Mediterranean California Ecoregions

Status and Trends of Land Change in the Western United States—1973 to 2000
Edited by Benjamin M. Sleeter, Tamara S. Wilson, and William Acevedo
U.S. Geological Survey Professional Paper 1794–A, 2012

Chapter 17

Central California Valley Ecoregion

By Benjamin M. Sleeter

Ecoregion Description

The Central California Valley Ecoregion, which covers approximately 45,983 km^2 (17,754 mi^2), is an elongated basin extending approximately 650 km north to south through central California (fig. 1) (Omernik, 1987; U.S. Environmental Protection Agency, 1997). The ecoregion is surrounded entirely by the Southern and Central California Chaparral and Oak Woodlands Ecoregion, which includes parts of the Coast Ranges to the west and which is bounded by the Sierra Nevada to the east. The Central California Valley Ecoregion accounts for more than half of California's agricultural production value and is one of the most important agricultural regions in the country, with flat terrain, fertile soils, a favorable climate, and nearly 70 percent of its land in cultivation (Kuminoff and others, 2000; Sumner and others, 2003). Commodities produced in the region include milk and dairy, cattle and calves, cotton, almonds, citrus, and grapes, among others (U.S. Department of Agriculture, 2004; Johnston and McCalla, 2004; Kuminoff and others, 2000) (figs. 2*A,B,C*). Six of the top eight agricultural-producing counties in California are located at least partly within the Central California Valley Ecoregion (Kuminoff and others, 2000) (table 1). The Central California Valley Ecoregion is also home to nearly 5 million people spread throughout the region, including the major cities of Sacramento (state capital), Fresno, Bakersfield, and Stockton, California (U.S. Census Bureau, 2000) (fig. 1).

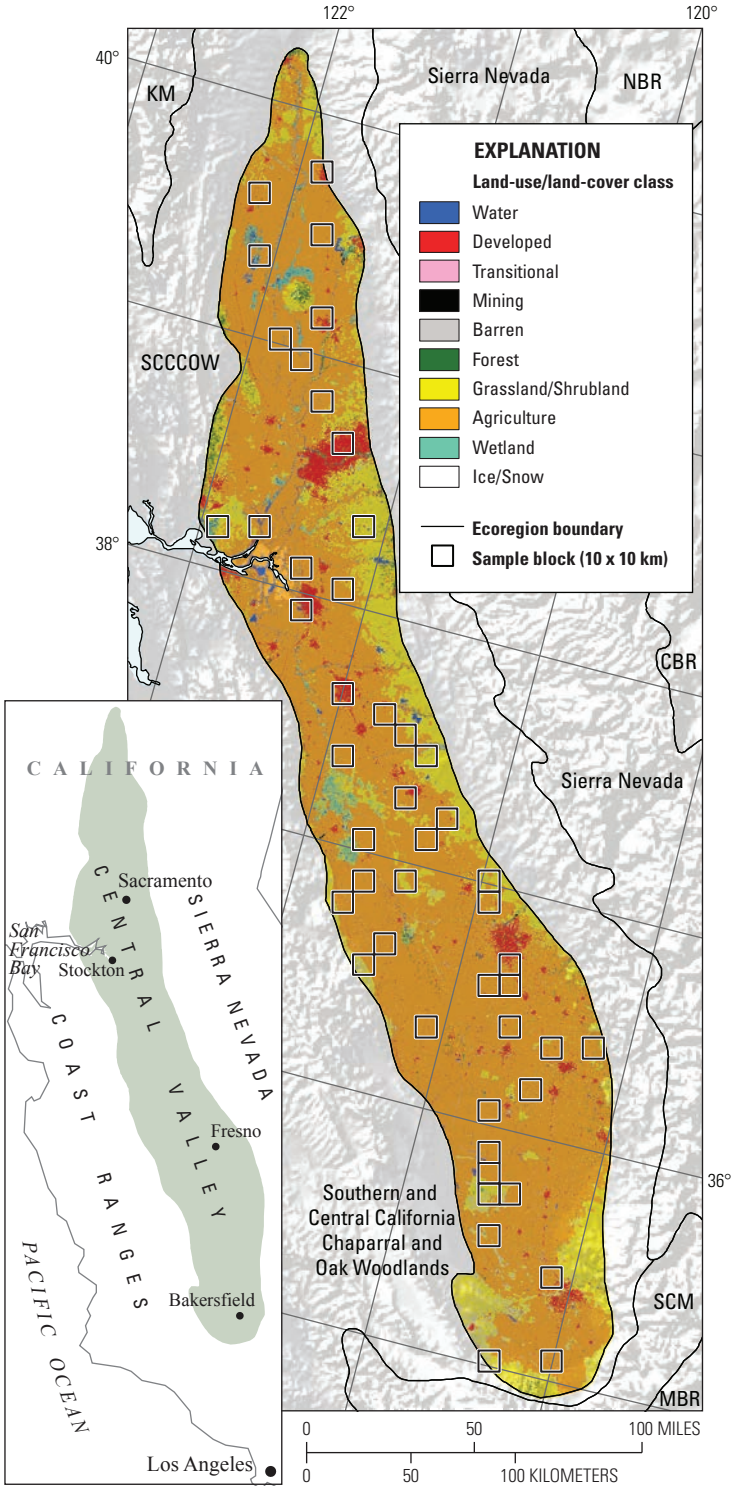

Figure 1. Map of Central California Valley Ecoregion and surrounding ecoregions, showing land-use/land-cover classes from 1992 National Land Cover Dataset (Vogelmann and others, 2001); note that not all land-use/land-cover classes shown in explanation may be depicted on map; note also that, for this "Status and Trends of Land Change" study, transitional land-cover class was subdivided into mechanically disturbed and nonmechanically disturbed classes. Squares indicate locations of 10 x 10 km sample blocks analyzed in study. Index map shows locations of geographic features mentioned in text. Abbreviations for Western United States ecoregions are listed in appendix 2. See appendix 3 for definitions of land-use/land-cover classifications.

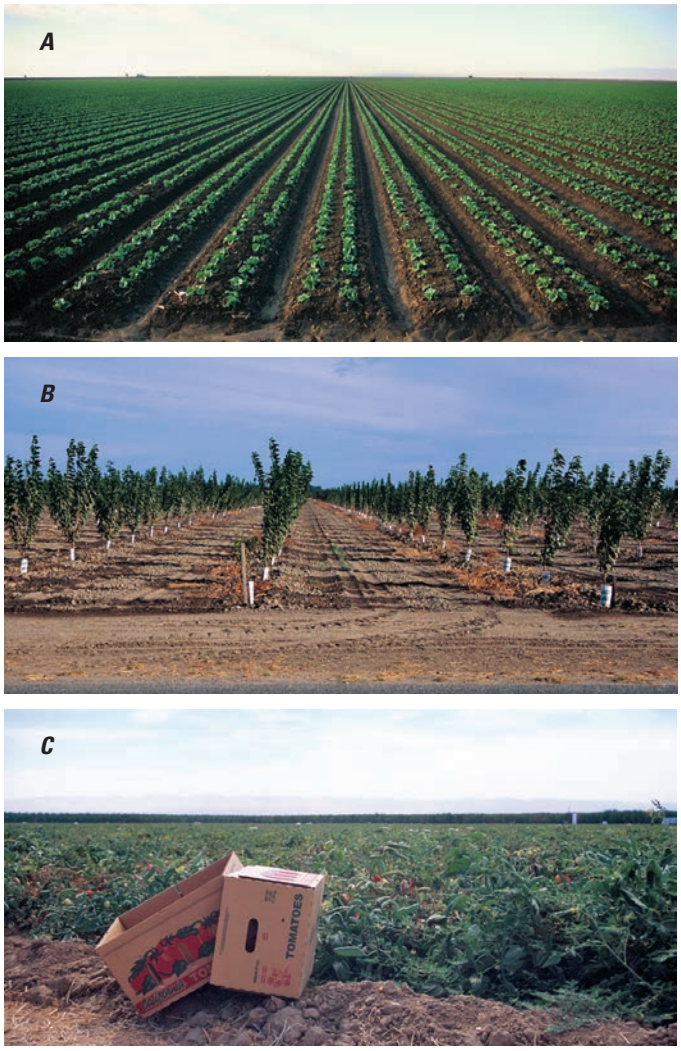

Figure 2. Agriculture in Central California Valley Ecoregion. *A*, Newly planted field. *B*, Young orchard. *C*, Tomato field.

Contemporary Land-Cover Change (1973 to 2000)

The overall spatial change in the Central California Valley Ecoregion (the percentage of area that changed at least one time between 1973 and 2000) was estimated at 12.9 percent (±3.1 percent at 85-percent confidence level) (table 2). Compared to other western ecoregions, change in the Central California Valley Ecoregion was above average (fig. 3). Total estimated change was highest in the first time period (1973–1980), when 5.7 percent of the ecoregion changed from one land cover to another (table 3). When change estimates are normalized to account for the varying lengths of the time periods, change is also highest in the first time period (at 0.8 percent per year) and then constant for the following three time periods at just greater than 0.5 percent per year (fig. 4).

The largest change in any one land-cover class between 1973 and 2000 was the loss of 1,782 km^2 of grassland/shrubland (20.2 percent of the area it occupied in 1973, table 4). The second largest change was the addition of 1,129 km^2 of developed land cover (an increase of 37.7 percent), increasing from 6.5 to 9.0 percent of the ecoregion area. Agricultural lands, which accounted for more than 70 percent of the Central California Valley Ecoregion, remained relatively stable throughout the study period with a net increase of 358 km^2 (1.1 percent increase). Estimates of percent cover for all land-cover classes by time period are found in table 4, and estimates of average annual change by class are found in figure 5.

