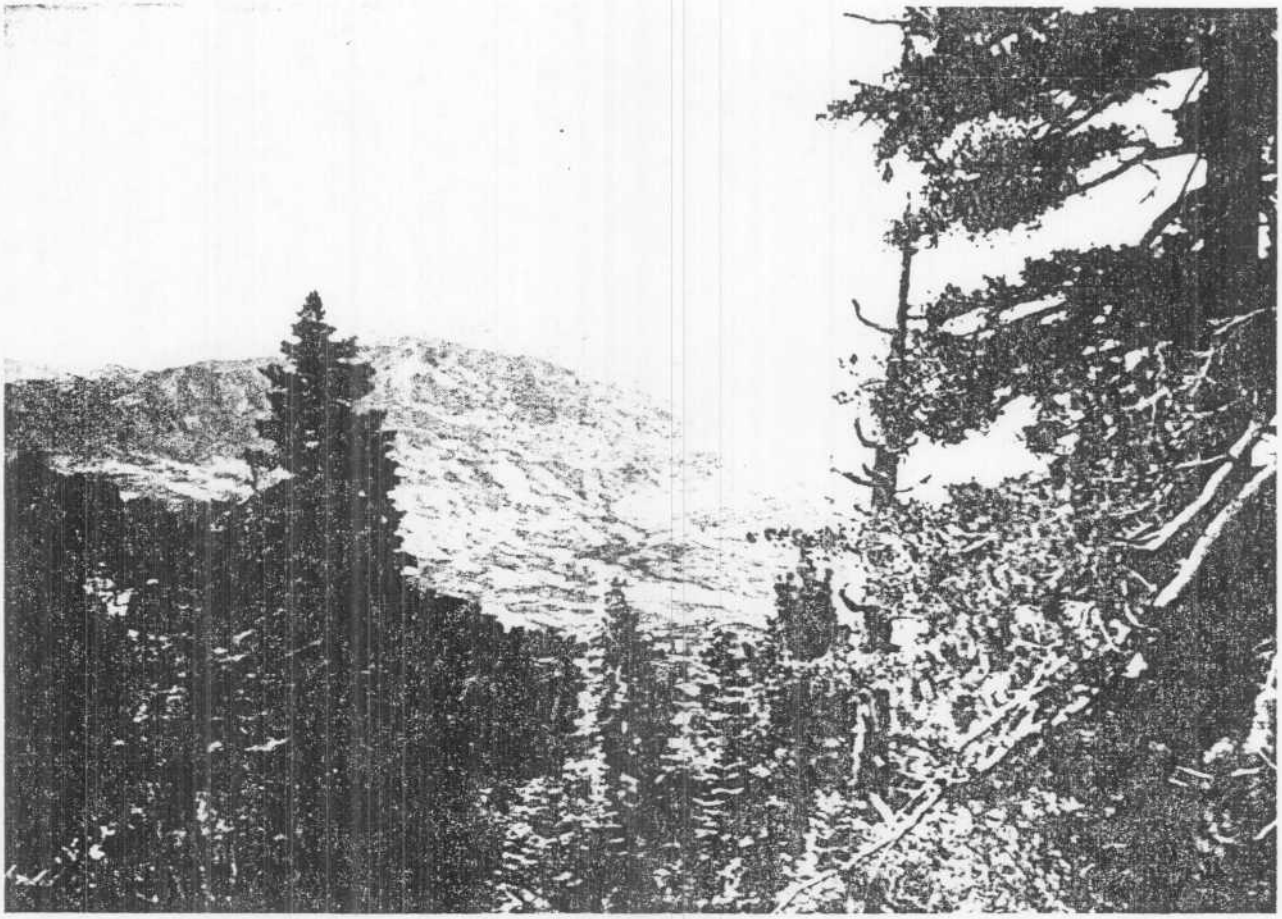


Figure 2—Elements of the Conifer Forest Subformation in southern California contrast sharply with the mosaic of Chaparral and Soft Chaparral Subformations seen in the background. The conifers nearly hide the smog in the valley bottom.

The Vegetation Classification System for Southern California was developed by an interagency, interdisciplinary team as an aid to communication among resource managers, planners, specialists, and their agencies. Its specific function is to define and name units of vegetation, regardless of their successional state. The area covered by the System extends south from the Central Valley of California to the border *(fig. 1)*, and includes a variety of vegetational elements *(fig. 2)*.

The System was developed to meet an existing need for a single, commonly accepted classification system that can be used as a basic "language" in discussing organizations of plants or plant assemblages. Existing classification systems did not have common acceptance because they were either too general or too functionally specific (as, for example, a "timber type" system), or because they incorporated other factors along with plants into the System. This issue is dealt with in greater depth in a forthcoming report.[1]

[1] Paysen, Timothy E., Ike Parker, Jeanine A. Derby, and Hugh Black, Jr. Vegetation classification: the conceptual basis of a system. (Manuscript in preparation.)

Common acceptance of a basic "language" system by a broad spectrum of disciplines is mandatory. Therefore, representatives of various agencies were initially brought together to analyze the problem and to recommend a plan of action. The following agencies participated: Forest Service, U.S. Department of Agriculture; Bureau of Land Management and Fish and Wildlife Service, U.S. Department of Interior; and California Department of Fish and Game. A team from within this group was charged with the task of developing an acceptable system. Review of the System, as its development proceeded, was given to an even broader spectrum of potential users, including staff members of State colleges and universities, other State agencies, and the Southern California Edison Company.

The classification system that was developed is hierarchical, in five levels of descriptive detail. It was designed to accommodate the kinds of information needed for management decisions at the project level or at the broad planning level.

The System shows categories of vegetation as they now exist in southern California. In time, these categories will be updated in order to keep the list of recognized Series relevant. The basic framework of the System allows vegetation

categories to be added or deleted at any level of the hierarchy in order to reflect new information. Although agencies and functions may need to extend or build upon the existing classification, a uniform terminology can be maintained.

SYSTEM OVERVIEW

Development of the Vegetation Classification System for Southern California began with a review of existing systems (Browne and Lowe 1974, Cheatham and Haller,[2] Driscoll and others,[3] Kuchler 1964, Mueller-Dombois and Ellenburg 1974, Munz 1973, Thorne 1976). The range and distribution of vegetation series were determined through literature review (Munz 1973, 1974; Critchfield 1971; Griffin and Critchfield 1972; Horton 1960; Shreve and Wiggins 1964; McMinn 1939; and Latting 1976), through personal contact with many specialists throughout central and southern California, and from our field experience. This Classification System is broadly patterned after an outlined system proposed by Leven and Horton.[4]

The Vegetation Classification System for Southern California is compatible at all levels with a national land classification system being proposed by the Forest Service[3] and which incorporates the international system for classifying vegetation (UNESCO 1973). The System is based upon a hierarchical stratification of plant cover as described below.

The *Formation* is the uppermost level in the hierarchy, and its elements are defined according to physiognomic criteria. A given Formation is an aggregate of individual plant communities with the *same* physiognomy or stand structure. A broad unit of vegetation that is a mosaic of different physiognomic types, but is predominantly made up of one physiognomic type, such as closed forest, is not itself a Formation. It is an aggregation of various Formations, each of which corresponds to a distinct physiognomic type within the mosaic (*fig. 3*). Example: An annual grass community is considered a member of the Herbaceous Formation, even though it may occur in an area that is generally dominated by stands of conifers (*figs. 4, 5*). Within a given Formation, plant communities with dominant species that have the same general leaf and stem morphology characteristics are grouped into a *Subformation*. The Closed Forest Formation is therefore composed of the Conifer and Broadleaf Subformations.

[2] Cheatham, Norden H., and Robert Haller. University of California natural land and water reserves system, an annotated list of California habitat types. (Manuscript in preparation.)

[3] Driscoll, Richard S., John W. Russell, and Marv C. Meier. Recommended national land classification system for renewable resource assessments. (Report on file at Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.)

[4] Leven, Andrew A., and Lowell E. Horton. 1976. Inventory of ecological land units, resource analysis units, and management units. *In* Land use planning training test materials. (Report on file at Pacific Southwest Region (R-5), Forest Serv., U.S. Dep. Agric., San Francisco, Calif.)

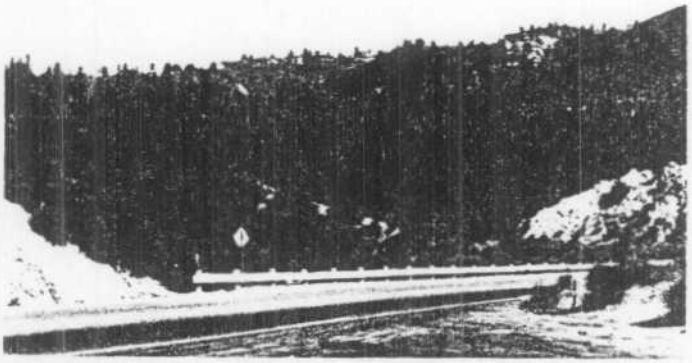


Figure 3—Disturbance by fire has resulted in this complex of Closed Forest and Shrub Formations.

The *Series* and *Association* are taxonomic units. These two categories address specific plant communities. Together they form the heart of the Classification System. The *Series* is a generalization of Associations with the same dominant overstory. The *Association* is the basic unit of the Classification System. An Association is a plant community, growing under uniform environmental conditions, with a particular dominant overstory species, and characteristic associated species. The nomenclature for Association reflects the dominant species, and the most prevalent (or distinguishing) associated species. The latter is most often an understory species, but can be an associated overstory species. Examples: Pinyon pine/mountain mahogany/phlox or interior live oak/manzanita/needlegrass.

The *Phase* is a category that allows us to deal with the variability that must exist within given associations (*fig. 6*). It can be used to specify growth stages or condition of vegetation, or it can be used to describe a particular realization of the Association that has an especially noteworthy character—such as a stand (or portion of a stand) with a particularly dense overstory.

The Associations have not yet been developed. They can be identified on the ground on a project basis or identified uniformly for the entire southern California area after adequate field samples are taken.

Regionalization

It is often useful to regionalize a classification system if it covers a large geographic area, or if it covers an extremely diverse environment. This kind of stratification assists the user by eliminating ambiguities that must exist in an extensive system. It provides a sorting process that facilitates practical application. To this end, we are suggesting the use of climate regions, according to descriptions adapted from Almquist.[5] While these climate regions do not represent

[5] Almquist, G.L. 1977. Macroclimatic regions of Southern California. (Report on file at the Forest Fire Laboratory, Pacific Southwest Forest and Range Experiment Station, Riverside, Calif.)

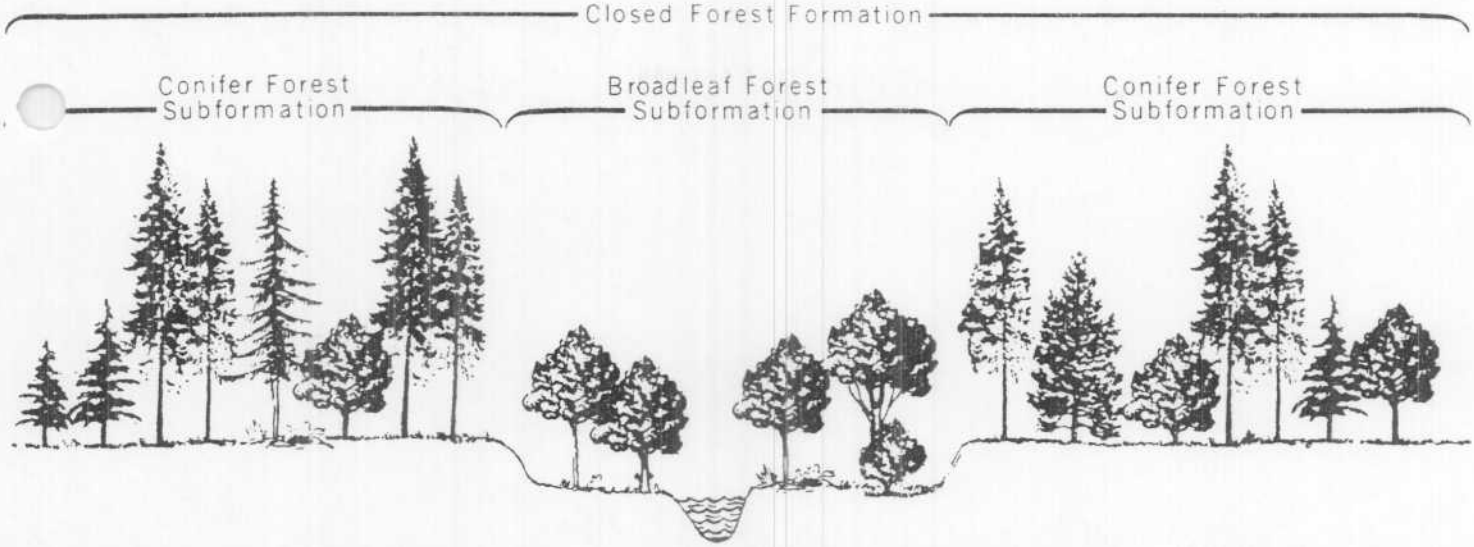


Figure 4—This "typical conifer forest" is, in fact, a complex of two distinct Subformations: the Conifer Forest Subformation and the Broadleaf Forest Subformation.

individual strata that are unique in a geographic sense, they do provide a set of environmental strata that are useful descriptive qualifiers. Example: The Montane region exists in a number of places in southern California; nevertheless, it is useful to distinguish elements of the Canyon Live Oak Series that exist in a Montane region from those that exist in an Interior Valley region.

A number of climatic and geophysical variables affect vegetative growth, reproduction, and distribution. Some of the variables include temperature, precipitation, and relative humidity, along with the seasonal distribution of these factors; dominant wind patterns; orographic influence; and proximity to major land mass changes. It is difficult to define all of these interactions with geographic and elevational boundaries, particularly in an area of great diversity such as southern California. The adaptation of Almquist's descriptions serves for the present as a regionalization of the southern California vegetation area. It may someday be supplanted by a more general regionalizing system, or it may remain as a local subregionalization of one of these systems.

Vegetation distribution relative to climate regions is presented in a table of the Series, along with the Field Key, below. The Appendix contains descriptions of each region.

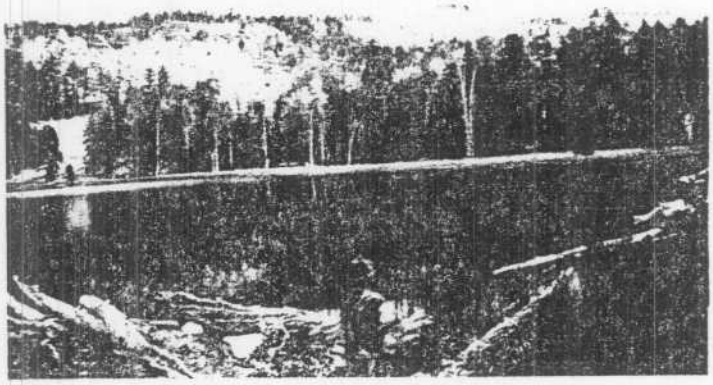


Figure 5—The Herbaceous Formation is represented in the middle foreground by an element of the Sedge Series, and in the meadow in the left middle ground by the Forb Series. The Lodgepole Pine Series represents the Closed Forest Formation in the middle ground and on the hill in the background, and the Dwarf Shrub Formation fills in the remainder of the hill that is devoid of lodgepole pine.

Application

The Vegetation Classification System for Southern California can be used to describe environmental settings, to provide a basic framework for vegetation mapping, and to qualify map class descriptions. It can also serve as the common link between functional or technical classification systems, thereby facilitating communication between disciplines.

The System will become most meaningful to land managers when Associations are identified for southern California vegetation. Significant Associations can be identified only

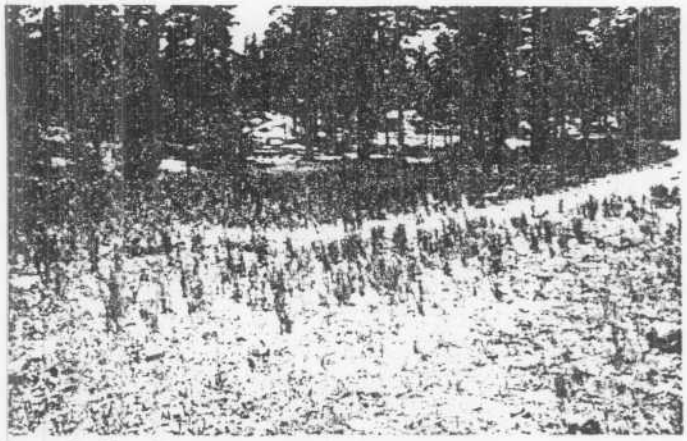


Figure 6—Two Phases of the Forb Series are evident in the foreground: The extreme foreground shows an early successional Phase resulting from equestrian overuse; the middle foreground contains a mature Phase of the Series.

after careful evaluation of plant distribution patterns and their associated environmental settings. Resource managers and researchers should work together in this process.

When Associations are identified, their successional status should eventually be determined. Knowledge of the potential inherent in a plant community has practical application in local resource management. It can also facilitate response to shifts in management direction from the national level. For example, an increased emphasis on managing forests and woodlands for recreation, wildlife, and energy production may bring about a response to increase production of oaks in southern California. Knowledge of sites that have potential for high oak productivity on an extended basis will eliminate fruitless attempts at oak management on marginal oak sites.

CLASSIFICATION SYSTEM

This hierarchical stratification (*fig. 7*) has been designed to describe existing vegetation—the dominant and associated vegetation which presently occupies the site. However, because the System is descriptive and is based upon stand physiognomy and floristics, it can also be used to describe potential vegetation—which is simply the "present vegetation" of some future time.

