

## Habitat Diversity

California's forests and rangelands contain a rich mix of plants and animals. Habitat diversity is the mix of different habitats and their distribution within a given area. Greater habitat diversity usually provides greater species diversity as different habitats support different species.

Descriptions of habitat diversity for this assessment cover a wide geographic scope of all of California's lands. Although the primary focus is forest and rangeland habitats, other ecosystems found within urban and agricultural lands, to the degree they influence forest and range conditions, are also discussed.

### Findings on land cover extent

Habitat diversity is assessed at the coarsest or broadest scale by classifying, mapping, and measuring the extent of the major land cover types in California. Land cover is a general term describing major vegetation life forms, natural features, or land uses. Measuring land cover helps determine the degree of ecosystem alteration at the coarsest scale.

Definitions of land cover classes used in this assessment are as follows:

**Conifer Forest:** lands with greater than ten percent of the overstory canopy occupied by trees of which 50 percent or more are conifers. Conifer Forests are generally located in higher elevation mountainous areas and have commonly recognized evergreen tree species such as ponderosa pine (*Pinus ponderosa*) or redwood (*Sequoia sempervirens*).

**Conifer Woodland:** lands with greater than ten percent of the overstory canopy occupied by trees of which 50 percent or more are conifers. Conifer Woodlands are generally located on the east side of the Sierra Nevada mountains and the southern regions of the state. These woodlands are generally dominated by small, brushy trees species such as California juniper (*Juniperus californica*) or pinyon pine (*Pinus edulis*).

**Hardwood Forest:** lands with greater than ten percent of the overstory canopy occupied by trees of which 50 percent or more are hardwood trees such as black oak (*Quercus kelloggii*), canyon live oak (*Quercus chrysolepis*), tanoak (*Lithocarpus densiflorus*) and madrone (*Arbutus menziesii*). Hardwood Forests are usually located in the mountainous elevations above the Woodlands and are often associated with Conifer Forest tree species.



Redwood forest in northwest California.



Shrub land cover with less than ten percent hardwood cover in the Sierra Nevada Mountains.

**Hardwood Woodland:** lands with greater than 10 percent of the overstory canopy occupied by trees of which 50 percent or more are hardwood trees. Hardwood Woodlands are very extensive throughout California and are found in many different lower elevation mountainous areas with both evergreen and deciduous tree species. In the Sierra Nevada range, tree species typically include blue oak (*Quercus douglasii*) and interior live oak (*Quercus wislizenii*). In the northern coastal ranges, tree species include black oak (*Quercus kelloggii*), and canyon live oak (*Quercus chrysolepis*). In the mid to southern coast range species include coast live oak (*Quercus agrifolia*) and California bay (*Umbrellula californica*) and further south, Englemann oak (*Quercus englemannii*). Typical understory is composed of extensive annual grass vegetation.

**Shrub:** lands with shrub canopy cover greater than 10 percent and less than 10 percent tree cover.

**Grassland (herbaceous):** lands with greater than two percent grass cover and less than 10 percent shrub or tree cover.

**Desert Shrub:** shrub vegetation in arid portions of the State, with greater than two percent vegetation. Vegetation is open with scattered assemblages of a wide variety of shrub species.

**Desert Woodland:** tree vegetation in arid portions of the State, with greater than two percent ground cover and the presence of desert tree species such Joshua tree (*Yucca brevifolia*) and California fan palm (*Washingtonia filifera*).

**Water:** areas with greater than 98 percent of the surface in open water.

**Wetland:** aquatic, water dominated areas with greater than two percent vegetation and less than 10 percent shrub or tree cover.

**Urban:** lands averaging at least one house per acre, or developed for commercial, transportation, or industrial land uses.

**Agriculture:** irrigated lands defined by the Farmland Mapping and Monitoring Program (California Department of Conservation) which have the productivity capable of supporting cash crops.