The dominant land-cover conversion that occurred in the Central California Valley Ecoregion was from grassland/shrubland to agriculture. This conversion was most common near the ecoregion boundary (fig. 6), because historically open grazing lands were brought into agricultural production to

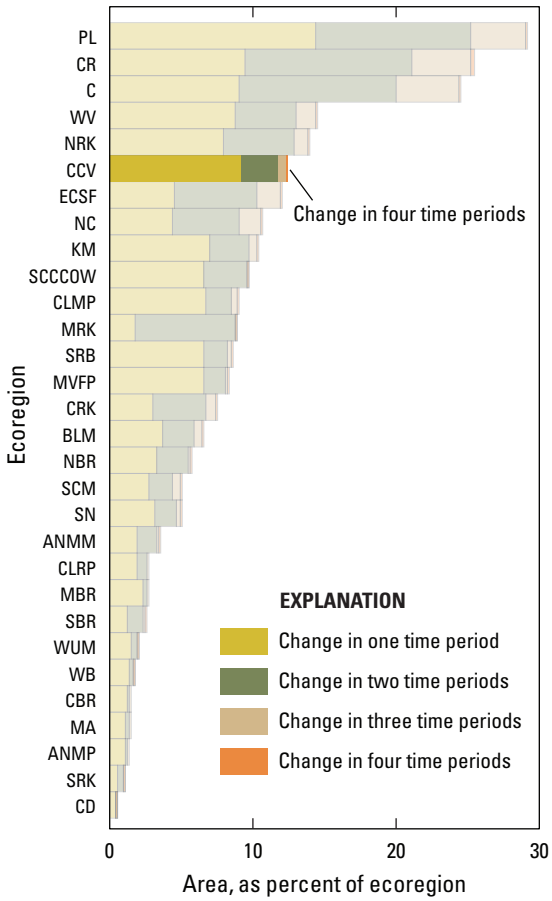

Figure 3. Overall spatial change in Central California Valley Ecoregion (CCV; darker bars) compared with that of all 30 Western United States ecoregions (lighter bars). Each horizontal set of bars shows proportions of ecoregion that changed during one, two, three, or four time periods; highest level of spatial change in Central California Valley Ecoregion (four time periods) labeled for clarity. See table 3 for years covered by each time period. See appendix 2 for key to ecoregion abbreviations.

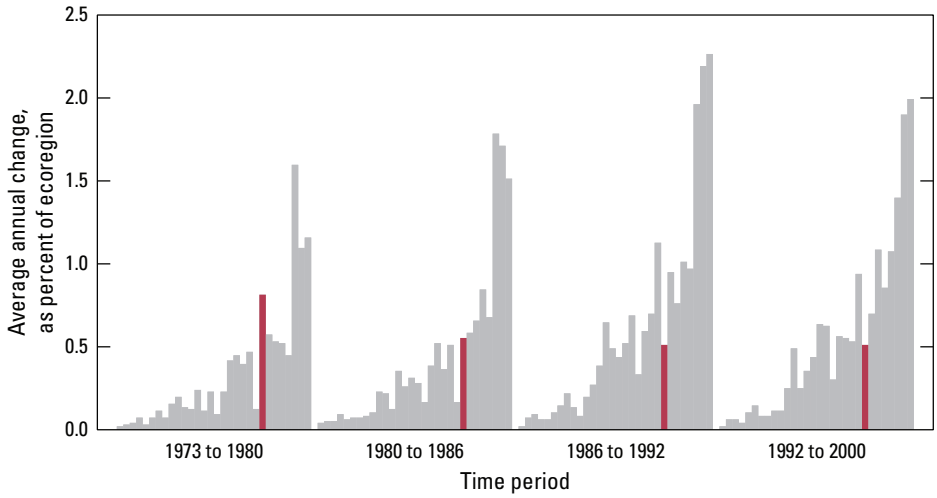

Figure 4. Estimates of land-cover change per time period, normalized to annual rates of change for all 30 Western United States ecoregions (gray bars). Estimates of change for Central California Valley Ecoregion are represented by red bars in each time period.

grow grapes, nut crops, and citrus. This change may also be attributed to the tilling cycle, when farmers allow parcels of land to revert to natural vegetation before eventually being returned to production. This particular conversion (grassland/shrubland to agriculture) accounted for 45.0 percent of all change in the ecoregion. The second most common conversion was from agriculture to grassland/shrubland (26.5 percent of all change). Again, a portion of this change can be attributed to the cycling of cropland into and out of production (fig. 7), although this conversion was also commonly observed at the edge of urban areas and new development. As urban areas expand, agricultural land is converted to developed land. In many instances, farmland converts to grassland/shrubland before being developed. The third and fourth most common conversions were from agriculture and grassland/shrubland to developed land (9.2 and 4.9 percent of ecoregion change, respectively). Combined, the top four conversions account for 88 percent of all land-cover change in the Central California Valley Ecoregion between 1973 and 2000. A detailed description of the most common land-cover conversions for the Central California Valley Ecoregion is found in table 5.

A major driver of change in the ecoregion is population growth. Population growth in the San Francisco Bay area and Los Angeles, as well as in the Central Valley itself, has resulted in a high demand for land for urban uses (figs. 8*A*,*B*). Within the ecoregion, as new development adjacent to existing urban areas converts agricultural land to homes, businesses, and other urban uses, farms are relocating to the ecoregion periphery and then converting traditional grazing lands (grassland/shrubland) into new agricultural uses. Annual climatic variability may also play a role in the conversion rates and, more importantly, in the types of land-cover conversions that occurred in the ecoregion. In all but the 1986 to 1992 period, the leading conversion was from grassland/shrubland

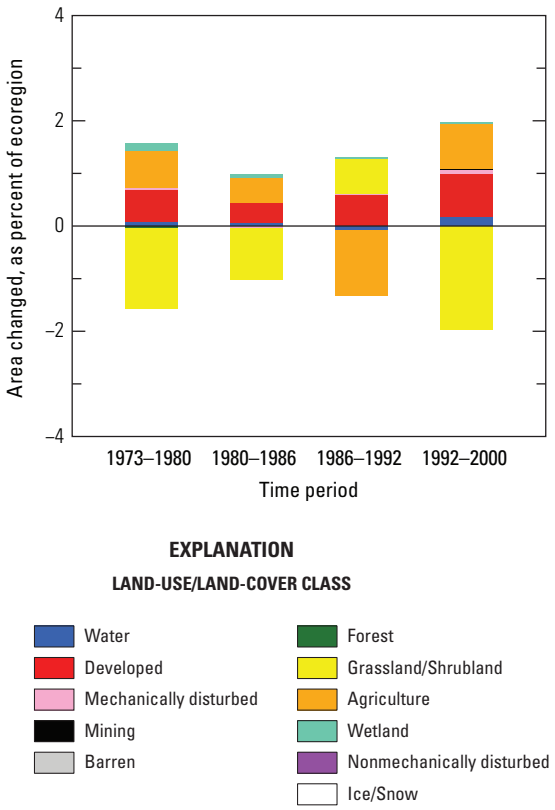

Figure 5. Normalized average net change in Central California Valley Ecoregion by time period for each land-cover class. Bars above zero axis represent net gain, whereas bars below zero represent net loss. Note that not all land-cover classes shown in explanation may be represented in figure. See appendix 3 for definitions of land-use/land-cover classifications.

Figure 6. New asparagus fields planted along Central California Valley Ecoregion boundary.

Figure 7. Abandoned agricultural field near Kern National Wildlife Refuge, Kern County, California.

Figure 8. Development in Central California Valley Ecoregion. *A*, New home construction. *B*, New subdivision for-sale signs in a Fresno, California, suburb.

to agriculture, and the second most common conversion was from agriculture to grassland/shrubland. This pattern was reversed during the 1986 to 1992 period, which also corresponded to a period of prolonged drought in California. During this period, irrigation-water-supply (figs. 9*A,B*) shortages coupled with increased cost and conservation efforts led to decreased production in some of the Central California Valley's primary crops, such as cotton and rice (U.S. Department of Agriculture, 1991). In response to the reduced surface-water supplies, producers who normally relied on irrigation increased groundwater usage, idled some land, sought to minimize waste, and shifted water to the production of higher value crops (U.S. Department of Agriculture, 1991). In 1991, conservation efforts alone resulted in widespread declines in irrigated lands, including 56,500 acres of corn, 36,000 acres of wheat, 12,600 acres of pasture, 9,200 acres of alfalfa, and

Figure 9. Irrigation systems in Central California Valley Ecoregion. *A*, Section of Delta-Mendota Canal, which runs 188 km through ecoregion. *B*, Single-field irrigation ditch.

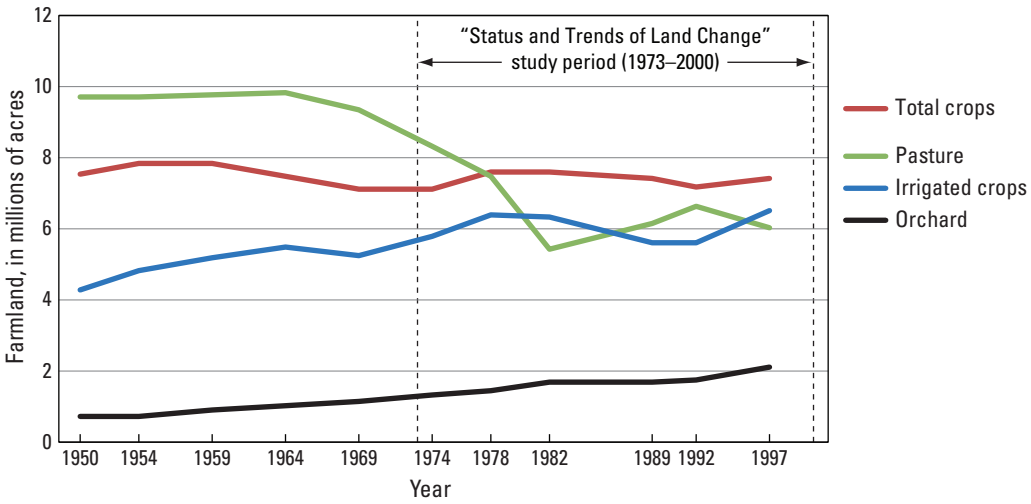

Figure 10. Changes in California agriculture (total crops, irrigated crops, pasture, and orchards) between 1950 and 1997 (U.S. Department of Agriculture, 2004).

9,100 acres of sugar beets, while surface water shortages resulted in an estimated 14-percent decrease in cotton production and a 23-percent decrease in rice production (U.S. Department of Agriculture, 1991).

The loss of farmland to urban uses is often assumed to be the single greatest threat to the Central California Valley Ecoregion (Hart, 2003). While significant amounts of high quality farmland are being converted to permanent urban uses (an estimated 684 km^2 between 1973 and 2000), agriculture is evolving and, in fact, increasing in scale (Hart, 2003; Johnston and McCalla, 2004; Sleeter, 2008). Farmers continue to make use of advances in irrigation technologies, such as drip systems, in an effort to cultivate lands once considered marginal for traditional crops (Charbonneau and Kondolf, 1993). Central California Valley Ecoregion agriculture continues its adaptation through investments in higher value, higher risk crops, such as almonds and grapes, instead of traditional field crops, such as alfalfa and grains (U.S. Department of Agriculture, 2004; Johnston and McCalla, 2004) (fig. 10). This is possible because these higher value crops can be successfully cultivated on slopes at the ecoregion periphery and on soils of significantly lower quality than those found on the fertile valley floor.

