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Shrubs of California's Chaparral, Timberland, and Woodland: Area, Ownership, and Stand Characteristics

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Abstract

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A statewide inventory of shrubs in chaparral and on timberland and woodland in California is presented, and the relevance of shrubs to resource management is discussed. Shrub types (excluding coastal sage and Great Basin and desert shrubs) cover about 10 million acres, 73 percent of which is chaparral. Chamise is the most widespread type in chaparral (51 percent of total area). Critically flammable chaparral stands cover an estimated 1 million acres, much of which is in heavily populated southern California. More than 2 million additional acres are on the threshold of the critically flammable stage.

Shrubs are the dominant vegetation on 2.1 million acres of timberland and 0.5 million acres of woodland. *Ceanothus, manzanita*, and poison-oak are the most widespread shrubs on timberland and woodland. Timber growth on shrub-dominated timberland is about one-fourth of the potential of the land.

Keywords: Shrubs, chaparral, forest inventory, vegetation inventory, biomass (phytomass), California.

Preface

Forest Inventory and Analysis is a nationwide project of the USDA Forest Service authorized by the Forest and Rangeland Renewable Resources Research Act of 1978. Work units of the project, located at Forest Service Experiment Stations, conduct forest inventories throughout the 50 States. The Pacific Northwest Research Station at Portland, Oregon, is responsible for inventories in California, Oregon, and Washington.

Summary

Shrub types, excluding coastal sage and the shrubs of the Great Basin and deserts of eastern California, cover more than 10 million acres. Chaparral types cover 7.4 million acres; timberland areas dominated by shrubs total about 2.2 million acres; and shrub types on woodland total about 0.5 million acres. Shrubs also are present on several million acres of welt-stocked and moderately stocked timberland and woodland.

About 57 percent of the chaparral area is in public ownership; 59 percent of the shrub-dominated timberland is in public ownership; and 55 percent of the shrub dominated woodland is in public ownership.

Chamise was the most widespread of the five major chaparral type groups recognized in the study (chamise, scrub oaks, mountain-mahogany, mixed and montane, and coastal transition) covering 3.8 million acres of the total of chaparral. "Pure" stands of chaparral were rare; three or more shrub species were usually present. Statewide, *Adenostoma fasciculatum* was the most widespread shrub species. Species of *Quercus, Arctostaphylos, Ceanothus,* and *Rhus* were also widespread. Chaparral stands in southern California had more shrub species than did similar stands in northern California.

Outside National Forests, 15 percent of the chaparral was decadent and 77 percent was mature. Decadent stands of chemise and mature and decadent stands of coastal transition types, which contain species that at any age have a high ratio of dead-to-live material, were considered critically flammable. Such stands are estimated to cover 1 million acres. An additional 2 million acres of chaparral with a moderate amount of dead material are on the threshold of the critically flammable stage. Outside National Forests, more than 70 percent of the critically flammable chaparral is in heavily populated southern California.

Chemise stands were the densest of the chaparral types with an average crown cover of 71 percent; but they were also the shortest with an average height of 5.4 feet. Scrub oak type was the tallest, with an average height of 8.0 feet, but its average density was only 55 percent. The mixed and montane type group had the greatest phytomass index (height times canopy closure). This group, consisting predominantly of ceanothus and manzanita, would seem to offer the greatest potential for fiber-based products or biomass energy. About one-third of the chaparral area is on gentle slopes (less than 25 percent) that might be manageable for biomass production. About one-fourth is on slopes greater than 45 percent.

Shrubs are the dominant cover on 2,183,000 acres of timberland, 356,000 acres of hardwood woodland, and 173,000 acres of pinyon-juniper woodland. Shrubs are also present on much of the remaining 28.8 million acres of timberland and woodland. Sixteen species of *Ceanothus* were found on 47 percent of the timberland area, and 12 species of *Arctostaphylos* on 35 percent. The species found most frequently on timberland statewide was *Toxicodendron diversilobum* (poison-oak). On timberland in the northern Coast Range, *Vaccinium ovatum* (evergreen huckleberry), *Gaultheria shallon* (salal), *Rhododendron macrophyllum* (rhododendron), *Ceanothus thyrsiflorus* (blue blossom), and *Toxicodendron diversilobum* were the most common species. On timberland in the interior, the most frequently encountered species included *Arctostaphylos patula* (greenleaf manzanita), *Symphoricarpos spp.* (snowberry), *Ceanothus prostratus* (squaw carpet), *Toxicodendron diversilobum, Ceanothus integerrimus* (deer brush), *Ribes spp.* (gooseberry), and *Arctostaphylos viscida* (whiteleaf manzanita). Many of the shrubs on timberland are beneficial to wildlife and protect the soil from erosion; species of *Ceanothus, Cercocarpus,* and other genera can improve site fertility by fixing nitrogen in the soil. On some of the better forest sites in the north Coast Ranges and northern interior, plants such as *Rhododendron macrophyllum, Gaultheria shallop, Vaccinium ovatum,* and *Ceanothus integerrimus* inhibit the regeneration and growth of desirable trees. The 2.2 million acres of timberland dominated by shrubs are capable of producing about 170 million to 180 million cubic feet of wood per year (roughly 870 million board feet). They are currently producing about 27 percent of that.

Contents

Introduction

This report presents the results of an inventory of shrubs in chaparral, timberland, and woodland conducted as part of a statewide forest inventory. The shrub inventory was done in recognition of the increasing importance that resource managers, users, and policymakers are placing on shrubs and the growing awareness that shrub types of differing composition and structure differ in their significance for management (Adams 1978; Conard and others 1985, 1986; Conrad and Oechel 1982; Gordon and Bowen 1978; McDonald and Tappeiner 1986; Minore and others 1982; Radosevich and Winterlin 1978; Wakimoto and Menke 1978). The information in this report should be useful to policymakers, educators, researchers, and members of the gen eral public interested in the management and protection of shrubs in California.

Shrub Types in California

Shrubs (woody plants generally less than 12 feet tall) are the dominant vegetation on extensive areas in California. Most of the shrubland in California is in three major shrub subformations: (1) chaparral and (2) soft chaparral (see "Terminology"), found mainly west of the Sierra Nevada and in the southern California mountains; and (3) woody shrubs, consisting of Great Basin sagebrush, creosote bush, and several other "series," of the arid region east of these mountains (Paysen and others 1980).

Shrubs also dominate on extensive areas of timberland and woodland where tree cover has been reduced or eliminated by fire, logging, and other disturbance. In addition, shrubs occur in differing amounts in the understory of several million acres of timber stands and oak woodland and juniper woodland.

The Importance of Chaparral

Chaparral is one of the most extensive vegetation types in California, which is viewed as both a blessing and a curse: Chaparral helps stabilize slopes, is important in main twining water quality, provides habitat for wildlife, and is pleasing to look at, to some people; conversely, some resource managers consider chaparral "one of nature's mistakes" (Vogl 1982). Chaparral is often impenetrable to humans and livestock; it competes with desirable forage plants on some sites; it is difficult and costly to re move (removal is usually temporary); and it is extremely flammable, especially at advanced ages.

Extensive areas of chaparral are at or approaching the age of high flammability. The situation is most acute in southern California where more than 13 million people live near or are surrounded by chaparral (Dougherty and Riggan 1982). Numerous fires in chaparral have caused loss of life and property and, indirectly, floods and land slides from slope denudation. The 1980 Panorama fire, for example, caused four deaths, destroyed 284 homes, damaged 113 other buildings, and destroyed numer- ous vehicles. From this fire, structural losses were $28 million, watershed losses were about $12 million, and suppression costs exceeded $5 million (Tyrrel 1982).

The extreme flammability of chaparral and two generally held notions-that chaparral has little intrinsic value and is highly uniform-have often resulted in single-objective management with blanket treatment of shrubs across vast areas. Except where management consisted of shrub removal for range improvement, the single objective was fire protection-"mostly for urban areas downstream" (Leisz 1982). In the past 5 to 10 years, it has been shown, however, that chaparral has potential for a variety of management purposes and commodities. For example, chaparral produces large volumes of woody material potentially usable for various products. Biomass accumulations of 15 to 20 tons per acre are typical, and more than 37 tons per acre have been measured (Riggan and Dunn 1982). Chaparral is not as uniform as it was once thought to be; this inventory confirms that chaparral is extremely diverse in size, density, and species composition.

The Importance of Shrubs on Timberland and Woodland

As with chaparral, shrubs in timberland and woodland can be beneficial or undesirable. Shrubs provide food and cover for wildlife and help reduce erosion and mass soil movement. Some shrubs improve site fertility by fixing nitrogen in the soil; among these are species of *Ceanothus, Cercocarpus,* and *Alnus,* and several genera in the Leguminosae. Shrubs can aid in the establishment of tree seedlings by shading them and protecting them from browsing animals. A common shrub that is both beneficial and undesirable is *Toxicodendron diversilobum* (poison-oak). It provides cover for many animals, and its fruit is an important food source for many birds, especially in winter when other food is scarce (Martin and others 1951); on the other hand, poison oak is a common cause of lost-time illness among outdoor workers (it was the most important factor in lost time during the statewide forest inventory and was a factor in crew morale).

On timberland, shrubs often hinder the establishment and growth of desired trees by usurping moisture, nutrients, and space (Gordon and Bowen 1978, McDonald and Tappeiner 1986). Some shrubs also seem to have an allelopathic influence on conifer seedlings (Tinnin and Kirkpatrick 1985). The presence of shrubs has reduced timber productivity on extensive areas despite considerable investment in shrub control. Some shrub species are resistant to chemicals, have built-in regeneration systems that foil control efforts, or can spread rapidly from distant sources. In some control projects, chemicals killed the dominant shrubs only to release other species that were more difficult to control.

Prescribed treatments intended to replace harvested forests with new forests have sometimes resulted in brushfields, for several reasons: (1) Seeds of several widespread shrub species in California can remain dormant for long periods, and logging and slash burning cause seeds to break dormancy and germinate. The only indication of shrub seeds in the soil may be scattered old shrub stems. "Disregarding the implications of old shrub stems has resulted in the failure of more than one conifer plantation in northern California" (McDonald and Tappeiner 1986). (2) Rapidly growing shrub sprouts choke out young conifer trees. (3) Interaction of competing plants with insects and animals accelerates damage to young conifer trees.

Shrubs in timberland and woodland can also hinder the movement of livestock, people, and machines; reduce forage production; increase operation costs; and, in some cases, make resources, inaccessible. Shrubs often increase the fire hazard in timberland and woodland areas, a critical problem in foothill residential areas. Several shrubs besides poison-oak contain irritating substances that cause skin rashes, eye inflammation, respiratory disorders, and other maladies (examples are *Lithocarpus densiflora* var. *echinatus, Chaemabatia foliolosa, Cytissus scoparius,* and *Holodiscus discolor).*

Previous Shrub Inventories in California

Shrub species have been catalogued in numerous vegetation studies in scattered localities in California (for example, Barbour and Major 1977, Critchfield 1971, Griffin 1967, Hanes 1977, Waring and Major 1964). Shrub types have been mapped or classified by Colwell (1974), Jensen (1939), and Parker and Matyas (1981). Wieslander and Jensen (1946) published the results of a statewide vegetation mapping project in which three major shrub types--chaparral, Great Basin sagebrush, and coastal sagebrush--were identified. Bolsinger (1980) published a statewide estimate of chaparral area based on a two-phase sample using aerial photos with ground verification for lands outside National Forests; it was compiled from USDA Forest Service mapping projects for National Forest lands. None of these projects included area estimates by specific type and ownership, or details on species composition and stand structure on a statewide basis.

The Current Study

During the planning stage of the current inventory, the following information needs were identified: area by type and ownership class; and stand characteristics that could be used for several purposes, including wildlife habitat analysis, fuel loading or biomass estimation, and vegetation management assessment. Also identified as an important need was a monitoring system for tracking change in area by type, stage of development, and ownership. All information was needed for each county. A sampling system was devised to satisfy most of the identified information needs. It was not possible, because of budgetary constraints, to devise a system that would provide detailed information by counties. Most information was developed for three major regions:,(1) **coastal,** which included all counties bordering the Pacific Ocean from Del Norte to Ventura plus Alameda, Contra Costa, San Benito, Santa Clara, and Solano; (2) **interior,** which extended from Siskiyou and Modoc Counties in the north to Kern and Inyo in the south; and (3) **southern California,** which included Los Angeles, Orange, Riverside, San Bernardino, and San Diego Counties (Imperial County was included in the sampling scheme, but fewer than 500 acres of forest and chaparral were found).

Sources Of Information and Methods

Most of the information in this report is based on three major data sources.

1. For National Forests, information was compiled from type maps prepared in connection with standard resource inventories. Chaparral was classified into broad shrub types somewhat analogous to Paysen's (Paysen and others 1980) series, but information was not gathered on shrub species or other chaparral stand characteristics. Area of shrub types on timberland and woodland was not available for National Forests, but was approximated by Forest Service officials familiar with the areas.

2. For National, State, regional, and county parks, information on vegetation types was supplied by park superintendents or their agencies. For most parks, chaparral was not classified into specific types. Although the vegetation of many parks is well understood, systematic inventories have not been conducted in most parks.

3. For lands outside National Forests and Parks, estimates of area by land class and broad vegetation class were obtained by using Cochran's (1977) double sampling for stratification. The primary sample consisted of aerial photo points located as follows: A computer-generated grid dividing land into 0.85-mile squares was projected over the State. Within each square a randomly located point was plotted on a U.S. Geological Survey quadrangle map and referenced to the Universal Transverse Mercator (UTM) coordinate system. Each point was transferred to an aerial photograph and was classified by broad land class and vegetation type. Points in timberland, woodland, and chaparral were also classified by ownership group from county assessors' records.