**Barren:** lands with less than two percent vegetative cover.

Forests and rangelands cover approximately 80 percent of California. The term “forest and rangeland” includes nearly all lands except urban, irrigated agriculture, barren, and water. Conifer Forest and Woodlands, Hardwood Forest and Woodland, Shrub, Grassland, Desert Shrub and Woodland, and Wetland cover contain forests and rangelands. Conifer Forest and Desert Shrub are the two largest land cover classes, covering nearly 43 percent of California and are predominantly in public ownership (Table 1).

Table 1. Area of land cover classes by major ownership (thousand acres)

Land cover	Private	USFS	BLM	NPS	Other public	Total
Conifer Forest	6,432	10,644	394	1,108	426	19,004
Conifer Woodland	458	1,051	482	220	151	2,363
Hardwood Forest	2,901	1,287	176	134	193	4,691
Hardwood Woodland	4,292	310	239	36	309	5,188
Shrub	5,433	5,673	2,261	319	878	14,565
Grassland	9,621	233	496	43	526	10,919
Desert Shrub	4,272	197	10,216	4,659	4,117	23,641
Desert Woodland	27	3	37	18	2	87
Wetland	334	69	12	22	103	540
Agriculture	11,201	4	42	(L)	174	11,421
Barren	229	918	203	680	254	2,283
Urban	4,606	17	29	8	250	4,909
Water						1,486
<b>Total</b>	<b>49,805</b>	<b>20,406</b>	<b>14,587</b>	<b>7,247</b>	<b>7,384</b>	<b>100,915</b>

BLM – U.S. Bureau of Land Management; (L) – less than 500 acres; NPS – National Park Service; USFS – U.S. Forest Service

Source: Fire and Resource Assessment Program (FRAP), 1999; FRAP, 2002b

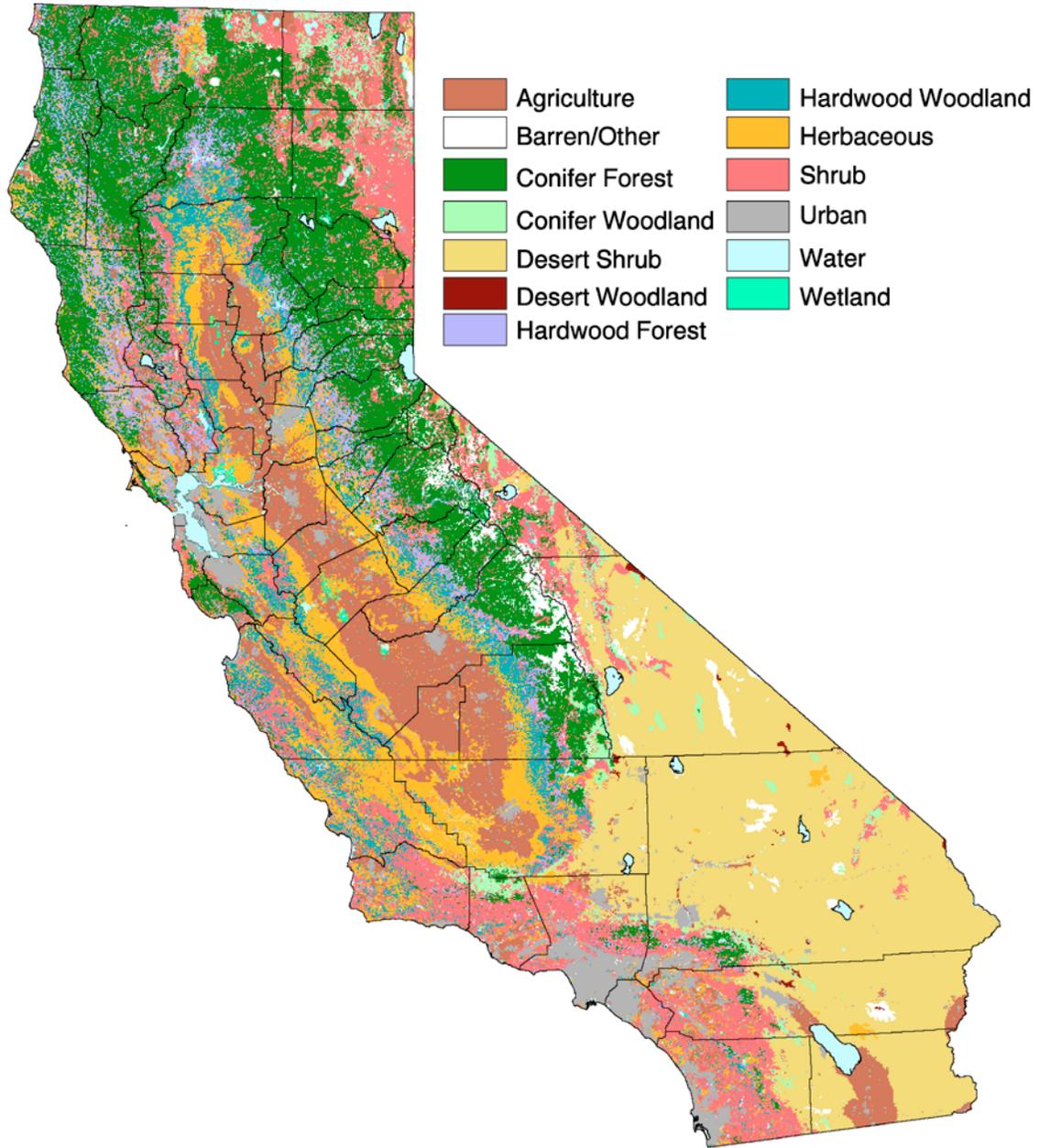
Maps of extent of land cover and habitat types provide the basis for many assessment analyses (Figure 1). The complete FRAP map product can be viewed and downloaded at [Land cover map](#).