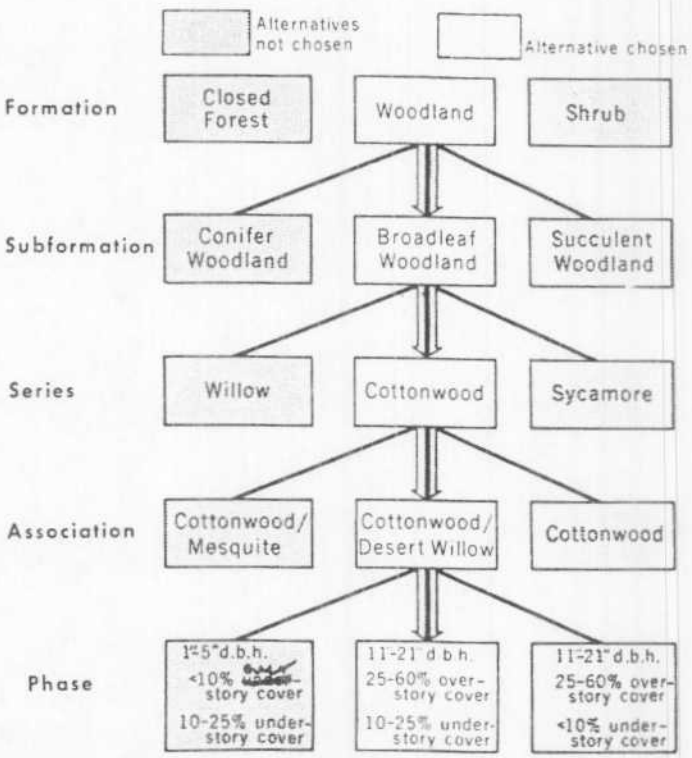


Figure 7—The hierarchy of the Vegetation Classification System as applied to southern California is shown here in an example. In the diagram, the classification of a stand becomes progressively more precise as it moves through the levels recognized in the classification (Formation, Subformation, and Series). The most specific level is the plant community (Association). Finally, the appropriate descriptive Phases are determined and the proper alternatives are chosen.

Perhaps the easiest way to understand the relationship between the various levels of the System is to start with its basic unit, the Association, and work up the hierarchy from it. The System is an aggregating system from the Association up through the Formation. In an aggregating (or agglomerative) system, the classes at a given level in the hierarchy are grouped, according to prescribed similarities, to form classes of the next higher hierarchal level. The Phase category, on the other hand, subdivides the classes to which it is applied—this means that predetermined classes have been generated, and are each to be subdivided on the basis of internal differences. See the paper by Bailey and others (1978) for a discussion of aggregative and subdivisive systems; the same concepts are discussed as agglomerative and divisive systems by Sneath and Sokal (1973) and by Pielou (1969). Logically, the Phase level of description could be applied anywhere in the hierarchy, since Series, Subformation, and Formation are simply generalizations of the Association concept.

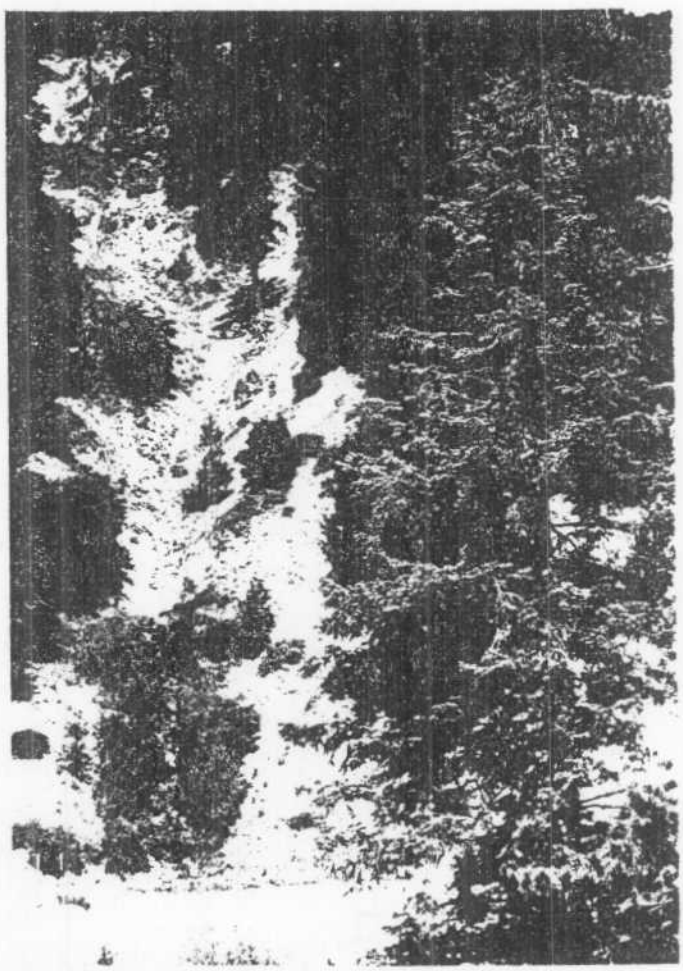


Figure 8—A natural habitat modification, such as a landslide, may result in an Association that is distinct from the surrounding elements of the Mixed Conifer Series.

Association

A plant Association is an assemblage of plants, with a characteristic floristic composition, that occurs under a uniform set of environmental conditions. This is the "standard" definition of a plant community (Ecological Society of America,[6] Schwartz and others 1976). Unfortunately, it is highly ambiguous. The meaning of a "uniform set of environmental conditions" is largely a function of the scale of description being addressed by the Classification System itself. To define precisely the scale of description for this (or any) classification system may not be entirely possible; this problem is dealt with in some depth in a forthcoming paper.[1] For the purpose of this presentation, a rule of thumb will serve under most situations: A plant Association is recognizable on the ground; the size of the unit may vary, but the Association *almost always* has single species dominance in the overstory. Exceptions to this rule will probably be rare.

Field reconnaissance will be required to identify Associations. Individual Associations may exist as a result of interactions between "constant" environmental characteristics, less predictable natural forces (*fig. 8*), and human influences. Though not necessarily permanent, a plant Association must be sufficiently long-lasting to affect management policy. For example, different environmental factors and different biogeographic history may determine that a stand of white fir in the New York Mountains (Mojave Desert) and another in the San Jacinto Mountains (Peninsular Ranges) represent different Associations within the White Fir Series. Similarly, environmental and human factors may determine that adjacent manzanita stands on the coast side of the San Bernardino Mountains represent different Associations.

Series

Series simply generalize plant Associations. All plant Associations with a given dominant overstory species constitute a Series that is named by that species. This category does not imply greater heterogeneity than the Association. It still recognizes the basic plant community, but does so at a general level. It also allows for reference to an entire set of floristically related communities. Example: A particular plant community may be recognized as an Interior Live Oak/Eastwood Manzanita Association, or it may be recognized as an element of the Interior Live Oak Series. The basic unit of precision—the plant community—has not changed, only the level of precision used to address it has changed.

Subformation

A Subformation is an aggregation of Series with a given physiognomic character, and a particular stem and leaf morphology in the dominant overstory species. This category is included in the System to provide a set of classes that are more distinct than those at the Formation level. Reference will probably be made to this level more often than any other in the System, because the distinctions that it makes relate to common generalized references to vegetation. Example: Conifer versus broadleaf forests; chaparral versus soft chaparral.

Formation

A Formation is an aggregation of Subformations with a given physiognomic character. Example: All Subformations that are characterized by an overstory of trees with a closed canopy (60 to 100 percent crown cover) make up the Closed Forest Formation. Five Formations are currently recognized in southern California.

Phase

Although Phase is treated as a category of the classification, it is primarily a vehicle for management application of the System. It is a means of addressing variability within a plant community, and therefore only the general pattern of its use can be prescribed—strict definition of all potentially relevant Phases of plant communities is not practical. For each Formation described, we have suggested some possible terms that might be generally useful to describe the kinds of variations that are included in the concept of Phase. Many other such descriptors could be used in an actual inventory of vegetation.

Phase descriptors are often chosen in relation to specific functional applications. A silviculturist may define Phases of a plant community as different stand aggregations that call for different silvicultural prescriptions. In this light, a small cluster of a given species within a community constitutes a Phase of that community. At a different level, the silviculturist may view an age class within a plant community as defining a unique Phase. Similarly, a fuels specialist may be concerned with various characteristics of a chaparral stand, such as age, species composition, and vigor. A fuels specialist would therefore choose age, vigor, and probably mortality as elements for defining Phase categories. For different reasons, a wildlife biologist may recognize the same categories as the fuels specialist.

Outside the realm of pure classification, the Phase category is also a logical means for describing certain stages of succession. Depending upon circumstances, such as management goals or constraints, a plant assemblage may be viewed as in an early stage of development of one Association or an advanced stage of development for another Association (*fig. 9*). For example, a recently burned chaparral stand bears little resemblance to chaparral. The burned site is often dominated by elements of the Herbaceous Formation. Yet, knowledge of the chaparral successional cycle tells us that, if chaparral seedlings and sprouts are present, the recent burn is a *potential* chaparral stand in a pioneer stage—and contains a particular Phase of a potential chaparral Associa-

[6] Ecological Society of America. 1952. Report of the Committee on Nomenclature. (Report on file at Ecological Society of America and Duke University Press, Durham, N.C.)

Figure 9—This Jeffrey Pine/Pinyon Pine/Sagebrush Association will, at some future date, become a Pinyon Pine/Sagebrush Association. The pinyon pine union represents a pioneer Phase of the potential Pinyon Pine/Sagebrush Association.

tion. This same logic can be applied to clearcuts in which the conifer reproduction has not yet attained dominant overstory status; a potential conifer stand exists and is described as being in a seedling Phase. We cannot, however, describe a bare granite slab as a pioneer Phase of a White Fir Association, even though we may be clever enough to trace community development forward to the potential existence of a stand of white fir. White fir seedlings must be clearly established in a pioneer Phase of a White Fir Association.

In using the Phase category for description of ecological stages, we are viewing the site in the context of what we know will probably happen, in order to classify it more usefully for our needs. The system itself does not tell us anything about succession: it simply allows us to take ecological development and succession into consideration in our classification. In *figure 10*, the development of one Association within another is diagrammed. The bottom strip shows how we might classify the site over the course of its probable future development. By establishing a sequence of Phases in this way, we provide a guide to classification of other sites representing different coexisting stages of development.

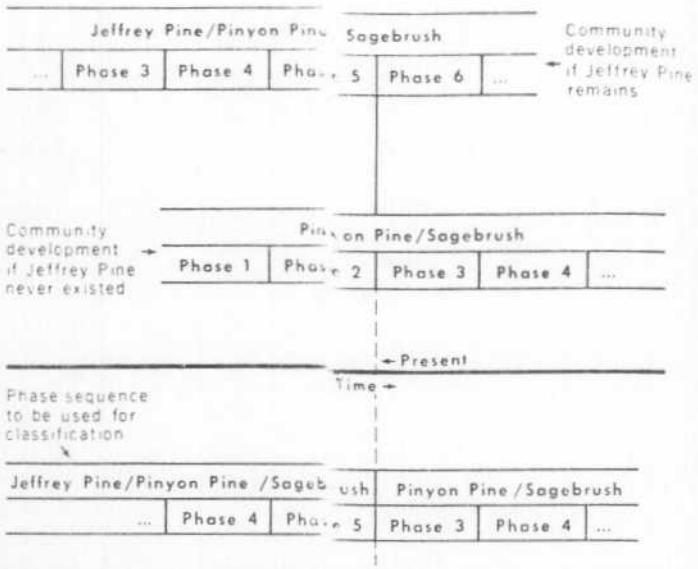


Figure 10—The Phase category may be used to describe the ecological stage of the stand in *figure 9*. The two upper strips show the developmental phase sequences from which the bottom strip—a successional sequence moving from Jeffrey pine dominance to pinyon pine dominance—is derived. The basis for this is that the Pinyon pine/Sagebrush Association was present, though "hidden" in the Jeffrey pine/Pinyon pine/Sagebrush Association. Thus, when it emerges, it is already in the third phase.

Further discussion regarding this aspect of Phase, the means by which we may classify vegetation for a particular point in time and concurrently focus on the entire successional spectrum of a vegetation community, is included in the paper mentioned earlier.[1]

To describe complex Phase categories, such as those that we have suggested, a Phase code or index can be derived on the basis of the elements used to define the Phase categories. For example, the Phases suggested for the Closed Forest Formation are based upon six diameter at breast height (d.b.h.) size class ranges, three overstory cover ranges, and three understory cover ranges. A stand with trees in the second size class range (1 to 5 inches d.b.h.), that is in the first overstory cover category (less than 40 percent), and in the third understory cover category (greater than 70 percent), would have a Phase Code of 2-1-3. The use of a Phase code is not mandatory, but it can be useful for data recording purposes.

NOMENCLATURE

The name given to an Association should indicate the dominant species and the dominant associated species. The combination of dominant and associated species should reflect the entire character of the Association—to the degree possible when using only a few species names. The following examples will illustrate the naming technique, and provide some rules of thumb.

Figure 11—A Chamise/Manzanita/Sugarbush Association on Mt. San Jacinto near Banning, California. Chamise dominates the shrub layer, and manzanita and sugarbush are the characteristic associated species of this community; for classification purposes, this would be considered a one-layered Association.

The first species listed in an Association name will always be the dominant species of the Association, and will be the dominant overstory species. Therefore, a Jeffrey Pine/Sagebrush Association will have Jeffrey pine as the dominant overstory species.

The order of species in the Association name reflects the order of dominance in the Association. The order of dominance can be taken in two ways: We can recognize the dominant species in each layer of a multilayered stand, and write the species names in descending order of dominance by layers; we can recognize the dominant species in the dominant layer (overstory) of an Association, and recognize characteristic associated species within the same layer. The second approach is most appropriate for single-layered Associations, but may occasionally be used for two-layered Associations when there is good reason for doing so. Layer dominance should take precedence over within-layer species dominance when naming the Association.

A multilayered Association will be named by the dominant species in each layer, beginning with the overstory layer, and ending with the herbaceous layer if one exists. Each species name will be separated by a slash. Example: Jeffrey Pine/Sagebrush/Squirreltail grass.

An Association with mixed species dominance will be named in the usual manner, with the exception that the place in the Association name that is normally relegated to a single dominant species will be occupied by more than one species—separated by a hyphen. Example: A Jeffrey Pine-White Fir/Manzanita Association.

A single-layered Association will be named by the dominant species in the layer and the dominant associated species. Many chaparral Associations will be named in this manner (*fig. 11*). Examples: A Chamise-Scrub Oak Association or a Ceanothus-Manzanita-Chamise Association; in both cases, the species that are named form a part of the single shrub layer of the Association.

Shrubs with trees and herbaceous vegetation with shrubs or trees represent a special situation that warrants some attention. A classification system must provide criteria for class discrimination that are to some extent arbitrary. Consequently, we will find savannah-like Associations with insufficient tree canopy cover to be called elements of the Woodland Formation; yet there may be enough trees in the Association to be ecologically significant. In cases like these, the "unrecognized" tree or shrub cover should be included in the Association name—at the end and enclosed in parentheses. Example: A Foxtail Fescue-Mustard (Blue Oak) Association. A rule of thumb to follow in such cases is: Whenever an element of the Shrub Formation has a tree canopy cover of 10 to 25 percent, or an element of the Herbaceous Formation has a tree or shrub canopy cover of 10 to 25 percent, the tree or shrub will be included parenthetically in the Association name.

Common names may be used for local application of the System, but Latin names should be used in official documents, reports, and regional, national, or international correspondence. Naming procedures will remain the same; the Latin species names will simply replace the common species names. Example: A Foxtail Fescue-Mustard (Blue Oak) Association will be properly called a *Festuca megalura-Brassica* (*Quercus douglasii*) Association, and will belong to the *Festuca* Series (rather than the Fescue Series).

Given the appropriate perspective, any Association will fall into the category of Ephemeral or Transient Associations. We will treat it from the standpoint of resource management planning and decisionmaking. The most consistent candidates for this category will be certain elements of the Herbaceous Formation. Many stands of nonperennial herbs will appear only because of an especially heavy rainy season—and will disappear for a number of years; their reappearance will often be with a different species dominance, and a different species composition in general. Other stands may be composed of pioneer species that appear after a recent disturbance; the composition of these stands may change from year to year. These communities should not be treated with a greater degree of precision than is warranted by current management needs or by requirements for advancing the state of our knowledge. It may be sufficient to note the fact that there are elements of the Herbaceous Formation or perhaps classify them to Series. On the other hand, it may be desirable to assign them to at least a provisional Association without carrying out an extensive inventory. Judgment will have to be used in these kinds of cases.