California has led the nation in agricultural cash receipts in every year since 1948 and, in 1999, recorded nearly $25 billion; California farmers have increased their national share from 9.5 percent in 1960 to 13.1 percent in 1999 (Kuminoff and others, 2000). For comparison, Australia and Canada each had approximately $18.5 billion in agricultural cash receipts in 1999 (Kuminoff and others, 2000). Due to the ecoregion's economic importance, consequences of land-cover change are a significant concern at multiple scales and will require detailed analysis. As California's population continues to increase, additional demands will be placed on the Central California Valley Ecoregion to support people and the agricultural complex they depend on, which will result in the continued evolution of the nation's most diverse agricultural region.

Table 1. Gross value of agricultural production in 1999 by county in Central California Valley Ecoregion (California Agricultural Statistics Service, 2001; modified from Kuminoff and others, 2000).

California county rank (1999)	County[1]	Value of production[2] (millions of dollars)	Top commodities[3]
1	Fresno	3,559	Grapes, Poultry, Cotton, Tomatoes, Milk
2	Tulare	3,075	Milk, Grapes, Navel and Valencia Oranges, Cattle and Calves, Plums
4	Kern	2,128	Grapes, Cotton and Processed Cottonseed, Citrus, Milk, Almonds and By-Products
5	Merced	1,534	Milk, Chickens, Almonds, Tomatoes, Cotton
6	San Joaquin	1,352	Grapes, Milk, Tomatoes, Cherries, Almond Meats
8	Stanislaus	1,210	Milk, Almonds, Chickens, Cattle and Calves, Tomatoes
12	Kings	901	Milk, Cotton, Cattle and Calves, Turkeys, Alfalfa Hay
14	Madera	700	Grapes, Milk, Almonds, Pistachios, Nursery Stock
18	Colusa	351	Rice, Processing Tomatoes, Almond Meats, Cucumber Seed, Rice Seed
19	Sutter	347	Rice, Prunes, Peaches, Tomatoes, Walnuts
21	Yolo	339	Processing Tomatoes, Winegrapes, Seed Crops, Rice, Alfalfa
22	Sacramento	293	Winegrapes, Milk, Bartlett Pears, Processing Tomatoes, Ornamental Nursery Stock
23	Butte	257	Milling Rice, Almonds, Prunes, Walnuts, Kiwifruit
24	Glenn	253	Rice Paddy, Dairy Products, Almonds, Prunes, Cattle and Calves
28	Solano	195	Processing Tomatoes, Nursery Stock, Alfalfa Hay, Winegrapes, Cattle and Calves
34	Yuba	108	Rice, Peaches, Walnuts, Cattle and Calves, Prunes
35	Tehama	97	Cattle and Calves, Walnuts, Prunes, Milk, Olives
37	Contra Costa	86	Bedding Plants, All Milk, All Tomatoes, Grapes, Sweet Corn
39	Placer	58	Rice, Cattle and Calves, Nursery, Chickens, Pasture and Range, Walnuts
47	Amador	19	Winegrapes, Cattle and Calves, Pasture and Range, Grain Hay, Alfalfa Hay
49	Mariposa	18	Cattle and Calves, Range, Misc. Livestock/Poultry Products, All Poultry
51	Calaveras	15	Cattle and Calves, Winegrapes, Poultry, Livestock and Poultry Products, Walnuts

[1]Counties in California that intersect the boundary of Central California Valley Ecoregion (Omernik, 1987; U.S. Environmental Protection Agency, 1997).

[2]Gross value of production includes all farm production, whether sold into usual marketing channels or used on farm where produced.

[3]Information reported by agricultural commissioners of each county. Level of detail reported differs by county. For example, some may report grapes (table, raisin, and wine) as an aggregate category, whereas others may report them as distinct categories.

Table 2. Percentage of Central California Valley Ecoregion land cover that changed at least one time during study period (1973–2000) and associated statistical error.

[Most sample pixels remained unchanged (87.1 percent), whereas 12.9 percent changed at least once throughout study period]

Number of changes	Percent of ecoregion	Margin of error (+/– %)	Lower bound (%)	Upper bound (%)	Standard error (%)	Relative error (%)
1	9.7	2.0	7.7	11.7	1.4	14.4
2	2.4	1.1	1.3	3.6	0.8	31.7
3	0.7	0.3	0.4	0.9	0.2	26.7
4	0.1	0.0	0.0	0.1	0.0	48.8
Overall spatial change	12.9	3.1	9.7	16.0	2.1	16.6

Table 3. Raw estimates of change in Central California Valley Ecoregion land cover, computed for each of four time periods between 1973 and 2000, and associated error at 85-percent confidence level.

[Estimates of change per period normalized to annual rate of change for each period]

Period	Total change (% of ecoregion)	Margin of error (+/– %)	Lower bound (%)	Upper bound (%)	Standard error (%)	Relative error (%)	Average rate (% per year)
Estimate of change, in percent stratum							
1973–1980	5.7	1.4	4.3	7.1	1.0	17.1	0.8
1980–1986	3.3	0.8	2.4	4.1	0.6	17.6	0.5
1986–1992	3.0	1.2	1.8	4.3	0.8	27.5	0.5
1992–2000	4.1	1.3	2.7	5.4	0.9	22.4	0.5
Estimate of change, in square kilometers							
1973–1980	2,624	656	1,968	3,279	448	17.1	375
1980–1986	1,504	387	1,116	1,891	265	17.6	251
1986–1992	1,395	562	833	1,957	384	27.5	232
1992–2000	1,879	615	1,264	2,494	420	22.4	235

Table 4. Estimated area (and margin of error) of each land-cover class in Central California Valley Ecoregion, calculated five times between 1973 and 2000. See appendix 3 for definitions of land-cover classifications.

	Water		Developed		Mechanically disturbed		Mining		Barren		Forest		Grassland/ Shrubland		Agriculture		Wetland		Non-mechanically disturbed	
	%	+/–	%	+/–	%	+/–	%	+/–	%	+/–	%	+/–	%	+/–	%	+/–	%	+/–	%	+/–
Area, in percent stratum																				
1973	0.7	0.3	6.5	3.1	0.0	0.0	0.2	0.1	0.0	0.0	0.3	0.1	19.2	5.1	71.6	5.8	1.4	1.0	0.0	0.0
1980	0.7	0.3	7.2	3.4	0.1	0.0	0.2	0.1	0.0	0.0	0.3	0.1	17.7	4.9	72.3	5.7	1.6	1.1	0.0	0.0
1986	0.8	0.5	7.6	3.5	0.1	0.0	0.2	0.2	0.0	0.0	0.3	0.1	16.7	4.7	72.8	5.6	1.7	1.2	0.0	0.0
1992	0.7	0.3	8.2	3.7	0.1	0.1	0.2	0.2	0.0	0.0	0.3	0.1	17.3	5.0	71.5	5.8	1.7	1.2	0.0	0.0
2000	0.9	0.5	9.0	3.8	0.2	0.1	0.2	0.2	0.0	0.0	0.3	0.1	15.4	4.4	72.4	5.6	1.7	1.2	0.0	0.0
Net change	0.2	0.2	2.5	1.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	−3.9	1.9	0.8	2.3	0.3	0.5	0.0	0.0
Gross change	0.9	0.5	2.5	1.0	0.3	0.2	0.1	0.1	0.0	0.0	0.1	0.0	8.7	2.8	10.3	2.8	0.6	0.5	0.0	0.0
Area, in square kilometers																				
1973	300	146	2,996	1,446	17	14	80	65	2	2	156	64	8,841	2,359	32,934	2,678	658	464	0	0
1980	330	153	3,293	1,562	29	22	87	66	2	2	147	60	8,129	2,231	33,249	2,610	718	503	0	0
1986	359	209	3,475	1,611	24	16	86	69	2	3	146	60	7,671	2,160	33,457	2,560	761	539	0	0
1992	323	159	3,755	1,688	36	30	91	76	3	5	145	59	7,965	2,288	32,895	2,681	771	549	0	0
2000	413	217	4,124	1,751	74	39	96	82	2	3	142	58	7,060	2,044	33,292	2,564	780	564	0	0
Net change	112	101	1,129	455	57	37	16	18	0	0	−14	11	−1,782	860	358	1,039	122	214	0	0
Gross change	391	222	1,129	455	160	76	29	25	3	5	26	15	4,020	1,302	4,747	1,307	253	217	0	0

Table 5. Principal land-cover conversions in Central California Valley Ecoregion, showing amount of area changed (and margin of error, calculated at 85-percent confidence level) for each conversion during each of four time periods and also during overall study period. See appendix 3 for definitions of land-cover classifications.

[Values given for "other" class are combined totals of values for other land-cover classes not listed in that time period. Abbreviations: n/a, not applicable]

Period	From class	To class	Area changed (km^2)	Margin of error (+/– km^2)	Standard error (km^2)	Percent of ecoregion	Percent of all changes
1973–1980	Grassland/Shrubland	Agriculture	1,305	462	316	2.8	49.7
	Agriculture	Grassland/Shrubland	748	351	240	1.6	28.5
	Agriculture	Developed	177	94	64	0.4	6.7
	Grassland/Shrubland	Developed	106	75	51	0.2	4.0
	Agriculture	Wetland	71	92	63	0.2	2.7
	Other	Other	217	n/a	n/a	0.5	8.3
		Totals	2,624			5.7	100.0
1980–1986	Grassland/Shrubland	Agriculture	734	275	188	1.6	48.8
	Agriculture	Grassland/Shrubland	316	179	122	0.7	21.0
	Agriculture	Developed	98	52	35	0.2	6.5
	Grassland/Shrubland	Developed	71	43	29	0.2	4.7
	Agriculture	Water	57	68	47	0.1	3.8
	Other	Other	227	n/a	n/a	0.5	15.1
		Totals	1,504			3.3	100.0
1986–1992	Agriculture	Grassland/Shrubland	675	460	314	1.5	48.4
	Grassland/Shrubland	Agriculture	271	119	81	0.6	19.5
	Agriculture	Developed	160	77	53	0.3	11.5
	Grassland/Shrubland	Developed	101	49	33	0.2	7.2
	Water	Agriculture	44	58	39	0.1	3.1
	Other	Other	144	n/a	n/a	0.3	10.3
		Totals	1,395			3.0	100.0
1992–2000	Grassland/Shrubland	Agriculture	1,024	536	366	2.2	54.5
	Agriculture	Developed	249	146	99	0.5	13.2
	Agriculture	Grassland/Shrubland	225	101	69	0.5	12.0
	Grassland/Shrubland	Developed	89	46	32	0.2	4.7
	Agriculture	Mechanically disturbed	62	37	26	0.1	3.3
	Other	Other	231	n/a	n/a	0.5	12.3
		Totals	1,879			4.1	100.0
1973–2000 (overall)	Grassland/Shrubland	Agriculture	3,334	1,160	792	7.3	45.0
	Agriculture	Grassland/Shrubland	1,965	960	656	4.3	26.5
	Agriculture	Developed	684	289	198	1.5	9.2
	Grassland/Shrubland	Developed	366	181	123	0.8	5.0
	Agriculture	Wetland	165	213	145	0.4	2.2
	Other	Other	887	n/a	n/a	1.9	12.0
		Totals	7,401			16.1	100.0

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U.S. Geological Survey Professional Paper 1794–A, 2012

Chapter 18

Southern California Mountains Ecoregion

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This chapter has been modified from original material published in Soulard and others (2007), entitled "Land-cover trends of the Southern California Mountains ecoregion" (U.S. Geological Survey Scientific Investigations Report 2007–5235).