The secondary sample, a subsample of about 1 out of 16 of the aerial photo points, was selected on a systematic square grid with a 3.4-mile interval. Each selected point was examined to determine the accuracy of the aerial photo classification. Ground plots were established at each of the 3.4-mile grid points in timberland and at every other grid point (6.8-mile interval) in woodland and chaparral. Timberland plots and most plots in woodland consisted of five subplots distributed over a 5-acre area; at each subplot, trees were tallied on a series of fixed- and variable-radius plots, and a vegetation profile was recorded on a 16.4-foot fixed-radius plot. In chaparral, one 55.8-foot fixed-radius plot was established at each location, and a vegetation profile was recorded.

Woody shrubs and vines and semiwoody plants were identified by species and recorded by height class, percentage of cover, and stage of development (immature, mature, and decadent or overmature). Shrub type for each location was named for the predominant species. Except for indicator plants identified in previous studies (MacLean and Bolsinger 1973a, 1973b, 1974), forbs, grasses, ferns, and mosses were usually not recorded by species. Total cover and height were recorded for each of these plant groups forbs, grasses, ferns, and mosses: Height was recorded to the nearest meter (3.3 feet) for plants 1 meter tall or taller, and to the nearest decimeter (0.3 foot) for plants shorter than 1 meter. Little (1978) was the authority for naming trees and some shrubs than can attain tree-size; Munz and Keck (1970) was the authority for other plants. Scientific names are used for shrub species mentioned in this report, and common names are used for shrub types and tree species. A list of scientific and common names of all plants mentioned is in the appendix.

Statewide, outside National Forests and Parks, 85,174 aerial photo points were classified of which 5,048 were checked on the ground. A shrub tally was made on 1,457 ground plots. The following tabulations summarize the classification:

Aerial photo sample points:

Classification	Number of sample points
Timberland or woodland	37,799
Chaparral	10,215
Nonforest	37,160
Total	85,174

Ground plots:

Vegetation type	Photo class verification	Shrub tally
Trees, timberland and woodland	2,067	1,182
Shrubs:		
Timberland and woodland	154	112
Chaparral	611	163
Total, shrubs	765	275
Nonforest	2,216	0
All types	5,048	1,457

In response to the stated need for monitoring change, all sample points and ground plots were referenced and marked on aerial photographs. These plots could provide the basis for tracking trends in shrubland and changes in vegetation type, ownership, and other characteristics. The U.S. Department of Agriculture, in its instructions for conducting the 1987 National Resources Inventory by the Soil Conservation Service, [1] defined chaparral and pinyon-juniper woodland as nonforest range; this relieved the USDA Forest Service of responsibility for inventorying these two extensive types. Whether or not the plots established in the study reported here will be used to monitor these types in California is not known.

[1]Shaw, Robert R. 1987. Supplemental materials for conducting the 1987 National Resources Inventory. Washington, DC: U.S. Department of Agriculture, Soil Conservation Service. 5 p. National Bulletin 290-7-4.

Reliability of Area Estimates

National Forests

Area by broad vegetation type in National Forests was determined by type mapping. Aerial photographs and satellite imagery were used along with elevation and topographical information to determine vegetation type. A check of the classification for two National Forests determined that mapped types were accurately defined 85 percent of the time (for details on the classification procedures contact the USDA Forest Service, 630 Sansome Street, San Francisco, CA 94111).

National, State, Regional, and County Parks

Area by broad vegetation type was determined by the various parks or agencies, either by personnel familiar with the properties or through contracts with private consultants. In most cases, chaparral was not identified by specific type (such as chamise or scrub oak). The total reported area in shrubs in parks is thought to be as reliable as that in National Forests.

Outside National Forests and Parks

Statistical accuracy-All area estimates for lands outside National Forests and Parks were obtained by sampling and are subject to sampling error. Table 1 shows the estimated area of chaparral, timberland, and woodland by region and ownership with associated confidence intervals (68-percent probability level).

Table 1—Estimated area and confidence intervals[a] of chaparral, timberland, and woodland outside National Forests and parks, by land class, region, and ownership, California, 1985

Land class and region	Public		Private		Total	
	Estimated area	Confidence interval	Estimated area	Confidence interval	Estimated area	Confidence interval
	Thousand acres					
Chaparral:						
Coast range	300	±37	1,256	±66	1,556	±74
Interior	467	±34	938	±54	1,405	±64
Southern	523	±35	1,043	±47	1,566	±33
Total	1,290	±59	3,237	±96	4,527	±111
Timberland:						
Coast range	271	±22	3,010	±56	3,281	±59
Interior	238	±24	4,438	±75	4,676	±79
Southern	8	±8	12	±12	20	±20
Total	517	±33	7,460	±94	7,977	99
Woodland:[b]						
Coast range	199	±24	1,738	±69	1,937	±73
Interior	962	±42	4,207	±89	5,169	±98
Southern	222	±21	224	±25	446	±33
Total	1,383	±53	6,169	±115	7,552	±126

[a] 68-percent probability level.
[b] Includes hardwood woodland, pinyon-juniper woodland, and all conifer types not classified as timberland because of harsh site conditions.

Accuracy of classification and plant identification-Field crews were trained by scientists and resource managers familiar with species and plant associations. Local experts assisted in classifying difficult sites and identifying uncommon plants. Local herbaria were made available and "traveling herbaria" were developed as new plants were encountered. A subsample of plots was systematically selected and revisited to maintain quality control. Accuracy of plot location was checked, measured items were remeasured, and identification of plants was verified. 1 believe these measures kept errors to a minimum.

Statewide Overview of Shrub Types

The three major woody vegetation land class groups in California-timberland, woodland, and chaparral-cover 38.9 million acres (table 2). Shrubs are the dominant vegetation on 10.2 million acres of this, including 7. 4 million acres of chaparral, 2.2 million acres of timberland, 0.4 million acres of hardwood woodland, and 0.2 million acres of pinyon-juniper woodland (table 3).

Table 2—Area of timberland, woodland, and chaparral, by land class and ownership, California, 1985

Land class	National Forest	Other public	Private	Total
		Thousand acres		
Timberland:				
Unreserved	8,286	517	7,460	16,263
Reserved	1,073	991	6	2,070
Total	9,359	1,508	7,466	18,333
Woodland:[a]				
Hardwoods	1,344	947	5,060	7,351
Pinyon-juniper	1,107	862	463	2,432
Other conifers	2,685	290	402	3,377
Total	5,136	2,099	5,925	13,160
Chaparral[a]	2,654	1,557	3,237	7,448
All land classes	17,149	5,164	16,628	38,941

[a] Includes unreserved and reserved. Reserved areas include lands in parks, wilderness, other statutory reservations, and properties owned by the Nature Conservancy.

Table 3—Area of chaparral and shrub-dominated timberland and woodland, by land class and ownership, California, 1985[a]

Land class	National Forest		Other Public			
	Unreserved	Reserved	Unreserved	Reserved	Private	Total
	Thousand acres					
Chaparral	2,314[b]	340[b]	1,290[c]	267[b]	3,237[c]	7,448
Shrub-dominated timberland	1,045[d]	230[d]	73[c]	181[e]	654[c]	2,183
Shrub-dominated woodland:						
Hardwoods	27[e]	5[e]	27[c]	2[e]	295[c]	356
Pinyon-juniper	75[e]	3[e]	61[c]	4	30[c]	173
Total	3,461	578	1,451	454	4,216	10,160[f]

[a] Shrub-dominated timberland is less than 20 percent stocked with trees and has at least 50 percent cover in shrubs. Shrub-dominated woodland has at least 50 percent cover in shrubs regardless of tree stocking.
[b] Based on type maps.
[c] Based on sampling.
[d] Based on the typed area of nonstocked and approximated area of sparsely stocked timberland multiplied by 0.80 (on recommendation of Forest Service personnel, Pacific Southwest Region, San Francisco).
[e] Based on the proportion in each land class outside National Forests and Parks that is occupied by shrubs.
[f] Excludes shrub types on 3,377,000 acres of other conifer woodland—mostly at high elevations in National Forests and Parks for which no information is available.

Timberland

Although most timber stands are classified according to the taller trees, the shrubs frequently dictate the initial management treatment, or limit the use of the land in the absence of treatment. The 2,183,000 acres of shrub-dominated timberland amount to about 12 percent of the total area of timberland in Calfornia.

In Public Ownership

About 58 percent of the total area of shrub types is in public ownership including National Forests; areas managed by the Bureau of Land Management; National, State, county, municipal, and regional parks; other State lands; Indian lands; military reservations; and lands managed by other Federal and local agencies. Ownership distribution of shrub types differs considerably by land class:

Land class	Public	Private
	(Percent)	(Percent)
Chaparral	57	43
Timberland	70	30
Woodland	39	61
All land classes	58	42

Species Diversity

More than 130 species and varieties of shrubs were identified on plots outside National Forests in chaparral, timberland, and woodland. Included were widespread species such as *Adenostoma fasciculatum* and *Ceanothus cuneatus* and uncommon plants such as *Calycanthus occidentalis* and *Chamaebatiaria millefolium,* which were found on only one or two plots. Some plants-- *Toxicodendron diversilobum,* for example--were found in all three broad vegetation types (chaparral, timberland, and woodland). Other plants- *Gaultheria shallon,* for example-were found only within a very narrow range of environmental conditions. Plots with fewer than three shrub species were rare, even in "pure" chamise, and as many as 15 species were found on some plots. See the appendix for a complete list of trees and shrubs identified in this study.

Chaparral

Extent and Ownership

In California, chaparral types are found from Siskiyou County to San Diego County, mostly west of the Sierra Nevada (fig. 1) and the Cascade Range (fig. 2). Ownership of chaparral differs by region (table 4); statewide, public ownership predominates (fig. 3).

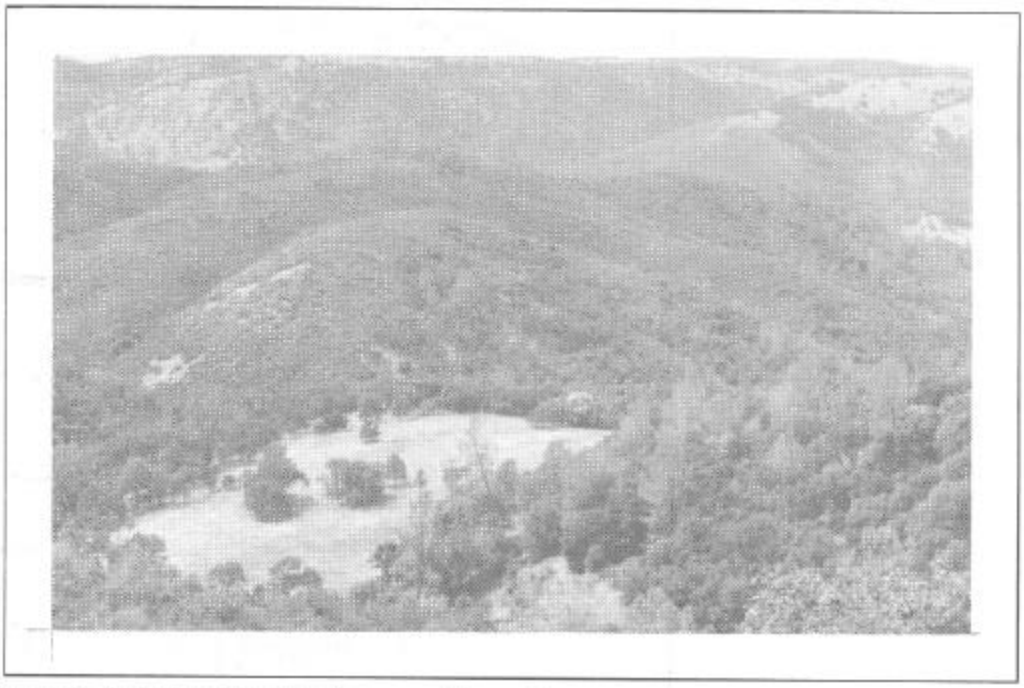

Figure 1—Chaparral covers extensive areas of the western foothills of the Sierra Nevada. This scene is in Calaveras County.