The forest and rangeland land covers of the state are an aggregation of habitats. Of the 59 habitats in the California Wildlife Habitat Relationships (CWHR) system, 42 of these habitat types (Table 2) are considered forest and rangeland. Of all habitats found in the State, Desert Scrub (19 percent) and Annual Grassland (11 percent) are the most extensive, while Palm Oasis, Aspen (see sidebar: Aspen in California), and Perennial Grassland are the most rare (less than one percent). Detailed tables of habitat information by owner and by county can be found at [Habitat types: county-state](#).



Blue Oak Woodland habitat in the Sierra Nevada foothills.

Figure 1. Land Cover of California



Source: FRAP, 2002b

Table 2. Area of forest and rangeland California Wildlife Habitat Relationship types by owner (thousand acres)

Habitats	Private	USFS	BLM	NPS	Other Public	Total
<b>Conifer Forest</b>						
Closed-Cone Pine-Cypress	56	50	25	12	11	155
Douglas Fir	1,323	1,726	163	21	102	3,335
Eastside Pine	443	929	40	(L)	8	1,420
Jeffrey Pine	38	409	8	109	6	570
Klamath Mixed Conifer	340	1,011	16	9	6	1,381
Lodgepole Pine	35	310	(L)	245	1	591
Montane Hardwood-Conifer	723	801	41	11	49	1,626
Ponderosa Pine	424	369	38	62	13	906
Red Fir	117	998	(L)	296	2	1,414
Redwood	1,079	5	1	45	167	1,297
Sierran Mixed Conifer	1,598	2,912	48	131	44	4,734
Subalpine Conifer	17	495	6	121	4	642
White Fir	153	628	2	38	4	826
Unclassified Conifer	85	1	6	6	10	107
Total	6,432	10,644	394	1,108	426	19,004
<b>Conifer Woodland</b>						
Juniper	339	317	234	66	59	1,015
Pinyon-Juniper	119	734	249	154	92	1,348
Total	458	1,051	482	220	151	2,363
<b>Hardwood Woodland</b>						
Blue Oak-Foothill Pine	754	39	121	17	49	979
Blue Oak Woodland	2,457	129	104	9	120	2,819
Coastal Oak Woodland	832	138	12	8	104	1,095
Eucalyptus	9	(L)	(L)	(L)	1	11
Valley Foothill Riparian	114	4	2	1	27	147
Valley Oak Woodland	126	1	2	(L)	9	137
Total	4,292	310	239	36	309	5,188
<b>Hardwood Forest</b>						
Aspen	3	32	1	2	1	40
Montane Hardwood	2,797	1,215	174	89	165	4,439
Montane Riparian	100	40	1	43	27	211
Total	2,901	1,287	176	134	193	4,691
<b>Shrub</b>						
Alpine Dwarf Shrub	1	201	(L)	18	(L)	219
Bitterbrush	81	162	25	26	5	299
Chamise-Redshank Chaparral	671	399	187	12	114	1,383
Coastal Scrub	1,175	218	74	28	235	1,730
Low Sagebrush	19	151	48	1	11	230
Mixed Chaparral	1,813	2,152	457	16	301	4,739
Montane Chaparral	369	1,032	23	43	14	1,481
Sagebrush	880	1,347	1,407	168	174	3,976
Unclassified Shrub	426	12	40	8	24	509
Total	5,433	5,673	2,261	319	878	14,565
<b>Grassland</b>						
Annual Grassland	9,592	233	496	38	494	10,852
Perennial Grassland	30	(L)	(L)	4	32	67
Total	9,621	233	496	43	526	10,919
<b>Desert Shrub</b>						
Alkali Desert Scrub	630	70	1,184	470	648	3,003
Desert Riparian	15		18	3	11	47
Desert Scrub	3,348	126	8,326	4,136	3,099	19,036