Ecoregion Description

The Southern California Mountains Ecoregion (Omernik, 1987; U.S. Environmental Protection Agency, 1997) encompasses approximately 17,871 km² (6,900 mi²) of land located entirely within California. The ecoregion is bounded on the far north by the Sierra Nevada Ecoregion, on the east by the Mojave Basin and Range Ecoregion, on the southeast by the Sonoran Basin and Range Ecoregion, and on the west and north by Southern and Central California Chaparral and Oak Woodlands Ecoregion. In addition, the northern part of the ecoregion is separated from the Central California Valley Ecoregion by a narrow strip of the Southern and Central California Chaparral and Oak Woodlands Ecoregion (fig. 1).

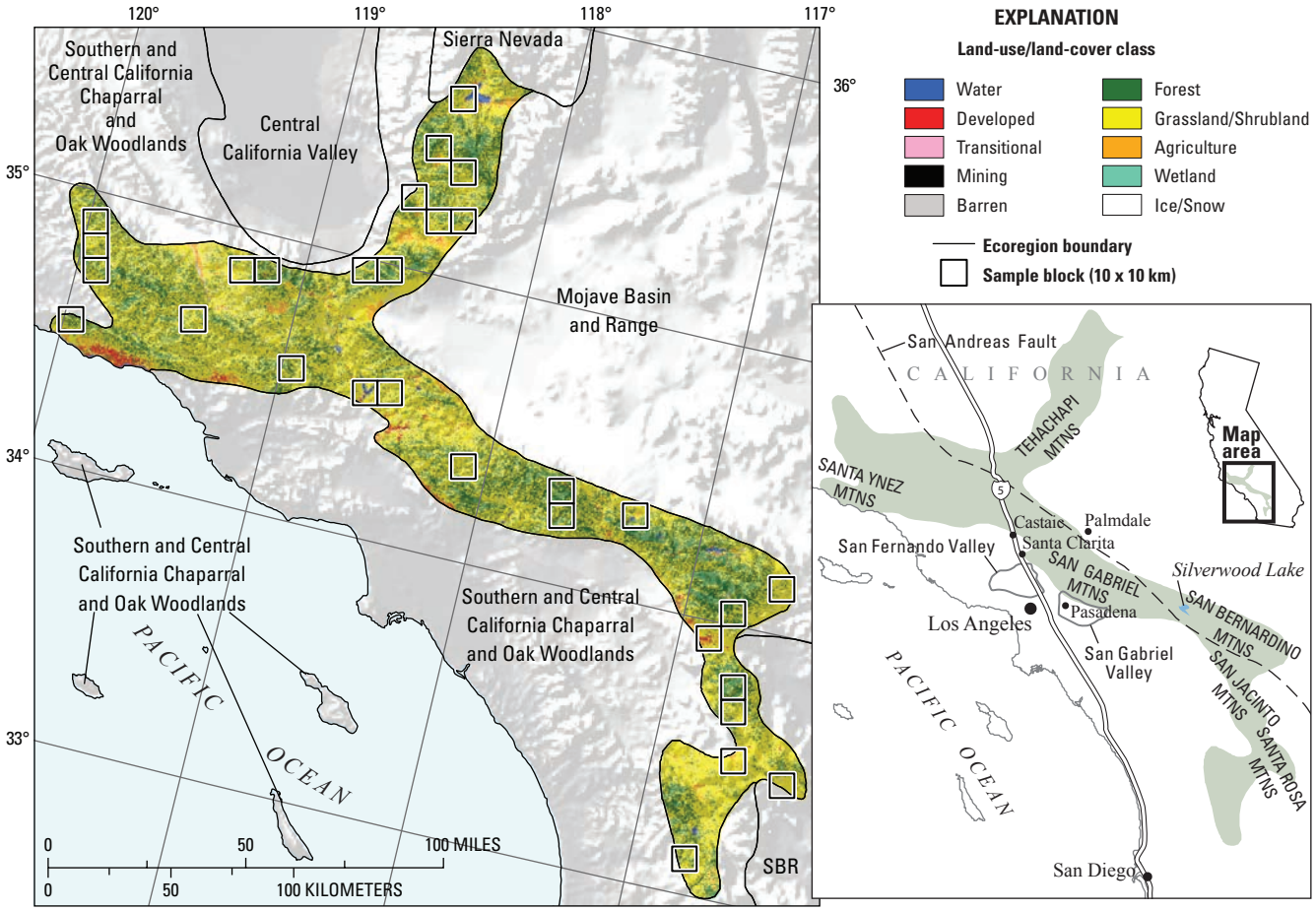

Figure 1. Map of Southern California Mountains Ecoregion and surrounding ecoregions, showing land-use/land-cover classes from 1992 National Land Cover Dataset (Vogelmann and others, 2001); note that not all land-use/land-cover classes shown in explanation may be depicted on map; note also that, for this "Status and Trends of Land Change" study, transitional land-cover class was subdivided into mechanically disturbed and nonmechanically disturbed classes. Squares indicate locations of 10 x 10 km sample blocks analyzed in study. Index map shows locations of geographic features mentioned in text. Abbreviations for Western United States ecoregions are listed in appendix 2. See appendix 3 for definitions of land-use/land-cover classifications.

The Southern California Mountains Ecoregion includes several Pacific Coast mountain ranges. From northwest to southeast, these are the Santa Ynez Mountains, the Tehachapi Mountains, the San Gabriel Mountains, the San Bernardino Mountains, the San Jacinto Mountains, and the Santa Rosa Mountains. These mountain ranges are composed primarily of Mesozoic granitic and metamorphic rocks, in addition to Tertiary sedimentary rocks. The mountains are fractured and discontinuous, owing to movement on the San Andreas Fault and also the associated thrust faults that underlie the region. Additionally, the Santa Ynez Mountains, San Gabriel Mountains, and San Bernardino Mountains make up part of the geologic province known informally as the "Transverse Ranges Province," so-named because of its atypical east-west orientation, which differs from the more typical northwest-southeast orientation (roughly parallel to the San Andreas Fault) of most mountain ranges and valleys elsewhere in California.

The mountains of the Southern California Mountains Ecoregion act as a barrier between a coastal Mediterranean climate to the west and a dry desert climate to the east. This physiographic-barrier effect, along with the topographic gradient of rolling hills to mountains, plays a large role in dictating regional land-use patterns. For example, most urban and agricultural development (for example, irrigated pasture, hay fields, orchards) occurs at lower elevations in the more temperate parts of the ecoregion. Much of this land use is also connected to the suburban growth occurring in adjacent ecoregions; population pressure from cities along the periphery of the Southern California Mountains ecoregion—specifically, the San Fernando and San Gabriel Valleys in the greater Los Angeles, California, area, as well as the cities of Pasadena, Santa Clarita, and Palmdale, California —has caused a spillover in development into the Southern California Mountains Ecoregion's foothills. At higher elevations, development is less dense and is primarily associated with recreational activities and their supporting infrastructure (for example, campgrounds, vacation homes, ski resorts).

The physiographic barrier between the coastal and desert climates also sets the stage for the annual fire season, which occurs from late summer to early fall. Dry conditions on the ground, coupled with the seasonal strong, offshore Santa Ana winds (created from steep pressure gradients that develop between the desert and the coast), have fueled frequent major wildfires throughout the region for more than 500 years (Mensing and others, 1999). The increase in contemporary development, coupled with the long fire history, makes human populations in the region susceptible to fire hazards on a regular basis.

Contemporary Land-Cover Change (1973 to 2000)

Between 1973 and 2000, the footprint (overall areal extent) of land-use/land-cover change in the Southern California Mountains Ecoregion was 5.1 percent, or 906 km². The footprint of change can be interpreted as the area that experienced land-cover change during at least one of the four multiyear time periods that make up the 27-year study period. Of the total change, 518 km² changed during one period, 268 km² changed during two periods, 107 km² changed during three periods, and less than 1 km² changed during all four periods (table 1). Compared to other western United States ecoregions, overall change was low (fig. 2).

The average annual rate of land-cover change in the Southern California Mountains Ecoregion between 1973 and 2000 was roughly 0.3 percent per year. This measurement, which normalizes the results for each period to an annual scale, means that the ecoregion averaged roughly 0.3 percent (50 km²) of change each year in the 27-year study period. However, this annual change varied between each of the four time periods (fig. 3). Between 1973 and 1980, the annual rate of change in the Southern California Mountains Ecoregion

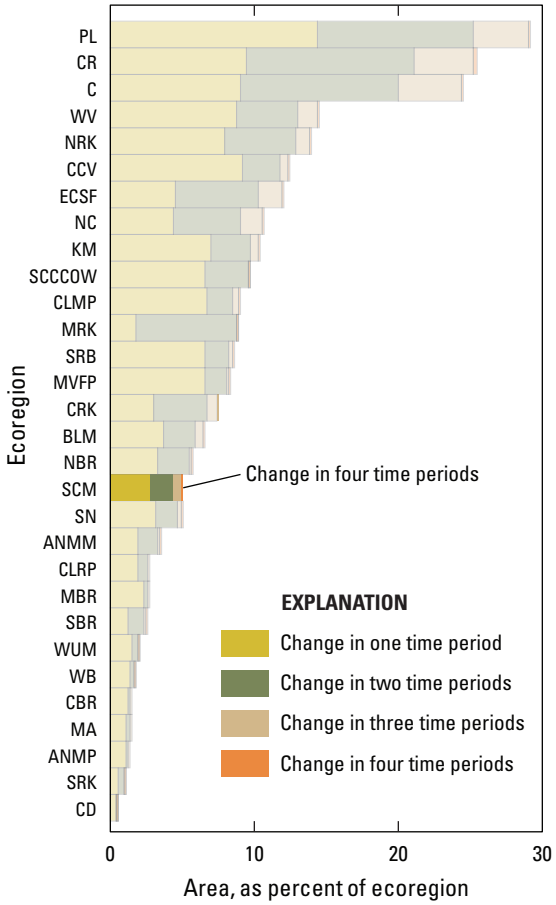

Figure 2. Overall spatial change in Southern California Mountains Ecoregion (SCM; darker bars) compared with that of all 30 Western United States ecoregions (lighter bars). Each horizontal set of bars shows proportions of ecoregion that changed during one, two, three, or four time periods; highest level of spatial change in Southern California Mountains Ecoregion (four time periods) labeled for clarity. See table 2 for years covered by each time period. See appendix 2 for key to ecoregion abbreviations.