Table 1—*Series distribution, by climate regions and habitats*

Subformation and Series	Climate regions[1]									Habitats[2]	
	Al	HMo	Mo	Co	Tr	IV	DTr	HDV	LDV	Rip	Alk
Closed Forest Formation											
Conifer Forest											
Cypress				×	×						
Bigcone Douglas-fir			×	×	×						
Douglas-fir			×	×							
Santa Lucia Fir				×							
White Fir		×	×								
Western Juniper		×	×								
Bishop Pine				×							
Bristlecone Pine	×	×									
Coulter Pine			×		×						
Knobcone Pine			×		×						
Limber Pine	×	×									
Lodgepole Pine		×	×								
Monterey Pine				×							
Ponderosa/Jeffrey Pine				×							
Torrey Pine				×							
Coast Redwood				×							
Mixed Conifer			×	×							
Broadleaf Forest											
Alder			×		×					×	
Aspen		×	×							×	
California Bay				×						×	
Eucalyptus						×					
Island Ironwood				×							
Madrone				×	×						
Bigleaf Maple			×	×	×					×	
Black Oak			×	×							
Canyon Live Oak			×	×			×				
Coast Live Oak			×	×	×	×					
Tanoak				×	×						
Woodland Formation											
Conifer Woodland											
Juniper							×				
Digger Pine					×	×					
Pinyon Pine			×				×				
Broadleaf Woodland											
California Buckeye					×	×					
Cottonwood					×	×		×	×	×	
Desert Ironwood									×	×	
Mesquite								×	×		
Blue Oak					×	×					
Engelmann Oak						×					
Interior Live Oak			×		×		×				
Valley Oak						×					
Palo Verde									×	×	
Salt-cedar								×	×	×	
Smoke Tree									×	×	
Sycamore					×	×				×	
Desert Willow									×	×	
Willow		×	×	×	×	×	×	×	×	×	
Succulent Woodland											
Joshua Tree			×				×	×			
Palm									×	×	

Table 1—*Series distribution, by climate regions and habitats*—continued

Subformation and Series	Climate regions[1]									Habitats[2]	
	Al	HMo	Mo	Co	Tr	IV	DTr	HDV	LDV	Rip	Alk
Shrub Formation											
Chaparral											
Ceanothus				×	×	×	×				
Chamise				×	×	×	×				
Bush Chinquapin		×									
Mountain Mahogany			×		×		×				
Manzanita		×	×		×		×				
Scrub Oak			×	×	×		×				
Prunus				×	×						
Redshank					×		×				
Sumac				×	×						
Toyon				×	×						
Soft Chaparral											
Baccharis				×		×		×	×	×	
California Buckwheat				×		×	×				
Coastal Sagebrush				×		×					
Croton									×		
Encelia						×			×		
Lupine				×							
Rabbitbrush			×				×	×			
Salvia				×	×	×					
Woody Shrub											
Arrowweed									×	×	
Blackbush							×	×			
Catclaw									×		
Creosote								×	×		
Greasewood								×			
Ocotillo									×		
Wild Rose			×	×	×	×				×	
Sagebrush			×				×				
Saltbush								×	×		
Succulent Shrub											
Agave							×		×		
Iodine Bush								×	×	×	×
Opuntia				×				×	×		
Dwarf Shrub Formation											
Cushion Plant											
Buckwheat	×										
Succulent Dwarf Shrub											
Pickleweed				×				×	×	×	×
Suaeda				×		×		×	×		×
Herbaceous Formation											
Graminoid											
Bromegrass			×	×	×	×					
Bulrush		×	×	×	×	×	×	×	×	×	×
Cattail (*Typha*)		×	×	×	×	×	×	×	×	×	
Cordgrass			×	×			×				×
Fescue				×	×	×					
Galleta Grass							×	×	×		
Muhlenbergia			×		×		×			×	
Needlegrass				×		×					
Wild Oats				×	×	×					
Ricegrass			×				×	×			
Wild Rye			×								
Sacaton						×		×	×	×	×
Saltgrass			×	×		×		×			×
Sedge (*Carex*)	×	×	×	×	×	×	×	×	×	×	
Wiregrass (*Juncus*)	×	×	×	×	×	×	×	×	×	×	

Table 1—*Series distribution, by climate regions and habitats*—continued

bformation and Series	Climate regions[1]									Habitats[2]	
	Al	HMo	Mo	Co	Tr	IV	DTr	HDV	LDV	Rip	Alk
Herbaceous Formation											
Forb											
Ambrosia				×							
Coldenia				×							
Goldenrod			×		×						
Mustard		×	×	×	×	×					
Wyethia					×	×					
Aquatic											
Pondweed		×	×	×	×	×	×	×	×		
Water Hyacinth		×	×	×	×	×	×	×	×		
Water Milfoil		×	×	×	×	×	×	×	×		
Cryptogam											
Fern	×	×	×	×	×	×	×	×	×		
Lichen	×	×	×	×	×	×	×	×	×		
Moss	×	×	×	×	×	×	×	×	×		

[1]Al = Alpine; HMo = High Montane; Mo = Montane; Co = Coastal; Tr = Transition; IV = Interior Valley; DTr = Desert Transition; HDV = High Desert Valley; LDV = Low Desert Valley. For description, see Appendix A.

[2]Rip = Riparian; Alk = Alkaline soil.

FIELD KEY TO SUBFORMATIONS

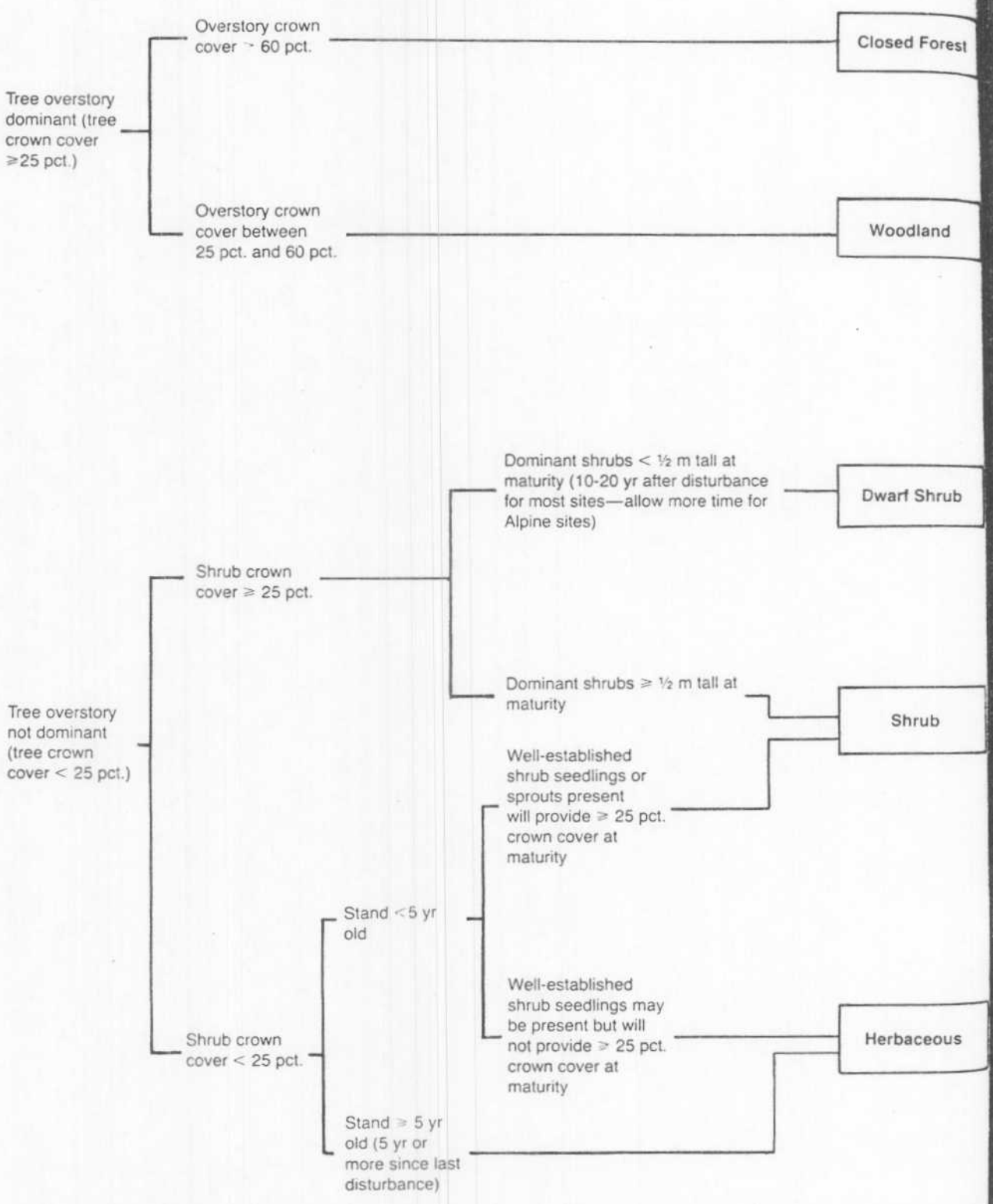
The following key may be used to identify Subformations in southern California. It is arranged in two parts: a key to Formations, and a key to Subformations. *Table 1* contains a list of Series keyed to the climate regions within which they most often occur. Series are identified by the dominant species present in a stand; therefore a dichotomous Series key is not necessary—a plant species key would be the necessary tool for determining Series. Associations will have to be identified at the site; for the present time, a key to Associations is not feasible.

Suggestions for Field Use of the Key. When using the key and *table 1* to interpret vegetation on the ground,

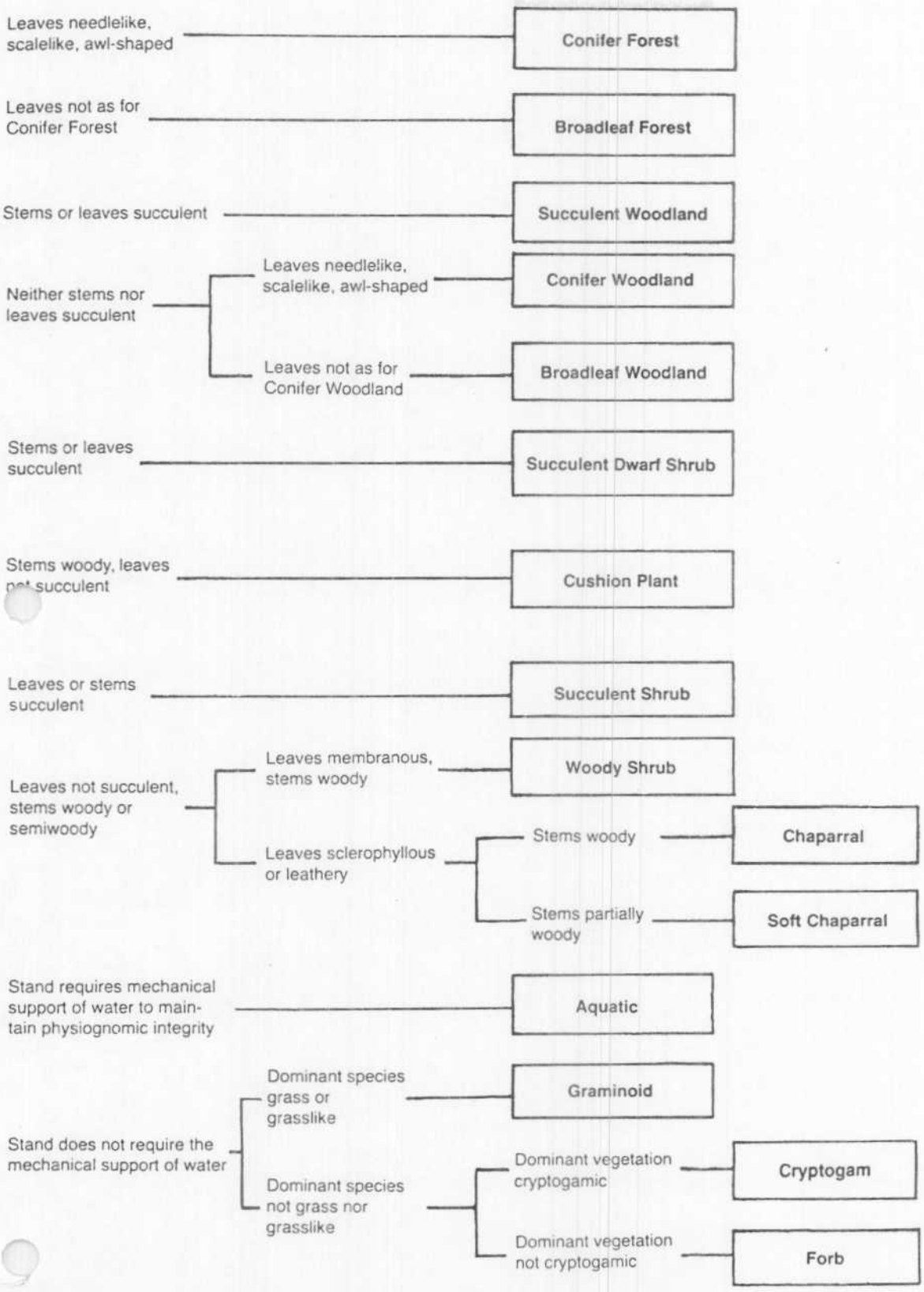
- Look at the variability across the landscape.
- Determine whether the variability can be explained by some ecological factor, i.e., soil differences, aspect differences, evaluation differences, changes in land form, etc. Specific communities may be related to unique combinations of these factors. For example: The Manzanita Series dominates northwest aspects, the Chamise Series dominates ridgetops and southeast aspects, and steep canyons contain the Bigcone Douglas-fir Series.
- If the overstory dominance is not clear, determine whether you are operating in an ecotone. Are understory or associated plants more characteristic of the Series present on either end of the ecotone? For example: As elevation increases, creosote bush drops out of the overstory and juniper, although present, does not replace it in dominance. Are the associated species more characteristic of the Creosote Series or the Juniper Series?
- Make the best interpretation possible based on your experience and ability to distinguish patterns in situations where interpretation is difficult (*fig. 12*). Distribution patterns for overstory species may be disrupted owing to local species competition, seed dispersal mechanisms and patterns, fire history, floristic history, or human use of the site. Most Associations that are identified in the field should be considered provisional until they can be placed within the context of general vegetation distribution patterns in a floristic region or zone.

Figure 12—Intepreting vegetation on the ground can be complicated by a variety of Associations. Elements of the Redshank, Chamise, Interior Live Oak, and Coulter Pine Series intermingle in the interface zone between brushland and timberland.

KEY TO FORMATIONS



KEY TO SUBFORMATIONS



SERIES DESCRIPTIONS

Closed Forest Formation

Vegetation: The Series and Subformations of the Closed Forest Formation are dominated by deciduous or evergreen trees that are at least 15 feet (5 m) tall, with crowns mostly interlocking (UNESCO 1973). Since many "forested" areas are only marginally capable of supporting a true closed forest, stands with an overstory crown cover of at least 60 percent will qualify as closed forests. The Closed Forest Formation is comprised of the Conifer and Broadleaf Subformations. The Conifer Subformation contains Series that are dominated by conifer species, and the Broadleaf Subformation contains Series that are dominated by evergreen or deciduous broadleaf species—broadleaf forests are sometimes described as hardwood or mixed-evergreen forests.

Distribution: The Closed Forest Formation is worldwide in distribution. Elements of the Conifer Forest Subformation occur from sea level near the coast to above 11,000 feet (3353 m) in the interior of southern California. The Broadleaf Forest Subformation is found in the coastal and interior mountain ranges of southern California, and also in some riparian habitats.

Suggested Phases are:

Size (d.b.h., 2 inches)	*Cover (percent)*	
	Overstory	*Understory*
1. <1	1. <25	1. <10
2. 1-5	2. 10-25	2. 10-25
3. 5-11	3. >60	3. 25-50
4. 11-21		4. 50-70
5. >21, <180 yrs		5. >70
6. >21, >180 yrs		

Conifer Forest Subformation

Series within the Conifer Forest Subformation are named for the dominant overstory species, usually that species which makes up 60 percent or more *of the total crown cover*. In a Mixed Conifer Series, two or three specified codominants make up 60 percent or more of the total crown cover (*fig. 13*).

Cypress Series

Vegetation: Dominant overstory may be Sargent cypress (*Cupressus sargentii*), Monterey cypress (*C. macrocarpa*), Gowan cypress (*C. goveniana*), Tecate cypress (*C. forbesii*), Cuyamaca cypress (*C. stephensii*), or Santa Cruz cypress (*C. abramsiana*). Disjunct stands of cypress, usually with only one dominant species per stand, occur within the Chaparral and Conifer Forest Formations. Chaparral shrubs often occur in the understory. Cypress stands occur on serpentine or low-nutrient soils.

Distribution: Localized populations of cypress are present in the Santa Cruz Mountains (*C. abramsiana*), Santa Ana Mountains, Otay Mountains, Baja California (*C. forbesii*), and Monterey Peninsula (*C. goveniana, C. macrocarpa*), from Mendocino County to Santa Barbara County (*C. sargentii*), and on Cuyamaca Peak in San Diego County (*C. stephensii*).

Bigcone Douglas-fir Series

Vegetation: Overstory species is *Pseudotsuga macrocarpa* with *Quercus chrysolepis* (canyon live oak) and occasionally black oak (*Q. kelloggii*). Dense stands are found in canyons or on north-facing slopes (*fig. 14*). Mature stands have a sparse herbaceous layer. Younger stands may have a chaparral shrub understory.

Distribution: The total range of bigcone Douglas-fir is within southern California, from near Mount Pinos in Kern County south to San Diego County.

Douglas-fir Series

Vegetation: Pseudotsuga menziesii is the dominant overstory species. Representatives of this Series may occur as extensive "pure" stands or be intermingled with elements of the Coast Redwood or Monterey Pine Series.

Distribution: The most extensive stands of Douglas-fir are in western Oregon and Washington, though the species grows throughout the Western States ranging from British Columbia south to Mexico. Within California, the species dominates stands through the Klamath and Coast Ranges to the Santa Cruz Mountains. Isolated stands occur in Monterey County.

Santa Lucia Fir Series

Vegetation: Abies bracteata is the dominant species. Stands are interspersed with the Broadleaf Forest Formation in steep, rocky, fire-resistant habitats.

Distribution: This Series has a restricted distribution consisting of relict stands within 15 miles (24.14 km) of the coast in the Santa Lucia Mountains of Monterey and San Luis Obispo Counties.

