tallied on plots, by chaparral type and by constancy value (percentage of plots on which a plant occurred; e.g., a plant that occurred on 10 percent of the plots would have a constancy of 10), in national forests and outside national forests. Species are included in this table only if they have a constancy value of 3 or greater, in one owner group or the other.[3] For a complete list of all species tallied, see “Scientific and Common Plant Names” section.

Species by Type, as Found on Inventory Plots

Despite the variable conditions that exist in southern and central coastal California, one could randomly select locations throughout the chaparral ecosystem and find chamise 7 times out of 10. Excluding plots with no shrub tally, chamise was present on 77 percent of the plots in national forests and 67 percent of the plots outside national forests. On the mesic sites where chamise was absent, *Arctostaphylos, Cercocarpus, Prunus,* and *Quercus* species often dominated. Scrub oak type had the lowest constancy of chamise in national forests, and second-lowest outside national forests. Coastal transition type outside national forests had the lowest constancy of chamise of all types. No single species, or genus for that matter, dominated coastal transition outside national forests. In this type, which is a collection of several associations, the major plants were *Artemisia californica, Baccharis* spp., *Ericameria* spp., *Heteromeles arbutifolia, Malosma laurina, Rhus ovata, Toxicodendron diversilobum, Eriogonum fasciculatum, Lotus scoparius,* and *Salvia* spp., with a smattering of *Ceanothus* spp., *Rhamnus* spp., *Ephedra* spp., *Encelia* spp., and others.

In chamise type, 35 species of shrubs were tallied. Common shrubs with high constancy value in this type in national forests were *Adenostoma fasciculatum, Yucc*a spp., *Ceanothus greggii* var. *perplexans, Quercus dumosa/john-tuckeri,*[4] and *Eriodictyon crassifolium;* outside national forests, shrubs in chamise with high constancy value included *Adenostoma fasciculatum, Ceanothus greggii* var. *perplexans, Quercus dumosa/john-tuckeri, Heteromeles arbutifolia,* and *Salvia mellifera.* On both ownerships, these and other species present show that chamise, as classified here, occurs over a rather broad range of moisture conditions. *Salvia* and *Yucca* would be expected on the more xeric sites, *Quercus dumosa/john-tuckeri* on more mesic sites, and *Ceanothus greggii* var. *perplexans* on intermediate sites. Four species of *Ceanothus* and three species of *Arctostaphylos* were tallied on plots in chamise type. A plant found only on plots in chamise type, both inside and outside national forests, is *Hazardia squarrosa* (sawtooth goldenbush), classified as a subshrub by McMinn (1939) but as a shrub in the *Jepson Manual* (Hickman 1993). *Salvia clevelandii* (fragrant sage), whose range barely reaches into San Diego County from Baja California, was found only in chamise type, in the Cleveland National Forest.

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[3] The list of herbaceous plants is longer and the constancy values are often greater for national forests because all plants were tallied down to a trace; outside national forests, herbaceous plants covering less than 3 percent of the plot area were not tallied.

[4] *Quercus dumosa* and *Q. tucker* were at one time identified as the same plant. *Quercus tucker* is now recognized as a separate species. In the PNW data, however, all *Q. dumosa* and *Q. tucker* are listed as *Q. dumosa. Quercus dumosa/john-tuckeri* in this bulletin may be in reference to *Q. dumosa* or *Q. tucker.*

In red shank type, which is usually grouped with chamise, 24 shrub species were tallied. A pattern of mesic and xeric shrubs similar to that in chamise occurred in both ownerships, with xeric-site plants such as *Artemisia tridentata,* mesic-site plants such as *Quercus dumosa/john-tuckeri,* and midsite plants such as *Ceanothus greggii* var. *perplexans.* The greater constancy of *Cercocarpus betuloides* on national forests suggests more mesic conditions there. One species of *Ceanothus* and two species of *Arctostaphylos* were tallied in red shank type. *Escobaria vivipara* (spiny-star), a rare plant threatened by collecting according to the *Jepson Manual* (Hickman 1993), was found only in red shank type on national forest land.

Fifty-two shrub species were tallied in scrub oak type, 44 in national forests, and 35 outside national forests. Only 2 species outside national forests had constancy values of 20 or higher—*Adenostoma fasciculatum* and *Quercus dumosa/john-tuckeri*—whereas in scrub oak type in national forests there were 14 species. Outside national forests only one oak species had a constancy value higher than 20–*Q. dumosa/ john-tuckeri.* In national forests there were three oak species—*Q. dumosa/john-tuckeri, Q. chrysolepis,* and *Q. wislizeni.* This suggests that in national forests there may be more mesic scrub oak sites or older chaparral stands, or both, in which oak species have germinated in accumulated duff. One species of oak that occurred only outside national forests (in scrub oak type and mixed and montane type) was *Q. durata,* which typically grows on serpentine sites. Seven species of *Ceanothus* and five species of *Arctostaphylos* were tallied in scrub oak type. Three shrubs tallied only on plots in this type were: *Fraxinus dipetala* (foothill ash), a widespread shrub or small tree that favors moist sites; *Leptodactylon californicum* (prickly phlox), a short-lived, showy shrub that occurs in a variety of vegetation types; and *Philadelphus microphyllus* (littleleaf mock orange) found on rocky sites from southern California east to Texas.

Sixty-nine shrub species were tallied on plots in mixed and montane type, which makes it floristically the richest type (one more species than coastal transition). This is not surprising given that, as its name implies, the type is actually a mixture of several types that occur on sites ranging from xeric to mesic, although mesic sites seem to be more common, as indicated by the greater number of mesic species tallied. However, *Adenostoma fasciculatum*—a xeric-site to midsite species—had the highest constancy value on both ownerships. Eleven species of *Ceanothus* were tallied in mixed and montane type (fig. 26), which ties coastal transition for number of species of this nitrogen-fixing genus. Six species of *Arctostaphylos* were tallied in this type (fig. 27), more than in any other type. *Malosma laurina* (fig. 28) in mixed and montane type in national forests had a constancy value of 6, compared with 17 outside national forests, possibly indicating more frost-prone sites in this type in national forests. National forests tend to be farther from the moderating influence of the ocean and at higher elevations where frost would seem more likely. Two shrubs tallied only in mixed and montane type were *Arctostaphylos hookeri* (fig. 22), a sprawling shrub of sandy flats, pine woods, and serpentine outcrops; and *Cneoridium dumosum* (bush rue), a strong-scented shrub occurring in San Diego County and south into Baja California (also on San Clemente Island and in Arizona).

Coastal transition type, with 68 species of shrubs, is almost as rich as mixed and montane. In many places, coastal transition interfaces or grades into coastal sage scrub, which explains the occurrence of shrubs such as *Artemisia californica, Salvia*

Figure 26—*Ceanothus spinosus* (redheart) in mixed chaparral. Note dead terminal branches. (Photo by Br. Alfred Brousseau, St. Mary's College)

Figure 27—*Arctostaphylos glandulosa* (Eastwood's manzanita), one of several species of manzanita, in mixed chaparral. (Photo by Br. Alfred Brousseau, St. Mary's College)

spp., and *Baccharis* spp. Eleven species of *Ceanothus* were tallied in coastal transition type, and three species of *Arctostaphylos. Heteromeles arbutifolia* (fig. 29), *Prunus ilicifolia* (fig. 30), and *Rhamnus crocea* (fig. 31) were much more abundant outside national forests in this type. Shrubs tallied only on plots in coastal transition type include *Baccharis salicifolia* (mule's fat), a coastal sage scrub riparian shrub; *Ceanothus griseus* (Carmel ceanothus), a sprawling shrub of the central coast, associated with serotinous-cone conifers and coastal sage scrub; *Eriodictyon capitatum* (Lompoc yerba santa), found only in Santa Barbara County in low-elevation chaparral (Hickman 1993); *Isomeris arborea* (bladderpod), common on ocean-facing

Figure 28—*Malosma laurina* (laurel sumac), a frost-sensitive shrub. (Photo by Br. Alfred Brousseau, St. Mary's College)

Figure 29—*Heteromeles arbutifolia* (toyon—Christmas berry—California holly), said to be the namesake of Hollywood. (Photo by J.E. (Jed) and Bonnie McClellan, California Academy of Sciences)

bluffs, but occasionally found inland; *Purshia glandulosa* (desert bitterbrush), found in canyons bordering the Colorado Desert, but extending westward to Ventura County; *Rhus integrifolia* (lemonade sumac), found at low elevations along the coast in southern California; and *Yucca schidigera* (Mohave yucca), common in the Mojave Desert, but found as far west as coastal San Diego County.

Development of Chaparral Stands

On most sites, regrowth of chaparral is rapid following fire, and within a very few years most stands are similar in composition and structure to prefire stands (Lloret et al. 1999). Fires generally occur in late summer or fall, but plant growth doesn't begin until

Figure 30—*Prunus ilicifolia* (hollyleaf cherry) (Photo by Br. Alfred Brousseau, St. Mary's College)

Figure 31—*Rhamnus crocea* (redberry buckthorn). (Photo by Beatrice F. Howitt, California Academy of Sciences)

late winter or spring (Carrington and Keeley 1999). For a few to several months after a fire, denuded slopes are vulnerable to widespread topsoil movement in a process of dry erosion called “ravel.” Winter rains accelerate the movement of material, sometimes causing floods, mudslides, and debris flows, often exacerbated by increased runoff from a crustlike layer of water-repellent soil created by the intense heat of burning chaparral plants (Beyers et al. 1998). Forbs and grasses appear in great abundance the first spring after a fire, including many species absent in the prefire stand. As shrubs gain dominance, most of the herbaceous plants, which originated from seed stored in the soil or brought in by wind, water, birds, mammals, and insects from adjacent areas (Westman 1979), disappear (generally within 1 to 3 years), or may persist in greatly reduced numbers but without blooming or producing seed. Allelopathy, or toxic effect of chemicals generated by dominant shrubs, once thought to explain the impoverishment and sterility of the herbaceous layer under developed chaparral canopies, is not believed to be so important now. More in favor is the idea that fire-induced seed germination brings on the herbaceous growth that flourishes in the sunlight until the developing shrub layer shades it out and captures the moisture and nutrients (Keeley and Keeley 1986).

For several decades–beginning in the 1940s–Italian ryegrass *(Lolium perenne* ssp. *multiflorum),* a native of Eurasia, had been seeded on burned chaparral areas for the purpose of reducing erosion during the initial recovery period. A study showed that rye-grass did reduce erosion by a small amount, but not until other vegetation had become established and erosion had returned to baseline levels (Beyers et al. 1998). Ryegrass, like many pioneer herbaceous plants, tends to dry out early in the growing season, thus increasing the possibility of another fire before a new stand is established. Fires at this early stage of chaparral stand development can result in local extinction of obligate seeders, which have germinated and begun to grow, but have not yet produced seed (Zedler and Zammit 1986). Ryegrass also can compete with native herbaceous plants, and may even in some cases affect the regrowth of shrubs (Wohlgemuth et al. 1998).