Desert Succulent Shrub	115		216	17	156	503
Desert Wash	164	(L)	471	33	204	872
Total	4,272	197	10,216	4,659	4,117	23,461
<b>Desert Woodland</b>						
Joshua Tree	27	3	34	18	2	84
Palm Oasis	(L)		3		(L)	3
Total	27	3	37	18	2	87
<b>Wetland</b>						
Wet Meadow	145	69	11	20	23	268
<b>TOTAL</b>	<b>33,582</b>	<b>19,468</b>	<b>14,312</b>	<b>6,558</b>	<b>6,626</b>	<b>80,545</b>

BLM – U.S. Bureau of Land Management; (L) – Less than 500 acres; NPS – National Park Service; USFS – U.S. Forest Service

Totals may not add due to rounding

Source: FRAP, 1999; FRAP, 2002b

**Aspen in California—assessment and management:** There has been increased interest in aspen (*Populus tremuloides*) management in California given the recent emphasis of land managers and policy makers to protect and manage California's biological diversity. Researchers in the Sierra Nevada and in the intermountain west studying plant and animal associations in aspen habitats concur that the unique value of aspen habitats warrant active management (e.g., DeByle and Winokur, 1985; Loft et al., 1987; Potter, 1998; Burton, 2000; Shepperd, 2001).



*Aspen stand in the Sierra Nevada.*

In California, quaking aspen ranges from the Siskiyou and Warner Mountains southward along both sides of the Sierra Nevada. East of the Sierra Nevada crest, aspen occurs in the Carson and Monitor Ranges and the Sweetwater and White Mountains. South of the Sierra Nevada, a few stands occur in the San Bernardino Mountains. According to partially completed U.S. Forest Service inventories conducted through the range of aspen habitat in California, aspen stands average less than five acres in size (Burton, 2000). However, larger stands are present; for example, one stand over 300 acres in area exists near Carson Pass. Other mapping efforts to identify aspen are ongoing. The

Department of Fish and Game and the U.S. Forest Service are focusing on mapping small patches of deciduous plants and identifying historic aspen distribution using decades-old aerial photography.

Extensive studies of aspen regeneration have addressed the importance of reducing grazing pressures by domestic livestock and wild ungulates as well as the reintroduction of disturbance event (fire) to foster regeneration (DeByle and Winokur, 1985). Because the principal means of aspen reproduction is vegetative—clones generating suckers off lateral roots (DeByle, 1985; DeByle and Winokur, 1985)—and because aspen is shade intolerant, resource managers have focused on issues of sucker regeneration and conifer encroachment. Resource managers and researchers are continuing to study impacts to aspen health including the following: 1) historic and current fire regime influence on conifer encroachment; 2) historic and current grazing regime effects on suckering success; and 3) stand treatment options.