White Fir Series

Vegetation: Abies concolor is the dominant overstory species, and may occur in nearly pure stands. The understory vegetation is sparse with a moderate accumulation of litter, including needles and fallen branches.

Distribution: White fir is widely distributed in the Western States from Oregon to New Mexico and south into Mexico. Small relict stands in the mountains of the north Mojave Desert appear more closely related genetically to the white fir of the Rocky Mountains than to the white fir of California.

Western Juniper Series

Vegetation: Juniperus occidentalis is the dominant overstory species, found in sparse stands with sparse shrubby understory of *Artemisia* (sagebrush) and *Chrysothamnus* (rabbitbrush) species.

Distribution: Western juniper extends from southern Washington throughout the Great Basin area of the West with disjunct populations in the mountains of southern California.

Bishop Pine Series

Vegetation: Pinus muricata is the dominant species with chaparral shrubs in the understory. Growth habit can be twisted, when the tree is subjected to winds and salt spray, or straight with a broad crown where it is protected from the wind.

Distribution: Intermittent relict stands range from Humboldt County south to Santa Barbara County and the Channel

Islands. Bishop pine grows within the fog belt along the Pacific Coast.

Bristlecone Pine Series

Vegetation: Pinus aristata (named *P. longaeva* by Bailey [1970]) is the dominant overstory species occurring in sparse stands with limber pine. This Series is found on dolomitic soils at the upper elevational limits of the conifer forest. It is interspersed with the Dwarf Shrub Formation in alpine habitats.

Distribution: Bristlecone pine extends west from Utah into Inyo County in California where it is found in the White, Last Chance, Inyo, and Panamint Mountains.

Coulter Pine Series

Vegetation: Pinus coulteri is the dominant overstory species with chaparral shrubs and interior live oaks in the understory (*fig. 15*). This Series interfaces with the Chaparral Formation.

Distribution: Coulter pine ranges from Contra Costa County south to Baja California.

Knobcone Pine Series

Vegetation: Pinus attenuata is the dominant overstory species with chaparral shrubs in the understory. This Series interfaces with the Chaparral Formation throughout much of its range and also occurs on serpentine soils with the Conifer Forest Formation.

Distribution: Knobcone pine occurs from the Oregon Cascades south to Baja California.

Limber Pine Series

Vegetation: Pinus flexilis is the dominant overstory species, a subalpine tree growing in sparse stands with a sparse understory. Above 11,000 feet (3352.8 m) elevation, limber pine tends to form krummholz stands, the prostrate forms appearing more like shrubs than ancient trees.

Distribution: Limber pine ranges from Canada to New Mexico in the mountains of the Western United States. Southern California stands are scattered on the highest peaks of the Inyo, Panamint, San Gabriel, San Bernardino, and San Jacinto Mountain ranges. The western limit is on Mount Pinos in Kern County.

Lodgepole Pine Series

Vegetation: Pinus contorta is the dominant overstory species, in sparse stands within xeric, high-elevation habitats or in dense stands surrounding meadows. Understory also varies according to habitat.

Distribution: Lodgepole pine ranges from Alaska to Baja California and east to South Dakota. It grows in a wider range of elevations—sea level to 12,000 feet (3657.6 m)—than any other pine (Griffin and Critchfield 1972). In southern California, this Series is a dominant one above 8000 feet (2438.4 m). However, Bluff Lake Meadow, at 7200 feet (2194.6 m), in the San Bernardino Mountains, supports a small stand of lodgepole pine including the Champion Lodgepole.[7]

[7] American Forestry Association. June 3, 1963. Report to the Forest Supervisor, San Bernardino National Forest, San Bernardino, Calif.

Figure 13—A classic example of the Mixed Conifer Series on steep, rugged terrain. An admixture of black oak can be seen with the dominant sugar pine and white fir. Because of the steep topography, litter accumulation is low.

Figure 14—Repeated fires have often relegated the Bigcone Douglas-fir Series to protected drainage bottoms in many parts of southern California.

Figure 15—An early Phase Coulter Pine/Interior Live Oak Association 5 years after a fire. The emergent Coulter pine has attained sufficient dominance to qualify this stand as an element of the Closed Forest Formation. Ceanothus and manzanita can also be seen in the shrub layer.

Figure 16—A mature Jeffrey Pine/Interior Live Oak/Bromegrass Association represents the Closed Forest Formation in the middle ground, and the Herbaceous Formation can be seen in the foreground. Environmental factors have maintained the distinction between the herbaceous layer of the Closed Forest Formation and the Herbaceous Formation.

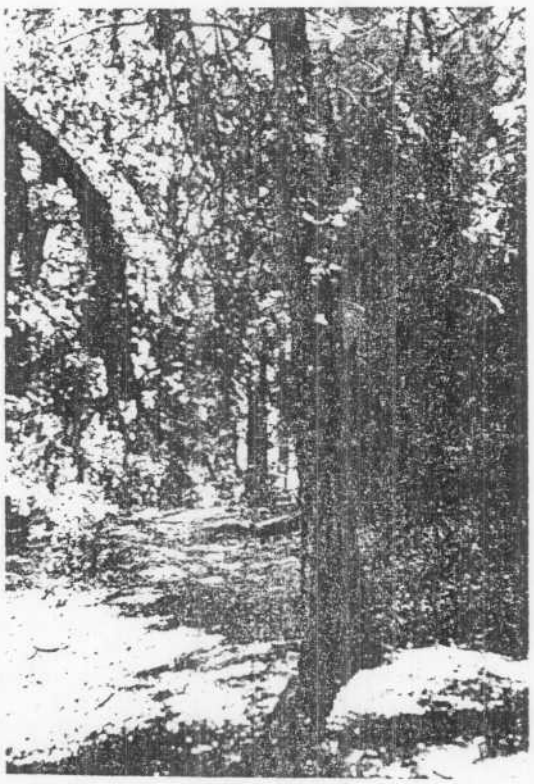


Figure 17—The interior of a stand belonging to the Mixed Conifer Series. In spite of the heavy use given to this stand (foot traffic), Jeffrey pine, white fir, and black oak seedlings are well established in the understory.

Monterey Pine Series

Vegetation: Pinus radiata is the dominant overstory species in open to moderately dense stands with live oaks and cypress. Shrubs and perennial herbs occupy the understory.

Distribution: Relict stands are present within the coastal fog belt at three different locations in central California: Ano Nuevo, Monterey Peninsula, and Cambria Hills.

Ponderosa/Jeffrey Pine Series

Vegetation: Dominant overstory species are *Pinus ponderosa* or *P. jeffreyi* with herbaceous or shrubby understory (*fig. 16*).

Distribution: Ponderosa pine is present in dominant stands in mountains throughout the Western States. Jeffrey pine ranges from southern Oregon to mountains of Baja California. Jeffrey pine generally occurs on the drier or higher elevation sites and ponderosa pine occupies the most mesic midelevation habitats where the ranges of the two species coincide.

Torrey Pine Series

Vegetation: Relict stands of *Pinus torreyana* form a sparse overstory with soft chaparral shrubs in the understory.

Distribution: Sea bluffs at Del Mar in San Diego County, and on Santa Rosa Island are the only remaining habitats for relict stands of Torrey pine.

Coast Redwood Series

Vegetation: Sequoia sempervirens is dominant in mixed stands with California laurel (*Umbellularia californica*) and Douglas-fir (*Pseudotsuga menziesii*). Mosses and ferns often grow in the understory. A deep litter layer covers the soil.

Distribution: Coast redwood occurs in discontinuous stands from southern Oregon south to San Luis Obispo County in California, growing within 30 miles (48.3 km) of the Pacific Coast.

Mixed Conifer Series

Vegetation: Overstory components are a mix of *Pinus lambertiana* (sugar pine), *Abies concolor* (white fir), *Pinus ponderosa* (ponderosa pine), or *Pinus jeffreyi* (Jeffrey pine), and *Calocedrus decurrens* (incense-cedar). The overstory is multistoried in dense stands with moderate to heavy litter accumulations (*fig. 17*).

Distribution: Mixed Conifer occurs throughout the California mountains, north into Oregon, and south into the Sierra San Pedro Martir of Baja California.

Broadleaf Forest Subformation

Series within the Broadleaf Forest Subformation are named for the dominant overstory species. Four represent strictly riparian habitats in southern California although they may occur outside of riparian areas in more mesic environments. One (*Eucalyptus*) represents introduced species which have become naturalized.

Alder Series

Vegetation: Alnus rhombifolia or *A. rubra* is the dominant overstory species in this Series, which occurs in riparian habitats with flowing water. Understory shrubs, such as *Ribes* and *Salix* species, with abundant herbaceous vegetation, make this a multistoried, diverse habitat.

Distribution: Alnus rhombifolia (white alder) is found throughout California, except for the Pacific Coast, where it is

replaced by *A. rubra* (red alder). White alder ranges north into British Columbia and east to Idaho.

Aspen Series

Vegetation: Populus tremuloides is the dominant overstory species. The Series occurs around moist mountain meadows.

Distribution: Aspen ranges from Alaska through Canada and the United States to Mexico. Southern California populations are disjunct, occurring in the White Mountains and San Bernardino Mountains.

California Bay Series

Vegetation: Dominant overstory is *Umbellularia californica* with shrubs in the understory.

Distribution: California bay extends from San Diego County north to southwest Oregon. It is present along streamcourses or springs in southern California and on coastal foothills north of Ventura County and on the Channel Islands.

Eucalyptus Series

Vegetation: Eucalyptus occurs in dominant stands with a dense litter layer and essentially no shrubs or herbaceous species in the understory.

Distribution: Native to Australia, this genus has been planted in dense stands widely scattered through California and has become naturalized, with some reproduction occurring. No exact distribution inventory exists.

Island Ironwood Series

Vegetation: Dominant overstory is *Lyonothamnus floribundus* with a shrubby understory.

Distribution: Island ironwood occurs in Santa Catalina Island and a subspecies (*asplenifolius*) with pinnate leaves is found on San Clemente, Santa Rosa, and Santa Cruz Islands.

Madrone Series

Vegetation: Arbutus menziesii is the dominant overstory species. The Series is often intermingled with both Coast Redwood and Douglas-fir Series.

Distribution: Madrone occurs in a few relict stands in southern California—on Palomar Mountain, the Santa Monica Mountains, and Santa Cruz Islands. From the Santa Lucia Mountains northward to British Columbia madrone is common, both as a Series dominant and as a component of the Coast Redwood Series and Douglas-fir Series.

Bigleaf Maple Series

Vegetation: Acer macrophyllum, a deciduous tree, is the dominant overstory species. The Series is riparian in southern California, but spreads over hillsides away from streams in the North.

Distribution: Bigleaf maple is found along the coast from British Columbia to San Diego County in southern California. The Series occurs on the west slopes of the Sierra Nevada Mountains and in the Peninsular and Transverse Ranges, but does not follow rivers into the Central Valley.

Black Oak Series

Vegetation: Quercus kelloggii is the dominant overstory species—a deciduous tree which produces a well-developed litter layer. Understory includes shrubs, grasses, and perennial forbs. Black oak will sometimes survive fire and resprout from the crown. If crowns are fire killed, it resprouts from the base.

Distribution: Black oak occurs from Oregon south to the Laguna Mountains in San Diego County (*fig. 18*).

Figure 18—The Black Oak Series is a common Broadleaf Forest element in southern California.

Canyon Live Oak Series

Vegetation: Quercus chrysolepis is the dominant overstory tree. This Series can occur in riparian habitats, interfacing the Chaparral Formation, or on mountain sideslopes at higher elevations. This species is usually fire-killed, resprouting from the base rather than the crown.

Distribution: Canyon live oak occurs from southwestern Oregon to Baja California, east to central Arizona.

Coast Live Oak Series

Vegetation: Quercus agrifolia is the dominant overstory species (*fig. 19*). Under optimum growth the Series is a dense forest, but it sometimes forms open savannah-like grasslands. This live oak has exceptional fire resistance. Trees greater than 8 inches (20.3 cm) d.b.h. will resist top kill, resprouting from the crown within 2 months after being totally blackened.[8]

Distribution: Coast live oak occurs from Mendocino County south to Baja California.

Tanoak Series

Vegetation: Lithocarpus densiflorus is the dominant overstory species often associated with madrone (*Arbutus menziesii*). Tanoak grows in a shrubby form on rocky, exposed ridges.

Distribution: Tanoak occurs from southwestern Oregon south to Santa Barbara County in California. It is the only North American representative of a large Asian genus.

Woodland Formation

Vegetation: Dominant trees are more than 15 feet (5 m) tall, with an open canopy. Crowns are not touching and canopy cover is between 25 and 60 percent. Both herbaceous and shrubby understories can be present. Trees may be deciduous or evergreen, and may be conifers or broadleaf species. Three Subformations are included in the Woodland Formation: The

[8] Plumb, T.R. 1976. Response of Southern California oaks to wildfire. (Report on file at the Forest Fire Laboratory, Pacific Southwest Forest and Range Experiment Station, Riverside, Calif.)

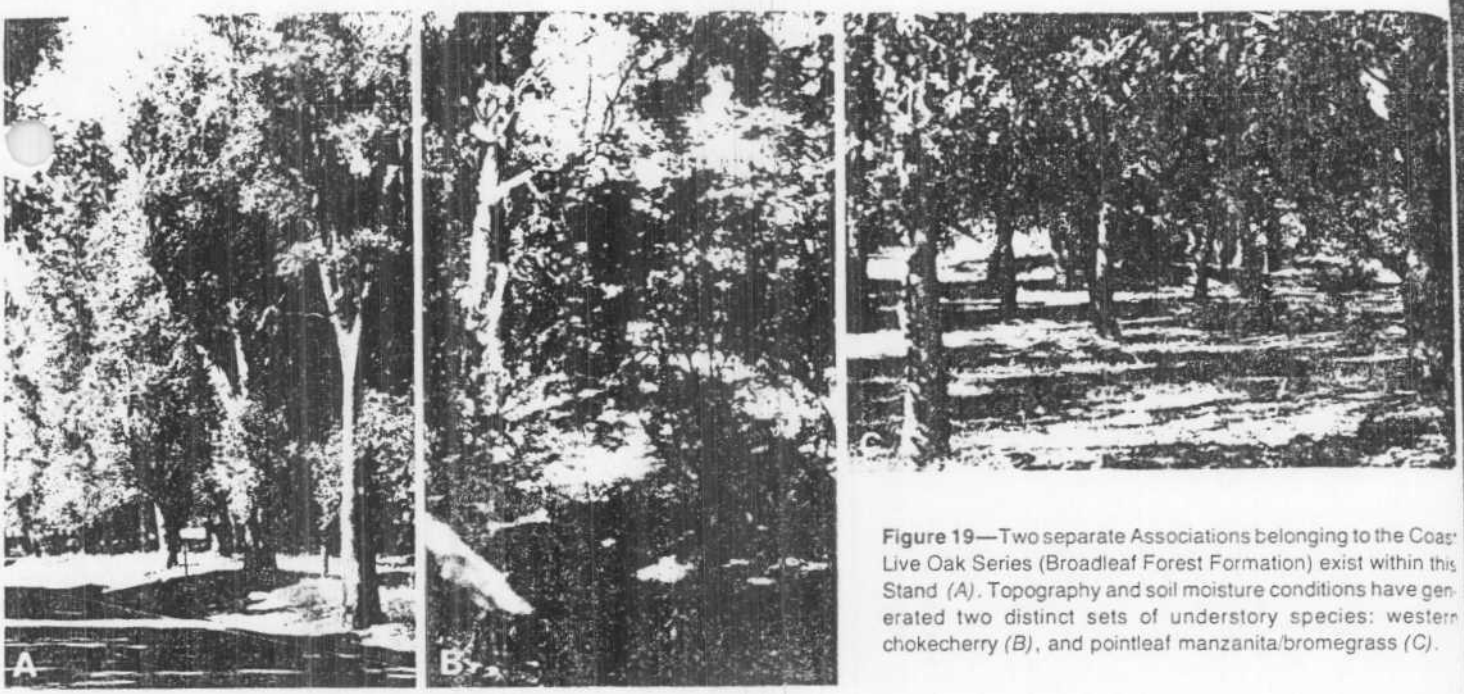


Figure 19—Two separate Associations belonging to the Coast Live Oak Series (Broadleaf Forest Formation) exist within this Stand *(A)*. Topography and soil moisture conditions have generated two distinct sets of understory species: western chokecherry *(B)*, and pointleaf manzanita/bromegrass *(C)*.

Conifer Woodland, Broadleaf Woodland, and Succulent Woodland Subformations.

Distribution: Woodlands occur worldwide. In southern California, they occupy riparian habitats, valley savannahs, and foothill and mountain habitats. Seven Series in the Woodland Subformation occupy desert riparian habitats exclusively, including dry washes and oases. Most of the remaining Series occupy riparian as well as nonriparian habitats, varying in density and understory as the habitat changes from xeric to mesic.

Suggested Phases are:

Size (d.b.h., 2 inches)	*Cover (percent)*	
	Overstory	*Understory*
1. <1	1. <25	1. <10
2. 1-5	2. 10-25	2. 10-25
3. 5-11	3. 25-60	3. 25-50
4. 11-21		4. 50-70
5. >21		5. >70

Conifer Woodland Subformation *(fig. 20)*

Juniper Series

Vegetation: Dominant overstory vegetation species is either *Juniperus californica* or *J. osteosperma*, with desert and chaparral shrubs in the understory. *J. californica* is an arborescent shrub.