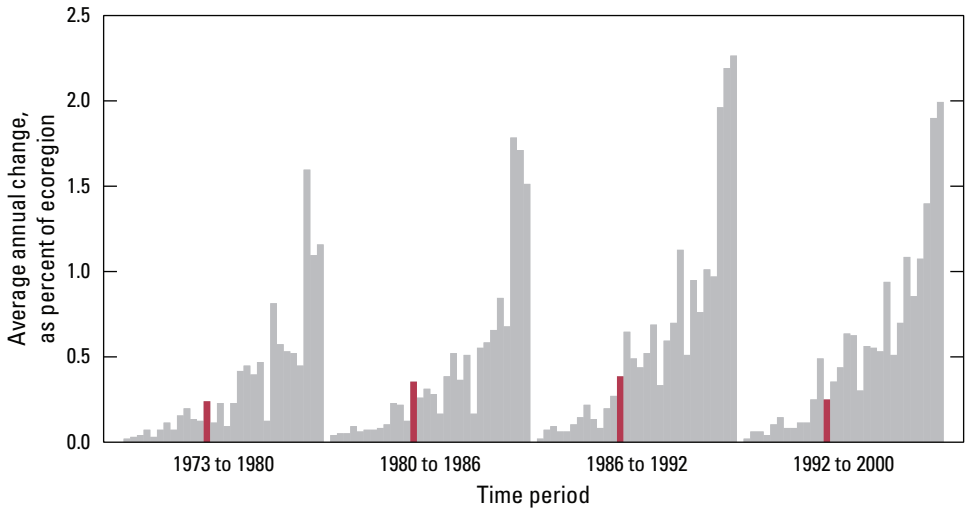

Figure 3. Estimates of land-cover change per time period, normalized to annual rates of change for all 30 Western United States ecoregions (gray bars). Estimates of change for Southern California Mountains Ecoregion are represented by red bars in each time period.

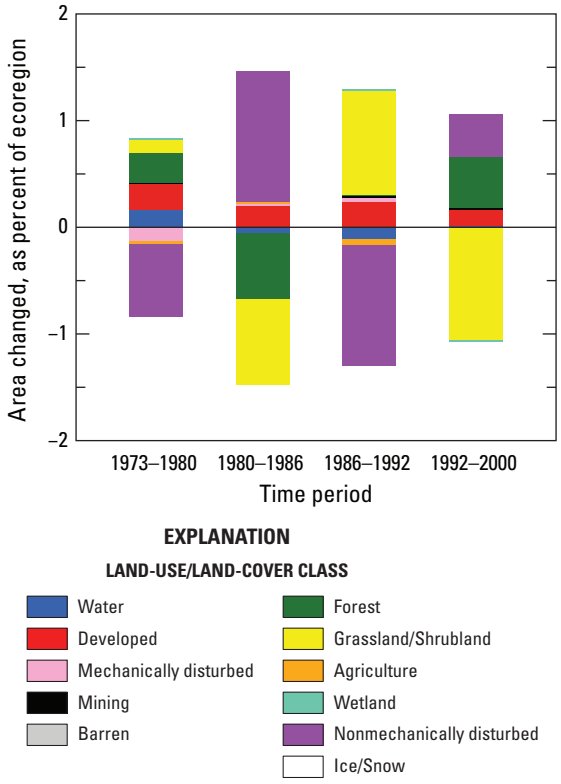

Figure 4. Normalized average net change in Southern California Mountains Ecoregion by time period for each land-cover class. Bars above zero axis represent net gain, whereas bars below zero represent net loss. Note that not all land-cover classes shown in explanation may be represented in figure. See appendix 3 for definitions of land-use/land-cover classifications.

was 0.2 percent per year, increasing to 0.3 percent per year between 1980 and 1986 and 0.4 percent per year between 1986 and 1992. The normalized annual rate dropped to 0.2 percent per year between 1992 and 2000 (table 2).

In 2000, 4 of the 11 land-cover classes occupied most of the Southern California Mountains Ecoregion: grassland/shrubland (65.9 percent), forest (27.5 percent), developed (2.6 percent), and agriculture (1.5 percent). Six other land-cover classes cumulatively made up the remaining 2.5 percent of the ecoregion in 2000, each making up less than 1.0 percent of the ecoregion (table 3).

Between 1973 and 2000, the land-cover classes that experienced a measurable net change in relation to the total Southern California Mountains Ecoregion area were, in descending order, developed (44.6 percent increase) and grassland/shrubland (1.1 percent decrease) (fig. 4). However, net change may not necessarily be the best indicator of change for individual land-cover classes as it can mask more complex land-use/land-cover dynamics. Analysis of gross change (that is, area gained or lost) by individual land-cover classes by time period shows that classes have fluctuated throughout the 27-year study period to a greater degree than net change values may indicate (fig. 5). Figure 5 illustrates how land-cover classes may experience gains and losses in area both within and between time periods. For example, the water class had no significant net change but experienced a gross change of nearly half its 1973 value. The nonmechanically disturbed class, which fluctuated greatly over the study period. underwent gross change totaling more than four times its original value.

The “from class–to class” information afforded by a postclassification comparison allows the identification of land-use/land-cover class conversions and the ranking of these conversions according to their magnitude. Table 4 illustrates the most frequent conversions between 1973 and 2000 in the Southern California Mountains Ecoregion. Five of the top ten

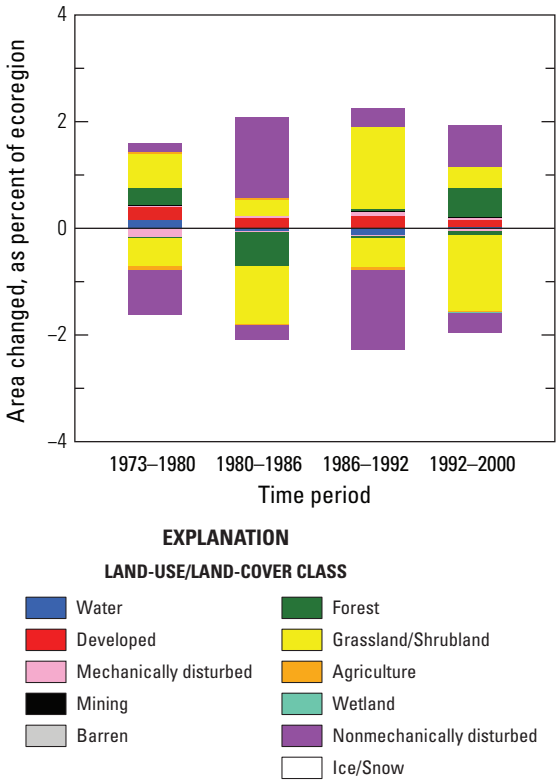

Figure 5. Gross change (area gained and lost) in Southern California Mountains Ecoregion by time period for each land-cover class. Bars above zero axis represent net gain, whereas bars below zero represent net loss. Note that not all land-cover classes shown in explanation may be represented in figure. See appendix 3 for definitions of land-use/land-cover classifications. Diagram illustrates that net change can mask within-class fluctuations within each time period and during entire 27-year study period.

Figure 6. Photograph taken in April 2005 of Silverwood Lake, California, and its surroundings, showing area undergoing regeneration following fire. Although grasses and shrubs tend to reestablish themselves quite soon after fire, trees take much longer to recover. Land-cover classes shown are grassland/shrubland and water.

most prominent conversions are connected to the nonmechanical disturbance of land cover by fire. Cumulatively, the effect of nonmechanical disturbance on grassland/shrubland and forest resulted in an estimated 501 km² of vegetated land-cover loss. However, much of this land experienced ecological succession, or regrowth, after each disturbance event (fig. 6). Regrowth accounted for 531 km² of vegetated land-cover gain; areas that were disturbed in consecutive periods account for an additional 21 km².

Conversions to the developed class also were common in the Southern California Mountains Ecoregion during the study period (146 km²) (fig. 7). The ecoregion is a geographically unique place, surrounded at lower elevations by human development and having few natural corridors that link its multiple mountain ranges. In the past, natural ignition sources such as lightning and wind dictated fire behavior in the Southern California Mountains Ecoregion, but today most of the fires are human-caused and are located at or near the interface between human development and wildlands (U.S. Department of Agriculture, 2005). These anthropogenic changes make predictions of future ecosystem health difficult as threats and outcomes

Figure 7. Photograph taken in April 2005 of new homes in Castaic, California, an unincorporated community in Los Angeles County located alongside Interstate 5. Land-use/land-cover classes shown are grassland/shrubland, forest, developed, and water.

cannot be measured against historical conditions. Topographic isolation, coupled with increased fragmentation of habitat by fire, poses significant threats to existing diversity and may ultimately drive species turnover in Southern California Mountains Ecoregion (Center for Biological Diversity, 2007). Protection of this designated biodiversity hotspot will become increasingly difficult given current land-use/land-cover trends (Myers and others, 2000). The consequences of land-use/land-cover change caused by nonmechanical disturbance and development, as well as the general loss of grassland/shrubland, do not necessarily follow managerial boundaries. On Federal lands, many agencies have adopted multiscale, integrated planning and management activities in an attempt to deal with these ecological processes within and across management units (Hann and Bunnell, 2001).

Table 1. Percentage of Southern California Mountains Ecoregion land cover that changed at least one time during study period (1973–2000) and associated statistical error.

[Most sample pixels remained unchanged (94.9 percent), whereas 5.1 percent changed at least once throughout study period]

Number of changes	Percent of ecoregion	Margin of error (+/– %)	Lower bound (%)	Upper bound (%)	Standard error (%)	Relative error (%)
1	2.4	1.3	1.5	4.2	0.9	31.6
2	1.1	1.6	0.0	3.1	1.1	68.8
3	0.6	0.7	−0.1	1.4	0.5	78.1
4	0.0	0.0	0.0	0.0	0.0	52.2
Overall spatial change	5.1	2.5	2.6	7.5	1.7	32.8

Table 2. Raw estimates of change in Southern California Mountains Ecoregion land cover, computed for each of four time periods, and associated error at 85-percent confidence level.