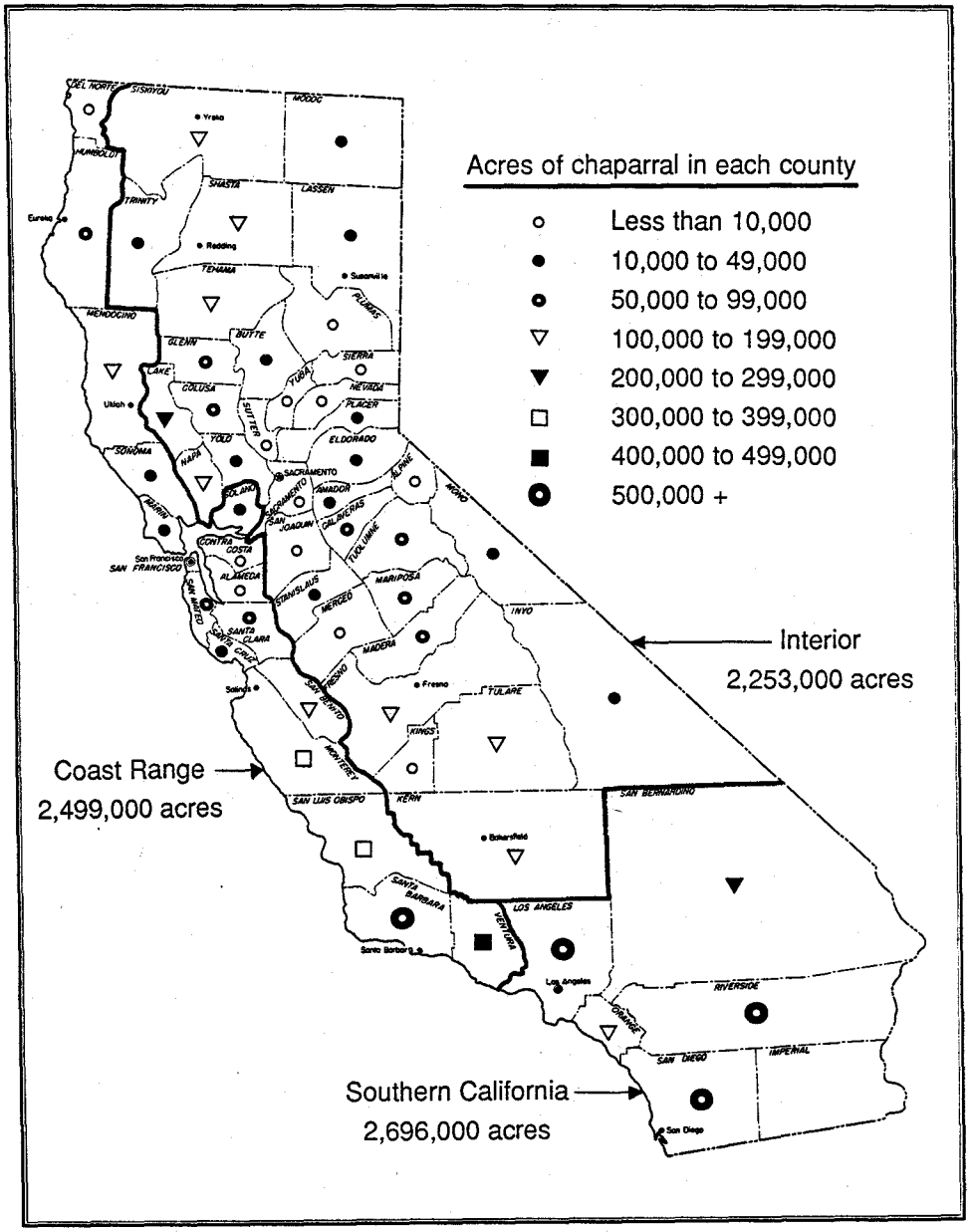

Figure 2—Distribution of chaparral in California by county and region.

Table 4—Area of chaparral by region, ownership, and type group, California, 1985

Region and ownership	Chamise	Mountain-mahogany	Scrub oaks	Mixed and montane	Coastal transition	Untyped (in parks)	Total
			Thousand acres				
Coast Range:							
National Forest	266	0	140	237	200	0	843
Other public	266	0	0	34	0	100	400
Private	891	0	259	0	106	0	1,256
Total	1,423	0	399	271	306	100	2,499
Interior:							
National Forest	345	51	28	360	0	0	784
Other public	223	68	53	123	0	64	531
Private	453	86	81	318	0	0	938
Total	1,021	205	162	801	0	64	2,253
Southern:							
National Forest	686	42	0	299	0	0	1,027
Other public	215	62	123	0	123	103	626
Private	477	0	268	149	149	0	1,043
Total	1,378	104	391	448	272	103	2,696
All regions:							
National Forest	1,297	93	168	896	200	0	2,654
Other public	704	130	176	157	123	267	1,557
Private	1,821	86	608	467	255	0	3,237
Total	3,822	309	952	1,520	578	267	7,448

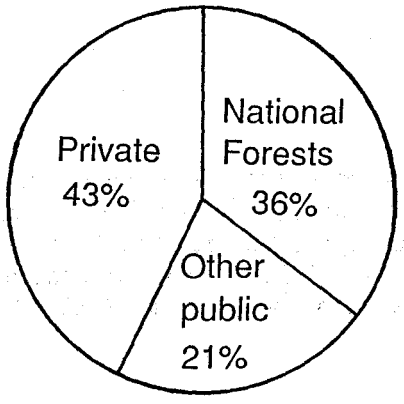

Figure 3—Ownership of chaparral in California.

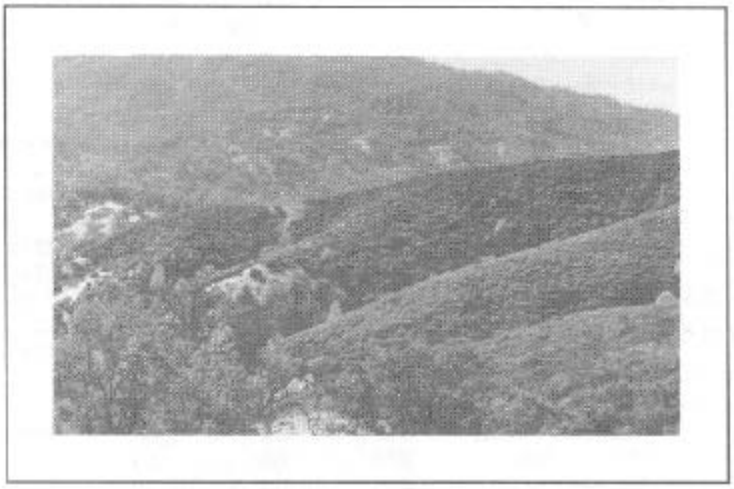

Figure 4—Chamise type in Mendocino County with scattered Digger pine trees and inclusions of blue-oak woodland. On the ridge in the background, chamise grades into mixed chaparral and woodland with inclusions of conifer timberland.

Five Major Type Groups

Five major type groups were recognized in the statewide chaparral inventory: chamise, mixed and montane, scrub oaks, coastal transition, and mountain mahogany (table 4).

Chamise Type Group Predominates

Chamise is the most extensive chaparral type group, as shown below (see table 4 for details by ownership and region):

Type group	Percentage of chaparral
Chamise (including redshank)	51
Mixed and montane chaparral	20
Scrub oaks	13
Coastal transition	8
Mountain-mahogany	4
Untyped (in parks)	4
	100

Chamise type was found from Shasta County in the northern interior and Mendocino County (fig. 4) in the northern Coast Range to San Diego County in southern California. Most of the chamise type is dominated by *Adenostoma fasciculatum*. In southern California, *Adenostoma sparsifolium* (redshank) sometimes dominates chamise type. Redshank was found on 61,000 acres outside National Forests.

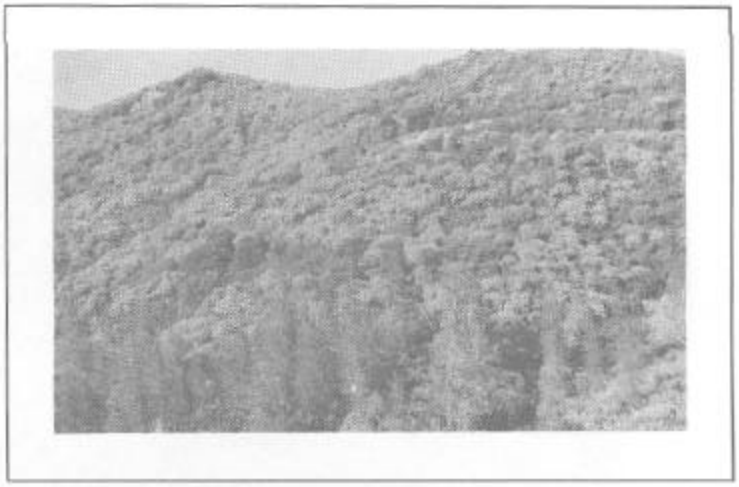

Figure 5—Mixed chaparral (manzanita series) in Shasta County. *Arctostaphylos viscida* predominates. Other shrubs include *Ceanothus lemmonii, Quercus wislizenii* var. *frutescens, Heteromeles arbutifolia, Toxicodendron diversilobum, Aesculus californica,* and *Eriodictyon californicum*. Knobcone pine and canyon live oak trees are also present.

The mixed and montane chaparral type group was found throughout the State. In National Forests, it includes undetermined amounts of bush chinkapin, ceanothus, manzanita, and prunus types (cherry and wild plum). Outside National Forests, the mixed and montane group includes ceanothus types (56 percent), manzanita (34 percent) (fig. 5), poison-oak (5 percent), and summer-holly (5 percent).

The scrub oaks type group consists predominantly of stands of *Quercus dumosa* but also includes stands in which the following shrubby oaks predominate: *Quercus agrifolia* var. *frutescens, Quercus chrysolepis* var. *nana*, *Quercus garryana* var. *breweri* and var. *semota*, and *Quercus wislizenii* var. *frutescens*. The two varieties of *Quercus garryana*, unlike most chaparral shrub species, are deciduous; but they are usually associated with, or grade into types of, evergreen shrubs, including species of *Arctostaphylos, Ceanothus, Cercocarpus*, and *Garrya*. Scrub oaks were found in most parts of the State, but were most extensive in the southern Coast Range and in southern California.

The coastal transition type group consists of plant associations in which "soft chaparral" species (Paysen and others 1980) make up 25 percent or more of the shrub cover, but chaparral species dominate. On plots where soft chaparral species such as *Artemisia californica, Eriogonum fasciculatum, Lotus scoparius, Lupinus* spp., and *Salvia* spp. predominate, the vegetation was classified as coastal sage and was not included as chaparral.

In the coastal transition type group, three types were recognized: baccharis, sumac, and toyon. In National Forests, the group is made up almost entirely of sumac. Outside National Forests, the distribution is baccharis 44 percent, sumac 40 percent, and toyon 16 percent.

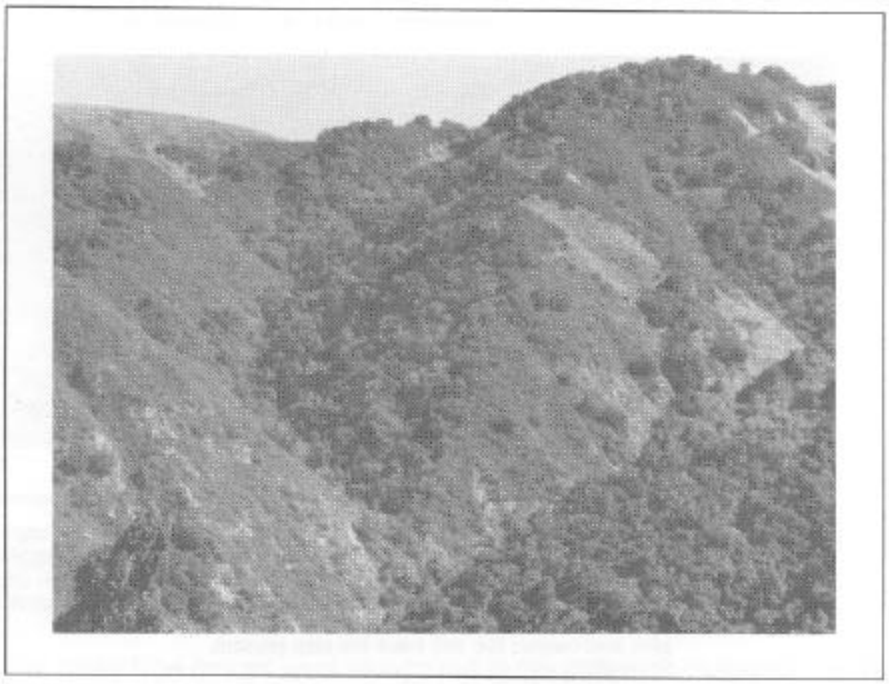

Figure 6—Baccharis and chamise are both present in this mosaic of chaparral, coastal sage, and coast live oak woodland in Monterey County.

Baccharis type was classified as chaparral where *Baccharis pilularis* was the species with the greatest crown cover and was associated with one or more of the following genera: *Adenostoma, Arctostaphylos, Ceanothus, Heteromeles, Quercus, Rhamnus,* and *Rhus. Baccharis* was found from Mendocino County to San Diego (fig. 6).

Sumac type includes stands in which *Rhus integrifolia, R. laurina,* or *R. ovata* predominate. This type was found in the southern part of the Coast Range and in southern California.

Toyon type was found mostly in the southern part of the Coast Range and in southern California, although toyon shrubs *(Heteromeles arbutifolia)* were found in many parts of the State, in chaparral, timberland, and woodland.

The mountain-mahogany type group consists of shrub types dominated by species of *Cercocarpus. Cercocarpus betuloides is* found in the Coast Range and on the western slopes of the Sierra Nevada and the southern California mountains; *C. ledifolius* is found in the drier interior (fig. 7). Older stands are generally found on rocky sites where the sparseness of herbaceous vegetation has protected the stands from ground fires. Absence of fire since about 1900 has allowed *C. ledifolius* to spread in many areas (Arno and Wilson 1986). Outside National Forests, 67 percent of the mountain-mahogany group consists of stands of *Cercocarpus betuloides* and 33 percent of *C. ledifolius. Cercocarpus intricatus,* and *C. minutiflorus* also are reported in California (Munz and Keck 1970) but were not found on plots outside National Forests.

Figure 7—Curlleaf mountain-mahogany type in Lassen County. Understory shrubs in this stand include *Artemisia tridentata*, *Chrysothamnus* spp., *Monardella* spp., *Purshia tridentata*, and *Ribes cereum*.