Distribution: Utah juniper, *Juniperus osteosperma*, ranges into California from the Great Basin and is present in spotty distributions from Inyo County to eastern Los Angeles County in the San Gabriel Mountains. California juniper, *J. californica*, occurs from Tehama County south to San Diego County.

Digger Pine Series

Vegetation: Pinus sabiniana is the dominant overstory species. Digger pine sometimes occurs as inclusions within the Broadleaf Forest Formation. Understory vegetation is mainly grass and forbs.

Distribution: The total distribution of this species is within California, in foothills from Shasta County south to Los Angeles County.

Pinyon Pine Series *(fig. 21)*

Vegetation: Pinus monophylla or *P. quadrifolia* are dominant overstory species, with shrubs in the understory.

Distribution: In southern California, pinyon pine occurs in desert mountains from Inyo County west to Santa Barbara County and south to San Diego County. *Pinus monophylla* ranges from Idaho to Baja California. *P. quadrifolia* extends into southern California from Baja California as far north as Riverside County.

Broadleaf Woodland Subformation

California Buckeye Series

Vegetation: Aesculus californica is the dominant overstory species, forming dense stands on hillsides or extending into valleys along rivers or streams. California buckeye is a deciduous tree with a shrubby form.

Distribution: The total distribution of this species is within California. It surrounds the Central Valley from Shasta County south to Los Angeles County.

Cottonwood Series

Vegetation: Dominant overstory species are *Populus fremontii* or *P. trichocarpa*. Both are riparian species and are deciduous. Fremont cottonwood, *Populus fremontii*, follows streams and dry washes at low elevations. Black cottonwood, *P. trichocarpa*, occurs at higher elevations in southern California.

Distribution: Both species of cottonwood are present throughout California. Black cottonwood ranges from Baja California throughout the West and north to Alaska. Fremont cottonwood covers the Southwest to Texas and Mexico.

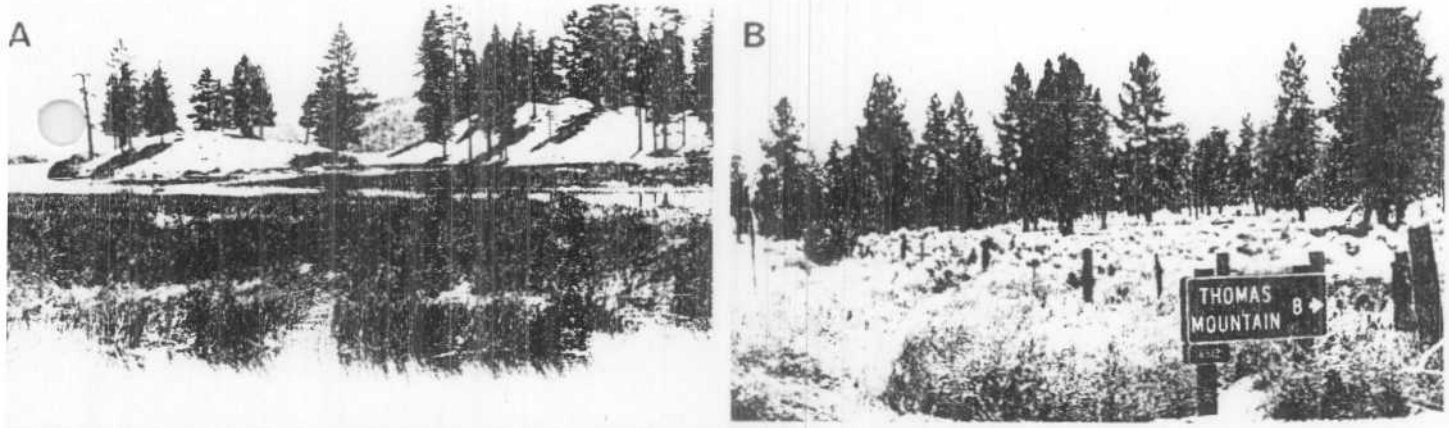


Figure 20—The Jeffrey pine stand near Big Bear Lake *(A)* and the Jeffrey Pine/Sagebrush Association in *B* both raise the question as to whether a Jeffrey Pine Series should be included in the Conifer Woodland Subformation. These stands may simply represent extreme, but acceptable, density variation within the Closed Forest Formation.

Figure 21—The Pinyon Pine/Sagebrush Association is an element of the Conifer Woodland Formation. A distinct environmental break defines the limit of the pinyon overstory and is an easily defined boundary for the Sagebrush Association (Shrub Formation) in the foreground.

Desert Ironwood Series

Vegetation: Olneya tesota is the dominant overstory species. This is a drought-deciduous California Sonoran Desert riparian Series with a sparse understory. The wood is extremely hard and dense, and weathers very slowly in the desert climate. Ironwood has an ability to go dormant and survive drought longer than riparian species. Seeds require scarification by tumbling in flash floods for germination.

Distribution: Desert ironwood ranges from the California Sonoran Desert to Arizona and south to Mexico.

Mesquite Series

Vegetation: The dominant overstory is either honey mesquite, *Prosopis glandulosa* var. *torreyana*, or screwbean mesquite, *P. pubescens*. These are a drought-deciduous desert riparian species occupying dry washes, oases, or moist seeps. Understory includes desert wash shrubs such as desert lavender, *Hyptis emoryi*, or desert broom, *Baccharis spp*.

Distribution: Honey mesquite is more prevalent in the California Sonoran Desert and screwbean mesquite is the more common Mojave Desert species. Both range from the San Joaquin Valley south and east to Texas and Mexico.

Blue Oak Series

Vegetation: Quercus douglasii is the dominant overstory species with shrub or grass-forb understory. Blue oak is a deciduous tree growing in open savannah-like stands on valley floors and forming woodlands in the foothills.

Distribution: Blue oak surrounds the Central Valley, reaching northward into Shasta County, and south to Los Angeles County, and Santa Cruz and Santa Catalina Islands.

Engelmann Oak Series

Vegetation: Quercus engelmannii is the dominant overstory species, with soft chaparral shrubs, grasses, and forbs in the understory.

Distribution: Englemann oak has a scattered distribution from Los Angeles County south to Baja California, but the major extent of the Series distribution is in western San Diego County.

Interior Live Oak Series

Vegetation: Quercus wislizenii is the dominant overstory species with chaparral shrubs in the understory. This Series occupies xeric habitats between Chaparral and Forest Formations, but follows intermittent streams into Chaparral. The species is very sensitive to fire.[8] The larger trees are usually located in areas that have not burned in 50 to 100 years. More often this live oak is present in dense shrublike thickets with multiple stems, the result of resprouting from the base following fire.

Distribution: Interior live oak is generally a California species ranging from Siskiyou County south to Baja California.

Valley Oak Series

Vegetation: Quercus lobata is the dominant overstory species with shrub or grass/forb understory.

Distribution: Valley oak follows the same distribution as blue oak, from Shasta County south to Los Angeles County and the Channel Islands.

Palo Verde Series

Vegetation: The dominant overstory tree is palo verde, *Cercidium floridum* or *C. microphyllum*, with a sparse understory. These are drought-deciduous riparian trees. The Series is common in California Sonoran Desert dry washes or rocky bajadas. Tumbling in flash floods or abrasion by some other means is necessary for seed germination.

Distribution: Palo verde ranges through both California deserts to Arizona and Mexico.

Salt-cedar Series

Vegetation: Tamarix spp. are the dominant overstory trees. All are introduced from Asia or the Mediterranean region. They form dense thickets competing aggressively with native species. *Tamarix* has a high rate of transpiration and is sometimes blamed for lowering water tables. This Series occupies moist seeps and streambanks in the desert. *Tamarix* is often planted as a windbreak.

Distribution: Tamarix has become naturalized throughout the Southwest.

Smoke Tree Series

Vegetation: Dalea spinosa is the dominant overstory tree. This is a drought-deciduous desert riparian tree common to dry washes in the California Sonoran Desert. Seeds germinate after scarification, usually from tumbling in flash floods. The extent of past flooding can be inferred from the distribution of smoke trees (*fig. 22*).

Distribution: Smoke tree ranges from the southern Mojave Desert through the California Sonoran Desert to Arizona and Mexico.

Sycamore Series

Vegetation: The dominant overstory species is *Platanus racemosa*. Sycamores follow perennial and intermittent streams with a soft chaparral shrub and herbaceous understory.

Distribution: California sycamore ranges from Baja California north to Shasta County.

Desert Willow Series

Vegetation: Chilopsis linearis is the dominant overstory species. This is a drought-deciduous riparian species of the California Sonoran Desert and inland valleys of southern California. It is not related to willow, *Salix* spp., but has drooping elongated leaves similar to some willow species. Understory vegetation is sparse to moderate, consisting of soft chaparral and desert shrub species.

Distribution: Desert willow ranges from the Mojave and California Sonora Deserts south to Mexico and east to Texas.

Willow Series

Vegetation: Salix lasiolepis (arroyo willow), *S. gooddingii* (black willow), *S. hindsiana* (sandbar willow), and other *Salix* spp. are dominant overstory species. They may be trees or shrublike, and always indicate riparian habitats. The understory is herbaceous. Since willows are deciduous, dense stands have deep litter layers.

Distribution: The genus has worldwide distribution at all elevations. In southern California, the Series may occur wherever surface water or subsurface seeps are present.

Succulent Woodland Subformation

Joshua Tree Series *(fig. 23)*

Vegetation: The dominant overstory species is *Yucca brevifolia*. Understory shrubs include desert and chaparral species. The herbaceous understory varies from moderately dense in mountain foothills to virtually absent on the Mojave Desert. Joshua trees occur more often as a component of the Pinyon Series, or of shrub Series that occur in desert climates, than as a dominant overstory.

Distribution: The Joshua tree occurs in foothills and desert highlands surrounding the Mojave Desert, from San Bernardino County north to Inyo County, into Nevada and northern Arizona.

Palm Series

Vegetation: The dominant overstory is usually the California fan palm (*Washingtonia filifera*) with an understory of shrubs and grasses. Occasionally date palms (*Phoenix* spp.) have become naturalized, and occur as dominants in the overstory. Cottonwoods and mesquites are sometimes present.

Distribution: The Palm Series is found in the California Sonora Desert and oases, which often follow earthquake-fault lines.

Shrub Formation

Vegetation: Elements of the Shrub Formation are dominated by shrubs that are between 1½ feet (½ m) and 15 feet (3 m) tall *at maturity*. Our definition of "shrub" includes succulent-stemmed species (such as cactus) that are not normally called shrubs. Evergreen sclerophyllous shrubs dominate Series in the Chaparral Subformation; the shrubs are adapted to fire resprouting or germinating following fire. The Soft Chaparral Subformation is dominated by shrubs with relatively little woody tissue; woody tissue that is present is generally confined to the basal portions of the shrubs. In terms of stand physiognomy and shrub morphology, we can, for practical purposes, describe the Woody Shrub Subformation as a membranous-leaved analogue of the Chaparral Subformation; some dominant species found in the Woody Shrub Subformation have survival mechanisms that allow them to maintain their existence in a fire regime, but adaptation to fire is not a diagnostic character of this Subformation. The Woody Shrub Subformation includes some plant communities that occur in dry desert habitats, and others that occur in mesic environments with a readily available supply of moisture. Dominant species in the Succulent Shrub Subformation are succulent stemmed (e.g., *Opuntia* spp.) or have succulent leaves (*Allenrolfea* spp. and *Agave* spp.).

Distribution: The Shrub Formation is worldwide in distribution, and occurs in a wide range of habitats.

Suggested Phases are:

Cover (percent)			
Overstory	*Understory*	*Annual*	*Litter*
1. <5	1. <5	1. <2	Expressed
2. 5-10	2. 5-10	2. 2-10	in percent
3. 10-25	3. 10-25	3. 11-25	cover and
4. 25-50	4. 25-50	4. 25-50	composition
5. 50-70	5. 50-70	5. 50-70	
6. >70	6. >70	6. >70	

Chaparral Subformation *(fig. 24)*

Vegetation: Chaparral is dominated by evergreen sclerophyllous shrubs, mostly less than 15 feet tall (3 m). Shrubs are adapted to fire, resprouting or germinating following fire. Shrub crown cover at maturity is often close to 100 percent, although it can remain sparse on very steep or poor sites.

Distribution: Chaparral occurs throughout California, but is best developed in southern California. The Subformation extends from southern Oregon to central Arizona and Baja California.

Figure 22—The Smoke Tree Series is a common representative of the Broadleaf Woodland Subformation in dry desert washes.

Figure 23—One of the two Series currently in the Succulent Woodland Subformation is represented by the Joshua Tree/Nevada Ephedra Association. Other associated species in this stand are cottonthorn (Tetradymia spinosa) and box-thorn (Lycium andersonii). Hairy Yerbasanta (Eriodictyon trichocalyx) occurs in disturbed areas.

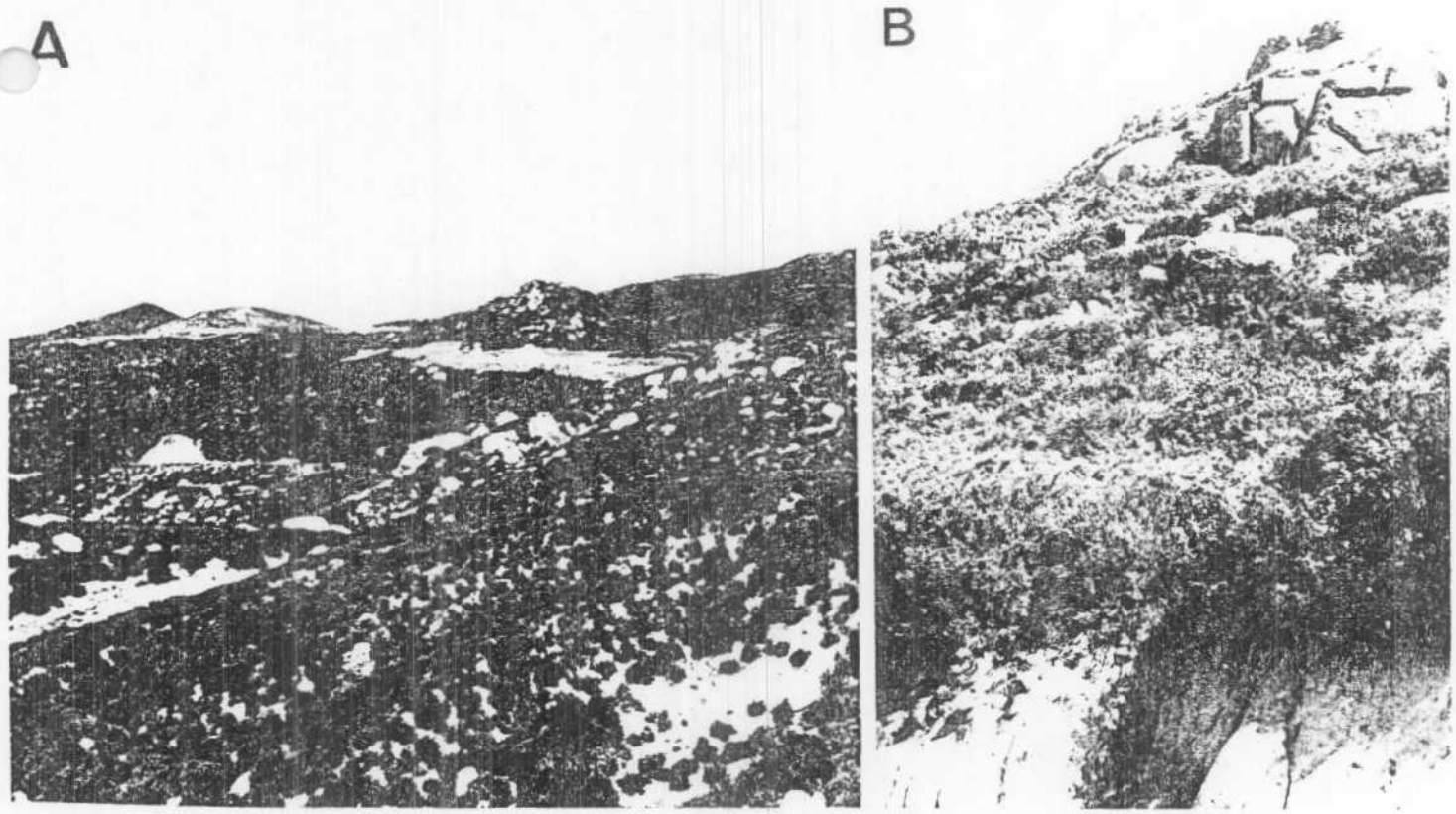


Figure 24—A complex of Associations dominated by elements of the Chamise, Manzanita, and Ceanothus Series with inclusion of the Interior Live Oak Series is seen in *A*. The predominant Series is chamise with associated manzanita species. The foreground is dominated by the Chamise/Pointleaf Manzanita Association *(B)*. Classification systems that use a broader descriptive level than ours might view the vegetation in *A* as a single community; the visual uniformity of the landscape cover will relegate most of the vegetation to a single "type" under some vegetation mapping systems. Most of the shrubs in *A* are from 2 to 3 feet (0.6 to 1 m) in height.

Figure 25—A Chamise/Wild Oats Association on a rocky site near Banning, California. Slow growth of the shrubs has been a factor contributing to the persistence of this two-layered Association. An admixture of ceanothus appears in the middle ground.