[Estimates of change per period normalized to annual rate of change for each period]

Period	Total change (% of ecoregion)	Margin of error (+/– %)	Lower bound (%)	Upper bound (%)	Standard error (%)	Relative error (%)	Average rate (% per year)
Estimate of change, in percent stratum							
1973–1980	1.6	1.0	0.6	2.6	0.7	41.6	0.2
1980–1986	2.1	1.5	0.6	3.5	1.0	47.4	0.3
1986–1992	2.3	1.6	0.6	3.9	1.1	48.4	0.4
1992–2000	1.9	1.1	0.8	3.0	0.7	38.4	0.2
Estimate of change, in square kilometers							
1973–1980	289	178	111	467	120	41.6	41
1980–1986	371	260	111	632	176	47.4	62
1986–1992	407	291	116	698	197	48.4	68
1992–2000	346	196	149	542	133	38.4	43

Table 3. Estimated area (and margin of error) of each land-cover class in Southern California Mountains Ecoregion, calculated five times between 1973 and 2000. See appendix 3 for definitions of land-cover classifications.

	Water		Developed		Mechanically disturbed		Mining		Barren		Forest		Grassland/ Shrubland		Agriculture		Wetland		Non-mechanically disturbed	
	%	+/–	%	+/–	%	+/–	%	+/–	%	+/–	%	+/–	%	+/–	%	+/–	%	+/–	%	+/–
Area, in percent stratum																				
1973	0.8	0.6	1.8	0.8	0.1	0.2	0.1	0.0	0.5	0.2	27.4	5.3	66.6	5.0	1.6	1.2	0.2	0.2	0.9	0.8
1980	1.0	0.7	2.1	0.9	0.0	0.0	0.1	0.1	0.5	0.2	27.7	5.3	66.7	5.0	1.5	1.2	0.2	0.2	0.3	0.2
1986	0.9	0.7	2.3	0.9	0.0	0.0	0.1	0.1	0.5	0.2	27.0	5.0	65.9	4.9	1.5	1.2	0.2	0.2	1.5	1.3
1992	0.8	0.6	2.5	1.0	0.1	0.1	0.1	0.1	0.5	0.2	27.0	5.0	66.9	4.8	1.5	1.2	0.2	0.2	0.4	0.4
2000	0.8	0.6	2.6	1.1	0.1	0.1	0.1	0.1	0.5	0.2	27.5	5.3	65.9	5.0	1.5	1.2	0.2	0.2	0.8	0.6
Net change	0.0	0.2	0.8	0.3	−0.1	0.2	0.0	0.0	0.0	0.0	0.1	0.3	−0.7	0.8	−0.1	0.2	0.0	0.0	−0.2	1.0
Gross change	0.4	0.3	0.8	0.3	0.3	0.2	0.0	0.0	0.0	0.0	1.6	1.5	4.6	2.4	0.2	0.2	0.0	0.0	4.1	2.4
Area, in square kilometers																				
1973	143	100	327	146	26	28	11	7	92	44	4,893	940	11,902	897	279	214	30	29	169	143
1980	175	120	368	159	3	4	13	10	92	44	4,943	941	11,924	892	274	210	30	29	49	43
1986	167	119	404	167	7	5	14	10	92	44	4,830	886	11,781	884	276	209	31	29	269	234
1992	147	101	448	185	14	13	17	12	92	44	4,831	888	11,958	849	267	207	31	30	66	80
2000	151	102	473	194	16	14	19	14	92	44	4,916	939	11,769	892	265	207	31	29	139	106
Net change	8	32	146	62	−10	31	8	7	0	0	24	58	−133	148	−13	30	1	1	−30	172
Gross change	70	46	146	62	55	36	8	7	0	0	291	266	814	426	32	29	2	2	741	431

Table 4. Principal land-cover conversions in Southern California Mountains Ecoregion, showing amount of area changed (and margin of error, calculated at 85-percent confidence level) for each conversion during each of four time periods and also during overall study period. See appendix 3 for definitions of land-cover classifications.

[Values given for "other" class are combined totals of values for other land-cover classes not listed in that time period. Abbreviations: n/a, not applicable]

Period	From class	To class	Area changed (km^2)	Margin of error (+/– km^2)	Standard error (km^2)	Percent of ecoregion	Percent of all changes
1973–1980	Nonmechanically disturbed	Grassland/Shrubland	98	89	60	0.5	33.7
	Nonmechanically disturbed	Forest	53	51	34	0.3	18.2
	Grassland/Shrubland	Nonmechanically disturbed	31	37	25	0.2	10.7
	Grassland/Shrubland	Developed	31	19	13	0.2	10.7
	Grassland/Shrubland	Water	24	20	13	0.1	8.4
	Other	Other	53	n/a	n/a	0.3	18.3
		Totals	289			1.6	100.0
1980–1986	Grassland/Shrubland	Nonmechanically disturbed	166	183	124	0.9	44.7
	Forest	Nonmechanically disturbed	103	132	89	0.6	27.9
	Nonmechanically disturbed	Grassland/Shrubland	48	43	29	0.3	12.8
	Grassland/Shrubland	Developed	21	9	6	0.1	5.8
	Forest	Developed	10	11	7	0.1	2.8
	Other	Other	23	n/a	n/a	0.1	6.1
		Totals	371			2.1	100.0
1986–1992	Nonmechanically disturbed	Grassland/Shrubland	262	232	157	1.5	64.3
	Grassland/Shrubland	Nonmechanically disturbed	62	76	51	0.3	15.3
	Grassland/Shrubland	Developed	30	14	9	0.2	7.3
	Water	Grassland/Shrubland	11	14	9	0.1	2.8
	Agriculture	Developed	10	13	9	0.1	2.3
	Other	Other	32	n/a	n/a	0.2	7.9
		Totals	407			2.3	100.0
1992–2000	Grassland/Shrubland	Nonmechanically disturbed	122	93	63	0.7	35.4
	Grassland/Shrubland	Forest	98	132	90	0.5	28.4
	Nonmechanically disturbed	Grassland/Shrubland	64	79	53	0.4	18.5
	Grassland/Shrubland	Developed	22	10	7	0.1	6.5
	Forest	Nonmechanically disturbed	14	19	13	0.1	4.1
	Other	Other	24	n/a	n/a	0.1	7.0
		Totals	346			1.9	100.0
1973–2000 (overall)	Nonmechanically disturbed	Grassland/Shrubland	471	377	255	2.6	33.3
	Grassland/Shrubland	Nonmechanically disturbed	382	344	233	2.1	27.0
	Forest	Nonmechanically disturbed	119	133	90	0.7	8.4
	Grassland/Shrubland	Developed	104	41	28	0.6	7.4
	Grassland/Shrubland	Forest	101	132	89	0.6	7.2
	Other	Other	236	n/a	n/a	1.3	16.7
		Totals	1,413			7.9	100.0

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Status and Trends of Land Change in the Western United States—1973 to 2000
Edited by Benjamin M. Sleeter, Tamara S. Wilson, and William Acevedo
U.S. Geological Survey Professional Paper 1794–A, 2012

Chapter 19

Southern and Central California Chaparral and Oak Woodlands Ecoregion

By Darrell E. Napton

Ecoregion Description

The Southern and Central California Chaparral and Oak Woodlands Ecoregion, which covers approximately 102,110 km^2 (39,425 mi^2), is characterized by a Mediterranean climate with cool, moist winters and hot, dry summers (Omernik, 1987; U.S. Environmental Protection Agency, 1997). Natural vegetation includes chaparral (for example, manzanita, *Arctostaphylos* spp.) and oak (*Quercus* spp.) woodlands with extensive grassland and shrubland cover. The low mountains and foothills of the ecoregion border or parallel the Pacific Ocean from Mexico to Point Reyes, California, and continue inland surrounding the Central California Valley Ecoregion (fig. 1). These mountains and hills are interrupted by limited areas of flat land generally used for development or agriculture. The largest developed area in the ecoregion is the Los Angeles Basin, followed by the San Francisco Bay area and the San Diego metropolitan area (fig. 1). The largest agricultural area

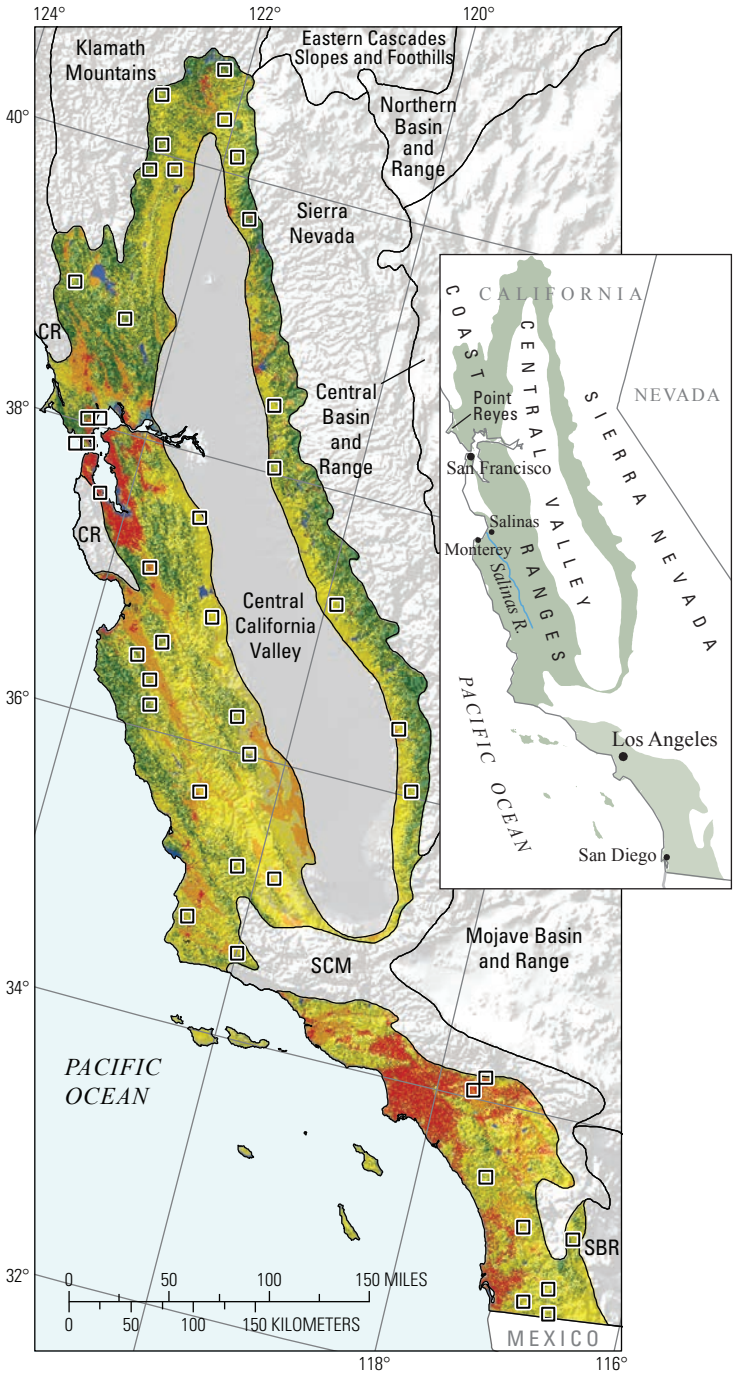

Figure 1. Map of Southern and Central California Chaparral and Oak Woodlands Ecoregion and surrounding ecoregions, showing land-use/land-cover classes from 1992 National Land Cover Dataset (Vogelmann and others, 2001); note that not all land-use/land-cover classes shown in explanation may be depicted on map; note also that, for this "Status and Trends of Land Change" study, transitional land-cover class was subdivided into mechanically disturbed and nonmechanically disturbed classes. Squares indicate locations of 10 x 10 km sample blocks analyzed in study. Index map shows locations of geographic features mentioned in text. Abbreviations for Western United States ecoregions are listed in appendix 2. See appendix 3 for definitions of land-use/land-cover classifications.