Most shrubs, both seedlings and sprouts, emerge during the first year after a fire. By the second year they begin to dominate over the herbaceous plants, which are ultimately relegated to open spaces between shrubs. Dense chaparral is typically devoid of herbaceous plants, and the lack of herbaceous vegetation can extend 2 to 6 feet beyond shrub crowns at interfaces of chaparral with other vegetation types (Keeley and Keeley 1986, Odion and Davis 2000). Chaparral stands often reach maximum density in a few years, and then become somewhat less dense as self-thinning sets in, although in general as chaparral stands age, both height and density increase (Guo and Rundel 1998). Data collected in this study show a definite trend of increasing height with increasing density for all chaparral types, although variations in site, drought, and unknown disturbances other than fire (diseases, herbivory, air pollution, frost, etc.) are confounding factors. For example, across all ownerships, of the stands that averaged taller than 6.6 feet, 66 percent had at least 60 percent shrub cover, and of the stands that averaged less than 3.4 feet tall, 53 percent had less than 40 percent cover (table 10).

Height of Chaparral Stands

Chaparral, by definition, consists of woody shrubs or short trees. Dominant shrubs rarely top 6 feet. In this study, scrub oak stands averaged the tallest—7.8 feet in national forests and 7.4 feet outside national forests (weighted average height of the tallest shrub layer) (table 11). Stands over 9.9 feet tall amounted to 16 percent of

scrub oak types in national forests and 31 percent of those outside national forests. Coastal transition and chamise were about tied for shortest, with stands in national forests averaging 5.0 and 5.1 feet, respectively, and stands outside national forest averaging 5.6 and 5.7 feet, respectively.

Density of Chaparral Stands

Most chaparral stands are very dense at maturity with shrub cover often exceeding 60 percent. On the more xeric sites, however, shrub cover in mature chaparral stands can be considerably less. Also, because of frequent fires in chaparral, many stands are young and haven't yet attained maximum density. Across all ownerships, 58 percent of the chaparral in this study had at least 60 percent shrub cover and only 1 percent had no shrub cover at all, as shown in table 12. Complete summaries of acres by PNW chaparral type, canopy cover class, owner class, and height class are tabulated in table 10.

Emergent Trees in Chaparral

There is evidence that many chaparral areas had previously been forest or woodland, although most of the present-day chaparral was in place when Europeans first saw it. Some believe chaparral is still expanding (offset by losses to human development) in response to changes in climate, and "aided by man's interference with the environment" (Axelrod 1986). Trees still occur in many chaparral areas (fig. 32). In some cases, as with pinyon, juniper, and foothill pine, the distribution of trees in chaparral seems random. Often, however, trees occur near chaparral-forest ecotones, or on moist sites on north and east slopes, along canyon bottoms and washes, or around springs and seeps. In some areas, islands of trees in chaparral occupy inclusions of soil and parent material different from the surrounding landscape, or occur on rocky, "fire-proof" sites, suggesting that in the long-term absence of fire in these areas, forest or woodland could eventually dominate. Seemingly in contradiction with the view that chaparral is replacing forest, or possibly concordant with the idea that longer intervals between fires would result in more emergent trees, Callaway and Davis (1998) found vigorous *Quercus agrifolia* (coast live oak) saplings in chaparral communities. Plot data gathered in a statewide oak woodland inventory in the 1980s showed that seedlings and saplings of *Quercus douglasii* (blue oak) and *Q. lobata* (California white oak) were often associated with patches of chaparral shrubs, whereas blue oak and California white oak woodlands and savannas without shrubs were usually without seedlings and saplings (Bolsinger 1988). In these cases, it is unclear how shrubs abet tree regeneration, if indeed they do at all. Perhaps the shrubs suppress grass competition, favorably modify soil pH and temperature, attract acorn-caching birds and small mammals, protect emerging seedlings from browsing animals, or merely indicate higher soil moisture.

Whether on their way out because of natural processes (fig. 33) and "man's interference with the environment," or increasing through recruitment under the protective cover of shrubs, trees in chaparral make a difference: several species of birds are attracted to trees in chaparral for nesting and roosting; raptors and flycatchers use trees for staging areas; large birds and mammals use the mast or catch animals that eat the mast; deer use the thermal cover of trees for resting and fawning; and unlike chaparral shrubs, trees usually have an understory of herbaceous plants that serve as food, cover, and bedding for many animals (Heske et al. 1997). In summer, reptiles and small mammals sometimes climb trees to get as far above the intolerably hot surface of the soil as possible. Arboreal species such as the western gray squirrel (*Sciurus griseus*) venture into chaparral only when trees are present (Quinn 1990,

Table 10—Area of chaparral in southern and central coastal California, in national forest (NF) and outside national forest (ONF) lands by PNW classification type, height, and shrub canopy cover

		Percentage of canopy cover											
		1-39			40-59			60+			Total		
Type	Height	NF	ONF	Total	NF	ONF	Total	NF	ONF	Total	NF	ONF	Total
	Feet	*Thousand acres*											
Chamise	<3.4	35	55	90	9	16	25	8	46	54	52	117	169
	3.4-6.5	13	102	115	44	194	238	257	548	805	314	844	1,158
	6.6-9.8	7	103	110	9	50	59	31	231	262	47	384	431
	9.9+	0	0	0	0	0	0	4	0	4	4	0	4
	Total	55	260	315	62	260	322	300	825	1,125	417	1,345	1,762
Scrub oak	<3.4												
	3.4-6.5	9	38	47	4	23	27	24	64	88	37	125	162
	6.6-9.8	2	16	18	0	0	0	106	57	163	108	73	181
	9.9+	5	42	47	0	0	0	22	48	70	27	90	117
	Total	16	96	112	4	23	27	152	169	321	172	288	460
Mixed	<3.4	16	0	16	24	0	24	7	23	30	47	23	70
	3.4-6.5	43	16	59	102	65	167	295	108	403	440	189	629
	6.6-9.8	46	55	101	45	31	76	220	163	383	311	249	560
	9.9+	0	21	21	0	0	0	14	16	30	14	37	51
	Total	105	92	197	171	96	267	536	310	846	812	498	1,310
Coastal transition	<3.4	8	28	36	3	2	5	0	0	0	11	30	41
	3.4-6.5	22	82	104	39	78	117	80	161	241	141	321	462
	6.6-9.8	0	49	49	0	6	6	9	50	59	9	105	114
	9.9+												
	Total	30	159	189	42	86	128	89	211	300	161	456	617
Grand total[a]		206	607	813	279	465	744	1,077	1,515	2,592	1,562	2,587	4,149

[a] Excludes acres of chaparral represented by plots with no shrubs on which to base classification.

Table 11—Average height and percentage of chaparral taller than 2 height thresholds in national forest (NF) and outside national forest (ONF) lands for each PNW chaparral type

PNW Type	Average height		6.6 foot +		9.9 foot +	
	NF	ONF	NF	ONF	NF	ONF
	----- *Feet* -----		---------- *Percent* ----------			
Chamise	5.1	5.7	12	29	1	0
Scrub oak	7.8	7.4	78	57	16	31
Mixed and montane	6.2	6.2	40	58	2	7
Coastal transition	5.0	5.6	6	23	6	0

Table 12—Chaparral plots by shrub cover class[a]

Shrub cover	Percentage of chaparral plots
Percent	
0	1
1–39	23
40–60	18
61+	58

[a] Cover is additive for all species-level estimates on a plot and thus sometimes exceeds 100 percent.

Wirtz 1991). Trees give depth and scale to chaparral vistas, although whether they improve the scenery or not is a matter of personal preference. Certain spring flowers, *Cynoglossum grande* for example, are often found under trees in chaparral, but are absent under shrubs (author's observation).

In the chaparral inventory, emergent trees at least 5 feet taller than the tallest shrub layer were found on plots representing 11 percent of the total chaparral area, or 455,000 acres (fig. 9). The chaparral plots, scattered across 4.3 million acres, and monumented for future relocation, could, if revisited periodically, provide an objective measure of the changing presence of trees in chaparral. Table 13 illustrates that trees were most common in scrub oak type and least common in mixed and montane chaparral. Sixteen species of emergent trees were tallied on plots in this study. The two tree species most common were coast live oak and foothill pine (table 14).

Figure 32—Emergent foothill pine tree, *Pinus sabiniana* (California foothill pine), in mixed chaparral; *Ceanothus leucodermis* (chaparral whitethorn) in foreground. (Photo by Br. Alfred Brousseau, St. Mary's College)

Figure 33—Conifer trees killed by a fire in chaparral. (Photo by USDA Forest Service, Pacific Southwest Research Station)

Table 13—Area and percentage of PNW chaparral type with emergent trees

Chaparral type	Area with emergent trees	Percentage of type
	Thousand acres	
Chamise	202	11
Scrub oak	84	17
Mixed and montane	105	8
Coastal transition	64	10
All types	455	11

Table 14—Chaparral with emergent trees by tree species

Emergent tree species	Percentage of occurrence
Quercus agrifolia (coast live oak)	25.9
Pinus sabiniana (California foothill pine)	14.9
Pinus monophylla (singleleaf pinyon)	10.8
Umbellularia californica (California laurel)	9.5
Aesculus californica (California buckeye)	7.8
Quercus chrysolepis (canyon live oak)	7.4
Quercus douglasii (blue oak)	4.0
Platanus racemosa (California sycamore)	4.0
Juniperus californica (California juniper)	3.8
Pseudotsuga menziesii (Douglas-fir)	3.2
Juniperus occidentalis (western juniper)	2.3
Quercus engelmannii (Engelmann oak)	1.6
Pinus coulteri (Coulter pine)	1.5
Populus fremontii (Fremont cottonwood)	1.5
Salix spp. (willow)	1.5
Pinus jeffreyi (Jeffrey pine)	.3
	100.0

A Look At Burned and Unburned Areas

Changes on Burned Plots

In the 1990s, on lands outside national forests, PNW inventory crews visited plots that had been established in the 1980s, including 11 plots in chaparral that had burned between the two occasions (fig. 9). In addition to gathering data on vegetation by species, density, height, etc., for each burned plot, crews determined the year of the fire from public records or by talking with knowledgeable people. For national forests where plots had not previously been established in chaparral, agency fire records were used along with vegetation maps to determine the acreage burned by chaparral types. The nominal period between inventories for lands outside national

forests was 10 years—1984-94; the records for burned area on national forest land covered the 20-year period 1975-95. Outside national forests, the estimated area burned over 10 years was 435,000 acres, or 16 percent of the chaparral area. Within national forests 849,000 acres burned over 20 years, or 54 percent of chaparral area, which comes out to 27 percent over 10 years, not counting the unknown acreage that burned twice. Fire occurred in all of the major type groups, although none of the plots in the small area of red shank outside national forests burned.