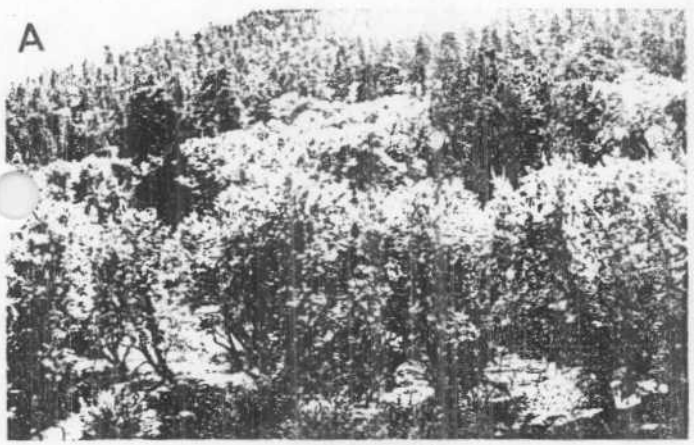


Figure 26—A Desert Mountain Mahogany/Sagebrush Association is seen in the middle and foreground in *A*. Juniper is scattered throughout the stand, but provides insufficient cover to place the stand in the Juniper Series (Conifer Woodland Subformation). Evidence in the form of downed snags and stump remnants *(B)* shows that this was once a Jeffrey Pine/Western Juniper/Desert Mountain Mahogany Association.

Ceanothus Series

Vegetation: Ceanothus species are the dominant overstory vegetation. This Series can produce open stands when mature since *Ceanothus* shrubs are rather short lived. Fifty-year-old stands may have herbaceous vegetation interspersed with shrubs. *Ceanothus* is one of the chaparral shrubs with ability to fix nitrogen in soils.

Distribution: Ceanothus spp. occur from southwestern Oregon to Baja California, on both inland and coastal slopes.

Chamise Series

Vegetation: Adenostoma fasciculatum is the dominant overstory shrub. The mature vegetation is dense and excludes any herbaceous understory. This Series occupies the hottest and driest of chaparral sites *(fig. 25)*.

Distribution: Chamise covers more land in California than any other single Series. It exists from the north Coast Ranges south to Baja California.

Bush Chinquapin Series

Vegetation: Chrysolepis sempervirens is the dominant overstory species, forming pure dense stands at high elevations.

Distribution: The Bush Chinquapin Series occurs from southern Oregon south to the San Jacinto Mountains.

Mountain Mahogany Series *(fig. 26)*

Vegetation: Cercocarpus betuloides, C. traskae, C. ledifolius, or *C. minutiflora* are the dominant overstory species. This Series occupies a more mesic habitat than many chaparral shrubs. *Cercocarpus* has the ability to fix soil nitrogen.

Distribution: Cercocarpus betuloides is found from Oregon through cismontane California to Baja California; *C. minutiflorus* from San Diego County south to Baja California; and *C. traskae* only on Santa Catalina Island. *C. ledifolius* occurs on slopes adjacent to the desert, and extends westward, through the Tehachapi Mountains, to the Mt. Pinos area.

Manzanita Series

Vegetation: Arctostaphylos species are the dominant overstory. Mature stands are very dense and impenetrable, and the form varies from low mats to small trees. This Series comprises higher elevation chaparral and is sometimes referred to as "cold chaparral."

Distribution: Manzanita occurs from southern Oregon to Baja California and east through central Arizona.

Scrub Oak Series

Vegetation: Dominant overstory is *Quercus dumosa, Q. turbinella, Q. macdonaldii, Q. tomentella,* or *Q. dunnii* in dense stands with no understory in mature stands. Many other shrub species may be associated with the Scrub Oak Series.

Distribution: Quercus dunnii is limited in distribution, occurring in San Luis Obispo County and in isolated stands to Baja California. *Q. dumosa* ranges from Baja California throughout the State. *Q. turbinella* ranges from transmontane California east to Texas. *Q. macdonaldii* and *Q. tomentella* are restricted to the Channel Islands.

Prunus Series *(fig. 27)*

Vegetation: Dominant overstory is Catalina cherry (*Prunus lyonii*), bitter cherry (*P. emarginata*), or desert apricot (*P. fremontii*). Catalina cherry and bitter cherry are evergreen and

may grow into small trees in optimum habitat. Desert apricot is a drought-deciduous shrub.

Distribution: Catalina cherry occupies canyons on the Channel Islands and bitter cherry occupies rocky ridges or canyons from San Diego County north. Desert apricot is found on slopes above 4000 feet (1219.2 m) at the western edge of the California Sonoran Desert and extends south into Baja California.

Redshank Series *(fig. 28)*

Vegetation: Adenostoma sparsifolium is the dominant overstory shrub. Individual shrubs have open crowns and therefore a herbaceous understory may be present, even in mature stands.

Distribution: Redshank exists from San Luis Obispo County south along the coast to Los Angeles County, then shifts in distribution inland to the Peninsular Mountain ranges, following them south into Baja California.

Sumac Series

Vegetation: Rhus laurina, R. ovata, or *R. integrifolia* are dominant overstory species. Sumacs are more often components of Scrub Oak or Manzanita Series than a dominant species. However, coastal and island slopes may support almost pure stands of sumac.

Distribution: Rhus laurina and *R. integrifolia* occur near the coast from Santa Barbara County south to Baja California and on the Channel Islands. *R. ovata* occurs away from the coast to desert edges throughout southern California.

Toyon Series

Vegetation: Dominant overstory is *Heteromeles arbutifolia* with other chaparral shrubs.

Distribution: Toyon grows on coastal foothills north to Humboldt County and on the Channel Islands.

Soft Chaparral Subformation *(fig. 29)*

Vegetation: Soft Chaparral is dominated by evergreen or deciduous soft shrubs (shrub forms with little woody tissue) mostly less than 5 feet (1.5 m) tall. Shrub crown cover ranges from 25 to 100 percent, often with grasses and forbs codominant. Trees, if present, have a crown cover of less than 25 percent.

Distribution: Soft Chaparral is present at lower elevations (below the Chaparral Subformation [*fig. 30*]), throughout southern California, extending north along the coast and Central Valley.

Series within the Soft Chaparral Formation are named for the dominant species present or the species representing 60 percent of the total overstory cover. Grasses and forbs are usually present in all phases.

Baccharis Series

Vegetation: The dominant shrub overstory is *Baccharis* spp. *Baccharis pilularis* is common on coastal foothills. Riparian species are *B. glutinosa, B. sergiloides,* and *B. sarathroides,* the latter two being confined to desert riparian habitats.

Distribution: Baccharis pilularis occurs from Sonoma County southward through central and coastal California to San Diego County, including the Channel Islands. The riparian species occur from Inyo County south to Mexico and east to Texas.

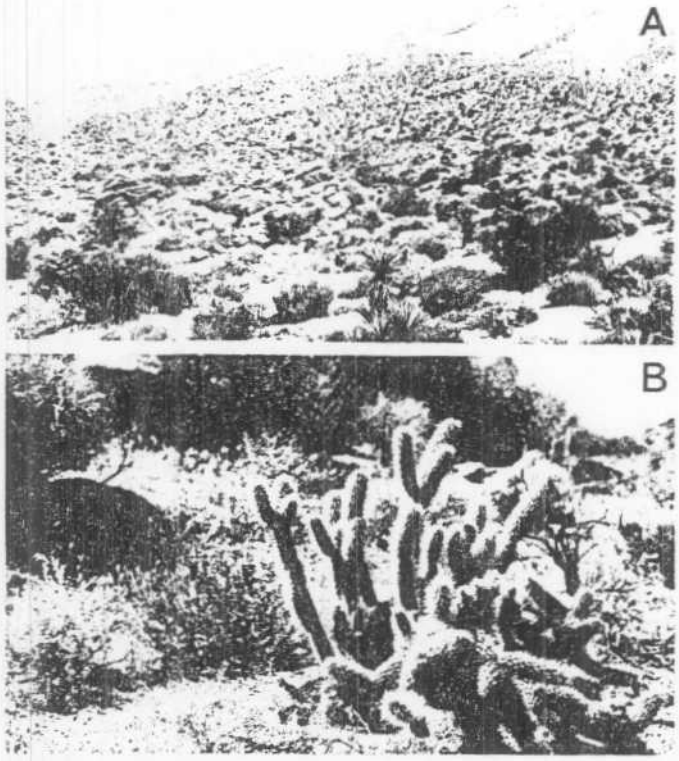


Figure 27—A Desert Apricot/Mojave Yucca/Silver Cholla Association is seen in the middle and foreground in *A*. Although plant density is lower than in communities found on more mesic habitats, the number of associated species is relatively high. An interior view of this stand shows the dominance of buckwheat, bladder-sage, and silver cholla *(B)*.

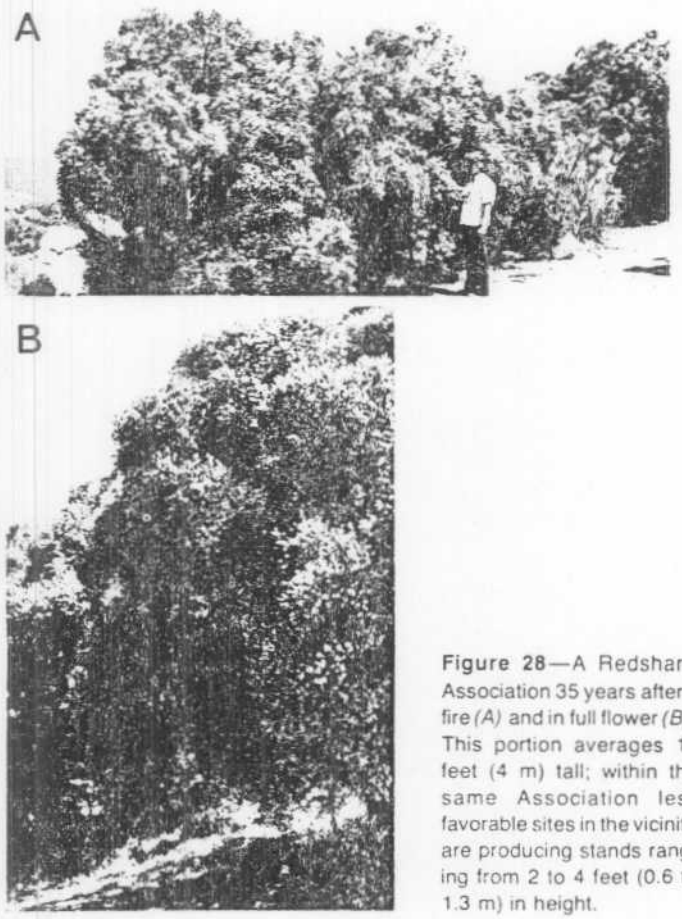


Figure 28—A Redshank Association 35 years after a fire *(A)* and in full flower *(B)*. This portion averages 12 feet (4 m) tall; within the same Association less favorable sites in the vicinity are producing stands ranging from 2 to 4 feet (0.6 to 1.3 m) in height.

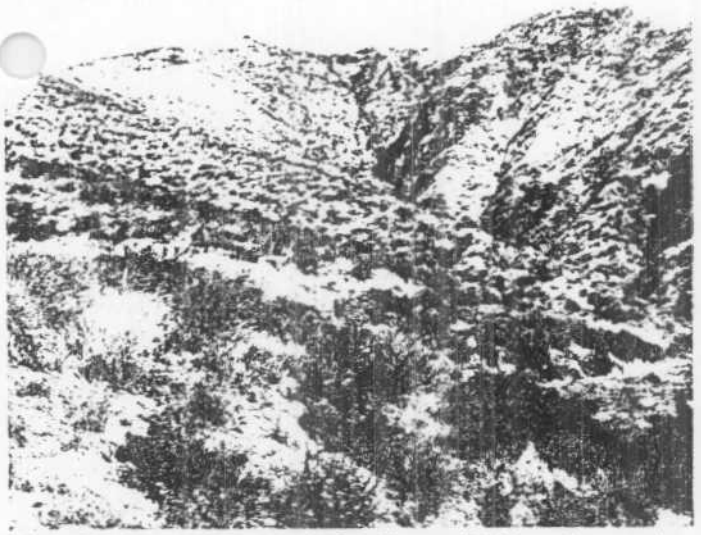


Figure 29—Associations within the Soft Chaparral Subformation occur in a mosaic pattern that reflects moisture availability and heat load.

Figure 30—Soft Chaparral often invades cutbanks in the interface zone between habitats of the Soft Chaparral and the Chaparral Subformations. Variation in plant density within an Association can be seen along this cutbank.

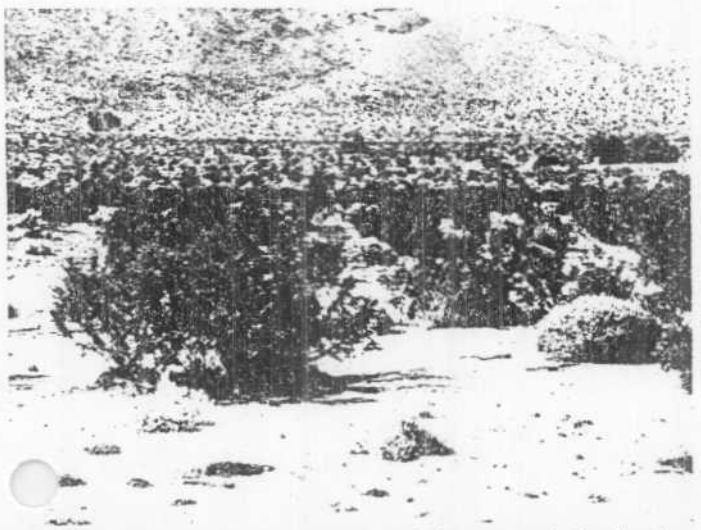


Figure 31—The Creosote Burrobush Association represents the Woody Shrub Subformation in this interface between Low Desert Valley and High Desert Valley climate regions.

California Buckwheat Series

Vegetation: Eriogonum fasciculatum is the dominant overstory shrub, with herbaceous understory.

Distribution: California Buckwheat Series is found at low elevations in mountain foothills and valleys from Santa Clara County south to Baja California. Varieties of California buckwheat can occur at high elevations as an understory component in several Forest or Woodland Series.

Coastal Sagebrush Series

Vegetation: Artemisia californica is the dominant shrub overstory with a grass/forb understory. *Yucca whipplei* is sometimes codominant in this Series, particularly in Santa Barbara County.

Distribution: This Series is present on low-elevation coastal foothills and interior valleys from Baja California north to San Francisco Bay including the Channel Islands.

Croton Series

Vegetation: Croton wigginsii is the dominant vegetation covering desert sand dunes.

Distribution: Croton Series is restricted to the dunes of the California Sonoran Desert in southeastern California and into Mexico.

Encelia Series

Vegetation: Encelia farinosa or *E. californica* are dominant overstory shrubs with a herbaceous understory.

Distribution: The Encelia Series occurs from Santa Barbara and Inyo Counties south to Baja California.

Lupine Series

Vegetation: Lupinus arboreus or *L. chamissonis* form the dominant overstory, with other soft shrubs and herbaceous species in the understory.

Distribution: Lupine shrubs range from Ventura County north along the California coastline. The Lupine Series occurs only on coastal bluffs.

Rabbitbrush Series

Vegetation: Chrysothamnus nauseosus or other *Chrysothamnus* species form the dominant overstory, with a grass and herbaceous understory.

Distribution: Rabbitbrush ranges throughout the Great Basin into western and southwestern California. There are many varieties of *Chrysothamnus nauseosus* from low elevations to above 9000 feet (2743.2 m).

Salvia Series

Vegetation: Purple sage (*Salvia leucophylla*), black sage (*Salvia mellifera*), or white sage (*Salvia apiana*) are dominant overstory species with a herbaceous understory. The Salvia Series covers coastal and inland foothills at low elevations.

Distribution: Salvia mellifera ranges from Contra Costa County south to Baja California and the Channel Islands. *S. leucophylla* ranges from San Luis Obispo County to Orange County; *S. apiana* ranges from Santa Barbara County to Baja California.

Woody Shrub Subformation

Arrowweed Series

Vegetation: Pluchea sericea is the dominant overstory vegetation in seeps or marshes and following canals.

Distribution: Pluchea sericea occurs from Santa Barbara County throughout cismontane southern California and east to Texas. The Series is common along the Colorado River and irrigation canals in the California Sonoran Desert.

Blackbush Series

Vegetation: Coleogyne ramosissima is the dominant overstory shrub. Blackbush is drought-deciduous. Associated species vary, but usually include *Ephedra* spp., *Chrysothamnus* spp., and California buckwheat (*Eriogonum fasciculatum*).

Distribution: Blackbush occurs from the southern Mojave Desert north and east through the Great Basin.

Catclaw Series

Vegetation: Acacia greggii, a winter-deciduous shrub, is the dominant overstory with subshrubs in the understory. The habitat in California often follows washes or canyons where some soil moisture is available.

Distribution: Catclaw is found in the southern Mojave Desert, throughout the California Sonoran Desert, south to Mexico, and east to Texas.

Creosote Bush Series

Vegetation: Larrea tridentata, an evergreen shrub, is the dominant overstory. Understory plants vary, but burrobush (*Ambrosia dumosa*) is most often codominant in California (*fig. 31*).

Distribution: Creosote is found throughout both deserts, ranging south from Inyo County into Mexico and east into Texas. *Larrea* spp. also occur in South America.

Greasewood Series

Vegetation: Sarcobatus vermiculatus is the dominant shrub occurring with saltbush (*Atriplex* spp.) on strongly alkaline, saline soils.

Distribution: Greasewood occurs throughout the Mojave Desert north to Washington and east throughout the Great Basin in suitable habitats.

Ocotillo Series

Vegetation: Fouquieria splendens, a drought-deciduous shrub, is the dominant overstory, with subshrubs and stem succulents present in the understory. The substrate is usually rocky.

Distribution: Ocotillo occurs from the southeastern Mojave Desert through the Sonoran Desert to Texas and Mexico.