Figure 2. Typical Southern and Central California Chaparral and Oak Woodlands Ecoregion landscape, consisting of grassland/shrubland or forest land cover.

is the Salinas River valley south of Monterey, California. Most of the ecoregion consists of rangelands classified as grassland/shrubland and forest land covers (figs. 1,2).

Contemporary Land-Cover Change (1973 to 2000)

The overall spatial change (that is, the percentage of area that changed at least one time between 1973 and 2000) in the ecoregion was estimated at 9.7 percent (table 1). The amount of change in the Southern and Central California Chaparral and Oak Woodlands Ecoregion was close to the median among the western United States ecoregions (fig. 3). Nearly seventy percent of the converted landscape changed land-cover class only one time, whereas thirty percent changed land cover twice (table 1). Fire, which produces a landscape classified as nonmechanically

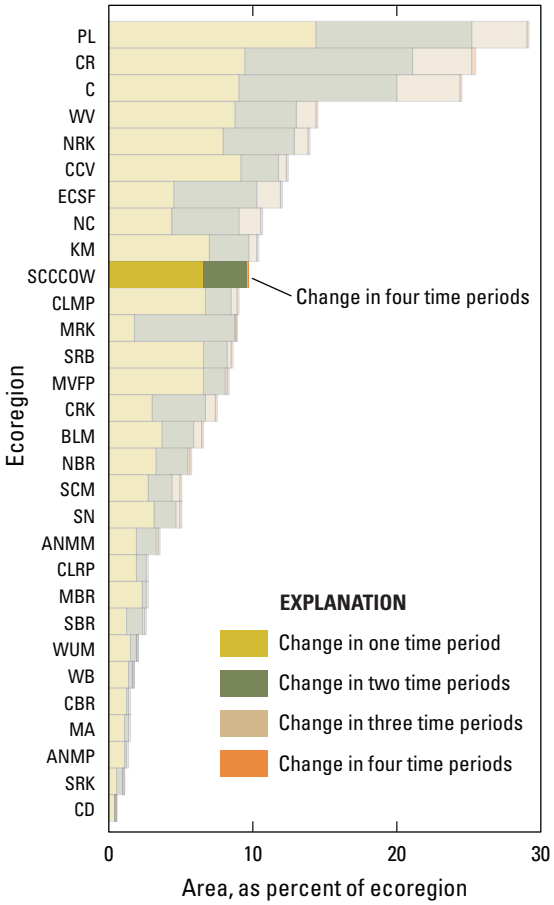

Figure 3. Overall spatial change in Southern and Central California Chaparral and Oak Woodlands Ecoregion (SCCCOW; darker bars) compared with that of all 30 Western United States ecoregions (lighter bars). Each horizontal set of bars shows proportions of ecoregion that changed during one, two, three, or four time periods; highest level of spatial change in Southern and Central California Chaparral and Oak Woodlands Ecoregion (four time periods) labeled for clarity. See table 2 for years covered by each time period. See appendix 2 for key to ecoregion abbreviations.

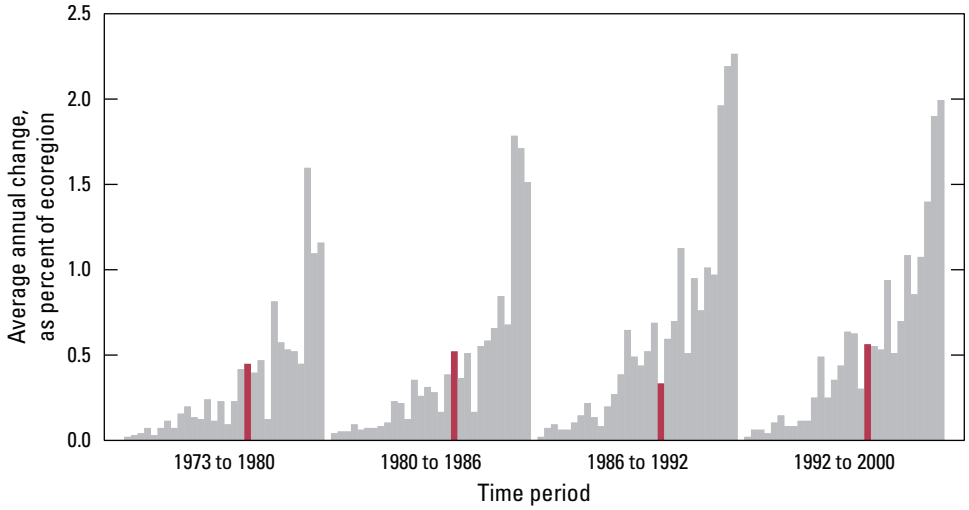

Figure 4. Estimates of land-cover change per time period, normalized to annual rates of change for all 30 Western United States ecoregions (gray bars). Estimates of change for Southern and Central California Chaparral and Oak Woodlands Ecoregion are represented by red bars in each time period.

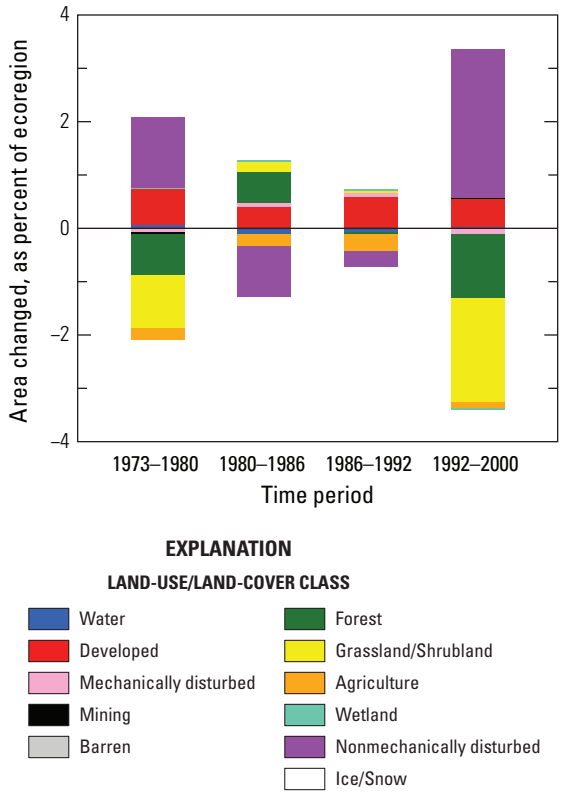

Figure 5. Normalized average net change in Southern and Central California Chaparral and Oak Woodlands Ecoregion by time period for each land-cover class. Bars above zero axis represent net gain, whereas bars below zero represent net loss. Note that not all land-cover classes shown in explanation may be represented in figure. See appendix 3 for definitions of land-use/land-cover classifications.

disturbed, was the primary cause of land-cover change in areas that experienced two or more changes during the study period. Land-conversion rates varied temporally with the fastest annual rates occurring between 1992 and 2000 (at 0.6 percent) and slowest rate between 1986 and 1992 (at 0.3 percent) (table 2; fig. 4).

Figure 5 provides an overview of the net land-cover change by time period. Forest and grassland/shrubland losses were associated with net increases in nonmechanical disturbances, a conversion normally attributed to fire, which is a major presence in the Southern and Central California Chaparral and Oak Woodlands Ecoregion. Cool, wet winters bring a growth of annual grasses providing the necessary fuel load for fires to spread during the ecoregion's hot, dry summers. Many of the endemic chaparral plant species here are adapted to survive low-frequency fires, and some species even depend on fire as part of their life-cycle strategy (fig. 6; see also, Halsey, 2005). Developed land cover increased throughout the study period and accounted for virtually all of the net change occurring between 1986 and 1992. A net loss of agriculture occurred during each time period in the study. As agriculture here typically occurs on flat, easily developed land, agriculture lands are often best suited for urban expansion (fig. 7).

Figure 6. Grassland/shrubland and forest in Southern and Central California Chaparral and Oak Woodlands Ecoregion, two land-cover classes that are prone to fires during dry summers associated with Mediterranean climate of ecoregion.

Figure 7. Conversion of grassland/shrubland to agriculture was most common nonfire land-cover change in Southern and Central California Chaparral and Oak Woodlands Ecoregion during study period.

Figure 8. Conversions of grassland/shrubland and agriculture to developed land were two common land-cover changes in Southern and Central California Chaparral and Oak Woodlands Ecoregion during study period.

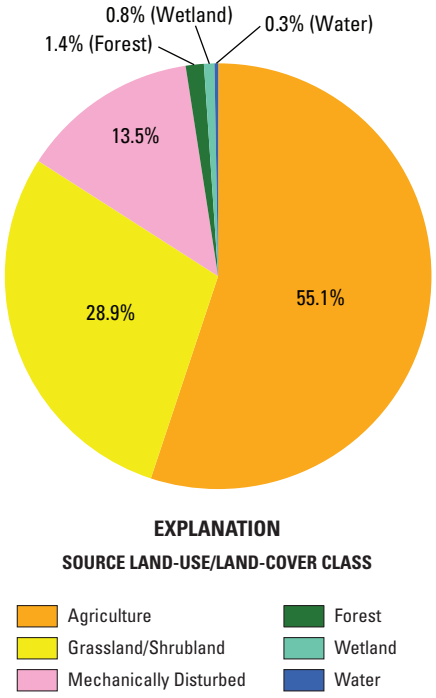

Figure 9. Areal percentages of sources of developed land in Southern and Central California Chaparral and Oak Woodlands Ecoregion during study period.