Stand Characteristics

Prevention of wildfire is the major focus of chaparral management, and controlled fire is the major management tool. In the evaluation of fire hazard and in the development of burning prescriptions, several chaparral characteristics are important: fuel volume, dead-to-live-fuel ratio, live-fuel moisture, chemical content of the fuel, season of the year, and terrain. These characteristics and their effect on the results of a burn differ by species, density, height, and stage of development; for example, the chamise type and stands in which *Eriogonum fasciculatum*, *Salvia* spp., or *Artemisia californica* are present usually burn more readily and more completely than scrub oak, manzanita, toyon, and mountain-mahogany (Green 1982). Characteristics of the fuel also affect the chemical and particulate content of air pollutants produced by a burn and soil characteristics after a burn. The characteristics of present stands are usually the best indicators for predicting response to management. Following is information on characteristics of California's chaparral as determined from the statewide inventory.

Species occurrence—A rich mixture of shrub species grows in the chaparral of California. On plots established outside National Forests, more than 75 shrub species were identified (tables 10, 11, and 12, appendix). *Adenostoma fasciculatum* was the most prevalent species and was found on 69 percent of the chaparral plots statewide. Nine species and varieties of *Quercus* (not counting tree-size *Quercus*), were found on 69 percent of the chaparral plots statewide. *Arctostaphylos* was the next most prevalent genus and was found on 36 percent of the plots in chaparral. A few species of *Quercus* and *Arctostaphylos*--possibly hybrids--could not be identified by species. *Ceanothus* spp. were found on 29 percent of the plots in chaparral. Ten species and varieties were identified and, as with *Arctostaphylos,* a few were found that could not be identified. Table 5 shows the occurrence of the major shrubs found on plots in chaparral outside National Forests (see tables 10, 11, and 12, appendix, for detailed lists).

Table 5—Occurrence of major shrub species or species groups in chaparral outside National Forests in California, by region, 1985

Species or group	Coastal	Interior	Southern	Statewide
		Percent of chaparral area		
Adenostoma spp.	81	50	73	69
Quercus spp.	37	40	63	47
Arctostaphylos spp.	30	48	31	36
Ceanothus spp.	16	28	44	29
Rhus spp.	2	1	39	15
Artemisia californica	19	—	18	13
Heteromeles arbutifolia	12	13	12	12
Eriogonum fasciculatum	5	—	29	12
Baccharis spp.	23	—	7	10
Salvia spp.	15	—	12	9
Cercocarpus spp.	2	18	9	9
Toxicodendron diversilobum	7	10	4	7
Lotus scoparius	—	—	18	6
Rhamnus spp.	2	3	7	4
Eriodictyon spp.	—	10	4	4
Chrysothamnus spp.	—	11	2	4

Species diversity within stands-The coastal transition type group had the most shrub species per plot, and chamise had the least, as shown in the following tabulation:

Type group	Number of shrub species per plot		
	1-2	3-4	5 or more
	(Percent of area)		
Chamise	45	38	17
Mountain-mahogany	0	60	40
Scrub oaks	18	55	27
Mixed and montane	34	40	26
Coastal transition	0	50	50

Associated species in the chamise type group-In the northern Coast Range, several chaparral species were commonly found in chamise type, including *Arctostaphylos canescens, A. manzanita, Ceanothus cuneatus, C. foliosus,* and *Quercus durata.* In the southern Coast Range, associates of chamise often included both chaparral shrubs (such as *Quercus* spp., *Rhus* spp., *Rhamnus* spp., *Ceanothus* spp., and *Arctostaphylos* spp.) and soft chaparral shrubs (such as *Artemisia californica, Eriogonum fasciculatum,* and *Salvia* spp.). In the interior, associates of chamise included *Arctostaphylos viscida, A. manzanita, Ceanothus cuneatus, C. lemmonii, C. leucodermis, Eriodictyon californicum, Heteromeles arbutifolia, Rhamnus* spp., and

Toxicodendron diversilobum. In southern California, plots in chamise often included species found to the north as well as species that were found only in the area; for example, *Arctostaphlos glauca, A. pungens, A. pringlei* var. *drupacea, Ceanothus crassifolius*, and *C. greggii* var. perplexans. Trees found in chamise-usually on microsites--included knobcone pine, Digger pine, several species of oak, and cypress.

Associated species in the mountain-mahogany type group-The two major species of mountain--mahogany-*Cercocarpus betuloides*, and *C. ledifolius*--grow in different environments and therefore are associated with different plants. On plots in *C. betuloides*, "typical" chaparral shrubs were found, including *Arctostaphylos* spp., *Ceanothus* spp., *Heteromeles arbutifolia, Quercus* spp., *Rhamnus* spp., and *Rhus* spp. Digger pine and tree-size oaks were also occasionally found. On plots in *Cercocarpus ledifolius,* shrubs common to the arid interior were found, including *Artemisia* spp., *Chrysothamnus* spp., *Haplopappus* spp., *Purshia tridentata*, and *Ribes* spp. Tree species found with *C. ledifolius* included western juniper, Utah juniper, singleleaf pinyon, Jeffrey pine and, in northeastern California, California black oak.

Associated species in the scrub oak type group-Scrub oak stands usually had shrub species common to other chaparral types, including *Adenostoma fasiculatum*, *Arctostaphylos* spp., *Ceanothus* spp., *Rhamnus* spp., and *Rhus* spp. In the *Quercus garryana* var. *brewerii* type, *Ceanothus integerrimus*, *Fraxinus dipetala*, and *Garrya* spp. were among the shrubs found. Several tree species were occasionally found, including Digger pine, knobcone pine, ponderosa pine, California juniper, canyon live oak, coast live oak, and interior live oak.

Associated species in the mixed and montane type group-Mixed chaparral is generally at lower elevations, and montane, as the name implies, is found higher in the mountains. Shrub species found on plots in mixed chaparral included *Arctostaphylos canescens, A, columbiana, A. glauca, A. manzanita, A. pringlei* var. *drupacea, A. pungens, A. viscida*, *Ceanothus cuneatus, C. greggii* var. *perplexans, C. incanus, C. lemmonii, C. leucodermis*, *C. oliganthus, C. palmeri, Cercocarpus* spp., *Cercis occidentalis, Comarostaphylis diversifolia, Heteromeles arbutifolia, Quercus* spp., *Rhamnus* spp., and *Rhus* spp. Tree species found in mixed chaparral included Digger pine, knobcone pine, ponderosa pine, a sem-iarborescent form of California laurel, several species of oak, and cypress. Montane chaparral is generally found within the conifer timberland zone on harsh sites unable to support trees. On timberland sites occupied by chaparral vegetation, mostly burned and logged areas, the land was classified as nonstocked timberland rather than chaparral. Some of the shrubs found in mixed chaparral were also found in the lower reaches of the montane chaparral zone. More commonly found in montane chaparral were *Arctostaphylos patula, Castanopsis sempervirens, Ceanothus cordulatus, C. velutinus, Garrya* spp., *Prunus emarginata*, and *Quercus vaccinifolia*. Trees commonly associated with montane chaparral include white fir, California red fir, sugar pine, ponderosa pine, Jeffrey pine, and incense-cedar.

Associated species in the coastal transition type group- three major types in this group-baccharis, toyon, and sumac-all include mixtures of chaparral and soft chaparral species. In addition to the namesake species (*Baccharis* spp., *Heteromeles arbutifolia*, and *Rhus* spp.), *Adenostoma fasciculatum* was the predominant associate found on plots. Many species found in mixed chaparral also were present. Soft chaparral species included *Artemisia californica, Eriogonum fasciculatum, Lotus scoparius*, and *Salvia* spp. Most of the plots in coastal transition types were in areas disturbed in recent years. The vegetation in such areas was in a seral stage; chaparral species will probably increase in these stands, and soft chaparral species decrease (Paysen and others 1980).

Diversity: north vs. south-Plot data confirmed the observation that chaparral in southern California has a richer mixture of species than chaparral in the northern part of the State. As shown in figure 8, 38 percent of the plots in southern California had five or more shrub species, compared with 18 percent in other regions.

Stage of development-As with timber stands, stage of development in chaparral is an important management consideration. Most chaparral types are relatively fireproof when young but become increasingly flammable with age. Flammability increases because of the buildup of volatile chemicals, the closing of gaps in the fuel as stand density increases, and, most importantly, the increase in dead material. Stage of development is also an important consideration in estimating biomass volume, evaluating wildlife habitat, and managing vegetation for water yield, livestock production, and aesthetics.

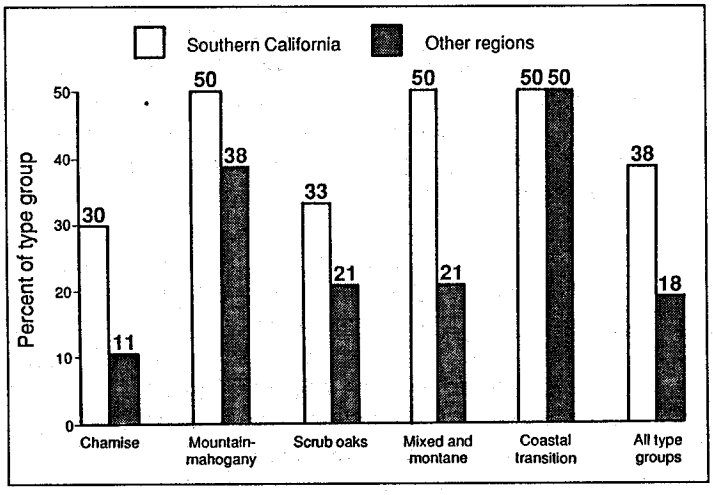

Figure 8—Percent of chaparral outside National Forests and Parks with five or more shrub species, in southern California and other regions, by type group.

Shrubs tallied on plots were classified by stage of development as follows:

Immature. Seedling, small shrub; no dead material (usually 1 to 10 years).

Mature. Large shrub; 1 to 24 percent dead material (usually 10 to 30 years).

Decadent. Large shrub; 25 percent or more dead material (usually 30 years or more).

The inventory showed that 15 percent of the total area of chaparral outside National Forests is decadent and 77 percent is mature: Table 6 shows stage of development by type group.

Critical fire hazard: about 1 million acres. The 684,000 acres of decadent chaparral outside National Forests (table 6) present a serious fire hazard. Most critical are the 283,000 acres of decadent chamise and 92,000 acres of decadent coastal transition chaparral, the two most flammable types (Conrad and Oechel 1982). The mature coastal transition chaparral should also be classified as critically flammable. Prevalent in coastal transition types are *Artemisia californica, Eriogonum fasciculatum*, and *Salvia* spp., which at any age have a high ratio of dead-to-live material and are therefore highly flammable. The total area in the critical hazard category outside National Forests is 661,000 acres (283,000 acres of decadent chamise + 378,000 acres of mature and decadent coastal transition). This is about 15 percent of the total chaparral area outside National Forests.

Data were not available on stage of development of chaparral in National Forests and Parks. If chamise and coastal transition type groups in National Forests, and the untyped chaparral in parks, are similar to chaparral outside National Forests and Parks; then about 383,000 acres in these ownerships are critically flammable. This would bring the total area of critically flammable chaparral up to 1,044,000 acres statewide.

Table 6—Area of chaparral outside National Forests by type group and stage of development, California, 1985

	Immature		Mature		Decadent		Total	
Type group	Thousand acres	Percent	Thousand acres	Percent	Thousand acres	Percent	Thousand acres	Percent
Chamise	261	10	1,982	79	283	11	2,526	100
Mountain-mahogany	0	0	216	100	0	0	216	100
Scrub oaks	84	11	544	69	156	20	784	100
Mixed and montane	25	4	445	71	153	25	623	100
Coastal transition	0	0	286	76	92	24	378	100
Total	370	8	3,473	77	684	15	4,527	100

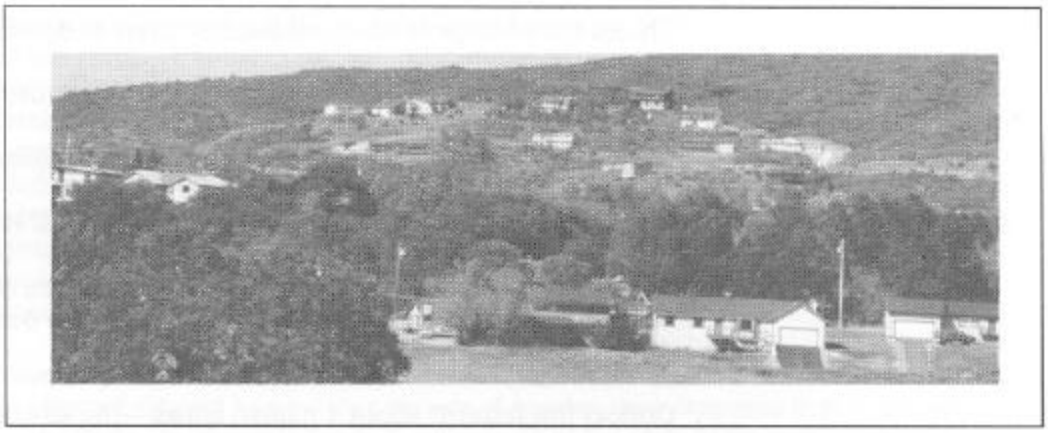

Figure 9—Spreading urbanization compounds the risks and costs of chaparral management. This scene is in Eldorado County.

In many parts of the State, urban developments continue to spread into chaparral areas (fig. 9). The seriousness of this situation is recognized by resource managers, community leaders, fire protection agencies, and many citizens. Millions of dollars are spent annually for fire protection, insurance, and rehabilitation after destructive fires. The increase in the number of urban developments in chaparral areas has magnified the potential for loss of lives, and damage to property, soil, water quality, and air quality.

Greatest fire hazard in southern California-Outside National Forests, about 74 percent of the critically flammable chaparral is in southern California, as shown in the following tabulation:

	Decadent chamise	Mature and decadent coastal transition	Total
		(Thousand acres)	
Southern California	220	272	492
Coast Range	0	106	106
Interior	63	0	63
Total	283	378	661

The 492,000 acres of critically flammable chaparral in southern California amount to 31 percent of the total chaparral outside National Forests there.