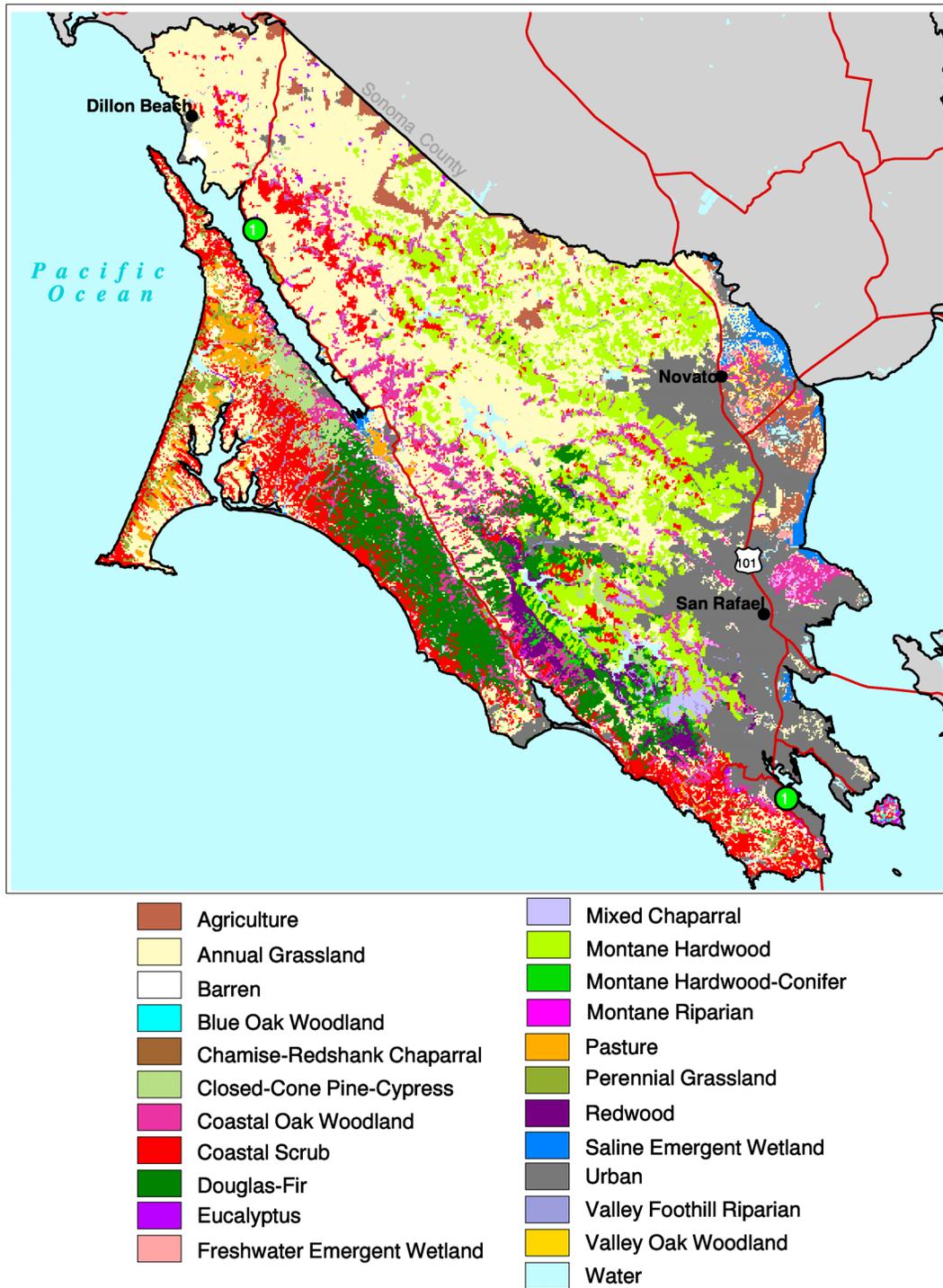
The direction that the U.S. Forest Service, Bureau of Land Management, and other governmental agencies take as they develop and implement management plans may greatly affect the health, diversity, size, and significance of aspen habitats in California. Agency resource managers have begun to prescribe a number of treatment options for aspen. These include prescribed fire, removal of competing vegetation, protection of regeneration from herbivores, and mechanical root stimulation (Shepperd, 2001). Sustaining aspen stands will enhance biological diversity, improve wildlife habitat, and help reduce extreme fire behavior events (Barrows et al., 1976; DeByle, 1985; DeByle and Winokur, 1985).