Fires in chamise type (fig. 34) accounted for the greatest area burned outside national forests (41 percent of the chaparral burned); mixed and montane type accounted for the greatest area burned (53 percent of the chaparral burned) inside national forests (table 15). Coastal transition type had the highest burn rate outside national forests, where 26 percent of that type burned. These burn rates translate to fire-return intervals ranging from 83 years for scrub oak outside national forests to 38 years for coastal transition in national forests, and averaging 50 years across all types and ownerships. This estimate differs from some that can be found in the literature for both presuppression- and postsuppression-era fire rotation periods (Byrne 1978, Minnich and Chou 1997, Zedler and Zammit 1986), but is very close to the post-1950 interval reported by Keeley et al. (1999) for nine counties in central coastal and southern California, based on the California Statewide Fire History Database.

Keeley et al. (1999) reported county-level fire intervals ranging from 29 years in Orange County to 81 years in Santa Barbara County. These intervals bracket ours and, when averaged over the nine-county area (weighted by mean fire size), come out to 51.7 years, fairly close to our 50 years.

The changes in vegetation on the plots that burned were generally predictable, although postburn shrub cover had not attained preburn density on any of the plots, even those burned shortly after they had been established in the mid-1980s. For the

Figure 34—Fire in chamise type. (Photo by USDA Forest Service, Pacific Southwest Research Station)

Table 15—PNW chaparral type burned in and outside national forest lands

	National forest		Outside national forest	
PNW Type	**Percentage of type burned**	**Percentage of all chaparral burned**	**Percentage of type burned**	**Percentage of all chaparral burned**
Chamise	24	22	14	41
Red shank	22	2	0	0
Scrub oak	18	11	12	9
Mixed and montane	20	53	20	25
Coastal transition	26	12	21	25
Total	NA	100	NA	100

NA = Not applicable.

burned plots as a group, shrub cover and number of shrub species decreased; cover and number of species of subshrubs increased (cover only slightly); and herbaceous cover increased (table 16). There were 19 shrub species present on all 11 plots before they burned, and 11 shrub species afterward (table 17).

Of the nine shrub species that were present before burning but absent afterward, four are obligate seeders *(Arctostaphylos canscens, A. viscida, Baccharis* spp., *Ceanothus crassifolius),* and four were on plots that had burned within 2 years of the field crew's visit *(Ceanothus leucodermis, Comarostaphylis diversifolia, Purshia tridentata,* and *Quercus wislizeni* var. *frutescens).* Notable is the loss of *Ceanothus* spp., important in soil nitrogen fixation, from three of the four plots on which they occurred before burning.

Of the 11 plots that burned, 3 were classified as different types when revisited. One plot changed from chamise to mixed chaparral, one from mixed chaparral to chamise, and one from mixed chaparral to coastal transition. The number of subshrub species increased from one before burning to four after burning, although subshrub cover hardly increased at all. Before burning, *Eriogonum fasciculatum* was the only subshrub tallied. After burning it was still present, along with *Lotus scoparius, Eriodictyon* spp., and *Chrysothamnus* spp. As expected, the data show generally, with a few exceptions, the longer the period since the plot had burned the denser the shrub cover (fig. 35).

Changes on Plots That Did Not Burn

Fifty-three of the plots established in the 1980s and revisited in the 1990s did not burn and had not been converted to nonchaparral. On 17 of these plots, or 32 percent, shrub cover did not change. Shrub cover increased on 20 plots and decreased on 16 plots (table 18).

Shrub cover changed by one or both of two ways: (1) cover of existing shrub species increased or decreased, (2) species dropped out or new ones appeared.

Table 16—Average cover before and after fire

Life form	Average cover	
	Preburn	Postburn
	Percent	
Shrub	81	33
Subshrub	4	5
Grass	3	18
Forb	5	9

Table 17—Regeneration mode and presence of species before and after fire

Species	Present		Regeneration mode[a]
	Before burning	After burning	
Adenostoma fasciculatum	Yes	Yes	fr
Aesculus californica	Yes	Yes	fr
Arctostaphylos canescens	Yes	No	os
Arctostaphylos glandulosa	Yes	Yes	fr
Arctostaphylos viscida	Yes	No	os
Artemisia californica	Yes	Yes	fr
Baccharis spp.	Yes	No	os
Ceanothus crassifolius	Yes	No	os
Ceanothus greggii var. *perplexans*	Yes	Yes	os
Ceanothus leucodermis	Yes	No (1992)[b]	or
Cercocarpus betuloides	No	Yes	or
Comarostaphylis diversifolia	Yes	No (1990)[b]	or
Heteromeles arbutifolia	Yes	Yes	or
Malosma laurina	Yes	Yes	fr
Purshia tridentata	Yes	No (1993)[b]	fr[c]
Quercus dumosa	Yes	Yes	or
Quercus wislizeni var. *frutescens*	Yes	No (1993)[b]	or
Rhus ovata	Yes	Yes	fr
Salvia mellifera	Yes	Yes	fr
Toxicodendron diversilobum	Yes	No	fr

[a] Fr = facultative resprouter, or = obligate resprouter, os = obligate seeder.
[b] Year burned.
[c] Variable over its extensive range (from Baja California to Saskatchewan), but fr in the study area.

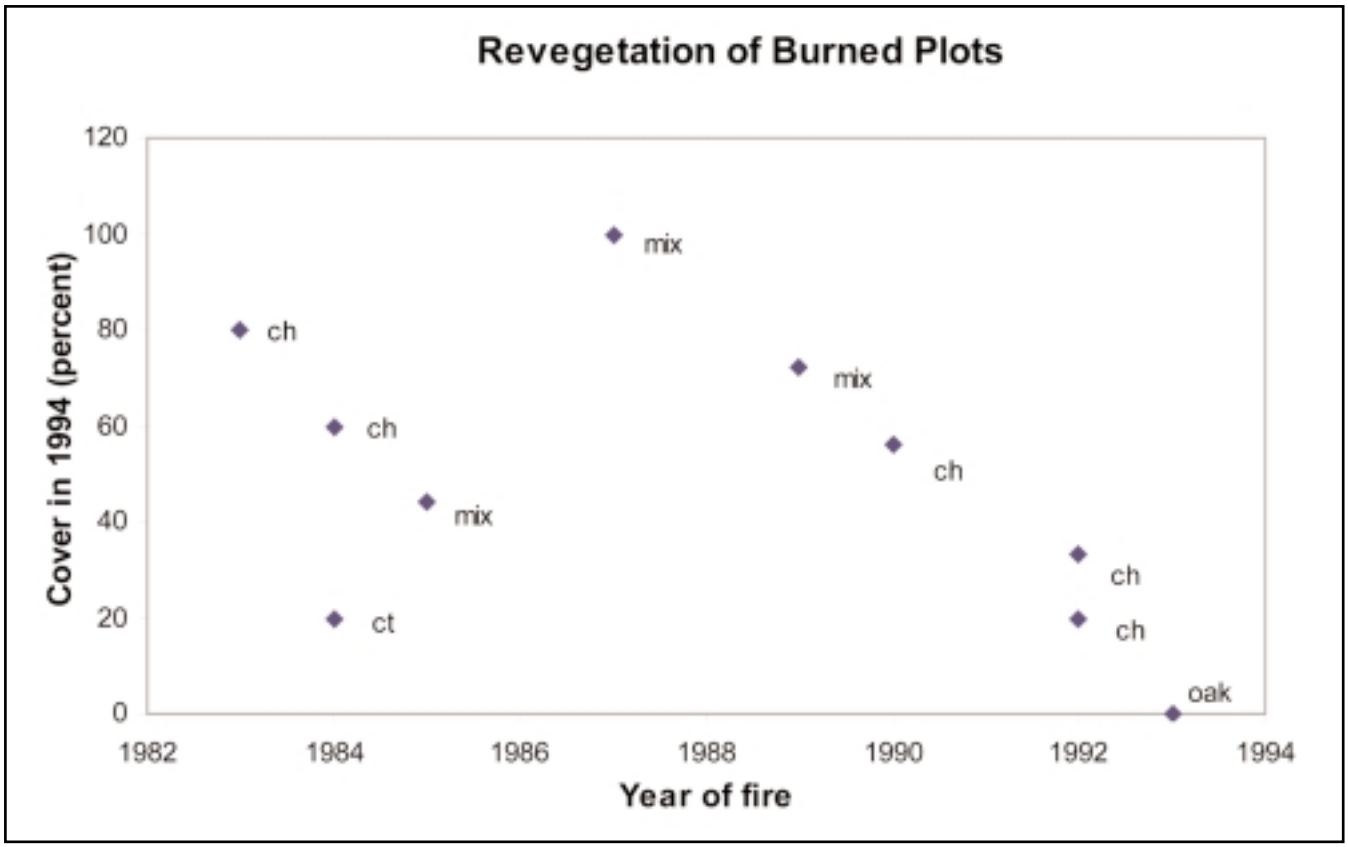

Figure 35—Revegetation of burned plots. Note: ch = chamise, mix = mixed chaparral, ct = coastal transition, oak = scrub oak.

Because of the difficulty of estimating shrub cover consistently within a few percentage points, estimated change of cover of species present at both occasions is probably reliable only at the 20-percent level. In other words, changes of less than 20 percent should probably be considered no change. This rule should not be followed, though, for percentage of cover in species that appeared or disappeared between inventories.

Forty-three percent of the plots neither gained nor lost shrub species, 46 percent gained shrub species, and only 11 percent lost species. Only two plots changed types between inventories (not counting burned plots). Both of these plots changed from scrub oak to other types, as shown in table 19. One plot changed from scrub oak to chamise; the other, from scrub oak to mixed and montane.

Although classification of chaparral, a complex ecosystem, into a few standard types provides a convenient communication tool, on some plots, even a minor change in species composition can change the classification. Such are the hazards of any classification system, and this needs to be taken into account when evaluating the significance of changes in area by type.

In general, plots that gained shrub species tended to be on mesic sites and were older stands, as evidenced by the height of the shrubs. Mixed and montane chaparral

Table 18—Change in shrub cover from 1984 to 1994 on unburned plots outside national forests

Change direction	Change in percentage of cover	Number of plots	Percentage of plots
No change	—	17	32
Increase	<20	10	19
	>20	10	19
Total increase		20	38
Decrease	<20	8	15
	>20	8	15
Total decrease		16	30
Grand total		53	100

Table 19—Shrub cover change on 2 plots outside national forests, 1984 to 1994

Plot change	Shrub species	Cover 1984	Cover 1994
		--------- *Percent* ----------	
Scrub oak to chamise	*Adenostoma fasciculatum*	25	25
	Artemisia tridentata	15	0
	Arctostaphylos canescens	10	25
	Quercus dumosa/john-tuckeri	50	10[a]
	Total cover	100	60
Scrub oak to mixed and montane	*Adenostoma fasciculatum*	20	10
	Malosma laurina	15	5
	Salvia mellifera	0	5
	Comarostaphylis diversifolia	0	15
	Quercus dumosa/john-tuckeri	50	0[a]
	Total cover	85	35

[a] Change of more than 20 percent.

was the major gainer—58 percent of the plots gained species. One plot in mixed and montane chaparral gained 6 shrub species, ending up with a total of 11. Shrubs up to 11 feet tall were tallied on the plot, indicating this was probably an older stand. Only 30 percent of the chamise plots gained species. Thirty-three percent of scrub oak plots, and 29 percent of coastal transition plots gained species. The “new” shrubs on these plots included 32 species, 5 of which were of the genus *Ceanothus* and 3 were *Arctostaphylos.*

In some cases, shrub cover and number of species changed in opposite directions. For example, on a plot in scrub oak type, shrub cover decreased from 75 to 60 percent, while the number of shrub species increased from five to six. On this plot, it appeared that some kind of partial dieback, or possibly herbivory, of *Arctostaphylos pungens* opened the stand to allow recruitment of another species.