Stand density and height-The amount of plant material (often referred to as biomass or phytomass) in chaparral differs considerably, depending on density, height, and species. Wakimoto and Menke (1978) report the total standing biomass in 10-year-old chamise to range from 279 kilograms per hectare in sparsely stocked stands to 19,543 kilograms per hectare in dense stands. Riggan and Dunn (1982) report biomass accumulation in various chaparral types of 2.8 to 85.0 metric tons per hectare. Density and height of chaparral are also important for assessing fire hazard, developing burning prescriptions, evaluating wildlife habitat, predicting water yields from shrub-covered slopes, and estimating forage value for livestock (Adams 1978; Knipe 1982; Longhurst 1978; Sidahmed and others 1978, 1982).

Chamise type densest and shortest-On all plots outside National Forests, height and canopy closure were recorded for each species present (table 7). Chamise stands were the densest (81 percent had at least 60 percent canopy closure), but they were also the shortest (fig. 10). Scrub oak types on average were the tallest (53 percent were 6.6 feet or more), but mountain-mahogany had the greatest proportion in stands more than 9.8 feet tall.

Table 7—Area of chaparral in California outside National Forests and Parks, by type group, height, and canopy closure, 1985

Type group	Height	Canopy closure (percent)			
		1-39	40-59	60-100	Total
	Feet	*Thousand acres*			
Chamise	Less than 3.4	147	91	797	1,035
	3.4 to 6.5	149	68	1,103	1,320
	6.6 to 9.8	0	32	139	171
Total		296	191	2,039	2,526
Mountain-mahogany	Less than 3.4	31	0	19	50
	3.4 to 6.5	38	31	39	108
	6.6 to 9.8	0	19	0	19
	9.9 and taller	39	0	0	39
Total		108	50	58	216
Scrub oaks	Less than 3.4	32	56	56	144
	3.4 to 6.5	72	64	93	229
	6.6 to 9.8	89	60	185	334
	9.9 and taller	44	33	0	77
Total		237	213	334	784
Mixed and montane	Less than 3.4	20	17	118	155
	3.4 to 6.5	60	80	161	301
	6.6 to 9.8	0	0	145	145
	9.9 and taller	0	0	22	22
Total		80	97	446	623
Coastal transition	Less than 3.4	54	0	26	80
	3.4 to 6.5	108	0	27	135
	6.6 to 9.8	0	0	163	163
Total		162	0	216	378
All type groups	Less than 3.4	284	164	1,016	1,464
	3.6 to 6.5	427	243	1,423	2,093
	6.6 to 9.8	89	111	632	832
	9.9 and taller	83	33	22	138
Total		883	551	3,093	4,527

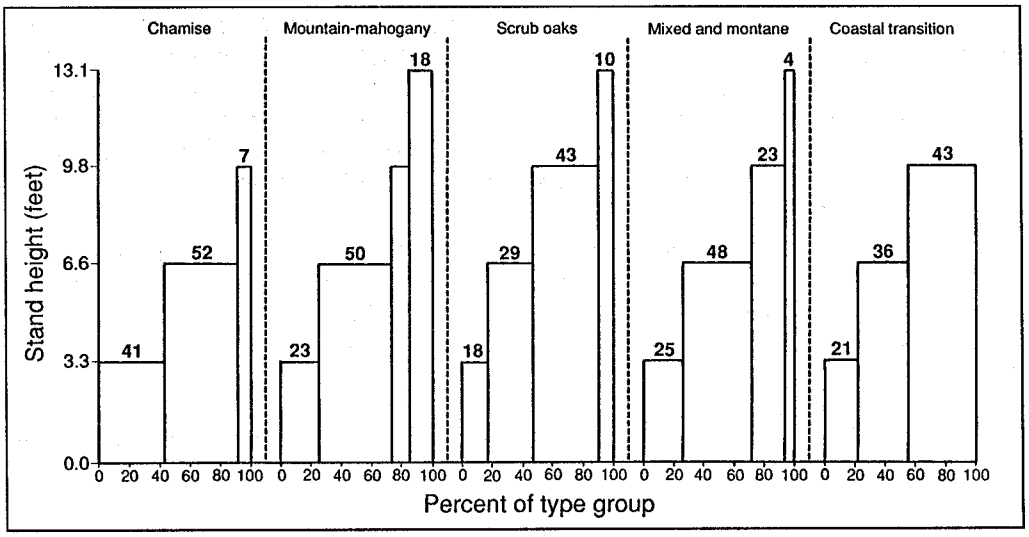

Figure 10—Chaparral stand height by type group, outside National Forests and Parks.

Phytomass greatest in mixed and montane chaparral-Although chamise stands were the densest, on average, of chaparral types, total phytomass was greatest in mixed and montane chaparral. Phytomass index (average height times average canopy closure times 43.560) is shown by type in the following tabulation:

Type	Average height	Average canopy closure	Phytomass index
	(Feet)	(Proportion)	
Chamise	5.44	0.71	168
Mountain-mahogany	7.28	.46	146
Scrub oak	8.00	.55	192
Mixed and montane	6.72	.68	199
Coastal transition	7.28	.56	178

Phytomass index includes air space within shrub crowns and dead stems as well as live. It is a rough approximation of the cubic volume of stems, twigs, and leaves per acre of chaparral. Other things being equal, it seems that mixed and montane chaparral and scrub oak types offer the greatest potential for fiber-based products or biomass energy development.

Slope percent-Land management activities are affected in many ways by the steepness of the ground. Erosion rates and sediment production in chaparral areas have been found to be weakly correlated with slope percent over a rather broad range of conditions. This is because erosion is not continuous and, except for sheet and rill erosion, tends to occur only after disturbance. Erosion occurs only if a threshold of equilibrium has been exceeded. The threshold of equilibrium seems more closely related to soil characteristics and stem and root biomass than to slope, up to some critical angle beyond which the slope can no longer resist failure under gravity. The critical angle for most soils in California is about 50 percent, at which point a fundamental change in erosion processes occurs; creep, landsliding, and dry ravel become more important than rain splash and channel transport (Brock and DeBano 1982, Conrad and Oechel 1982, Howard 1982, Taylor 1982, Wells 1982).

One-fourth of chaparral outside National Forests critically steep-Outside National Forests, 23 percent of the chaparral area was on slopes steeper than 45 percent (table 8). Only 8 percent of the chaparral outside National Forests in southern California was steeper than 45 percent, much less than was expected. In southern California, the steeper areas of chaparral seem to be in National Forests.

The plot sample indicated little difference in steepness of ground for chamise, mountain-mahogany, mixed and montane, and coastal transition type groups (24 to 29 percent of the area in these types was steeper than 45 percent). Scrub oaks occurred on gentler ground---only 10 percent was on slopes steeper than 45 percent.

Change in Chaparral Area

In 1946, Wieslander and Jensen reported 9,866,000 acres of chaparral in California, as determined from type maps. This is about 2.4 million acres more than determined in the current inventory. There is no doubt that chaparral area has declined, but the actual reduction in area is probably much less than 2.4 million acres. The 1946 estimate of chaparral included shrub types on timberland. Jensen (1939) states that only soil conditions could be used to separate "timberland chaparral ...from the chaparral type proper." In his text, he estimates that 72 percent of the blue-blossom-coast whitethorn type in the Santa Cruz Mountains was timberland and 28 percent was chaparral. The entire area was listed as chaparral in the statistical tables.

Table 8—Area of chaparral in California outside National Forests and Parks, by region and slope percent, 1985

Region	Slope (percent)			Total
	0-25	26-45	46+	
	Thousand acres			
Coastal	372	633	551	1,556
Interior	313	734	358	1,405
Southern	705	739	122	1,566
Total	1,390	2,106	1,031	4,527

For lands outside National Forests and Parks, the type mapping procedures used in the 1946 inventory probably resulted in a greater estimated area of chaparral than would be determined by the current sampling procedures, mainly because of the prevalence of forest inclusions in chaparral. In the current design, vegetation type could be as small as 1 acre; in 1946, vegetation types smaller than 500 acres were classified according to the surrounding vegetation. In California, inclusions of forest in chaparral are more common than inclusions of chaparral in forest (fig. 11).

A considerable area of chaparral has been cleared for roads, reservoirs, and urban and commercial expansion, and a small amount for vineyards, avocado orchards, and other agricultural development. The major factor, and the only one documented statewide, is range clearing. Between 1945 and 1973, the California Division of Forestry (now Department of Forestry and Fire Protection) reported that 1.9 million acres were cleared in "brushland range improvements" (State of California 1953-74). Nearly all clearing was by burning, although mechanical and chemical treatments were sometimes used, either to prepare for burning or to kill sprouting shrubs after burning. Many areas were also reburned, as shown in the following tabulation:

Burned area	Million acres
Total area burned under permit	2.5
Excess area burned by escaped fire	.2
Total area burned	2.7
Area reburned	.8
Net area burned	1.9

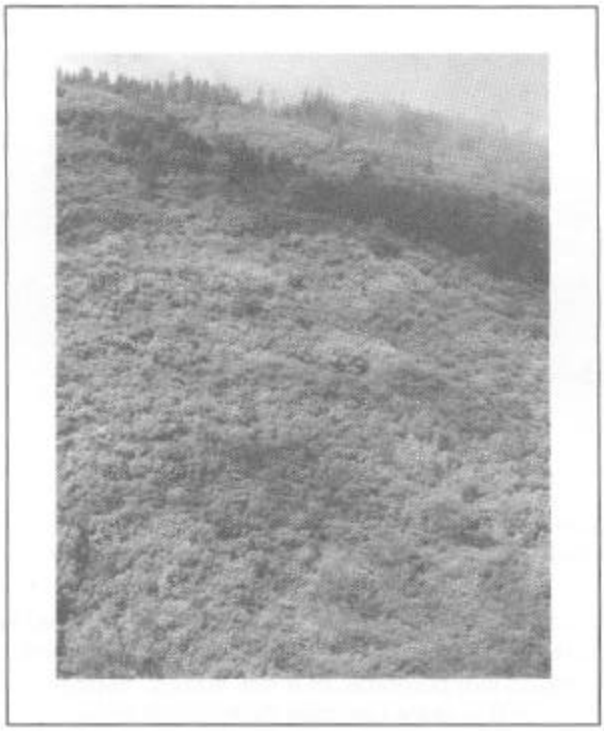

Figure 11—Inclusions of timber conifers, Digger pine, and hardwood trees in chaparral in Glenn County.

Of the net area cleared, about 890,000 acres were estimated to be in oak woodland and 1,050,000 in chaparral (Bolsinger 1987). Because chaparral often repossesses cleared sites, despite repeated efforts to keep it out, it is probable that of the 1,050,000 net acres cleared in range improvements, some has reverted to chaparral. The decrease in chaparral since 1946, by all causes (including urban expansion; road, reservoir, and powerline construction; range improvement; and wildfire), is not known, but the available information would place it between 1.0 and 1.5 million acres. The aerial photo points and field plots established outside National Forests and Parks could provide a way to monitor future change in chaparral area.

Shrubs On **Timberland and Woodland**

Shrubs Types on 2.7 Million Acres

Shrubs are estimated to dominate 2,183,000 acres of timberland and 529,000 acres of woodland (see table 3). Included are timberland and woodland areas in which the canopy of trees 5.0 inches in d.b.h. and larger is less than 20 percent and shrub cover is 50 percent or more. Also included are 240,000 acres of sapling and seedling stands with 50 percent or more shrub cover on timberland outside National Forests. Most of the area is sparsely stocked with trees because of fire, logging, or other disturbance (fig. 12); but on some sites, tree cover is sparse because of natural stocking limitations (MacLean and Bolsinger 1973b). In some areas it was difficult to distinguish chaparral from shrub types on nonstocked forest land. The classification of such areas was aided by soil-vegetation maps (Colwell 1974), plant indicators, evidence or lack of evidence of past tree stocking (stumps, snags, logs, and remnants of rotten trees on the ground), and conversation with resource experts and local residents.

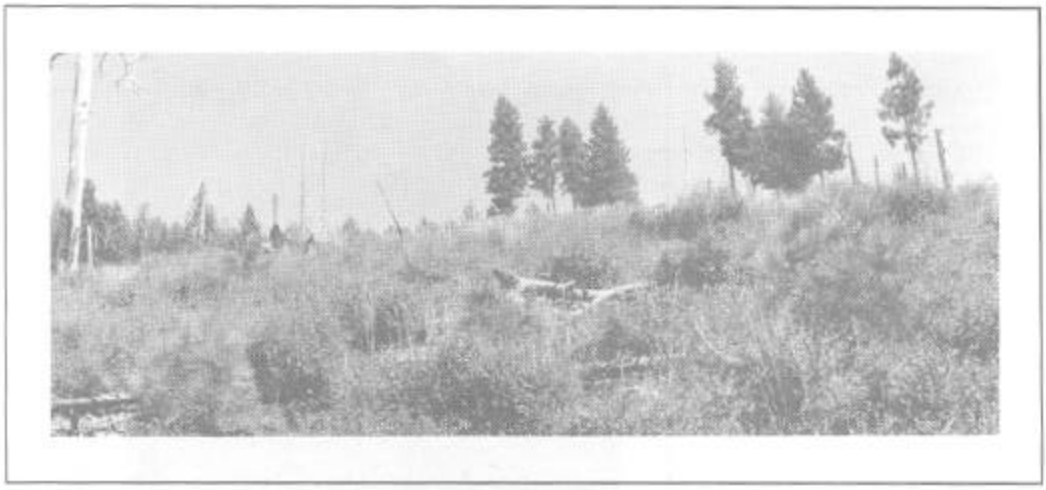

Figure 12—Ponderosa pines planted in this burned area in the Klamath National Forest are dominated by *Ceanothus integerrimus*.