*Contributed by David Burton, Eldorado National Forest*

Spatial location data of specific California habitats are crucial for assessing wildlife species distribution and habitat value. For example, spatial modeling permits analysis of the distribution and extent of one habitat type relative to another, degree of habitat fragmentation, and level of wildlife use. Habitat location and wildlife use data provides for an analysis of treats and effect on habitat condition from disturbance that would come from urbanization fire or exotic plant invasion. Maps of forest and rangeland habitats are available at [Interactive habitat map](#).

For example, Marin County in the northern San Francisco Bay Area supports a rich mixture of Coastal Oak Woodland, Coastal Scrub, and Redwood habitats adjacent to Urban and Water land covers (Figure 2). A complete FRAP map product can be viewed and downloaded for each county at [County habitat maps](#).

Figure 2. Marin County habitat distribution



Source: FRAP, 2002b

### Findings on habitat stages of California's forests

The California Wildlife Habitat Relationship (CWHR) system identifies habitat stages important to wildlife. Habitat stages are descriptions of vegetation condition and include measures such as tree size and canopy closure for forest and woodland types. These measures allow a more informed picture of habitat conditions by relating vegetation condition to species' breeding, feeding, and cover requirements.

California Conifer Forests support a range of tree sizes and levels of canopy closure (Table 3, Figure 3). Size class is defined by the average tree diameter at breast height (DBH). Canopy closure (CC) is defined by the horizontal area that trees cover when viewed from above.



*Small canopy closure forest.*

Table 3. Percentage area of Conifer Forest by tree size and canopy closure

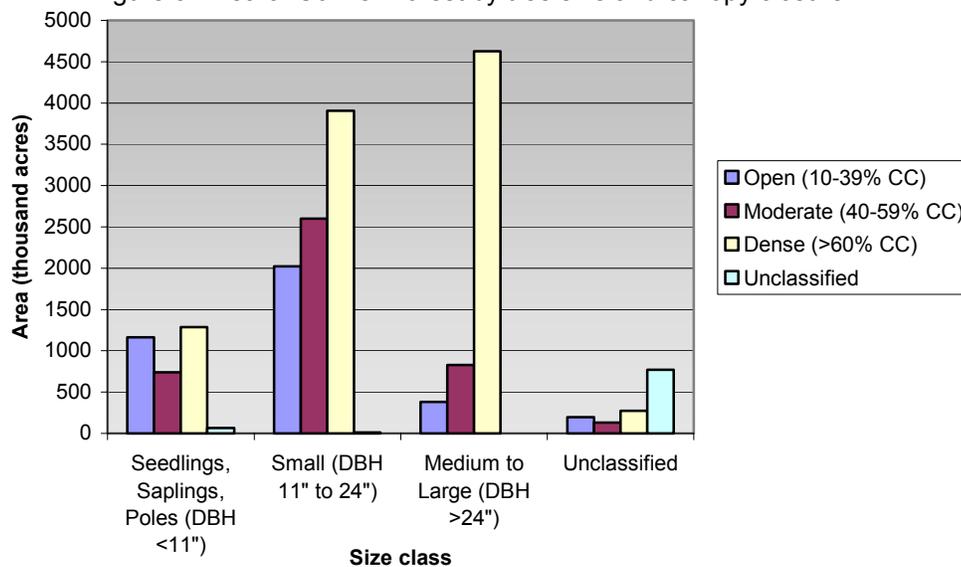
Canopy closure	Seedlings and Saplings <10" dbh	Small trees 11" to 24" dbh	Medium to large trees >24" dbh	Unclassified	Total
Open (10-39% CC)	6	11	2	1	20
Moderate (40-59% CC)	4	14	4	1	23
Dense (>60% CC)	7	21	24	1	53
Unclassified	<1	<1	<1	4	5
Total	17	45	31	7	100