Gainers and Losers in Unburned Chaparral

Over the 10-year period, 22 shrub species increased in occurrence, 6 decreased, and 2 balanced out with gainers equaling losers. The occurrence of some species increased on as many as seven plots, while none decreased on more than two plots. One plot represents about 2 percent of the unburned area. The net increase of some species (or genera) was as much as 10 percent, while the maximum net decrease was only 2 percent (table 20). One possible explanation is that perhaps chaparral has a natural tendency to become more complex with age, recruiting new species but retaining most of those already present until fire ends the process and it begins anew. Another is that the period 1984-94 was, in some way, anomalous, and a more likely outcome over most 10-year periods would have been gainers and losers balancing out.

Dead Material and Fire Hazard in Chaparral

For at least three decades, many fire and resource managers in southern California have considered dead vegetation to be the most important single characteristic related to chaparral flammability (Conrad and Oechel 1982, Countryman and Philpot 1970, Philpot 1974, Rothermel and Philpot 1973). It was assumed by most—and indeed it seems logical—that, barring abscission, the amount of dead vegetation in chaparral increased with stand age. Naturally, then, to keep fire danger low, a major goal of chaparral management was to maintain young stands (Conrad and Oechel 1982). Observations during prescribed burns and wildfires in southern California led researchers to question the assumed strong relationship between stand age and amount of dead material in chaparral, and prompted a study in chamise, the most extensive chaparral type in southern California, and the state. The study revealed a very weak relationship between amount of dead material and stand or shrub age (Paysen and Cohen 1990).

Although their study did not identify the specific agents responsible for the dead material, one can find many in the literature. Wagner et al. (1998) found that certain species of shrubs are more prone to breakage than others; sprouters generally have weaker stems than obligate seeders and would likely contribute more dead material at a given age. But even among sprouters, there may be differences. *Rhus ovata* and *Malosma laurina,* for example, are both sprouters, but *M. laurina* is much more susceptible to frost and on certain sites could become established and thrive until the first cold snap (Boorse et al. 1998). Natural longevity differs among chaparral shrubs. Most species of *Quercus, Cercocarpus,* and *Rhamnus,* for example, tend to be long lived, whereas some species of *Arctostaphylos* and *Ceanothus* are short lived and would contribute

Table 20—Shrub species occurrence on unburned plots

Species or genus	Increase	Decrease	Net change
		Number of plots	
Adenostoma fasciculatum	5	1	+4
Arctostaphylos spp.	3	1	+2
Artemisia californica	5	1	+4
Artemisia tridentae	1	2	-1
Ceanothus spp.	7	2	+5
Cercocarpus betuloides	1	1	0
Cercocarpus ledifolius	1	0	+1
Chrysothamnus spp.	1	0	+1
Cneoridium dumosum	1	0	+1
Comarostaphylis diversifolia	1	0	+1
Ericameria spp.	0	1	-1
Eriodictyon spp.	2	0	+2
Fraxinus dipetala	0	1	-1
Heteromeles arbutifolia	5	1	+4
Holodiscus spp.	1	0	+1
Juniperus californica	1	0	+1
Keckiella antirrhinoides	1	0	+1
Lonicera spp.	2	0	+2
Malosma laurina	1	0	+1
Prunus fremontii	0	1	-1
Quercus dumosa/john-tuckeri	4	1	+3
Quercus wislizeni	1	0	+1
Rhamnus crocea	2	1	+1
Rhamnus crocea var. *ilicifolia*	0	1	-1
Rhus ovata	1	1	0
Ribes spp.	0	1	-1
Salvia mellifera	6	1	+5
Sambucus spp.	1	0	+1
Toxicodendron diversilobum	4	0	+4

dead material at an earlier age, all else being equal (fig. 36). Chaparral stands that become very dense when young typically undergo self-thinning (Guo and Rundel 1998). Differential resistance to drought among species may cause dead material to build up more rapidly in one stand than in another of the same age. Characteristics of the stand that existed before the current one and the intensity and nature of the fire that destroyed it also may come into play: sprouts from weak lignotubers will be more likely to die than those from strong ones, and spotty, intense fires can damage some lignotubers more than others. Young shrubs generated from seed near vigorous sprouts often die from competition, and those in openings may outgrow the sprouts (Keeley 1986, Oechel and Reid 1984). Other factors include insects and disease, herbivory, air pollution, and inclusions of shallow soils or serpentine outcrops (Keeley 1986, Mills and Kummerow 1986, Moreno and Oechel 1993, Quinn 1990).

Figure 36—*Arctostaphylos glandulosa* (Eastwood's manzanita) with more than 25 percent dead branches. (Photo courtesy of Todd Keeler-Wolf, California Department of Fish and Game)

Paysen and Cohen (1990) state: "…fire behavior variations in chamise chaparral are more complex than can be described by a single fuel characteristic like the fraction of dead vegetation." This is not to say, however, that dead material is not important. It probably is a major factor in ignition and intensity of both small and large fires. The majority of the area burned is in the relatively small number of large fires that occur during hot, windy weather (Conard and Weise 1998, Keeley et al. 1999). Once these fires start raging across the landscape, stand characteristics—such as species, density, and amount of dead material—have little to do with whether a stand burns or not.

We assume there is some relationship or even possibly a synergistic function, between amount of dead material and shrub cover, or at least shrub cover above some threshold. We also assume that shrub species or type is an important factor in the flammability of a given stand, the effect of fire on the site, and the chemical composition of the smoke produced by a fire. And height and dead material may well influence fire behavior in ways that affect difficulty of suppression. It is also possible, we think, that the characteristics of postfire stands could be affected by the amount of dead material in stands before they burn.

These assumptions led to the development of what we call "hazard" classes for land outside national forests, based on amount of dead material by shrub layer and percentage of shrub cover (amount of dead material was not rated on national forest plots). Layers were recognized for a species that occurred in two distinct height classes. Field crews coded the amount of dead material (DM) for each species and layer combination as follows:

DM1—No dead material.
DM2—1 to 25 percent dead material.
DM3—More than 25 percent dead material.

Hazard classes (HC) were assigned as follows:

HC4—Shrub cover at least 25 percent; 50 percent or more of the cover coded DM3.
HC3—Shrub cover at least 25 percent; less than 50 percent coded DM3, but more than 50 percent DM3 + DM2.
HC2—Shrub cover at least 25 percent; 33 percent to 50 percent DM3 + DM2.
HC1—All other stands (shrub cover present).
HC0—Recently disturbed areas with no shrub cover.

As shown in (table 21), HC4 is the highest hazard class based on shrub density and amount of dead material and amounts to 38 percent of the chaparral outside national forests. When added to the next class, HC3, it can be seen that the total area with at least 25 percent shrub cover and a notable amount of dead material amounts to 2,190,000 acres, or 80 percent of the chaparral. That leaves 20 percent with very small amounts of dead material, which is fairly close to the 16 percent of chaparral outside national forests that burned between 1984 and 1994, according to the plot sample, and is therefore in young age classes. There appear to be no obvious spatial patterns in hazard class, in that every hazard class was represented throughout the study area (fig. 37).

Reliability of Data Used in This Report

Except for area of parks and other reserved areas outside national forests, the estimates of area by chaparral type and ownership in this report were obtained by sampling and are subject to sampling error. Tables 22, 23, and 24 report estimates of area, standard errors of area, and coefficients of variation to facilitate relative comparison of reliability among estimates. Smaller subsets of these estimates (e.g., chaparral with emergent trees, chaparral that burned) will have proportionately greater sampling errors.

Accuracy of Classification and Plant Identification

In the 1984 inventory, supervisory personnel and field crews from PNW were trained by local scientists and resource managers familiar with the plants and vegetation types, and many of the same people were involved in the 1994 inventory. National forest crews in the 1994 inventory were also trained by scientists familiar with the plants and vegetation types, and field crews included experienced botanists and a botanical illustrator. For PNW and national forest inventories, field crews had access to published and in-house plant guides and local herbaria, and they maintained their own collections, augmented by new plants when encountered. Plants that could not be identified with these resources were sent to experts at other locations. In addition to these measures taken to assure accurate plant identification and type classification, a formalized quality control/quality assurance system, based on a systematic remeasurement of a subsample of plots, was used to attain a high level of reliability of all measurements and classifications.

Discussion of Results

Chaparral occupies 4.6 million acres or 14 percent of the study area. Ironically, it covers a proportionately greater part of the landscape—22 to 37 percent—in the densely populated and/or high wildland urban interface counties of Los Angeles, Orange, Santa Barbara, Ventura, and San Diego. The mixed ownership of chaparral—45 percent in numerous private holdings and 55 percent in public ownership, including federal, state, county, and municipal agencies—adds to the complexity of managing

Table 21—Area of chaparral by type and hazard class outside national forests

Type	HC0	HC1	HC2	HC3	HC4	Total
			Thousand acres			
Chamise	NA	71	77	543	654	1,345
Scrub oak	NA	0	30	176	83	289
Mixed and montane	NA	52	52	235	159	498
Coastal transition	NA	53	64	202	138	457
Shrub cover zero	147	NA	NA	NA	NA	147
Total	147	176	223	1,156	1,034	2,736
Percent	5	7	8	42	38	100

HC0 = recently disturbed areas with no shrub cover.
HC1 = all other stands (shrub cover present).
HC2 = shrub cover at least 25 percent; 33 percent to 50 percent DM3 + DM2.
HC3 = shrub cover at least 25 percent; less than 50 percent coded DM3, but more than 50 percent DM3 + DM2.
HC4 = shrub cover at least 25 percent; 50 percent or more of the cover coded DM3.
NA = Not applicable.