Timber Growth on Shrub-Dominated Timberland

On the 727,000 acres of shrub-dominated unreserved timberland outside National Forests (see table 3), current annual cubic foot growth of conifers was compared with the estimated site potential. In a few stands, conifer growth was found to exceed 60 percent of the site's potential despite the shrub cover; but most stands were producing much less:

Growth as a percentage of site potential	Percentage of shrub-dominated timberland
0-20	58
21-40	16
41-60	13
61+	13

On the 727,000 acres of shrub-dominated timberlands outside National Forests, net annual growth of softwoods averages 28 cubic feet per acre. This is about 27 percent of the estimated site potential and 45 percent of growth rates on the 7,250,000 acres of timberlands not dominated by shrubs (where annual growth averages 62 cubic feet per acre, 60 percent of estimated site potential). Growth rates in shrub-dominated timberlands within National Forests are unknown, but are assumed to be about 45 percent of growth rates on sites not dominated by shrubs. For the entire area of shrub-dominated timberland—1,772,000 acres excluding reserved areas— current growth is about 50 million cubic feet. If these lands were producing as much as timberlands not dominated by shrubs, growth would be about 110 million cubic feet. If they were producing 90 percent of full site potential (instead of the current 60 percent), growth on these lands would be about 165 million cubic feet. The potential increase in timber yield ranges from 60 million cubic feet to 105 million cubic feet, or from about 310 million board feet to 550 million board feet. This is 8 to 14 percent of the statewide timber harvest in recent years and is comparable to the 1985 timber harvest in each of the three leading timber-producing counties: Humboldt, Mendocino, and Siskiyou (State of California, Board of Equalization, 1986).

Shrub Types on Timberland and Woodland

Vegetation management techniques-whether aimed at eliminating unwanted species or at promoting desirable ones--can vary according to species type. Outside National Forests, 19 shrub types were recognized; they included 10 found only on timberland, 8 found on both timberland and woodland, and 1 found only on woodland (table 9). Four types accounted for 51 percent of the area in shrubs: (1) greenleaf manzanita tobacco brush-bush chinkapin (19 percent), found at mid to higher elevations within

Table 9—Area of shrub types on nonstocked and sparsely stocked timberland and woodland outside National Forest and Parks, by shrub type and forest type group, California, 1985[a]

Shrub type[b]	Timberland	Hardwood woodland	Pinyon-juniper woodland	Total
		Thousand acres		
Greenleaf manzanita-tobacco brush-bush chinkapin	187	28	—	215
Evergreen huckleberry	141	—	—	141
Whiteleaf manzanita	65	61	—	126
Poison oak	39	65	—	104
Salal-salmonberry-thimbleberry	70	—	—	70
Mexican manzanita	6	60	—	66
Basin sagebrush-bitterbrush	—	—	61	61
Beaked hazel	22	28	—	50
Baccharis	—	48	—	48
Mountain-mahogany	18	—	30	48
Wedgeleaf ceanothus	12	33	—	45
Blue blossom	38	—	—	38
Rhododendron	30	—	—	30
Huckleberry oak	29	—	—	29
Snowbush	28	—	—	28
Deer brush	16	—	—	16
Squaw carpet	12	—	—	12
Dwarf tanoak	7	—	—	7
Wax-myrtle	7	—	—	7
All types	727	323	91	1,141

[a] Includes areas with at least 50 percent cover in shrubs and less than 20 percent stocking in trees. Stands were classified as less than 20 percent stocked with trees when (1) the quadratic mean diameter was less than 11.0 inches and no trees on 80 percent of the plots or only 1 tree on 40 percent of the subplots; and (2) the quadratic mean diameter was 11.0 inches and larger and total basal area was less than 50 square feet.

[b] Shrub types are named for the dominant species tallied on sample plots. Multiple-species types are used for common associations in which 2 or more species collectively dominate but differ in their proportional occupancy.

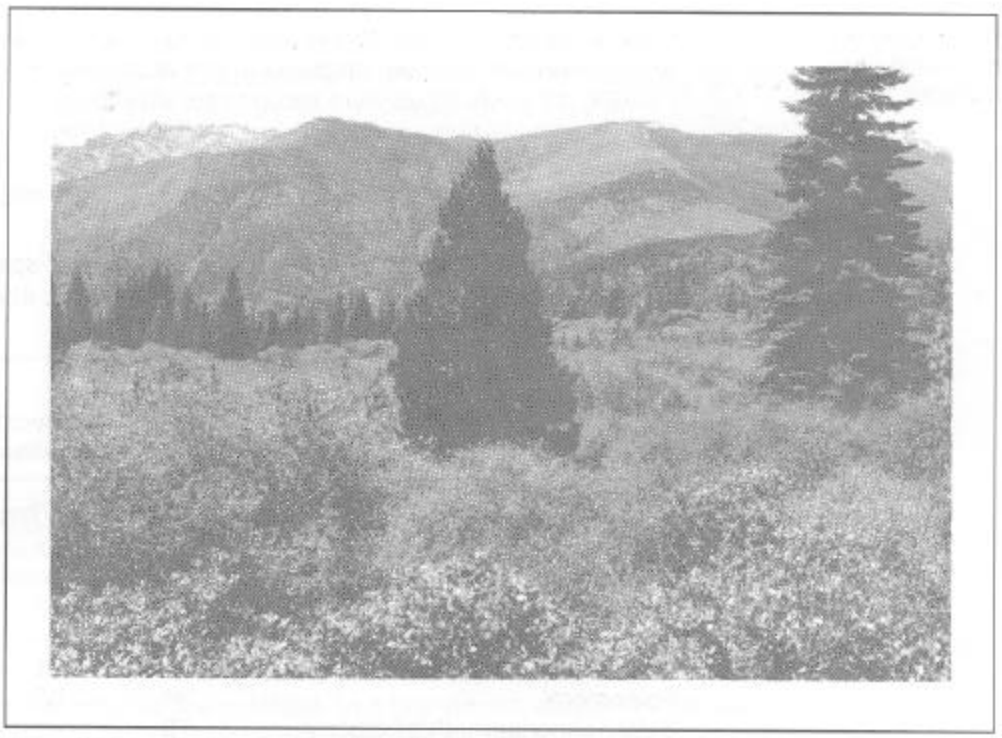

Figure 13—Greenleaf-manzanita—tobacco-bush—bush chinkapin is the most extensive shrub type on timberland in California outside National Forests and Parks. *Prunus emarginata* (bitter cherry) is conspicuous in this stand. White fir, ponderosa pine, and incense-cedar trees are also present.

the mixed conifer zone (fig. 13) and on harsh sites where it is classified as montane chaparral; (2) evergreen huckleberry (12 percent), found near the coast in the redwood-Douglas-fir belt; (3) whiteleaf manzanita (11 percent), found in the higher elevations of the oak woodland zone and the lower elevations of the conifer timber zone in the interior (whiteleaf manzanita is also widespread in chaparral in the interior); and (4) poison-oak (9 percent), found in many forest types west of the Sierra Nevada-Cascade Range crest below the red fir zone.

Shrub Species on Timberland and Woodland

In addition to the estimated 2.7 million acres of shrub types on timberland and wood land, where shrubs cover at least 50 percent of the ground, shrubs also occur as scattered plants or in thickets on most of the remaining 28.8 million acres of timber land and woodland.

Shrubs species on timberland-More than 100 shrub species were found on timberland outside National Forests. The most prevalent shrub species on timberland was *Toxicodendron diversilobum* (poison-oak), which was found in all regions and in many types (fig. 14). Species of *Ceanothus,* the most widespread genus, was found on 47 percent of the timberland. Considerable variety is found among species within *Ceanothus,* which includes plants that are matlike *(C. prostratus),* treelike *(C. thyrsiflorus),* spined *(C. cordulatus),* unspined *(C. velutinus),* deciduous *(C. integerrimus),*

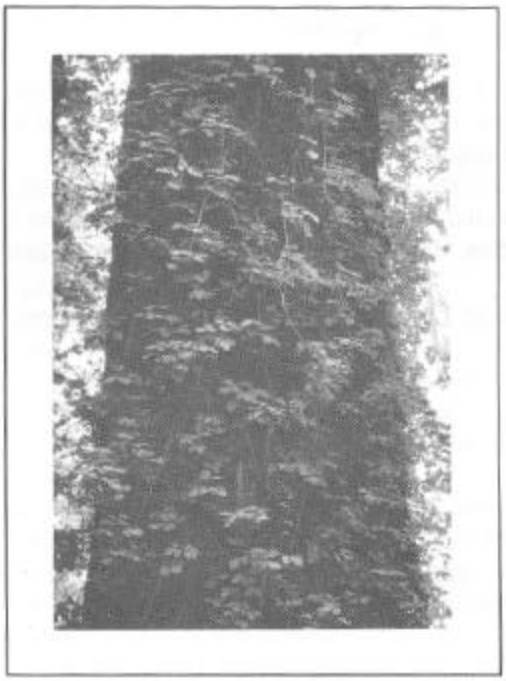

Figure 14—Poison-oak climbing on a redwood tree. Poison-oak, as a vine or shrub, is the most widespread nontree woody plant in forests outside National Forests and Parks in California.

and evergreen (most species). Species of *Ceanothus* were found in nearly every forest type. *Arctostaphylos*, another genus with many species of differing size and form, was found on 35 percent of the timberland. The following tabulation shows the major shrub species and groups on timberland outside National Forests (see tables 10, 11, and 12, appendix, for detailed lists of shrubs tallied):

Species or group	Percentage of timberland
Ceanothus (16 species)	47
Arctostaphylos (12 species)	35
Toxicodendron diversilobum	28
Vaccinium ovatum	20
Ribes spp.	14
Symphoricarpos spp.	14
Rubus spp.	12
Gaultheria shallon	11
Castanopsis sempervirens	7
Rosa spp.	7
Berberis spp.	6
Amelanchier spp.	6
Chamaebatia foliolosa	6
Heteromeles arbutifolia	5
Corylus cornuta var. *californica*	5
Cornus spp.	5

Shrubs on hardwood woodland-In many areas, hardwood woodland and chaparral intermingle; on some sites, one type may convert to the other over time, or after fire or other disturbance. Hardwood woodland and chaparral also interface and intermingle with timberland at lower elevations. For these reasons, the shrubs found in hardwood woodland are often the same species found in timberland at lower elevations or in chaparral. About 55 shrub species were tallied on hardwood woodland plots outside National Forests. The major species are shown in the following tabulation (see tables 10, 11, and 12, appendix, for detailed lists of shrubs tallied):

Species or group	Percentage of hardwood woodland
Toxicodendron diversilobum	50
Arctostaphylos (5 species)	29
Ceanothus (7 species)	21
Cercocarpus spp.	12
Heteromeles arbutifolia	11
Cercis occidentalis	5
Symphoricarpos spp.	5
Adenostoma fasciculatum	4
Baccharis spp.	4
Rhamnus spp.	4

Shrubs on pinyon-juniper woodland-Pinyon-juniper type covers 2.4 million acres in California, mostly east of the Cascade Range, the Sierra Nevada, and the southern California mountains. In the northern part of the State, the type consists of western juniper, usually in pure stands; oaks, aspen, and pines are occasionally present. In the southern part of the State, the type usually consists of singleleaf pinyon mixed with Utah juniper. The primary use of pinyon-juniper woodland is for livestock grazing; pinyon-juniper also provides habitat for many species of wildlife. About 25 shrub species were tallied on plots in pinyon-juniper outside National Forests. These shrubs differ in their significance for management. Several shrubs are thought of as weeds. *Chrysothamnus* spp., *Artemisia* spp., *Haplopappus* spp., and others may replace grass and other forage plants; they also make it difficult for people and livestock to get around in range areas. *Ephedra* spp. are poisonous to livestock, especially sheep. *Purshia tridentata,* although considered a weed by some livestock producers, provides up to 50 percent of the deer browse in some areas and is used by several other wildlife species (Martin and others 1951). *Cercocarpus ledifolius is* valuable as a cover and forage species for deer and other ungulates and as cover and nesting habitat for many smaller animals (Dealy and others 1986).