CC – canopy closure; DBH – diameter at breast height (4.5'); <1 – less than one percent

Note: totals may not add due to rounding

Source: FRAP, 2002b

Figure 3. Area of Conifer Forest by tree size and canopy closure



Source: FRAP, 2002b

Two dominant characteristics of California’s Conifer Forest are the prevalence of smaller size trees and very dense forest stands. Forty-five percent of the Conifer Forest in California is found in the 11-24 inch size class. In terms of canopy closure, 53 percent of Conifer Forest is classified as having dense canopy closure (greater than 60 percent closure).

*Fifty three percent of the State’s Conifer Forest acreage exceeds 60 percent canopy closure.*

Although small size trees are a prominent characteristic of Conifer Forest in California, medium to large size trees (greater than 24 inch DBH) are also quite abundant. Thirty one percent of the State’s Conifer Forest is classified as medium to large. Additionally, medium to large with dense canopy closure is the most abundant combined size and canopy closure class covering 24 percent of the State’s Conifer Forest.

Hardwood Forest and Woodland size and canopy closure patterns illustrate a greater tendency towards stands with smaller tree sizes and more open canopy cover than Conifer Forests (Figure 4, Table 4). Nearly 64 percent of the Hardwood Forest and Woodland in the State have stands with average tree sizes of less than 11 inches DBH. Twenty six percent of Hardwood Forests and Woodlands are open stands.

Table 4. Percentage area of Hardwood Forest and Woodland by tree size and canopy closure

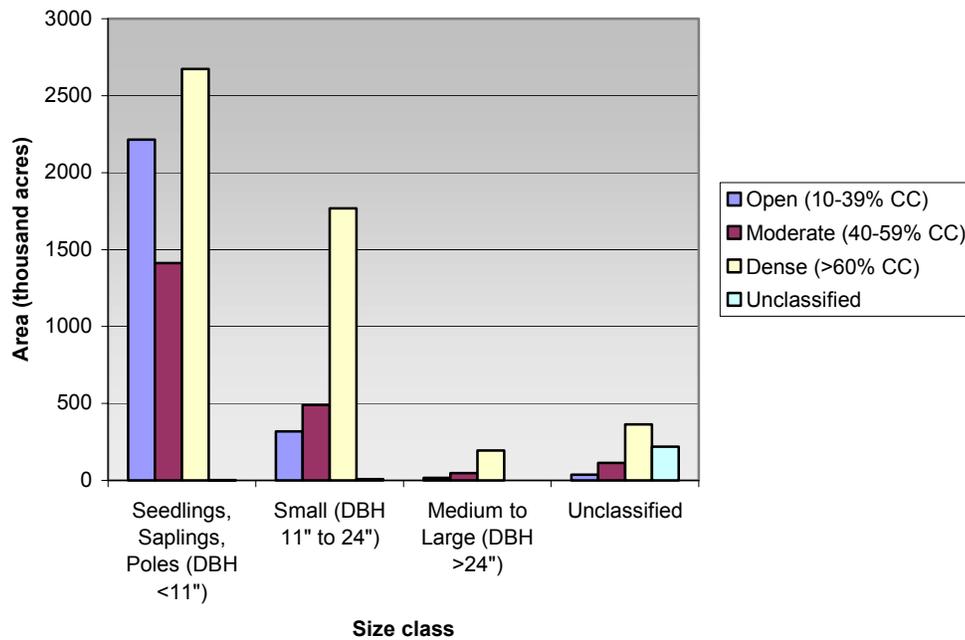
<b>Canopy closure</b>	<b>Seedlings and saplings &lt;11” DBH</b>	<b>Small trees 11-24” DBH</b>	<b>Medium to large trees &gt;24” DBH</b>	<b>Unclassified</b>	<b>Total</b>
Open (10-39% CC)	22	3	<1	<1	26
Moderate (40-59% CC)	14	5	<1	1	21
Dense (>60% CC)	27	18	2	4	51
Unclassified	<1	<1	<1	2	2
<b>Total</b>	<b>64</b>	<b>26</b>	<b>3</b>	<b>7</b>	<b>100</b>