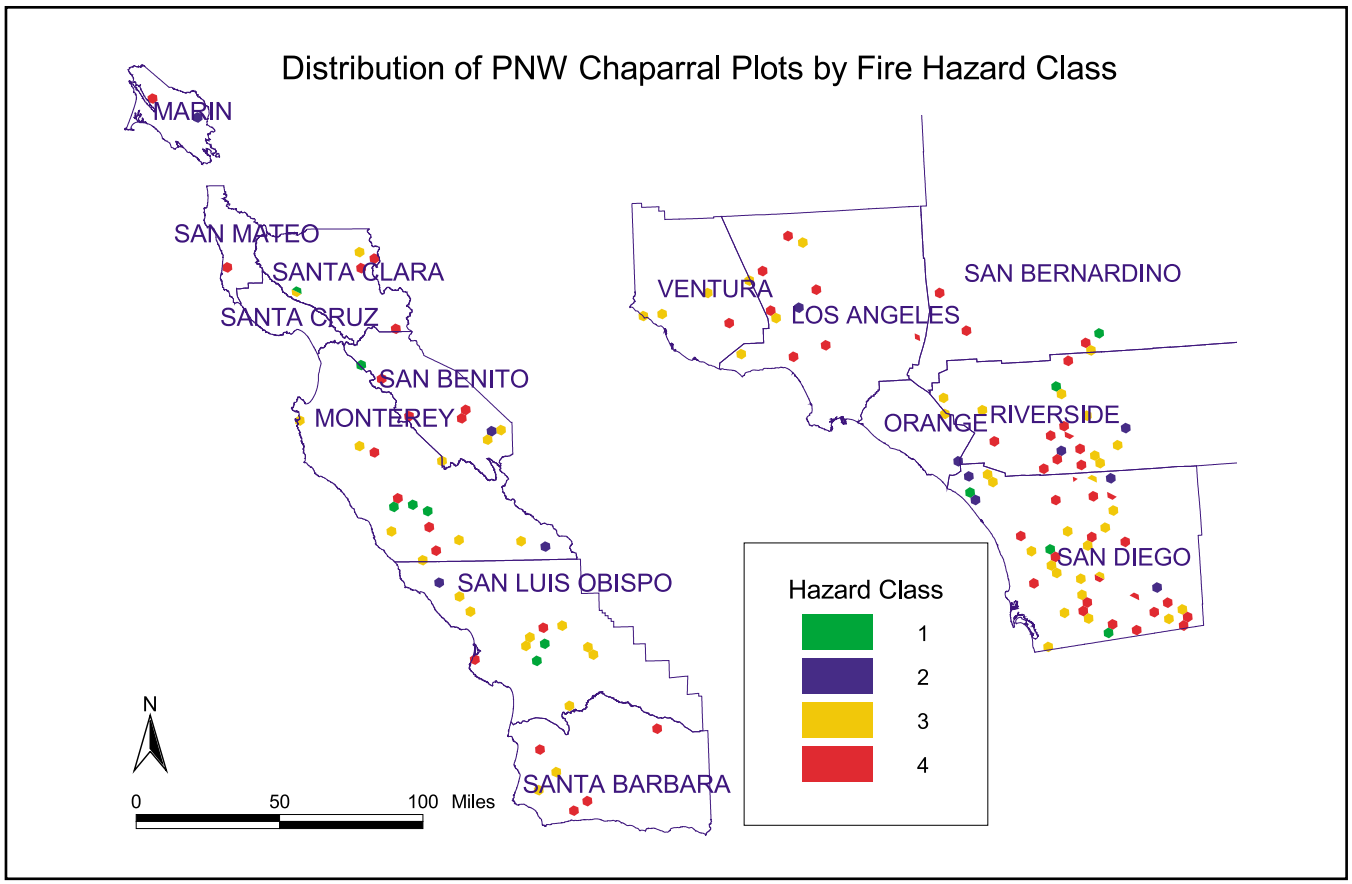

Figure 37—Fire hazard class, which was evaluated only for chaparral outside national forests, is mainly high or very high in nearly every part of the chaparral study area.

Table 22—Area estimates by chaparral classification system and owner class

Chaparral type	Private	Other public	National forest	National forest reserved
		Acres		
PNW:				
Chamise	1,091,111	283,312	316,406	100,434
Coastal transition	314,785	180,892	114,245	46,397
Mixed chaparral	354,042	184,892	607,192	206,469
Scrub oak	290,967	37,647	128,468	43,832
CALVEG:[a]				
BM—Curl-leaf mountain mahogany	0	0	7,208	0
BS—Basin sagebrush	0	0	5,517	0
BX—High desert mixed chaparral	0	0	10,264	0
CA—Chamise	865,391	222,418	257,313	68,524
CC—Ceanothus chaparral	0	17,169	27,617	0
CD—Southern mixed chaparral	87,567	0	10,347	0
CG—Greenleaf manzanita	0	9,357	0	0
CQ—Lower montane mixed chaparral	450,413	167,723	626,680	234,642
CR—Red shank	64,599	17,970	19,860	28,948
CS—Scrub oak	224,169	28,290	60,434	15,248
CX—Montane-mixed chaparral	0	0	0	9,024
CZ—Semidesert mixed chaparral	22,811	21,462	31,206	7,233
DX—Mixed desert shrub	0	10,782	0	0
JC—California juniper	0	0	6,156	0
ML—Baccharis	15,710	0	0	0
NC—North coast chaparral	62,411	0	0	0
RS—Alluvial fan sage scrub	0	0	49,746	7,233
SD—Manzanita chaparral	13,687	42,923	18,847	5,140
SH—Coastal bluff scrub	22,811	0	0	0
SM—Sumac	94,259	50,316	10,933	0
SQ—Mixed soft scrub chaparral	0	21,462	3,564	0
SS—Coastal sage scrub	127,079	58,901	40,405	14,466
WM—Birchleaf mountain mahogany	0	17,970	36,134	6,675
California Wildlife Habitat Relationships:				
CRC—Chamise-red shank	914,280	240,388	276,565	87,239
MCH—Mixed chaparral	924,324	327,883	822,846	276,380
MCP—Montane chaparral	0	27,327	51,265	19,047
SCS—Coastal scrub	212,301	80,362	36,520	14,466

Note: Other public includes federal, state, county, and municipal agencies.
[a] CALVEG = classification and assessment with Landsat of visible ecological groupings.

Table 23—Standard errors for acreage estimates[a] by chaparral type and owner class

Chaparral type	Private	Other public	National forest	National forest reserve
		Acres		
PNW:				
Chamise	112,720	70,727	36,377	23,996
Coastal transition	65,933	54,471	25,145	19,000
Mixed chaparral	73,352	58,474	47,803	34,790
Scrub oak	68,005	24,290	25,892	16,868
CALVEG:[b]				
BM—Curl-leaf mountain mahogany			7,208	
BS—Basin sagebrush			3,189	
BX—High desert mixed chaparral			6,375	
CA—Chamise	104,858	62,690	33,440	19,868
CC—Ceanothus chaparral		17,169	11,393	
CD—Southern mixed chaparral	37,525		7,306	
CG—Greenleaf manzanita		9,357		
CQ—Lower montane mixed chaparral	82,793	56,196	49,195	37,602
CR—Red shank	29,903	17,970	9,596	14,967
CS—Scrub oak	60,383	22,484	17,791	8,027
CX—Montane-mixed chaparral				6,433
CZ—Semidesert mixed chaparral	22,811	21,462	15,004	7,233
DX—Mixed desert shrub		10,782		
JC—California juniper			6,156	
ML—Baccharis	15,710			
NC—North coast chaparral	28,782			
RS—Alluvial fan sage scrub			16,463	7,233
SD—Manzanita chaparral	13,687	30,263	8,761	5,140
SH—Coastal bluff scrub	22,811			
SM—Sumac	36,038	29,030	6,359	
SQ—Mixed soft scrub chaparral		21,462	3,564	
SS—Coastal sage scrub	48,013	30,190	14,090	10,214
WM—Birchleaf mountain mahogany		17,970	13,887	6,675
California Wildlife Habitat Relationships:				
CRC—Chamise-red shank	105,639	64,857	34,254	22,530
MCH—Mixed chaparral	104,959	75,832	51,226	40,190
MCP—Montane chaparral		20,212	16,761	11,071
SCS—Coastal scrub	59,258	36,842	13,575	10,214

Note: Other public includes federal, state, county, and municipal agencies.
[a] Calculated as $N\sqrt{\mathrm{var}(x)/N}$ where X is a vector of plot expansion factors for the chaparral inventory (PNW or NF) including zeros for plots containing no acres in the type, and N is the number of plots in the PNW or NF chaparral inventory.
[b] CALVEG = classification and assessment with Landsat of visible ecological groupings.

Table 24—Coefficient of variation for acreage estimates[a] by chaparral type and owner class

Chaparral type	Private	Other public	National forest	National forest reserve
PNW:				
Chamise	0.10	0.25	0.11	0.24
Coastal transition	0.21	0.30	0.22	0.41
Mixed chaparral	0.21	0.32	0.08	0.17
Scrub oak	0.23	0.65	0.20	0.38
CALVEG:[b]				
BM—Curl-leaf mountain mahogany			1.00	
BS—Basin sagebrush			0.58	
BX—High desert mixed chaparral			0.62	
CA—Chamise	0.12	0.28	0.13	0.29
CC—Ceanothus chaparral		1.00	0.41	
CD—Southern mixed chaparral	0.43		0.71	
CG—Greenleaf manzanita		1.00		
CQ—Lower montane mixed chaparral	0.18	0.34	0.08	0.16
CR—Red shank	0.46	1.00	0.48	0.52
CS—Scrub oak	0.27	0.79	0.29	0.53
CX—Montane-mixed chaparral				0.71
CZ—Semidesert mixed chaparral	1.00	1.00	0.48	1.00
DX—Mixed desert shrub		1.00		
JC—California juniper			1.00	
ML—Baccharis	1.00			
NC—North coast chaparral	0.46			
RS—Alluvial fan sage scrub			0.33	1.00
SD—Manzanita chaparral	1.00	0.71	0.46	1.00
SH—Coastal bluff scrub	1.00			
SM—Sumac	0.38	0.58	0.58	
SQ—Mixed soft scrub chaparral		1.00	1.00	
SS—Coastal sage scrub	0.38	0.51	0.35	0.71
WM—Birchleaf mountain mahogany		1.00	0.38	1.00
California Wildlife Habitat Relationships:				
CRC—Chamise-red shank	0.12	0.27	0.12	0.26
MCH—Mixed chaparral	0.11	0.23	0.06	0.15
MCP—Montane chaparral		0.74	0.33	0.58
SCS—Coastal scrub	0.28	0.46	0.37	0.71

Note: Other public includes federal, state, county, and municipal agencies.

[a] Calculated as $\frac{\sqrt{\mathrm{var}(x)/N}}{\mathrm{mean}\ (x)}$ where X is a vector of plot expansion factors for the chaparral inventory (PNW or NF) including zeros for plots containing no acres in the type and N is the number of plots in the PNW or NF chaparral inventory.

[b] CALVEG = classification and assessment with Landsat of visible ecological groupings.

chaparral and protecting lives and property when it burns. About 15 percent of the chaparral is in parks and other reserves.