Wild Rose Series (*fig. 32*)

Vegetation: Rosa californica, *R. gymnocarpa*, or *R. woodsii* are dominant, forming thickets in moist soil.

Distribution: Rosa species occur throughout the West in many vegetation types. The Series usually occurs below 6000 feet (1828.8 m) elevation in cismontane southern California.

Sagebrush Series (*fig. 33*)

Vegetation: Artemisia tridentata is the most common dominant shrub, although *A. nova*, *A. arbuscula*, or *A. rothrockii* may also form the dominant overstory. These are all evergreen shrubs and may be associated with perennial grasses.

Distribution: The Sagebrush Series is found from the mountains of southern California north to Oregon and throughout the Great Basin. The Series occurs at 7000 feet (2133.6 m) elevation interspersed with Series of the Closed Forest or Woodland Formations, as well as in the Mojave Desert.

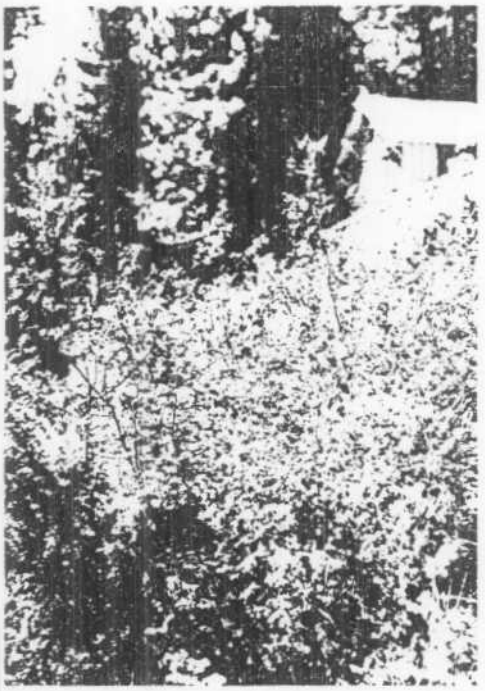


Figure 32—An element of the Rose Series (Woody Shrub Subformation) occurring in a moist opening in a landscape cover dominated by the Closed Forest Formation—near Big Bear Lake, California.

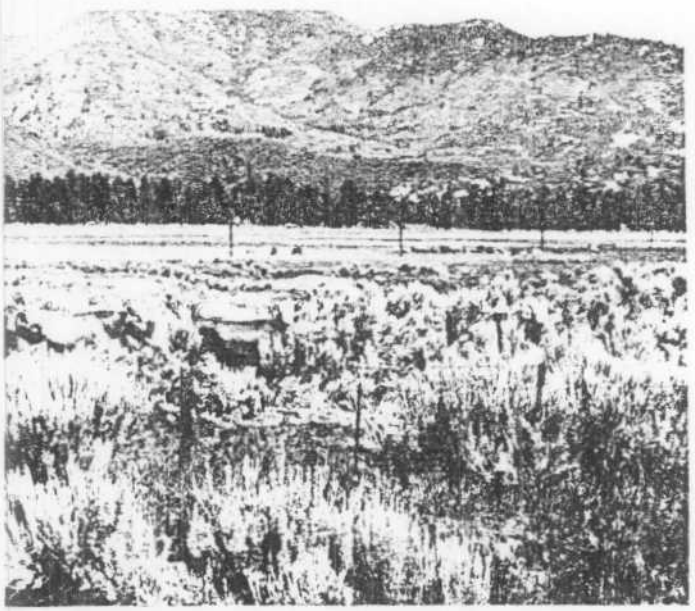


Figure 33—Portions of this range being used by cattle belong to the Sagebrush Series of the Woody Shrub Subformation. Jeffrey pine (Closed Forest Formation) flanks the Herbaceous Formation that occurs in the pastureland, while a mosaic comprised of elements of the Shrub Formation carries upward on the far slopes to the Closed Forest Formation that occurs along the ridge.

Saltbush Series

Vegetation: Dominant overstory may be *Atriplex confertifolia, A. polycarpa, A. canescens,* and other *Atriplex* spp. [illegible] species may be evergreen or drought-deciduous [illegible] occurring on alkaline and saline soils.

Distribution: The Saltbush Series occurs in both California [illegible]serts, north to eastern Oregon, and throughout the Great [illegible]sin.

[illegible]cculent Shrub Subformation

Agave Series

Vegetation: Agave deserti is the dominant species, with a [illegible]ghly diverse group of associated species. The Agave Series [illegible]curs on foothills between the Desert Shrub and Chaparral [illegible]rmations.

Distribution: Agave occurs in the southern Mojave Desert [illegible]d western California Sonoran Desert.

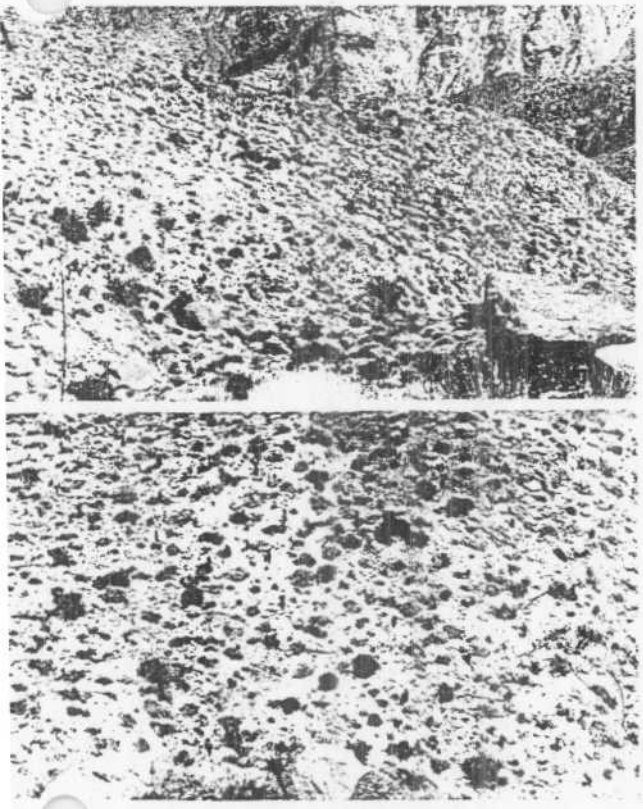
Iodine Bush Series

Vegetation: Allenrolfea occidentalis, a low-growing succu[illegible]t shrub, is the dominant species occurring with saltbush (*[illegible]riplex* spp.) and seep-weed (*Suaeda* spp.). Soils are wet, [illegible]ongly alkaline, and saline.

Distribution: Iodine bush occurs in the Mojave Desert, [illegible]ntral Valley north to Oregon, east to Utah, and south into [illegible]exico.

Opuntia Series *(fig. 34)*

Vegetation: Dominant overstory is cholla (*Opuntia [illegible]gelovii* and other *Opuntia* species), or prickly pear (*Opuntia*



[illegible]ur. [illegible]-The Cholla Series dominates the middle and foreground of [illegible]scene *(A)*. A closeup shows the sparse occurrence of dominant and [illegible]ociated species, as well as the patterns of oxidation found on the rock [illegible] soil surfaces in desert environments *(B)*.

Figure 35—The Dwarf Shrub Formation is found in the remnants of this glacial tarn. To the left of the tarn is an element of the Lodgepole Pine Series, and krummholtz limber pine can be seen on the right. The cushion Plant Subformation is the grey texture in the bottom of the tarn.

spp.) occurring with barrel (*Ferocactus acanthodes*) and hedgehog (*Echinocereus* spp.) cacti. *Opuntia* reproduces vegetatively when joints fall to the ground. The species are more often associates of other Series than dominant stands.

Distribution: Opuntia bigelovii occurs from the southeast Mojave Desert throughout the Sonoran Desert into Mexico. *O. littoralis* is a succulent-stemmed, prostrate shrub that occurs within 50 miles (80.4 km) of the coastline from Santa Barbara County south to Baja California; varieties of the species occur up to 7000 feet (213 m) as a component of several other Series.

Dwarf Shrub Formation

Vegetation: The shrubs that dominate this Formation are less than 1½ feet (½ m) in height at maturity. The Cushion Plant Subformation is dominated by nonsucculent (stem or leaves) dwarf shrubs; in southern California, only one Series is currently recognized with this Subformation. The Succulent Dwarf Shrub Subformation contains all Series dominated by succulent dwarf shrubs; two Series are currently recognized for this Subformation in southern California.

Distribution: The Dwarf Shrub Formation has worldwide distribution. It occurs in a wide range of habitats, from alpine environments above timberline to alkaline desert environments below sea level.

Suggested Phases are:

	Cover
1.	<2
2.	2-10
3.	10-25
4.	25-50
5.	50-70
6.	>70

Cushion Plant Subformation

Buckwheat Series

Vegetation: Dominant cover is *Eriogonum* spp. and other cushion plants. This Series is sometimes called "barren" because of the sparse vegetation cover *(fig. 35)*.

Distribution: The Buckwheat Series occurs throughout the West on high mountain peaks above tree line. In southern California, this Series is interspersed among subalpine forests [illegible]mber Pine or Bristlecone Pine Series.

Succulent Dwarf Shrub Subformation

Pickleweed Series

Vegetation: Salicornia spp. is the dominant vegetation occurring in saltwater marshes. Most species are winter dormant.

Distribution: Pickleweed occurs in coastal salt marshes and around inland saltwater lakes such as the Salton Sea and Mono Lake.

Suaeda Series

Vegetation: Dominant overstory is *Suaeda californica, S. fruticosa,* or *S. torreyana,* all succulent shrubs or subshrubs occupying salt marshes or alkaline marshes.

Distribution: The Suaeda Series is present worldwide. *Suaeda californica* occurs along the coast from San Francisco Bay to Baja California. *S. torreyana* ranges from eastern Oregon through inland California east to Texas and into Mexico. *S. fruticosa* extends from the San Joaquin Valley south to Mexico, but is also found in West Indies, Europe, Asia, and Africa (McMinn 1939).

Herbaceous Formation

Vegetation: The Herbaceous Formation is dominated by [illegible]ses, sedges, rushes, forbs, or freshwater aquatic plants. At least 2 percent of the land surface has an herbaceous cover. If shrubs are present, they contribute less than 25 percent crown cover (*fig. 36*). Grasslands, wet meadows, marshes, and vegetation in shallow freshwater ponds are all part of the Herbaceous Formation (*fig. 37*). Herbaceous coastal strand plants and plants of coastal salt marshes are included. However, this system makes no attempt to cover marine or intertidal zones.

Distribution: The Herbaceous Formation occurs worldwide in appropriate habitats. Four Subformations of the Herbaceous Formation are recognized: Grasses and Grasslike Plants (Graminoid), Forb, Aquatic, and Cryptogam Subformations.

Suggested Phases are:

	Cover	
Productivity	*Living Vegetation*	*Litter*
Pounds per acre (optional)	1. <2 2. 2-25 3. 25-50 4. 50-70 5. >70	1. <25 2. 25-50 3. >50

Graminoid Subformation

The Series are named for the dominant genus or species, usually that plant comprising more than 60 percent of the total herbaceous cover (*fig. 38*).

[illegible]romegrass Series

Vegetation: Dominant vegetation is *Bromus rubens, B. diandrus, B. mollis,* or *B. tectorum,* all introduced species.

Figure 36—The Herbaceous Formation in the foreground is represented by the Bromegrass and the Wiregrass Series. Evidence indicates that the Wild Rye Series is the most immediate potential vegetation for the entire stand; whether the change to this Series occurs or not will depend upon future use of the range and disturbance.

Figure 37—A temporarily drained lake provided an opportunity to observe the Graminoid Subformation in a normally inaccessible riparian zone. Distinct zones occupied by the Herbaceous, Shrub, and Woodland Formations can be seen. The Closed Forest Formation occurs in the background.

Figure 38—Sand dunes provide a unique habitat for the Graminoid Subformation in this desert environment; the grass is *Panicum urvilleanum*—a possible requirement for a Panicum Series. The Forb Subformation dominates the cover adjacent to the dunes.

Distribution: Introduced *Bromus* species occur throughout the West and are now considered to be climax stands in much of California's Central Valley (Heady 1977).

Bulrush Series

Vegetation: Dominant vegetation is *Scirpus* species. Bulrushes are rooted in mud beneath shallow water.

Distribution: The Bulrush Series occurs worldwide in shallow saltwater marshes.

Cattail Series

Vegetation: Dominant vegetation is *Typha* species. Cattails are rooted in mud beneath shallow water.

Distribution: The Cattail Series occurs worldwide in shallow freshwater marshes.

Cordgrass Series

Vegetation: Dominant vegetation is *Spartina foliosa* or *S. gracilis*, coarse perennial grasses from stout creeping rootstock.

Distribution: Spartina occurs in coastal salt marshes or interior alkaline meadows throughout North America.

Fescue Series

Vegetation: Dominant vegetation is *Festuca megalura*, *F. myuros* (introduced from Europe), *F. octoflora*, and other *Festuca* species mixed with other annual grasses.

Distribution: Festuca species occur throughout the West from British Columbia to Baja California.

Galleta Grass Series

Vegetation: Dominant vegetation is *Hilaria rigida*, *H. jamesii*, or *H. belangeri*.

Distribution: Galleta grass occurs throughout the western parts. *Hilaria rigida* is found below 4000 feet (1219.2 m) and *H. jamesii* occurs from 4000 to 7500 feet (1219.2 to 2286 m). *H. belangeri* is reported from extreme southeastern California and through Arizona to Sonora, Mexico.

Muhlenbergia Series

Vegetation: Dominant vegetation is *Muhlenbergia rigens*, a perennial bunchgrass or other *Muhlenbergia* species.

Distribution: Muhlenbergia rigens occurs in seasonally wet meadows throughout California. Other *Muhlenbergia* species occupy moist alkaline to dry habitats throughout North America.

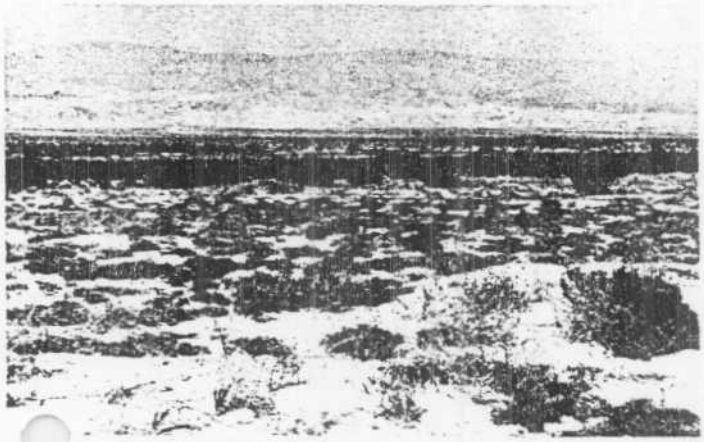


Figure 39—The Forb Subformation dominates most of this desert valley. The Plicate Coldenia/Desert Dichoria Association dominates the middle ground. Just beyond it is a Plicate Coldenia/Desert Dichoria (Creosote Bush) Association.

Figure 40—The Goldenrod Series occurs in an opening in a Jeffrey pine forest.

Needlegrass Series

Vegetation: Dominant vegetation is *Stipa pulchra*, *S. cernua*, *S. speciosa*, *S. coronatum*, or other *Stipa* species. All are perennial bunchgrasses.

Distribution: Stipa species once covered extensive areas of California. Minor remnants occur today. The perennial grasslands of California have been largely replaced by introduced annual grasses and are now included in the Bromegrass Series.

Wild Oats Series

Vegetation: Dominant vegetation is *Avena barbata* or *A. fatua*, both introduced species.

Distribution: Avena species occur throughout California and is sometimes considered to be climax in the Central Valley (Heady 1977).

Ricegrass Series

Vegetation: Dominant vegetation is *Oryzopsis hymenoides*, a perennial bunchgrass.

Distribution: Oryzopsis hymenoides occurs throughout Western North America, from the desert to 11,000 feet (3352.8 m) elevation.

Wild Rye Series

Vegetation: Dominant vegetation is *Elymus glaucus*, *E. triticoides*, or other *Elymus* species.

Distribution: Elymus species occur throughout the West up to 10,500 feet (3200.4 m). *Elymus triticoides* is restricted to moist alkaline habitats.

Sacaton Series

Vegetation: Dominant vegetation is *Sporobolus airoides*, a densely-tufted perennial.

Distribution: Sporobolus airoides occurs in dominant stands throughout the West in river bottoms or moist alkaline places.

Saltgrass Series

Vegetation: Dominant vegetation is *Distichlis spicata* in dense rhizomatous mats. Saltgrass is a dioecious perennial frequently forming all male or all female clones which reproduce vegetatively.

Distribution: Saltgrass occurs in dominant stands throughout much of North America, growing in coastal salt marshes or inland alkaline soils.

Sedge Series

Vegetation: Dominant vegetation is sedge members of the genus *Carex* or *Cyperus*.

Distribution: Sedges are grasslike plants occurring worldwide, usually in meadows or seasonally wet habitats.

Wiregrass Series

Vegetation: Dominant vegetation is *Juncus* species or *Luzula* species.

Distribution: Juncus and *Luzula* species are grasslike plants occurring worldwide in moist meadows or marshy habitats.

Forb Subformation

Series in this Subformation are varied, and are named for the species comprising 60 percent or more of the herbaceous cover. Only two examples are described here. Others may be added as inventories reveal what exists. Care must be taken to classify *only* those vegetation types with forbs as the relatively permanent vegetation type within the Forb Subformation.

Ambrosia Series

Vegetation: Ambrosia chamissonis and other *Ambrosia* spp. form the dominant overstory with a herbaceous understory.