The major shrub species in pinyon-juniper woodland outside National Forests are shown in the following tabulation (see tables 10, 11, and 12, appendix, for detailed lists of shrubs tallied):

Species or group	Percentage of pinyon-juniper woodland
Artemisia tridentata	73
Purshia tridentata	32
Chrysothamnus spp.	29
Ribes spp.	22
Cercocarpus ledifolius	18
Cercocarpus betuloides	11
Yucca spp.	8
Ephedra spp.	7
Atriplex canescens	3
Bernardia incana	3
Haplopappus spp.	3
Artemisia arbuscula	3

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Metric Equivalents

1,000 acres =404.7 hectares
1,000 cubic feet = 28.3 cubic meters
1 cubic foot per acre = 0.07 cubic meter per hectare
1 inch = 2.54 centimeters
1 foot = 30.48 centimeters
1 mile = 1,609.3 meters

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Appendix

Tables

Table 10—Occurrence of shrub species by broad vegetation type on lands outside National Forests in the Coast Range, California, 1985

Species	Conifer forest	Hardwood woodland	Chaparral
	Percent of vegetation type		
Acer circinatum	1	0	0
Adenostoma fasciculatum	1	7	81
Arctostaphylos canescens	4	4	7
Arctostaphylos columbiana	7	1	2
Arctostaphylos manzanita	1	2	7
Arctostaphylos patula	5	4	0
Arctostaphylos spp.	0	0	12
Arctostaphylos viscida	1	2	7
Artemisia californica	0	2	19
Aesculus californica	0	0	1
Baccharis pilularis	10	13	23
Berberis spp.	9	1	0
Ceanothus cordulatus	1	0	0
Ceanothus cuneatus	1	2	7
Ceanothus foliosus	1	0	2
Ceanothus incanus	3	2	0
Ceanothus integerrimus	5	5	0
Ceanothus leucodermis	0	0	2
Ceanothus pumilus	1	0	0
Ceanothus sorediatus	1	0	0
Ceanothus spp.	1	2	0
Ceanothus thyrsiflorus	12	0	0
Ceanothus velutinus	1	0	2
Cercis occidentalis	1	2	0
Cercocarpus betuloides	1	9	2
Cornus spp.	3	0	0
Corylus cornuta var. *californica*	10	0	0
Cystisus spp.	1	2	0
Eriogonum fasciculatum	0	0	5
Gaultheria shallon	26	0	0
Haplopappus spp.	1	2	0
Heteromeles arbutifolia	6	18	12
Holodiscus discolor	6	4	0
Ledum glandulosum	1	0	0
Lonicera spp.	3	4	0
Myrica californica	4	0	0
Osmaronia cerasiformis	1	0	0
Penstemon spp.	0	5	0
Philadelphus spp.	1	0	0
Physocarpus spp.	1	0	0
Prunus emerginata	1	0	0
Prunus spp.	1	0	0
Quercus agrifolia var. *frutescens*	0	0	15
Quercus chrysolepis nana	0	0	5
Quercus dumosa	0	5	15

Table 10—Occurrence of shrub species by broad vegetation type on lands outside National Forests in the Coast Range, California, 1985 (continued)

Species	Conifer forest	Hardwood woodland	Chaparral
	Percent of vegetation type		
Quercus durata	1	0	7
Quercus vaccinifolia	1	0	0
Quercus wislizenii var. *frutescens*	0	0	2
Rhamnus californica	2	9	0
Rhamnus crocea	0	0	2
Rhamnus crocea ilicifolia	0	2	0
Rhus laurina	0	0	2
Rhus trilobata	1	0	0
Rhododendron macrophyllum	14	0	0
Rhododendron occidentale	1	0	0
Ribes spp.	8	4	2
Rosa spp.	3	5	0
Rubus leucodermis	5	2	0
Rubus parviflorus	4	0	0
Rubus spectabilis	5	0	0
Rubus spp.	6	0	0
Salix spp.	1	0	2
Salvia spp.	0	0	15
Sambucus spp.	1	0	2
Symphoricarpos spp.	2	7	0
Toxicodendron diversilobum	39	62	7
Vaccinium ovatum	49	0	0
Vaccinium parvifolium	6	0	0
Vitis spp.	0	0	2
Whipplea modesta	7	0	0

Table 11—Occurrence of shrub species by broad vegetation type on lands outside National Forests in Interior California, 1985

Species	Conifer forest	Hardwood woodland	Pinyon and juniper	Chaparral
	Percent of vegetation type			
Acer circinatum	2	0	0	0
Acer glabrum	1	0	0	0
Adenostoma fasciculatum	1	1	5	50
Aesculus californica	—	—	—	10
Alnus tenuifolia	1	0	0	0
Amelanchier spp.	10	1	0	3
Arctostaphylos canescens	1	1	0	3
Arctostaphylos manzanita	1	10	0	11
Arctostaphylos nevadensis	4	0	0	0
Arctostaphylos patula	27	6	0	5
Arctostaphylos viscida	17	30	0	34
Arctostaphylos spp.	2	0	0	1
Artemisia arbuscula	1	0	3	0
Artemisia spp.	1	0	0	5
Artemisia tridentata	5	0	82	0
Baccharis pilularis	1	0	0	0
Berberis spp.	4	1	1	0
Calycanthus occidentalis	1	0	0	1
Castanopsis sempervirens	12	0	0	0
Ceanothus cordulatus	10	1	3	0
Ceanothus cuneatus	7	20	1	23
Ceanothus diversifolius	1	0	0	0
Ceanothus incanus	1	0	0	0
Ceanothus integerrimus	21	1	0	1
Ceanothus lemmonii	1	1	0	3
Ceanothus leucodermis	2	6	3	1
Ceanothus prostratus	20	0	0	0
Ceanothus spp.	1	0	0	1
Ceanothus velutinus	12	0	0	1
Cercis occidentalis	3	6	1	5
Cercocarpus betuloides	3	12	9	8
Cercocarpus ledifolius	4	2	21	10
Chamaebatia foliolosa	10	1	0	0
Chamaebatiaria millefolium	1	0	0	0
Chrysothamnus spp.	3	1	18	11
Cornus spp.	7	0	0	0
Corylus cornuta californica	1	1	0	0
Cytissus spp.	1	0	0	0
Ephedra spp.	0	0	1	0
Eriodictyon californicum	1	3	0	10
Fraxinus dipetala	0	1	0	3
Fremontodendron californica	1	0	0	5
Garrya spp.	1	1	1	5
Haplopappus spp.	1	0	3	1
Heteromeles arbutifolia	5	16	0	13

Table 11—Occurrence of shrub species by broad vegetation type on lands outside National Forests in interior California, 1985 (continued)

Species	Conifer forest	Hardwood woodland	Pinyon and juniper	Chaparral
		Percent of vegetation type		
Holodiscus discolor	1	1	0	0
Holodiscus microphyllus	0	0	1	0
Ledum glandulosum	0	1	0	0
Lithocarpus densiflorus var. *echinoides*	1	0	0	0
Lonicera spp.	4	1	0	0
Paxistima myrsinites	2	0	0	0
Penstemon spp.	1	0	0	0
Philadelphus spp.	3	1	0	0
Physocarpus spp.	1	1	0	0
Prunus emarginata	4	0	0	1
Prunus spp.	1	0	0	0
Prunus subcordata	2	4	2	0
Purshia tridentata	6	1	37	3
Quercus chrysolepis nana	0	0	0	10
Quercus dumosa	0	1	0	15
Quercus durata	0	1	0	1
Quercus garryana breweri	1	1	0	15
Quercus garryana semota	1	0	0	3
Quercus kelloggii f. *cibata*	0	0	0	3
Quercus vaccinifolia	5	0	0	3
Quercus wislizenii var. *frutescens*	0	0	0	11
Rhamnus californica	3	4	0	3
Rhamnus crocea	1	0	0	0
Rhamnus crocea ilicifolia	0	1	0	0
Rhamnus spp.	1	1	0	0
Rhododendron occidentale	1	0	0	0
Rhus trilobata	1	0	1	1
Ribes spp.	19	2	25	0
Rosa spp.	9	1	1	0
Rubus leucodermis	4	1	0	0
Rubus parviflorus	5	0	0	0
Rubus spp.	1	1	0	0
Salix spp.	1	1	0	0
Sambucus spp.	1	0	0	0
Symphoricarpos spp.	22	4	1	0
Toxicodendron diversilobum	21	44	0	10
Vitis spp.	1	1	0	0
Whipplea modesta	1	0	0	0
Yucca spp.	0	0	3	0

Table 12—Occurrence of shrub species by broad vegetation type on lands outside National Forests in southern California, 1985 (continued)

Species	Conifer forest	Hardwood woodland	Pinyon and juniper	Chaparral
	Percent of vegetation types			
Adenostoma fasciculatum	10	60	—	73
Adenostoma sparsifolium	0	0	0	7
Arctostaphylos glandulosa	10	17	0	20
Arctostaphylos glauca	20	0	0	9
Arctostaphylos pringlei var. *drupa red*	44	0	0	5
Arctostaphylos pungens	10	0	—	5
Arctostaphylos spp.	0	0	0	2
Artemisia californica	0	0	0	18
Artemisia tridenta	20	0	20	5
Atriplex canescens	0	0	20	2
Baccharis glutinosa	0	0	0	2
Bernardia incanis	0	0	20	0
Ceanothus crassifolius	0	17	—	35
Ceanothus greggii var. *perplexans*	10	0	—	27
Ceanothus integerrimus	10	0	0	0
Ceanothus leucodermia	20	0	0	16
Ceanothus oliganthus	10	0	0	2
Ceanothus palmeri	0	0	0	2
Ceanothus sorediatus	10	0	0	0
Ceanothus spp.	0	0	0	2
Cercocarpus betuloides	20	17	20	9
Chamaebatia australis	10	0	0	0
Chrysothamnus spp.	0	0	40	2
Comarostaphylis diversifolia	0	17	0	5
Ephedra spp.	0	0	40	0
Eriodictyon crassifolium	0	0	0	4
Eriogonum fasciculatum	0	0	0	29
Gutierrezia californica	0	0	0	2
Haplopappus spp.	0	0	0	2
Heteromeles arbutifolia	10	17	—	12
Lonicera spp.	0	17	0	0
Lotus scoparius	0	0	0	18
Philadelphus spp.	0	0	0	2
Prunus fremontii	0	0	0	2
Prunus spp.	10	0	0	2
Purshia glandulosa	0	0	0	2
Quercus dumosa	30	33	—	59
Quercus palmeri	0	0	20	2
Quercus wislizenii frutescens	0	0	0	2
Rhamnus californica	10	0	0	0
Rhamnus crocea	0	0	0	5
Rhamnus crocea ilicifolia	0	0	0	2
Rhus integrifolia	0	0	0	2

Table 12—Occurrence of shrub species by broad vegetation type on lands outside National Forests in southern California, 1985 (continued)

Species	Conifer forest	Hardwood woodland	Pinyon and juniper	Chaparral
	Percent of vegetation types			
Rhus laurina	0	17	0	16
Rhus ovata	0	17	0	21
Rhus trilobata	30	0	0	2
Ribes spp.	10	0	0	2
Rosa spp.	10	0	0	0
Salvia spp.	0	0	0	12
Sambucus spp.	0	0	0	2
Symphoricarpos spp.	30	0	0	0
Toxicodendron diversilobum	20	33	0	4
Yucca spp.	0	0	40	2

Terminology

Bureau of Land Management lands-Federal lands administered by the Bureau of Land Management, U.S. Department of the Interior.

Chaparral--Areas covered with heavily branched dwarf trees or shrubs, mostly less than 15 feet (3 meters) tall, usually evergreen, the crown canopy of which at maturity usually covers more than 50 percent of the ground. The principal genera are *Adenostoma, Arctostaphylos, Ceanothus, Cercocarpus, Garrya*, and *Quercus*. Areas in which the predominant cover is *Artemisia, Gutierrezia, Larrea, Opuntia, Salvia*, and other semi-desert species are considered nonforest. Shrub types on timberland and woodland are not classified as chaparral. Such areas are termed shrub-dominated timberland or shrub-dominated woodland.

County and municipal lands-Lands owned by county and other local public agencies.

Forest land-Land at least 10 percent covered by crowns of live trees, or land formerly having such cover and not currently developed for nonforest use (before March 1987, chaparral was classified as forest land).

Forest lands, reserved-Forest land withdrawn from forest management through statute or ordinance. Included are National Forest Wilderness Areas; National, State and county parks; other statutory reservations, and properties owned by The Nature Conservancy.

Forest types-Stands in which 50 percent or more of the cover is in live conifer trees are classed as softwood types. Stands with a majority of the cover in live hardwood trees are classed as hardwood types. Within these two groups, the individual forest type is determined by plurality of species, with the exception of the mixed conifer type. Mixed conifer includes stands containing two or more of the following species when no single species makes up 80 percent of the cover: Douglas-fir, white fir, red fir, ponderosa pine, Jeffrey pine, sugar pine, and incense-cedar.

Land area-Area reported as land by the Bureau of the Census. Total land area includes dry land and land temporarily or partially covered by water, such as marshes, swamps, and river flood plains, streams, sloughs, and canals less than 1/8 mile wide; and lakes, reservoirs, and ponds less than 40 acres in area.

Land class-A classification of land by major use. The minimum area for classification is 1 acre.

National Forest lands-Federal lands that have been designated by Executive order or statute as National Forest or purchase units and other lands under the administration of the Forest Service, including experimental areas and Bankhead-Jones Title III lands.

Nonstocked areas-in mapped areas, timberland with less than 10 percent crown cover; in sampled areas, timberland with no tally trees on four or five subplots.

Other public lands-Lands administered by public agencies other than the USDA Forest Service.

Public lands--Lands administered by Federal, State, regional, county, and municipal agencies.

Productive forest-Forest land capable of producing 20 cubic feet or more per acre per year in continuous crops of industrial wood.

Sapling and seedling stands-In National Forests, stands with less than 10 percent crown cover in sawtimber-sized trees and more than 10 percent crown cover in smaller trees, the predominance of which have crowns less than 5 feet in diameter. Outside National Forests, stands with a mean diameter (weighted by basal area) less than 5.0 inches.

Sapling and seedling trees-Live trees less than 5.0 inches in d.b.h.

Soft chaparral-Areas covered with soft shrubs (shrubs with little woody tissue), mostly less than 5 feet (1.5 meters) tall. Shrub crown cover ranges from 25 to 100 percent. Soft chaparral is found in southern California and in the Coast Range from Sonoma County to Ventura County. Common plants are *Artemisia californica, Eriogonum fasciculatum*, Lotus scoparius, *Lupinus* spp., *and Salvia* spp. Soft chaparral was classified as nonforest in this study.

Timberland (productive forest)-Forest lands capable of continuously producing 20 cubic feet or more per acre per year of industrial wood, and not withdrawn by statute, ordinance, or administrative order from timber utilization.