Between 1984 and 1994, an estimated 179,400 acres of chaparral were lost to development, about 3.3 percent of the chaparral area in 1984. This comes out to roughly 15 square miles per year. This loss, which may seem innocuous to some, is not the whole story. While development decreases the chaparral area, it also creates islands and stringers of vegetation too small and narrow to be sustained, or useful to wildlife, and increases the chaparral-urban interface, a stress zone of rather continuous degradation by human activity. Spreading development also increases the probability of fire, thus further complicating protection, and raising the stakes and the costs.

The systematic samples on which this study was based confirm what has been determined by other methods—that chamise is the most widespread chaparral shrub species, occurring in 70 percent of stands. Chamise also is the most extensive single type (mixed chaparral exceeds chamise, but is actually a conglomerate of several species and types). The abundance of chamise, however, belies the complexity of the chaparral ecosystem, which is indicated by the large number of shrub species tallied on plots—more than 100—a considerably larger number of woody dominants than represented by trees in forests in the same area.

During the 10-year period 1984-94, fires outside national forests burned 16 percent of the chaparral area as estimated from the area-weighted proportion of plots on which evidence of fire was recorded. Fire records for national forests indicate that for the 20-year period 1975-95, fires there burned 54 percent of the chaparral, or 27 percent over 10 years, ignoring any differences by decade. These burn rates translate to an average fire-return interval of 50 years across all types and ownerships.

On none of the plots that burned between 1984 and 1994 had shrub cover attained the preburn density at time of data collection, although as expected, density was generally greater in plots that burned during the first few years of the decade. Fewer shrub species were present after burning; 44 percent of those that dropped out were obligate seeders. Subshrubs increased by 25 percent and grasses and forbs by over 300 percent. Chaparral type changed on 27 percent of the burned plots between the 1984 and 1994 inventories.

During the period 1984-94 unburned chaparral outside national forests showed little evidence of degradation or loss of biodiversity. Shrub cover held steady or increased on 70 percent of the plots, and many shrub species increased in occurrence while very few decreased. We wonder if this trend toward richer, more complex chaparral follows a natural tendency in the ecosystem, or if the period 1984-94 was in some way anomalous. Would gainers and losers tend to balance out over most 10-year periods? Future remeasurement of the chaparral plots on which this study was based could answer that question and provide many other useful facts about chaparral dynamics. An estimated 38 percent of the chaparral is in a high hazard status, and another 42 percent can be classified as moderate hazard or on the threshold of high hazard. This leaves 20 percent in low-hazard categories, which is close to the percentage of chaparral that burns during an average 10-year period, according to the sample used here and the state's fire records.

Emergent trees, important to wildlife and scenery values, and thought by some to have been more prevalent in chaparral before Europeans settled here, were found on 11 percent of the area.

Sixteen tree species were tallied on plots in chaparral; the three most common were *Quercus agrifolia, Pinus sabiniana,* and *P. monophylla.* The plots on which this study was based could, if remeasured periodically, provide useful information on the changing presence of emergent trees in chaparral and structural data, which could provide a clearer picture of successional dynamics.

The Next Steps

In this report, we sought to provide a concise overview and summary of current status and one decade's change in chaparral composition and extent over the majority of its range in California and to address selected issues that have been raised concerning chaparral in the past (e.g., area burned annually, implied fire frequency, emergent trees, and hazard classes). We also believe that the data summarized here, if linked with other spatially referenced databases, hold considerable promise for exploring a range of basic ecological science and issue-driven, policy-relevant questions.

For example, the often-reported premise that chaparral distribution is overwhelmingly, if not exclusively, controlled by climate could be tested if these data were combined with spatially referenced weather observation series, digital elevation models, and other environmental components such as soil or parent material. Vulnerability to air pollution might be inferred by relating the chaparral data on patterns of species composition and proportion of dead material to data on distance and direction from pollution-generating population centers. Chaparral type occurrence and even woody species richness gradients could be evaluated relative to latitude, elevation, precipitation, and other climatological factors. Integration of spatially referenced data derived from the 1990 and 2000 censuses would facilitate assessments of changes in the extent of wildland urban interface and its character (e.g., level of risk posed to homes, nature of structure protection challenges likely to be faced by firefighters, and degree of chaparral use).

The data summarized here are available for anyone to use to address these or any other questions. We, and others affiliated with the PNW Forest Inventory and Analysis Program, welcome opportunities to collaborate with other researchers and clients to address basic and applied research questions whenever our inventory data are likely to contribute useful information. To obtain the data or to discuss ideas for possible collaboration, please contact the senior author.

This will not be the last inventory of chaparral in California. A new chaparral data collection protocol, identical for lands in and outside national forests, has been developed and reviewed. It retains PNW-FIA-specific variables like percentage of dead material and local knowledge of fire activity, but changes the plot footprint to be consistent with the four-point, national FIA design that is now implemented on all forested FIA plots. This change will facilitate assessing within-stand variation, and provide better temporal continuity on plots that “migrate” between forest and chaparral types over time. Other changes from the previously implemented one-point protocol include estimating average heights of each species independently, measuring trees greater than 5 inches diameter at breast height according to standard tree protocols (i.e., height, crown ratio, insect and disease damage) instead of mere cover by

species, and obtaining global positioning system-accurate plot location data to enable fine-scale spatial overlay analysis in conjunction with other spatially referenced data. As of this writing, data collection has begun in California's national forests on a 5-year, annual inventory cycle under which 20 percent of all forest and chaparral plots in the state on 3.4-mile (or in some cases, 1.7-mile) grids are visited and measured each year. Current plans call for converting to a 10-year cycle (10 percent of plots visited each year) beginning in 2006. There is currently no funding or plan for conducting remeasurement of chaparral plots outside of national forests.

Scientific and Common Plant Names[a]

Life form[b]/genus	Species (citation)	Common name
Trees		
Adenostoma	*sparsifolium* Torr.	red shank
Aesculus[c]	*californica* (Spach) Nutt.	California buckeye
Arctostaphylos	*glauca* Lindl.	bigberry manzanita
Arctostaphylos	*pringlei* Parry var. *drupacea* (Parry) P.V. Wells	pinkbracted manzanita
Arctostaphylos	*viscida* Parry	sticky whiteleaf manzanita
Arctostaphylos	*viscida* Parry spp. *pulchella* (T.J. Howell) P.V. Wells	sticky whiteleaf manzanita
Artemisia	*tridentae* Nutt.	big sagebrush
Ceanothus	*spinosus* Nutt.	redheart
Ceanothus	*thyrsiflorus* Eschsch.	blueblossom ceanothus
Cercocarpus Kunth	spp.	mountain mahogany
Cercocarpus	*betuloides* Nutt.	birchleaf mountain mahogany
Cercocarpus	*ledifolius* Nutt.	curl-leaf mountain mahogany
Fraxinus	*dipetala* Hook. & Arn.	California ash
Heteromeles M. Roemer	spp.	toyon
Heteromeles	*arbutifolia* (Lindl.) M. Roemer	toyon
Juniperus[c]	*californica* Carr.	California juniper
Juniperus[c]	*occidentalis* Hook.	western juniper
Malosma Nutt. ex Abrams	spp.	laurel sumac
Malosma	*laurina* (Nutt.) Nutt. ex Abrams	laurel sumac
Olea[c]	*europaea* L.	olive
Pinus L.	spp.	pine
Pinus[c]	*attenuata* Lemmon	knobcone pine
Pinus[c]	*coulteri* D. Don	Coulter pine
Pinus[c]	*jeffreyi* Grev. & Balf.	Jeffrey pine
Pinus[c]	*monophylla* Torr. & Frem.	singleleaf pinyon
Pinus	*ponderosa* P. & C. Lawson	ponderosa pine
Pinus[c]	*sabiniana* Dougl. ex Dougl.	California foothill pine

Platanus[c]	*racemosa* Nutt.	California sycamore
Populus[c]	*fremontii* S. Wats.	Fremont cottonwood
Prunus L.	spp.	plum
Prunus	*fremontii* S. Wats.	desert apricot
Pseudotsuga	*macrocarpa* (Vasey) Mayr	bigcone Douglas-fir
Pseudotsuga[c]	*menziesii* (Mirbel) Franco	Douglas-fir
Quercus[c]	*agrifolia* Lee	California live oak/coast live oak
Quercus	*berberidifolia* Liebm.	scrub oak
Quercus[c]	*chrysolepis* Liebm. var. nana (Jepson) Jepson	canyon live oak
Quercus[c]	*douglasii* Hook. & Arn.	blue oak
Quercus	*dumosa* Nutt.	coastal sage scrub oak
Quercus	*dumosa/john-tuckeri* Nutt./ Nixon & C.H. Muller	California scrub/Tucker oak
Quercus	*durata* Jepson	leather oak
Quercus[c]	*engelmannii* Greene	Engelmann oak
Quercus	*john-tuckeri* Nixon & C.H. Muller	Tucker oak
Quercus	*kelloggii* Newberry	California black oak
Quercus	*lobata* Nee	California white oak
Quercus	*palmeri* Engelm.	Palmer oak
Quercus[c]	*wislizeni* A.DC. var. *frutescens* Engelm.	interior live oak
Rhus	*integrifolia* (Nutt.) Benth. & Hook. f. ex Brewer & S. Wats.	lemonade sumac
Rhus	*ovata* S. Wats.	sugar sumac
Salix[c] *L.*	spp.	willow
Sambucus L.	spp.	elderberry
Sequoia	*sempervirens* (Lamb. ex D. Don) Endl.	redwood
Umbellularia[c]	*californica* (Hook. & Arn.) Nutt.	California laurel
Yucca[c] L.	spp.	yucca
Yucca	*schidigera* Roezl ex Ortgies	Mojave yucca

Shrubs

Adenostoma Hook. & Arn.	spp.	chamise
Adenostoma[c]	*fasciculatum* Hook. & Arn.	common chamise
Adenostoma[c]	*sparsifolium* Torr.	red shank
Amelanchier[c]	*utahensis* Koehne	Utah serviceberry
Amorpha[c]	*californic*a Nutt.	California false indigo
Arctostaphylos Adans.	spp.	manzanita
Arctostaphylos	*bakeri* Eastw.	Baker's manzanita
Arctostaphylos[c]	*canscens* Eastw.	hoary manzanita
Arctostaphylos[c]	*glandulosa* Eastw.	Eastwood's manzanita
Arctostaphylos[c]	*glauca* Lindl.	bigberry manzanita