*DBH – diameter at breast height (4.5’); <1 – less than one*

*Note: totals may not add due to rounding*

*Source: FRAP, 2002b*

Figure 4. Area of Hardwood Forest and Woodland by tree size and canopy closure



Source: FRAP, 2002b

Each conifer and hardwood habitat has a size and canopy closure profile. Specific information for habitat stages by bioregion, county and/or ownership is at [Custom Query](#).

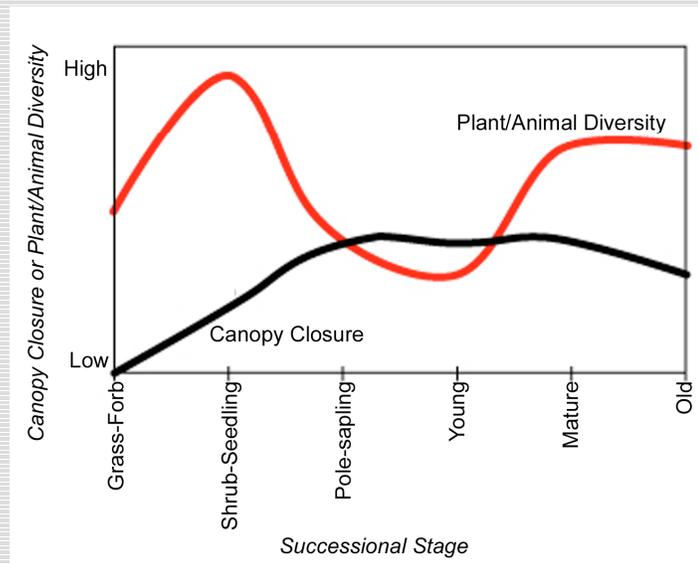
**Effect of tree size and canopy cover on vertebrate species richness and habitat value:** In recent decades, some of the most contentious forest management issues have been associated with the amount and distribution of forest conditions (Centers for Water and Wildland Resources, 1996). The amount of large, old forests (late successional or old growth) has been the most notable issue. However, reductions of early successional forests due to management practices such as fire suppression and limited timber management are also a concern. These management actions, along with natural growth and development of forests, have likely contributed to an increase in dense, younger tree canopies and a loss of understory (herbaceous and shrub) vegetation. Forest composition and structure that emphasize dense, young tree canopies has a negative effect on plant and animal species diversity when compared to early and late stages of forest succession or development (Figure 5).

Loft and Smith (2000) used the California Wildlife Habitat Relationships System to examine the relative species richness and habitat value of forest development and forest canopy cover for 13 habitat types found in the Sierra Nevada. They found that in all five conifer habitats and for each tree size class, CWHR predicted species richness to be greatest in open and sparse canopy condition (less than 40 percent cover). Habitat value (ability of habitat to support species) was highest when canopy cover was less than 60 percent in all size classes.

Hardwood types showed results similar to the conifer types except both species richness and habitat value were highest in open and sparse canopy conditions (less than 40 percent cover). Shrub and montane riparian types also showed the highest levels of species richness and habitat value in open and sparse canopy conditions and lowest in dense (greater than 60 percent canopy cover) canopy stages.

The possible decline in early successional forest habitats with open and sparse canopies may ultimately affect the conservation of terrestrial vertebrate biodiversity. The decline in extent of this land condition and sustainability of herbivores like deer and use by domestic cattle has already been extensively documented. Similarly, the number of species breeding in shrublands and showing a measurable decline in population increased from four (1969-1979) to eight (1980-1999). These trends are also likely for other early successional species that are not as closely monitored for change in population status.

Figure 5. Relationship between successional stage and plant and animal diversity



Source: Loft and Smith, 2000