Woodland (unproductive forest)-Forest land incapable of continuously producing 20 cubic feet per acre per year of industrial wood because of adverse site conditions such as sterile soils, dry climate, poor drainage, high elevation, steepness, or rockiness. Includes steep rocky areas supporting stands of conifers, such as ponderosa pine and Douglas-fir, and areas of oak, pinyon, juniper, and cypress woodlands (before March 1987, chaparral was classified as unproductive forest).

Names of Woody Plants	Scientific name	Common name
	Softwood trees:	
	Abies concolor (Gord. & Glend.) Lindl. ex Hildebr.	white fir
	Abies grandis (Dougl.) Lindl.	grand fir
	Abies magnifica A. Murr.	California red fir
	Abies magnifica var. *shastensis* Lemm.	Shasta red fir
	Chamaecyparis lawsoniana (A. Murr.) Parl.	Port-Orford-cedar
	Juniperus californica Carr.	California juniper
	Juniperus occidentalis Hook.	western juniper
	Juniperus osteosperma (Torr.) Little	Utah juniper
	Libocedrus decurrens Torr.	incense-cedar
	Picea sitchensis (Bong.) Carr.	Sitka spruce
	Pinus albicaulis Engelm.	whitebark pine
	Pinus aristata Engelm	bristlecone pine
	Pinus attenuata Lemm.	knobcone pine
	Pinus balfouriana Grev. & Balf.	foxtail pine
	Pinus contorta Dougl. ex. Loud.	lodgepole pine
	Pinus coulteri D. Don	Coulter pine
	Pinus jeffreyi Grev. & Balf.	Jeffrey pine
	Pinus lambertiana Dougl.	sugar pine
	Pinus monophylla Torr. & Frem.	singleleaf pinyon
	Pinus monticola Dougl. ex D. Don	western white pine
	Pinus muricata D. Don	bishop pine
	Pinus ponderosa Dougl. ex Laws.	ponderosa pine
	Pinus radiata D. Don	Monterey pine
	Pinus sabiniana Dougl.	Digger pine
	Pseudotsuga macrocarpa (Vasey) Mayr	bigcone Douglas-fir
	Pseudotsuga menziesii (Mirb.) Franco	Douglas-fir
	Sequoia sempervirens (D. Don) Endl.	coastal redwood
	Sequoiadendron giganteum (Lindl.) Buchholz	giant sequoia
	Taxus brevifolia Nutt.	Pacific yew
	Thuja plicata Donn ex. D. Don	western redcedar

Torreya californica Torr.	California torreya
Tsuga heterophylla (Raf.) Sarg.	western hemlock
Tsuga mertensiana (Bong.) Carr.	mountain hemlock

Hardwood trees:

Acer macrophyllum Pursh	bigleaf maple
Acer negundo ssp. *californicum* (Torr. & Gray)	California box elder
Aesculus californica (Spach) Nutt.	California buckeye
Alnus rhombifolia Nutt.	white alder
Alnus rubra Bong.	red alder
Arbutus menziesii Pursh	Pacific madrone
Betula occidentalis Hook.	western water birch
Castanopsis chrysophylla (Dougl.) A. DC.	giant chinkapin
Cornus nuttali Audubon	Pacific dogwood
Eucalyptus spp. L'Her.	eucalyptus
Fraxinus latifolia Benth.	Oregon ash
Juglans spp. L.	walnut
Lithocarpus densiflorus (Hook. & Arn.) Rehd.	tanoak
Platanus racemosa Nutt.	California sycamore
Populus fremontii Wats.	Fremont cottonwood
Populus tremuloides Michx.	quaking aspen
Populus trichocarpa Torr. & Gray	black cottonwood
Prunus spp. L.	cherry
Quercus agrifolia Nee	coast live oak
Quercus chrysolepis Liebm.	canyon live oak
Quercus douglasii Hook. & Arn.	blue oak
Quercus engelmannii Greene	Engelmann oak
Quercus garryana Dougl. ex Hook.	Oregon white oak
Quercus kelloggii Newb.	California black oak
Quercus lobata Nee	valley oak
Quercus wislizenii A. DC.	interior live oak
Salix spp. L.	willow
Umbellularia californica (Hook. & Arn.) Nutt.	California-laurel, bay

Shrubs and vines:

Acer circinatum Pursh	vine maple
Acer glabrum Torr. var. *torreyi* (Greene) Smiley	mountain maple
Adenostoma fasciculatum H. & A.	chamise
Adenostoma sparsifolium Torr.	red shank
Alnus tenuifolia Nutt.	thinleaf alder
Amelanchier Medic. spp.	service-berry
Aralia californica Wats	spikenard
Arctostaphylos Adans. spp.	manzanita
Arctostaphylos canescens Eastw.	hoary manzanita
Arctostaphylos columbiana Piper	hairy manzanita
Arctostaphylos glandulosa Eastw.	Eastwood manzanita
Arctostaphylos glauca Lindl.	bigberry manzanita
Arctostaphylos manzanita Parry	Parry manzanita
Arctostaphylos nevadensis Gray	pinemat manzanita
Arctostaphylos patula Green	greenleaf manzanita
Arctostaphylos pringlei Parry var. *drupacea* Parry	pink-bracted manzanita
Arctostaphylos pungens HBK.	Mexican manzanita
Arctostaphylos viscida Parry	whiteleaf manzanita
Artemisia L. spp.	sagebrush
Artemisia arbuscula Nutt.	low sagebrush
Artemisia californica Less.	California sagebrush
Artemisia tridentata Nutt.	Basin sagebrush
Atriplex canescens (Pursh) Nutt.	four-winged saltbush
Baccharis glutinosa Pers.	seep-willow
Baccharis pilularis ssp. *consanguinea* (DC.) C.B. Wolf	baccharis, coyote bush
Berberis L. spp.	Oregon grape, barberry
Bernardia incana Mort.	bernardia
Calycanthus occidentalis H.v.A.	spice-brush
Castanopsis sempervirens (Kell.) Dudl.	bush chinkapin, Sierra chinkapin
Ceanothus L. spp.	ceanothus, California-lilac
Ceanothus cordulatus Kell.	snowbush, mountain whitehorn
Ceanothus crassifolius Torr.	ceanothus

Ceanothus cuneatus (Hook.) Nutt.	wedgeleaf ceanothus, buck brush
Ceanothus diversifolius Kell.	pine mat
Ceanothus foliosus Parry	ceanothus
Ceanothus greggii Gray var. *perplexans* (Trel.) Jeps.	ceanothus
Ceanothus incanus T. & G.	Coast whitehorn
Ceanothus integerrimus H. & A.	deer brush
Ceanothus lemmonii Parry	Lemmon ceanothus
Ceanothus leucodermis Greene	chaparral whitehorn
Ceanothus oliganthus Nutt. in T. & G.	ceanothus
Ceanothus palmeri Trel.	ceanothus
Ceanothus prostratus Benth.	squaw carpet
Ceanothus pumilus Greene	mat ceanothus
Ceanothus sorediatus H. & A.	Jim brush
Ceanothus thyrsiflorus Esch.	blue blossom
Ceanothus velutinus Dougl. ex Hook	tobacco brush, shiny leaf ceanothus
Cercis occidentalis Torr. ex Gray.	California redbud
Cercocarpus betuloides Nutt. ex T. & G.	birchleaf mountain-mahogany
Cercocarpus ledifolius Nutt.	curlleaf mountain-mahogany
Chamaebatia australis (Bdg.) Abrams	—
Chamaebatia foliolosa Benth.	mountain-misery, bear clover
Chamaebatiaria millefolium (Torr.) Maxim.	fern brush
Chrysothamnus Nutt. spp.	rabbit-brush
Comarostaphylis diversifolia (Parry) Greene	summer-holly
Cornus L. spp.	dogwood
Corylus cornuta Marsh var. *californica* (A.DC.) Sharp	beaked hazel
Cytisus L. spp.	broom
Ephedra L. spp.	Mormon tea
Eriodictyon californicum (H. & A.) Torr.	yerba santa
Eriodictyon crassifolium Benth.	yerba santa
Eriogonum fasciculatum Benth.	California buckwheat
Fraxinus dipetala H. & A.	chaparral ash, flowering ash
Fremontodendron californicum (Torr.) Cov.	flannel bush, California fremontia

Gaultheria shallon Pursh.	salal
Garrya Dougl. spp.	silk-tassel bush
Gutierrezia californica Lag.	snakeweed
Haplopappus Cass. spp.	golden fleece, haplopappus
Heteromeles arbutifolia M. Roem	toyon
Holodiscus discolor (Pursh) Maxim.	ocean spray, rock spirea
Holodiscus microphyllus Rydb.	—
Larrea divaricata Cav.	creosote bush
Ledum glandulosum Nutt. var. *californicum* (Kell.) C.L. Hitchc.	Labrador tea
Lithocarpus densiflorus (H. & A.) var. *echinoides* (R. Br. Abrams)	shrub tanoak
Lonicera ciliosa (Pursh) Poir	honeysuckle
Lonicera hispidula Dougl.	hairy honeysuckle
Lonicera interrupta Benth.	honeysuckle
Lonicera involucrata (Richards.) Banks	twinberry
Lotus scoparius (Nutt. in T. & G.) Ottley	lotus
Mimulus L. spp.	bush monkey-flower
Monardella Benth. spp.	monardella
Myrica californica Cham. & Schlecht.	wax-myrtle
Osmaronia cerasiformis (T. & G.) Greene	Osoberry, Indian plum
Paxistima myrsinites (Pursh) Raf.	Oregon boxwood
Penstemon Mitch. spp.	beard-tongue
Philadelphus L. spp.	mock-orange
Physocarpus Maxim. spp.	ninebark
Prunus L. spp.	cherry, plum
Prunus emarginata (Dougl.) Walp	bitter cherry
Prunus fremontii Wats.	desert apricot
Prunus ilicifolia (Nutt.) Walp	holly-leaved cherry
Prunus subcordata Benth.	Sierra plum
Purshia glandulosa Curran.	bitterbrush
Purshia tridentata (Pursh) DC.	bitterbrush, antelope bush
Quercus agrifolia Nee var. *frutescens* Engelm.	shrubby coast live oak
Quercus chrysolepis Liebm. var. *nana* Jeps.	shrubby canyon live oak
Quercus dumosa Nutt.	scrub oak

Quercus durata Jeps.	leather oak
Quercus garryana Dougl. var. *breweri* (Engelm. in Wats.) Jeps.	brewer oak
Quercus garryana Dougl. var. *semota* Jeps.	shin oak
Quercus kelloggii Newb. f. *cibata* Jeps.	shrubby black oak
Quercus palmeri Engelm.	Palmer oak
Quercus vaccinifolia Kell.	huckleberry oak
Quercus wislizenii A. DC. var. *frutescens* Engelm.	shrubby interior live oak
Rhamnus californica Esch.	coffeeberry
Rhamnus crocea Nutt. in T. & G.	buckthorn
Rhamnus crocea Nutt. in T. & G. ssp. *ilicifolia* (Kell.) C.B. Wolf	holly-leaf buckthorn
Rhamnus L. spp.	buckthorn, cascara
Rhamnus purshiana DC.	cascara
Rhododendron macrophyllum D. Don	Pacific rhododendron
Rhododendron occidentalis (T. & G.) Gray	western azalea
Rhus integrifolia (Nutt.) Benth. & Hook.	lemonadeberry
Rhus laurina Nutt. in T. & G.	laurel sumac
Rhus ovata Wats.	sugar bush
Rhus trilobata Nutt. ex T. & G.	skunk bush
Ribes L. spp.	currant, gooseberry
Ribes cereum Dougl.	squaw current
Ribes roezlii Regel.	sierra gooseberry
Rosa L. spp.	rose
Rubus L. spp.	blackberry, raspberry, etc.
Rubus leucodermis Dougl. ex T. & G.	blackcap raspberry, western raspberry
Rubus parviflorus Nutt.	thimbleberry
Rubus spectabilis Pursh	salmonberry
Rubus ursinus Cham. & Schecht.	mountain blackberry
Salix L. spp.	willow
Salvia L. spp.	sage
Sambucus L. spp.	elderberry
Sorbus L. spp.	mountain-ash
Symphoricarpos Duhamel.	snowberry
Symphoricarpos mollis Nutt. in T. & G.	snowberry

Toxicodendron diversilobum (T. & G.) Green	western poison-oak
Vaccinium ovatum Pursh	evergreen huckleberry
Vaccinium parvifolium Sm. in Rees.	red huckleberry
Viburnum ellipticum Hook.	viburnum
Vitis californica Benth.	California grape
Whipplea modesta Torr.	yerba de selva
Yucca L. spp.	yucca

Bolsinger, Charles L. 1988. Shrubs of California's chaparral, timberland, and woodland: area, ownership, and stand characteristics. Resour. Bull. PNW-RB-160. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 50 p.

A statewide inventory of shrubs in chaparral and on timberland and woodland in California is presented, and the relevance of shrubs to resource management is discussed. Shrub types (excluding coastal sage and Great Basin and desert shrubs) cover about 10 million acres, 73 percent of which is chaparral. Chamise is the most widespread type in chaparral (51 percent of total area). Critically flammable chaparral stands cover an estimated 1 million acres, much of which is in heavily populated southern California. More than 2 million additional acres are on the threshold of the critically flammable stage.

Shrubs are the dominant vegetation on 2.1 million acres of timberland and 0.5 million acres of woodland. Ceanothus, manzanita, and poison-oak are the most widespread shrubs on timberland and woodland. Timber growth on shrub-dominated timberland is about one-fourth of the potential of the land.

Keywords: Shrubs, chaparral, forest inventory, vegetation inventory, biomass (phytomass), California.

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