Distribution: Ambrosia chamissonis is a coastal strand species occurring in scattered locations along the southern California coastline north to British Columbia and on the Channel Islands.

Coldenia Series *(fig. 39)*

Vegetation: Coldenia species form the dominant vegetation, often associated with other herbaceous plants.

Distribution: The Series occurs throughout the Western United States in desert and Great Basin environments.

Goldenrod Series *(fig. 40)*

Vegetation: Dominant vegetation is *Solidago californica, S. confinis, S. occidentalis,* or *S. spectabilis.*

Distribution: Solidago species occur from lower California to Oregon, and from the coast to the desert. Habitats vary with species.

Mustard Series

Vegetation: Dominant vegetation is *Brassica* or *Sisymbrium* species, annual introduced plants of the mustard family.

Distribution: Mustards occur worldwide and may occur in relatively permanent dominant stands as a result of man's activities.

Wyethia Series

Vegetation: Dominant vegetation is *Wyethia ovata*, a coarse perennial with a thick taproot.

Distribution: Wyethia ovata occurs from the southern Sierra Nevada to Baja California, occasionally occurring in dominant stands interspersed with grasslands or as islands in open woodlands.

Aquatic Subformation *(fig. 41)*

Series in this Subformation include those whose dominant species require water for structural support. Several examples are described and when comprehensive inventories are done, the list of Series in the Aquatic Subformation may increase *(fig. 42)*.

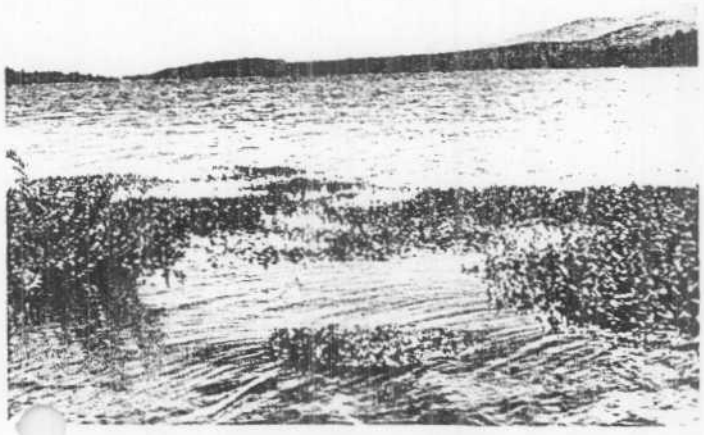


Figure 41—The Aquatic Subformation is represented here by water smartweed (*Polygonum amphibium*), another potential candidate for Series status in the Vegetation Classification System.

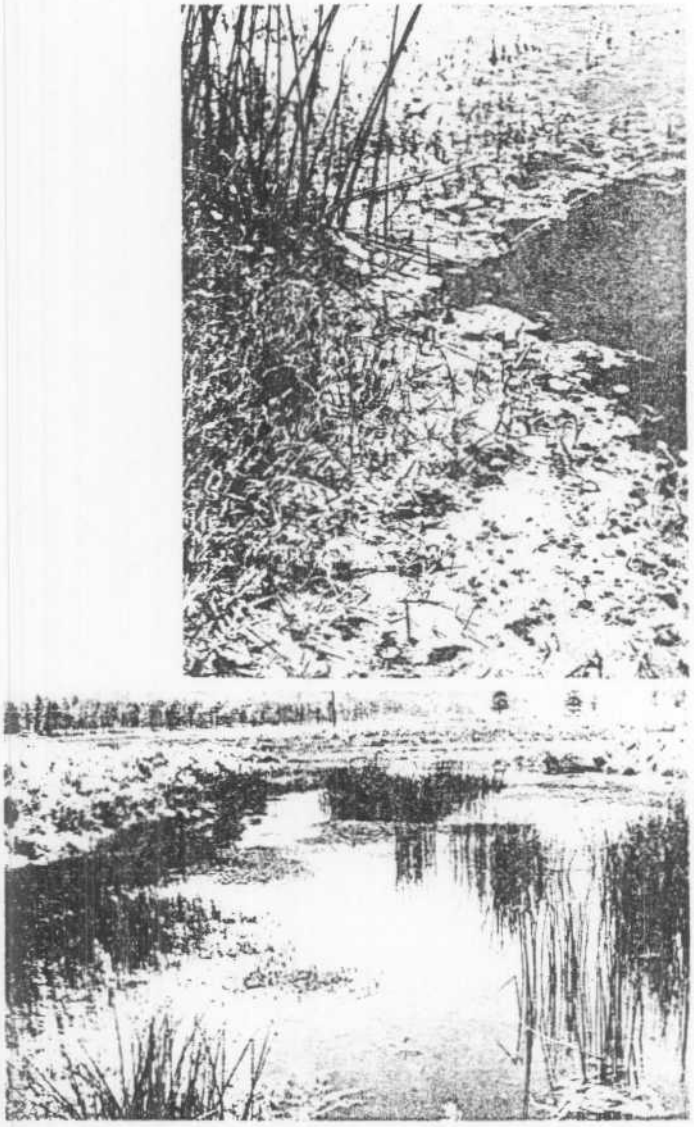


Figure 42—Elements of the Aquatic Subformation often require more than a cursory above-water examination to determine their classification status. The aquatic element of this river community (below) can be comprised of one or two distinct communities or can be an "understory" to the *Scirpus, Ludwigia repens* and *Hydrocotyle* species, both aquatics, are found here (above).

Pondweed Series

Vegetation: Dominant vegetation is *Potamogeton* species, ubmerged plants, barely reaching the water surface. .

Distribution: Potamogetons occur worldwide in quiet r waters.

Water Hyacinth Series

Vegetation: Dominant vegetation is *Eichornia crassipes*, a ubmerged and floating aquatic.

Distribution: Eichornia is a native of tropical America vhich has become naturalized in some of southern California's reshwater systems.

Water Milfoil Series *(fig. 43)*

Vegetation: Dominant vegetation is *Myriophyllum exalbescens*, a submerged aquatic floating from stems up to 3.3 feet (1 m) long and rooted in the shallow lake bottom.

Distribution: Myriophyllum occurs in quiet water throughout North America.

Cryptogam Subformation

Series within the Cryptogam Subformation are poorly represented in California, whereas they cover vast expanses of land in the arctic tundra. Alpine areas lacking overstory vegetation are designated barren in some classification schemes. However, as inventories are completed, some of them may be named for their dominant cryptogam genera. Mosses, lichens, and ferns are included in this Subformation *(fig. 44)*.

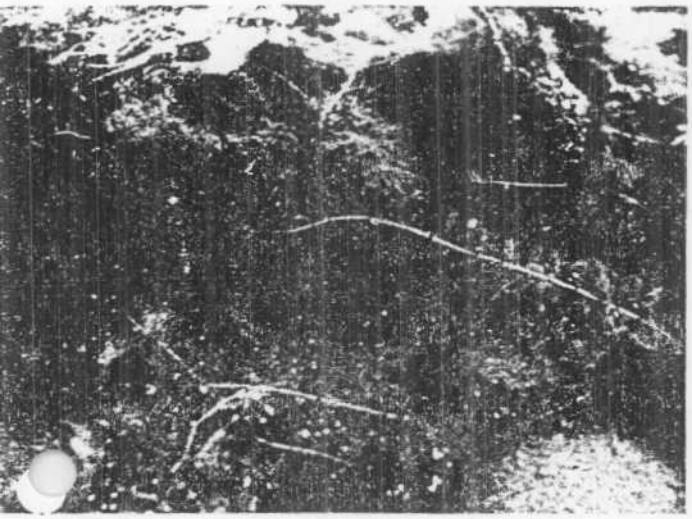


Figure 43—The Water Milfoil Series (Aquatic Subformation) is a common inhabitant of quiet waters in southern California. Where nutrient levels are high, this series can become troublesome to human activities.

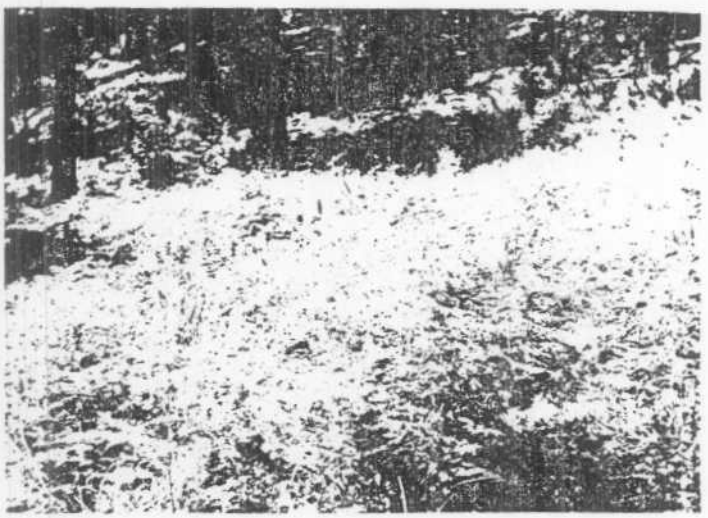


Figure 44—The Fern Series (Pteridium aquilinum) is a common element of the Cryptogam Subformation in southern California.

APPENDIX

A. Climate Regions of Southern California

The climate regions adapted from Almquist's study are defined as follows:[5]

Coastal

The westernmost portion of southern California, extending inland to the coastal foothills. Maritime influence dominates, with even seasonal temperatures averaging 50° F (10° C) in winter and 67° F (19.4° C) in summer,[9] and little daily fluctuation. Average humidity is above 50 percent and precipitation in the form of winter rains ranges from 6 inches (152 mm) in the south to 60 inches (1524 mm) in the coastal ranges of the north.

Interior Valley

The gentle undulating terrain from the coastal foothills to the interior mountain foothills, up to 2500 feet (762 m) elevation at the eastern limit. Temperature extremes can range from below freezing in the winter to above 100° F (37.8° C) in the summer, with an average of 55° F (12.8° C) in winter and 7[illegible] 23.9° C) in summer. Relative humidity averages 15 to 2[illegible]ercent. Precipitation occurs primarily as winter rains, averaging 8 to 13 inches (20.3 to 330.2 mm) per year.

Transition

A region characterized by higher precipitation (12 to 20 inches [304.8 to 508 mm] per year) and lower average temperatures (51° F [10.6° C] in winter, 72° F [22.2° C] in summer) than the interior valley. It occurs on the coastal (cismontane) side of the mountains. There are extreme elevational differences, with lower limits ranging from 500 to 2500 feet (152.4 to 762 m), and usually an upper limit of 4500 feet (1371.6 m).

[9] As used here, summer months are considered May through October, winter months November through April.

Montane

Mountainous areas between 4500 and 9000 feet (1371 and 2833 m) on the coastal (cismontane) side and between 6500 and 900[illegible] feet (1981 and 2743 m) on the desert (transmontane) side. Precipitation from 15 to 40 inches (254 to 1016 mm) with an average of 25 inches (635 mm) per year. Snow is common at higher elevations and some summer rainfall (5 to 7 inches) (127 to 177 mm) occurs. In winter, average temperature is 38° F (3.3° C), in summer, 62° F (16.7° C).

High Montane

Mountainous areas between 9000 and 10,500 feet (2743 and 3200 m). Precipitation is mainly in the form of snow. Average temperatures are lower than those in the montane region.

Alpine

All mountainous regions above 10,500 feet (3200 m). Average temperatures are lower than in the high montane region, snow pack remains longer, and strong winds are common.

Desert Transition

Areas on the desert (transmontane) side of the mountains between 3500 and 6500 feet (1066 and 1981 m) elevation. Precipitation generally occurs in the winter with some snow, and averages 6 to 10 inches (152 to 254 mm) per year. Average temperatures are 50° F (10° C) in winter and 70° F (21.1° C) in summer.

High Desert Valley

Primarily, the Mojave Desert and adjacent mountain slopes up to 3500 feet (1066 m). Rainfall is generally less than 6 inches (152 mm) per year. Little weather data are available.

Low Desert Valley[10]

The California Sonora Desert and adjacent slopes up to 3500 feet (1066 m). This region is somewhat influenced by the Gulf Coast air mass, and therefore receives more summer rainfall than the high desert. Daily temperature fluctuations can be extreme, with highs up to 120° F (48.9° C). Rainfall is less than 4 inches (101 mm) per year. Again, little weather data are available.

[10] The lowest elevations in this region are lower than any in the High Desert Valley region; the interface between the two is difficult to define.

B. Species Index

C. Glossary

Annual plant—A plant which completes its life cycle within one year or one growing season.

Broadleaf—Refers to leaves that are *not* needlelike or scalelike and plants that are angiosperms. For this publication, trees and shrubs that are *not* conifers will be said to have broad leaves.

Bunch grass—A perennial grass which forms evenly spaced clumps, spreading by vegetative reproduction at the outer edge of the clump and dying at the center of old age. It does not form a closed sod.

Canopy—The aggregate of tree and shrub crowns that provide a broken layer of cover; most often used in reference to tree crowns that provide an "overhead" canopy.

Montane—This side of the mountains. For this publication, west of the main axis of the Sierra Nevada, Transverse, and Peninsular Mountain ranges, as opposed to the desert side.

Codominant—Refers to plants of different species that share stand dominance in the overstory (see Dominant). This use of codominant is different from timber management usage referring to dominant individuals in a stand that are slightly subordinate to a few individuals that have achieved superior stature.

Conifer—A cone-bearing tree with evergreen needle or scalelike leaves. Includes genus *Pinus, Calocedrus, Juniperus, Cupressus,* etc.

Crown cover—The vertical projection of a tree or shrub crown perimeter to the ground.

Crown sprout—A form of vegetative reproduction. A new shoot from the main crown of a tree which has been damaged, as by fire.

Cryptogam—A group of primitive plants such as mosses, club mosses, lichens, and ferns, which do not produce true flowers or seeds.

Cushion plant—A plant that forms a low-growing mat of vegetation which hugs the ground. Individual plants spread vegetatively at the outer edge of the mat, sometimes rooting at nodes or branch tips.

D.b.h.—Diameter at breast height. The diameter of a tree trunk at 4.5 feet (1.37 m) above the ground.

Deciduous plant—A plant which sheds its leaves, triggered by some environmental factor, such as temperature or water availability.

Density—The average number of individuals (plants) per unit of space.

Disjunct—Separate, noncontinuous; occurring in isolated, separate populations.

Dominant—Characteristic of plants within a system of vegetation, which by reason of size or numbers exert some controlling influence on the environment. For this publication, most numerous in the overstory.

Ecotone—A transition zone between two different types of dominant vegetation, containing components of each type.

Established tree—For this publication, a young tree with the crown rising above surrounding understory vegetation.

Evergreen—Refers to plants that do not generally shed their leaves in response to normal fluctuations in environmental conditions.

Forb—A broadleafed herbaceous plant.

Forest—Generally, an area of land covered by trees whose crowns are mostly touching. Because closed forests with interlocking crowns are rare in southern California, areas that grow trees with a crown cover of 60 percent or more are considered forests.

Grass—Herbaceous plants with narrow leaves in the family Poaceae.

Habitat—As an abstract concept, refers to that combination of environmental factors which provides suitable conditions for the existence of an organism or group of organisms; also, the concrete realization of such a combination in the field.

Herbaceous—Herblike or composed of herbs—plants with soft green leaves and no woody tissue.

Hydric—Characterized by considerable moisture.

Krummholtz—A twisted, dwarfed, or prostrate growth habit of trees that is the result of severe environmental conditions.

L[illegible]—Slightly decayed, nonliving plant parts scattered on the ground; duff.

Mesic—Characterized by moderately moist conditions.

Overstory—The taller plants within a vegetation type, forming the upper layer of canopy cover.

Perennial plant—A plant which lives for 2 years or more. Sometimes only the underground parts remain alive while the green herbaceous parts die back.

Physiognomy—The characteristic structure of vegetation, apart from land form.

Relict stands—Remnants of a vegetation type that once occupied an extensive area (or was present in scattered form over an extensive area), but has since become nearly extinct. This often results from shifts in the state of a given environmental factor or combination of factors.

Riparian—Pertaining to the bank or edge of a river, lake, stream, or subsurface water source within 10 feet (3.05 m) of the ground surface.

Root sprouts—Vegetative growth (branches) emerging from a basal root burl or root nodes. Common in chaparral shrubs.

Rush—A grasslike plant in the family Juncaceae.

Savannah—A grassland containing scattered trees or shrubs.

Scrub—Vegetation consisting mainly of shrubs or stunted trees.

Se[illegible]—A grasslike or rushlike herb of the family Cyperaceae.

Shrub—A short, low-branching woody perennial, usually having several main stems arising from a central point in the root system.

Succulent—Refers to a characteristic related to water storage within the cells of stems and leaves, making these parts soft and thick in texture.

Transmontane—The other side of the mountains; for this publication, east of the main axis of the Sierra Nevada, Transverse, and Peninsular Mountain ranges.

Understory—Those plants with canopy heights at a lower level than the tallest vegetation species present.

Woodland—An area of land covered by trees of a characteristic form whose crowns are generally not touching.

Xeric—Characterized by dry conditions (low rainfall).

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A classification system for use in describing vegetation has been developed and is being applied to southern California. It is based upon a hierarchical stratification of vegetation, using physiognomic and taxonomic criteria. The system categories are Formation, Subformation, Series, Association, and Phase. Formations, Subformations, and Series have been specified for current southern California plant communities. The system has application to local resource management activities and will serve as a framework for resource assessment reporting as it applies to vegetation.

Retrieval Terms: vegetation types, plant community classification, taxonomy, southern California.