Arctostaphylos	*hispidula* T.J. Howell	Gasquet manzanita
Arctostaphylos[c]	*hookeri* G. Don	Hooker's manzanita
Arctostaphylos	*hookeri* spp. *montana* (Eastw.) P.V. Wells	Mt. Tamalpais manzanita
Arctostaphylos	*manzanita* Parry spp. *elegans* (Eastw.) P.V. Wells	Konocti manzanita
Arctostaphylos[c]	*parryana* Lemmon	Parry manzanita
Arctostaphylos[c]	*patula* Greene	greenleaf manzanita
Arctostaphylos[c]	*pringlei* spp. *drupacea* (Parry) P.V. Well	pinkbracted manzanita
Arctostaphylos[c]	*pungens* Kunth	pointleaf manzanita
Arctostaphylos[c]	*viscida* Parry	sticky whiteleaf manzanita
Artemisia L.	spp.	sagebrush
Artemisia[c]	*californica* Less.	coastal sagebrush
Artemisia[c]	*tridentata* Nutt.	big sagebrush
Atriplex[c]	*canescens* (Pursh) Nutt.	fourwing saltbush
Baccharis L.	spp.	baccharis
Baccharis[c]	*pilularis* DC.	coyote brush
Baccharis[c]	*salicifolia* (Ruiz & Pavon) Pers.	mule’s fat
Bidens[c]	*pilosa* L.	hairy beggarticks
Ceanothus L.	spp.	ceanothus
Ceanothus[c]	*cordulatus* Kellogg	whitethorn ceanothus
Ceanothus[c]	*crassifolius* Torr.	hoaryleaf ceanothus
Ceanothus[c]	*cuneatus* (Hook.) Nutt.	buckbrush
Ceanothus	*ferrisiae* McMinn	coyote ceanothus
Ceanothus[c]	*greggii* Gray	desert ceanothus
Ceanothus[c]	*greggii* var. *perplexans* (Trel.) Jepson	desert ceanothus
Ceanothus[c]	*griseus* (Trel. ex B.L. Robins.) McMinn	Carmel ceanothus
Ceanothus[c]	*integerrimus* Hook. & Arn.	deerbrush
Ceanothus	*jepsonii* Greene	Jepson ceanothus
Ceanothus[c]	*lemmonii* Parry	Lemmon's ceanothus
Ceanothus[c]	*leucodermis* Greene	chaparral whitethorn
Ceanothus[c]	*megacarpus* Nutt.	bigpod ceanothus
Ceanothus[c]	*oliganthus* Nutt.	hairy ceanothus
Ceanothus[c]	*palmeri* Trel.	Palmer ceanothus
Ceanothus[c]	*papillosus* Torr. & Gray	wartleaf ceanothus
Ceanothus	*sorediatus* Hook. & Arn.	jimbrush
Ceanothus[c]	*spinosus* Nutt.	redheart
Ceanothus[c]	*thyrsiflorus* Eschsch.	blueblossom ceanothus
Ceanothus[c]	*tomentosus* Parry	woolyleaf ceanothus
Cercocarpus[c]	*ledifolius* Nutt.	curl-leaf mountain mahogany
Cercocarpus[c]	*montanus* Raf. var. *glaber* (S. Wats.) F.L. Martin	birchleaf mountain mahogany
Chrysothamnus Nutt.	spp.	rabbitbrush
Chrysothamnus[c]	*nauseosus* Nutt. (now *Ericameria*)	rubber rabbitbrush

Clematis[c]	*pauciflora* Nutt.	ropevine clematis
Cleome[c] Greene	spp.	spiderflower
Cneoridium[c]	*dumosum* (Nutt.) Hook. f. ex Baill.	bush rue
Coleogyne Torr.	spp.	coleogyne
Comarostaphylis[c]	*diversifolia* (Parry) Greene	summer holly
Croton[c] L.	spp.	croton
Dendromecon[c]	*rigida* Benth.	tree poppy
Diplacus[c]	*aurantiacus* (W. Curtis) Jepson	orange bush monkeyflower
Encelia Adans.	spp.	brittlebush
Encelia[c]	*farinosa* var. *farinosa* Gray ex Torr.	goldenhills
Ephedra[c] L.	spp.	jointfir
Ephedra[c]	*viridis* Coville	mormon tea
Ericameria Nutt.	spp.	goldenbush
Ericameria[c]	*ericoides* (Less.) Jepson	California goldenbush
Eriodictyon Benth.	spp.	yerba santa
Eriodictyon[c]	*californicum* (Hook. & Arn.) Torr.	California yerba santa
Eriodictyon[c]	*capitatum* Eastw.	Lompoc yerba santa
Eriodictyon[c]	*crassifolium* Benth.	thickleaf yerba santa
Eriodictyon[c]	*tomentosum* Benth.	woolly yerba santa
Eriodictyon[c]	*trichocalyx* Heller	hairy yerba santa
Eriogonum[c] Michx.	spp.	buckwheat
Eriogonum	*fasciculatum* Benth.	Eastern Mojave buckwheat
Eriophyllum[c]	*confertiflorum* (DC.) Gray	golden-yarrow
Escobaria[c]	*vivipara* (Nutt.) Buxbaum	spinystar
Frangula[c]	*californica* (Eschsch.) Gray	California buckthorn
Fraxinus[c]	*dipetala* Hook. & Arn.	California ash
Fremontodendron[c]	*californicum* (Torr.) Coville	California flannelbush
Garrya Dougl. ex Lindl.	spp.	silktassel
Garrya[c]	*elliptica* Dougl. ex Lindl.	wavyleaf silktassel
Garrya[c]	*fremontii* Torr.	bearbrush
Garrya[c]	*veatchii* Kellogg	canyon silktassel
Hazardia[c]	*squarrosa* (Hook. & Arn.) Greene	sawtooth goldenbush
Heteromeles[c]	*arbutifolia* (Lindl.) M. Roemer	toyon
Holodiscus (K. Koch) Maxim.	spp.	oceanspray
Holodiscus	*discolor* (Pursh) Maxim.	oceanspray
Isocoma[c]	*acradenia* (Greene) Greene	alkali goldenbush
Isomeris	*arborea* Nutt.	bladderpod
Juniperus[c]	*californica* Carr.	California juniper
Keckiella[c]	*antirrhinoides* (Benth.) Straw	snapdragon penstemon
Keckiella[c]	*cordifolia* (Benth.) Straw	heartleaf keckiella
Keckiella[c]	*ternata* (Torr. ex Gray) Straw	Scarlet keckiella
Larrea Cav.	spp.	creosote bush
Leptodactylon[c]	*californicum* Hook. & Arn.	California prickly phlox
Lonicera L.	spp.	honeysuckle

Lonicera[c]	*interrupta* Benth.	chaparral honeysuckle
Lotus[c]	*scoparius* (Nutt.) Ottley	common deerweed
Lupinus L.	spp.	lupine
Mahonia Nutt.	spp.	barberry
Malacothamnus[c]	*fasciculatus* (Nutt. ex Torr. & Gray) Greene	Mendocino bushmallow
Malosma[c]	*laurina* (Nutt.) Nutt. ex Abrams	laurel sumac
Nicotiana[c]	*glauca* Graham	tree tobacco
Opuntia[c] P. Mill.	spp.	pricklypear
Penstemon[c] Schmidel	spp.	penstemon
Philadelphus[c]	*microphyllus* Gray	littleleaf mock orange
Prosopis L.	spp.	mesquite
Prunus[c]	*fremontii* S. Wats.	desert apricot
Prunus[c]	*ilicifolia* (Nutt. ex Hook. & Arn.) D. Dietr. spp. *lyonii* (Eastw.) Raven	hollyleaf cherry
Purshia DC. ex Poir.	spp.	bitterbrush
Purshia[c]	*glandulosa* Curran	desert bitterbrush
Purshia[c]	*tridentata* (Pursh) DC.	antelope bitterbrush
Quercus[c]	*agrifolia* Nee var. *oxyadenia* (Torr.) J.T. Howell	coast live oak (shrub form)
Quercus[c]	*chrysolepis* Liebm. var. *nana* (Jepson) Jepson	canyon live oak
Quercus[c]	*dumosa* Nutt.	coastal sage scrub oak
Quercus[c]	*dunnii* Kellogg	Palmer oak
Quercus[c]	*durata* Jepson	leather oak
Quercus[c]	*engelmannii* Greene	Engelmann oak
Quercus[c]	*john-tuckeri* Nixon & C.H. Muller	Tucker oak
Quercus[c]	*turbinella* Greene	Sonoran scrub oak
Quercus[c]	*wislizeni* A.DC.	interior live oak
Quercus[c]	*wislizeni* A.DC. var. *frutescens* Engelm	interior live oak
Rhamnus L.	spp.	buckthorn
Rhamnus	*californica* Eschsch.	California buckthorn
Rhamnus	*californica* spp. *occidentalis* (T.J. Howell) C.B. Wolf	California buckthorn
Rhamnus[c]	*crocea* Nutt.	redberry buckthorn
Rhamnus	*crocea* var. *ilicifolia*	holyleaf redberry
Rhamnus[c]	*ilicifolia* Kellogg	hollyleaf redberry
Rhus L.	spp.	sumac
Rhus[c]	*integrifolia* (Nutt.) Benth. & Hook. f. ex Brewer & S. Wats.	lemonade sumac
Rhus[c]	*ovata* S. Wats.	sugar sumac
Rhus[c]	*trilobata* Nutt.	skunkbush sumac
Ribes L.	spp.	currant
Ribes[c]	*roezlii* Regel	Sierra gooseberry
Rosa[c] L.	spp.	rose
Rosa[c]	*californica* Cham. & Schlecht.	California wildrose

Rubus[c]	*ursinus* Cham. & Schlecht.	California blackberry
Salix[c] L.	spp.	willow
Salix[c]	*exigua* Nutt.	narrowleaf willow
Salvia L.	spp.	sage
Salvia[c]	*apiana* Jepson	white sage
Salvia[c]	*clevelandii* (Gray) Greene	fragrant sage
Salvia[c]	*leucophylla* Greene	San Luis purple sage
Salvia[c]	*mellifera* Greene	black sage
Sambucus L.	spp.	elderberry
Sambucus[c]	*nigra* L. spp. *cerulea* (Raf) R. Bolli	blue elderberry
Senecio[c]	*flaccidus* Less var. *douglasii* (DC.) B.L. Turner & T.M. Barkl.	Douglas ragwort
Symphoricarpos[c] Duham.	spp.	snowberry
Symphoricarpos[c]	*mollis* Nutt.	creeping snowberry
Toxicodendron P. Mill.	spp.	poison oak
Toxicodendron[c]	*diversilobum* (Torr. & Gray) Greene	Pacific poison oak
Trichostema[c]	*lanatum* Benth.	woolly bluecurls
Trichostema[c]	*parishii* Vasey	Parish's bluecurls
Umbellularia[c]	*californica* (Hook. & Arn.) Nutt.	California laurel
Vitis[c] L.	spp.	grape
Xylococcus[c]	*bicolor* Nutt.	mission manzanita
Yucca[c]	*schidigera* Roezl ex Ortgies	Mojave yucca
Yucca[c]	*whipplei* Torr.	chaparral yucca