Grassland/shrubland land cover makes up the largest share of this ecoregion, followed by forest, agriculture, and developed lands (table 3). These four land-cover classes accounted for 96 percent of the ecoregion in 1973 but only 93.2 percent in 2000, largely because of the net increase in nonmechanically disturbed land cover coupled with a decrease in forest and grassland/shrubland land covers. Developed land increased 33 percent during the study period as population in the Southern and Central California Chaparral and Oak Woodlands Ecoregion increased from 14.5 to 22.2 million between 1970 and 2000 (U.S. Census Bureau, 2000). More than half of the land converted to developed land cover came from agriculture, and nearly thirty percent was converted from grassland/shrubland (figs. 8, 9).

Between 1973 and 2000, the five most common land conversions accounted for 73 percent (by area) of the change in the ecoregion (table 4). The most common land-cover conversion was grassland/shrubland to nonmechanically disturbed, accounting for nearly one-quarter of all area converted, whereas forest to nonmechanically disturbed accounted for an additional 19 percent. These conversions largely represent the impact of wildfire in the ecoregion. The third and fifth most common conversions (nonmechanically disturbed back to grassland/shrubland and nonmechanically disturbed back to forest) reflect the cyclic nature of landscape changes associated with wildfire and postfire vegetation recovery. The numbers do not balance because there is a lag time between fire occurrence and the conversion back to the original land cover, especially in the case of forests where an intermediate, successional vegetation cover is likely to occur. The conversion of agriculture to developed land was the fourth most common conversion and accounted for nearly 10 percent of the land-cover change in the ecoregion.

The Southern and Central California Chaparral and Oak Woodlands Ecoregion is the most populous of the nation's ecoregions. Many people find the ecoregion's Mediterranean climate desirable, but little accessible, flat land suitable for affordable housing is available. Additionally, water shortages and drought are common, and much of the ecoregion's water is imported from other ecoregions. Consequently, most of the ecoregion's landscape remains open rangeland with land covers of grassland/shrubland mixed with oak forest. The region's limited farmland is used for specialty crops such as wine grapes, table grapes, and strawberries. New development has resulted in the conversion of some agricultural land, but the largest driver of land-cover change has been the periodic burning of grassland/shrubland and forested land during the ecoregion's long, hot, and dry summers.

Table 1. Percentage of Southern and Central California Chaparral and Oak Woodlands Ecoregion that changed at least one time during study period (1973–2000) and associated statistical error.

[Most sample pixels remained unchanged (90.3 percent), whereas 9.7 percent changed at least once throughout study period]

Number of changes	Percent of ecoregion	Margin of error (+/– %)	Lower bound (%)	Upper bound (%)	Standard error (%)	Relative error (%)
1	6.7	2.3	4.4	9.0	1.5	23.1
2	2.9	1.6	1.3	4.5	1.1	37.9
3	0.1	0.1	0.0	0.1	0.0	50.5
4	0.0	0.0	0.0	0.0	0.0	87.5
Overall spatial change	9.7	2.9	6.7	12.6	2.0	20.8

Table 2. Raw estimates of change in Southern and Central California Chaparral and Oak Woodland. land cover, computed for each of four time periods between 1973 and 2000, and associated error at 85-percent confidence level.

[Estimates of change per period normalized to annual rate of change for each period]

Period	Total change (% of ecoregion)	Margin of error (+/– %)	Lower bound (%)	Upper bound (%)	Standard error (%)	Relative error (%)	Average rate (% per year)
Estimate of change, in percent stratum							
1973–1980	3.1	1.7	1.5	4.8	1.1	36.1	0.4
1980–1986	3.1	1.6	1.5	4.7	1.1	35.8	0.5
1986–1992	2.0	0.9	1.1	2.9	0.6	29.6	0.3
1992–2000	4.5	2.2	2.3	6.8	1.5	33.8	0.6
Estimate of change, in square kilometers							
1973–1980	3,216	1,704	1,512	4,921	1,161	36.1	459
1980–1986	3,149	1,653	1,496	4,802	1,126	35.8	525
1986–1992	2,037	. 885	1,151	2,922	. 603	29.6	339
1992–2000	4,607	2,286	2,321	6,893	1,557	33.8	576

Table 3. Estimated area (and margin of error) of each land-cover class in Southern and Central California Chaparral and Oak Woodlands Ecoregion, calculated five times between 1973 and 2000. See appendix 3 for definitions of land-cover classifications.

	Water		Developed		Mechanically disturbed		Mining		Barren		Forest		Grassland/ Shrubland		Agriculture		Wetland		Non-mechanically disturbed	
	%	+/–	%	+/–	%	+/–	%	+/–	%	+/–	%	+/–	%	+/–	%	+/–	%	+/–	%	+/–
Area, in percent stratum																				
1973	2.5	1.7	6.6	3.6	0.1	0.1	0.2	0.2	0.3	0.3	21.3	4.2	58.0	5.7	10.1	3.1	0.6	0.4	0.3	0.2
1980	2.5	1.7	7.3	4.0	0.1	0.1	0.2	0.2	0.3	0.3	20.5	4.0	57.0	5.7	9.9	3.1	0.6	0.4	1.6	1.6
1986	2.5	1.7	7.7	4.0	0.2	0.1	0.2	0.2	0.3	0.3	21.1	4.1	57.2	5.6	9.7	3.0	0.6	0.4	0.6	0.6
1992	2.4	1.7	8.3	4.2	0.2	0.1	0.2	0.2	0.3	0.3	21.0	4.0	57.2	5.7	9.4	3.0	0.6	0.4	0.3	0.2
2000	2.5	1.7	8.8	4.4	0.1	0.1	0.2	0.2	0.3	0.3	19.8	3.5	55.3	5.6	9.3	3.0	0.6	0.4	3.1	2.1
Net change	0.0	0.1	2.2	1.4	0.0	0.1	0.0	0.1	0.0	0.0	−1.5	1.6	−2.7	1.3	−0.8	1.1	0.0	0.0	2.8	2.0
Gross change	0.4	0.3	2.2	1.4	0.6	0.3	0.1	0.1	0.0	0.0	3.2	2.4	6.1	2.2	2.3	1.1	0.1	0.1	7.5	3.8
Area, in square kilometers																				
1,973	2,507	1,776	6,743	3,650	140	112	199	234	339	291	21,741	4,296	59,216	5,777	10,340	3,200	627	424	257	212
1,980	2,601	1,773	7,417	4,039	62	71	188	220	338	291	20,924	41,20	58,220	5,783	10,121	3,170	644	440	1,595	1,586
1,986	2,505	1,770	7,836	4,101	155	93	187	220	338	291	21,520	4,216	58,408	5,763	9,905	3,103	654	428	602	598
1,992	2,455	1,772	8,456	4,279	216	140	168	161	337	291	21,491	4,133	58,447	5816	9,563	3,069	663	432	315	221
2,000	2,502	1,773	8,977	4,443	116	71	214	169	346	291	20,234	3,611	56,471	5,707	9,478	3,043	626	416	3,146	2,097
Net change	−5	55	2,234	1,381	−25	99	15	88	7	15	−1,506	1,677	−2,746	1,326	−862	1,170	−1	31	2,889	2,057
Gross change	447	278	2,234	1,381	612	314	135	91	13	15	3,305	2,499	6,221	2,247	2,346	1,076	116	80	7,620	3,843

Table 4. Principal land-cover conversions in Southern and Central California Chaparral and Oak Woodlands Ecoregion, showing amount of area changed (and margin of error, calculated at 85-percent confidence level) for each conversion during each of four time periods and also during overall study period. See appendix 3 for definitions of land-cover classifications.

[Values given for "other" class are combined totals of values for other land-cover classes not listed in that time period. Abbreviations: n/a, not applicable]

Period	From class	To class	Area changed (km^2)	Margin of error (+/– km^2)	Standard error (km^2)	Percent of ecoregion	Percent of all changes
1973–1980	Forest	Nonmechanically disturbed	825	990	674	0.8	25.6
	Grassland/Shrubland	Nonmechanically disturbed	755	803	547	0.7	23.5
	Agriculture	Developed	481	437	298	0.5	14.9
	Grassland/Shrubland	Agriculture	409	306	209	0.4	12.7
	Nonmechanically disturbed	Grassland/Shrubland	226	186	127	0.2	7.0
	Other	Other	520	n/a	n/a	0.5	16.2
		Totals	3,216			3.1	100.0
1980–1986	Nonmechanically disturbed	Grassland/Shrubland	810	841	573	0.8	25.7
	Nonmechanically disturbed	Forest	769	926	631	0.8	24.4
	Grassland/Shrubland	Nonmechanically disturbed	448	523	357	0.4	14.2
	Agriculture	Developed	210	184	125	0.2	6.7
	Agriculture	Grassland/Shrubland	156	141	96	0.2	5.0
	Other	Other	756	n/a	n/a	0.7	24.0
		Totals	3,149			3.1	100.0
1986–1992	Nonmechanically disturbed	Grassland/Shrubland	485	526	358	0.5	23.8
	Agriculture	Developed	327	328	224	0.3	16.1
	Grassland/Shrubland	Developed	210	124	85	0.2	10.3
	Grassland/Shrubland	Nonmechanically disturbed	169	123	84	0.2	8.3
	Forest	Nonmechanically disturbed	134	170	116	0.1	6.6
	Other	Other	712	n/a	n/a	0.7	34.9
		Totals	2,037			2.0	100.0
1992–2000	Grassland/Shrubland	Nonmechanically disturbed	1,771	1,230	838	1.7	38.4
	Forest	Nonmechanically disturbed	1,353	1,589	1,082	1.3	29.4
	Grassland/Shrubland	Agriculture	261	174	119	0.3	5.7
	Agriculture	Developed	213	147	100	0.2	4.6
	Grassland/Shrubland	Developed	183	107	73	0.2	4.0
	Other	Other	826	n/a	n/a	0.8	17.9
		Totals	4,607			4.5	100.0
1973–2000 (overall)	Grassland/Shrubland	Nonmechanically disturbed	3,144	1,643	1,119	3.1	24.2
	Forest	Nonmechanically disturbed	2,442	2,018	1,375	2.4	18.8
	Nonmechanically disturbed	Grassland/Shrubland	1,680	1,080	736	1.6	12.9
	Agriculture	Developed	1,230	931	634	1.2	9.5
	Nonmechanically disturbed	Forest	1,007	939	640	1.0	7.7
	Other	Other	3,506	n/a	n/a	3.4	27.0
		Totals	13,009			12.7	100.0

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