Forbs

Achillea[c]	*millefolium* L.	common yarrow
Agave[c]	*deserti* Engelm.	desert agave
Allium[c] L.	spp.	wild onion
Amaranthus[c]	*albus* L.	prostrate pigweed
Antennaria[c]	*rosea* Greene	rosy pussytoes
Arabis[c] L.	spp.	rockcress
Artemisia[c]	*douglasiana* Bess.	Douglas' sagewort
Artemisia[c]	*palmeri* Gray	San Diego sagewort
Astragalus[c] L.	spp.	milkvetch
Brassica[c]	*nigra* (L.) W.D.J. Koch	black mustard
Brassica[c]	*rapa* L.	field mustard
Brickellia[c]	*californica* (Torr. & Gray) Gray	California brickellbush
Brodiaea[c]	*jolonensis* Eastw.	chaparral brodiaea
Calystegia[c] R.Br.	spp.	false bindweed
Castilleja[c] Mutis ex L.F.	spp.	Indian paintbrush
Castilleja[c]	*minor* (Gray) Gray spp. *spiralis* (Jepson) Chuang & Heckard	lesser Indian paintbrush

Centaurea[c]	*solstitialis* L.	yellow star-thistle
Cheilanthes[c] Sw.	spp.	lipfern
Chloris[c] Sw.	spp.	windmill grass
Chlorogalum[c] Kunth	spp.	soap plant
Chlorogalum[c]	*pomeridianum* (DC.) Kunth	wavyleaf soap plant
Chrysothamnus[c] Nutt.	spp.	rabbitbrush
Cirsium[c] P. Mill.	spp.	thistle
Cirsium[c]	*vulgare* (Savi) Ten.	bull thistle
Claytonia[c]	*perfoliata* Donn ex Willd.	miner's lettuce
Clematis[c] L.	spp.	leather flower
Clinopodium[c]	*douglasii* (Benth.) Kuntze	yerba buena
Collinsia[c] Nutt.	spp.	blue eyed Mary
Cordylanthus[c]	*rigidus* (Benth.) Jepson	stiffbranch bird's beak
Croton[c]	*setigerus* Hook.	turkey mullein/dove weed
Cuscuta[c]	*californica* Hook. & Arn.	chaparral dodder
Cynoglossum	*grande* Dougl. ex Lehm.	Pacific hound's tongue
Delphinium[c] L.	spp.	larkspur
Descurainia[c]	*incana* (Bernh. ex Fisch. & C.A. Mey.) Dorn	mountain tansymustard
Dichelostemma[c]	*congestum* (Sm.) Kunth	ookow
Dodecatheon[c]	*clevelandii* Greene	padre's shootingstar
Dryopteris[c]	*arguta* (Kaulfuss) Watt	coastal woodfern
Dudleya[c]	*edulis* (Nutt.) Moran	fingertips
Epilobium[c]	*canum* (Greene) Raven	hummingbird trumpet
Equisetum[c] L.	spp.	horsetail
Eriastrum[c] Woot. & Standl.	spp.	woollystar
Ericameria[c] Nutt.	spp.	goldenbrush
Eriogonum[c] Michx.	spp.	buckwheat
Eriogonum[c]	*fasciculatum* Benth.	Eastern Mojave buckwheat
Eriophyllum[c]	*lanatum* (Pursh) Forbes	common woolly sunflower
Erodium[c]	*botrys* (Cav.) Bertol.	longbeak stork's bill
Erysimum[c]	*capitatum* (Dougl. ex Hook) Greene	sanddune wallflower
Eschscholzia[c] Cham.	spp.	California poppy
Eschscholzia[c]	*californica* Cham.	California poppy
Eucrypta[c]	*chrysanthemifolia* (Benth.) Greene	spotted hideseed
Frasera Walt.	spp.	green gentian
Galinsoga[c] Ruiz & Pavon	spp.	gallant-soldier
Galium[c] L.	spp.	bedstraw
Galium[c]	*angustifolium* Nutt. ex Gray	narrowleaf bedstraw
Galium[c]	*nuttallii* Gray	climbing bedstraw
Gayophytum[c] A. Juss.	spp.	groundsmoke
Gnaphalium[c] L.	spp.	cudweed

Gutierrezia[c]	*sarothrae* (Pursh) Britt. & Rusby	broom snakeweed
Hemizonia[c] DC.	spp.	tarweed
Horkelia[c] Cham. & Schlecht.	spp.	horkelia
Lepidium[c] L.	spp.	pepperweed
Linaria[c] P. Mill.	spp.	toadflax
Lotus[c]	*scoparius* (Nutt.) Ottley	common deerweed
Lotus[c]	*scoparius* (Nutt.) var. *brevialatus* Ottley	western birdsfoot trefoil
Lotus[c]	*wrangelianus* Fisch.& C.A. Mey.	Chilean bird's-foot trefoil
Lupinus[c] L.	spp.	lupine
Madia[c] Molina	spp.	tarweed
Malva[c] L.	spp.	mallow
Marah[c]	*fabaceus* (Naud.) Naud. ex Greene	California manroot
Marah[c]	*macrocarpus* (Greene) Greene	Cucamonga manroot
Mentha[c] L.	spp.	mint
Mimulus[c] L.	spp.	monkeyflower
Mimulus[c]	*brevipes* Benth.	widethroat yellow monkeyflower
Mimulus[c]	*cardinalis* Dougl. ex Benth.	scarlet monkeyflower
Minuartia[c]	*douglasii* (Fenzl ex Torr. & Gray) Mattf.	Douglas' stitchwort
Mirabilis[c] L.	spp.	four o'clock
Monardella[c]	*odoratissima* Benth.	mountain monardella
Montia[c] L.	spp.	minerslettuce
Navarretia[c] Ruiz & Pavon	spp.	navarretia/pincushionplant
Opuntia[c] P. Mill.	spp.	pricklypear
Opuntia[c]	*acanthocarpa* Engelm. & Bigelow	buckhorn cholla
Opuntia[c]	*basilaris* Engelm. & Bigelow	beavertail pricklypear
Opuntia[c]	*occidentalis* Engelm. & Bigelow (pro sp.)	pricklypear
Paeonia[c]	*californica* Nutt.	California peony
Papaver[c]	*californicum* Gray	western poppy
Pedicularis[c]	*densiflora* Benth. ex Hook.	Indian warrior
Pellaea[c]	*andromedifolia* (Kaulfuss) Fée	coffee cliffbrake
Pellaea[c]	*mucronata* (DC. Eat.) DC. Eat.	birdfoot cliffbrake
Penstemon[c] Mitch.	spp.	beardtongue
Pentagramma[c]	*triangularis* (Kaulfuss) Yakskievych Windham & Wollenwebber	goldback fern
Phacelia[c] Juss.	spp.	scorpionweed
Phacelia[c]	*cicutaria* (Greene)	caterpillar phacelia
Phacelia[c]	*distans* Benth.	distant phacelia
Phacelia[c]	*imbricata* Greene	imbricate phacelia

Phacelia[c]	*minor* (Harvey) Thellung ex F. Zimmerman	wild canterbury bells
Phacelia[c]	*parryi* Torr.	Parry’s phacelia
Phlox[c] L.	spp.	phlox
Phlox[c]	*diffusa* Benth.	spreading phlox
Plagiobothrys[c] Fisch. & C.A. Mey.	spp.	popcornflower
Plagiobothrys[c]	*collinus* (Phil.) I.M. Johnston	Cooper's popcornflower
Polypodium[c]	*californicum* Kaulfuss	California polypody
Polystichum[c]	*munitum* (Kaulfuss) K. Presl.	western swordfern
Potentilla[c] L.	spp.	cinquefoil
Pteridium[c]	*aquilinum* (L.) Kuhn	western brackenfern
Pteridium[c]	*aquilinum* (L.) Kuhn var. *pubescens* Underwood	hairy brackenfern
Ranunculus[c] L.	spp.	buttercup
Salvia[c]	*apiana* Jepson	white sage
Salvia[c]	*columbariae* Benth.	chia
Scrophularia[c]	*californica* Cham. & Schlecht.	California figwort
Selaginella[c]	*bigelovii* Underwood	bushy spikemoss
Senecio[c] L.	spp.	ragwort
Solanum[c] L.	spp.	nightshade
Solanum[c]	*xanti* Gray	chaparral nightshade
Solidago[c]	*californica* Nutt.	California goldenrod
Sphaeralcea[c]	*ambigua* Gray	desert globemallow
Stachys[c]	*bullata* Benth.	California hedgenettle
Thalictrum[c]	*fendleri* Engelm. ex Gray var. *polycarpum* Torr.	Fendler’s meadow-rue
Trifolium[c] L.	spp.	clover
Urtica[c]	*urens* L.	dwarf nettle
Verbascum[c]	*thapsus* L.	common mullein
Viola[c] L.	spp.	violet
NA	NA	forb (herbaceous, not grass)

Grasses

Achnatherum[c]	*coronatum* (Thurb.) Barkworth	giant ricegrass
Agropyron[c] Gaertn.	spp.	wheatgrass
Arundo[c]	*donax* L.	giant reed
Atriplex L.	spp.	saltbush
Avena[c]	*fatua* L.	wild oat
Bromus[c] L.	spp.	brome
Bromus[c]	*carinatus* Hook. & Arn.	California brome
Bromus[c]	*ciliatus* L.	fringed brome
Bromus[c]	*hordeaceus* L.	soft brome
Bromus[c]	*tectorum* L.	cheatgrass
Carex[c] L.	spp.	sedge
Elymus[c] L.	spp.	wildrye
Festuca[c]	*californica* Vasey	California fescue
Hesperostipa[c]	*comata* (Trin. & Rupr.) Barkworth	needle and thread grass

Lolium	*perenne* L. ssp. *multiflorum* (Lam.) Husnot	Italian ryegrass
Muhlenbergia[c]	*rigens* (Benth.) A.S. Hitchc.	deergrass
Phalaris[c]	*minor* Retz.	littleseed canarygrass
Poa[c] L.	spp.	bluegrass
Poa[c]	*secunda* J. Presl.	Sandberg bluegrass
NA	NA	graminoid (grass or grasslike)
NA	NA	grass, annual
NA	NA	grass, perennial

[a] Plants were named according to Jepson (Hickman 1993) and Munz and Keck (1970) when field data were collected, then checked with, or converted to, names shown in the PLANTS data base (USDA NRCS 2000), with the exception of species not in the PLANTS data base, and a few reclassified plants whose names in the PLANTS database could not be verified; in such cases, Munz and/or Jepson was the final authority.

[b] Primary growth habit as listed in PLANTS database—FIA often classifies plants as secondary growth habit according to definitions of trees and shrubs (i.e., *Arctostaphylos* spp. are sometimes tree size but are never tallied as a tree regardless of size and form).

[c] Identified on field plots.

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Metric Equivalents

When you know:	Multiply by:	To find:
Acres	0.405	Hectares
Fahrenheit	.5555(F- 32)	Celsius
Inches	2.54	Centimeters
Feet	.3048	Meters
Miles	1.609	Kilometers
Square miles	2.59	Square kilometers

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