

Chapter 17

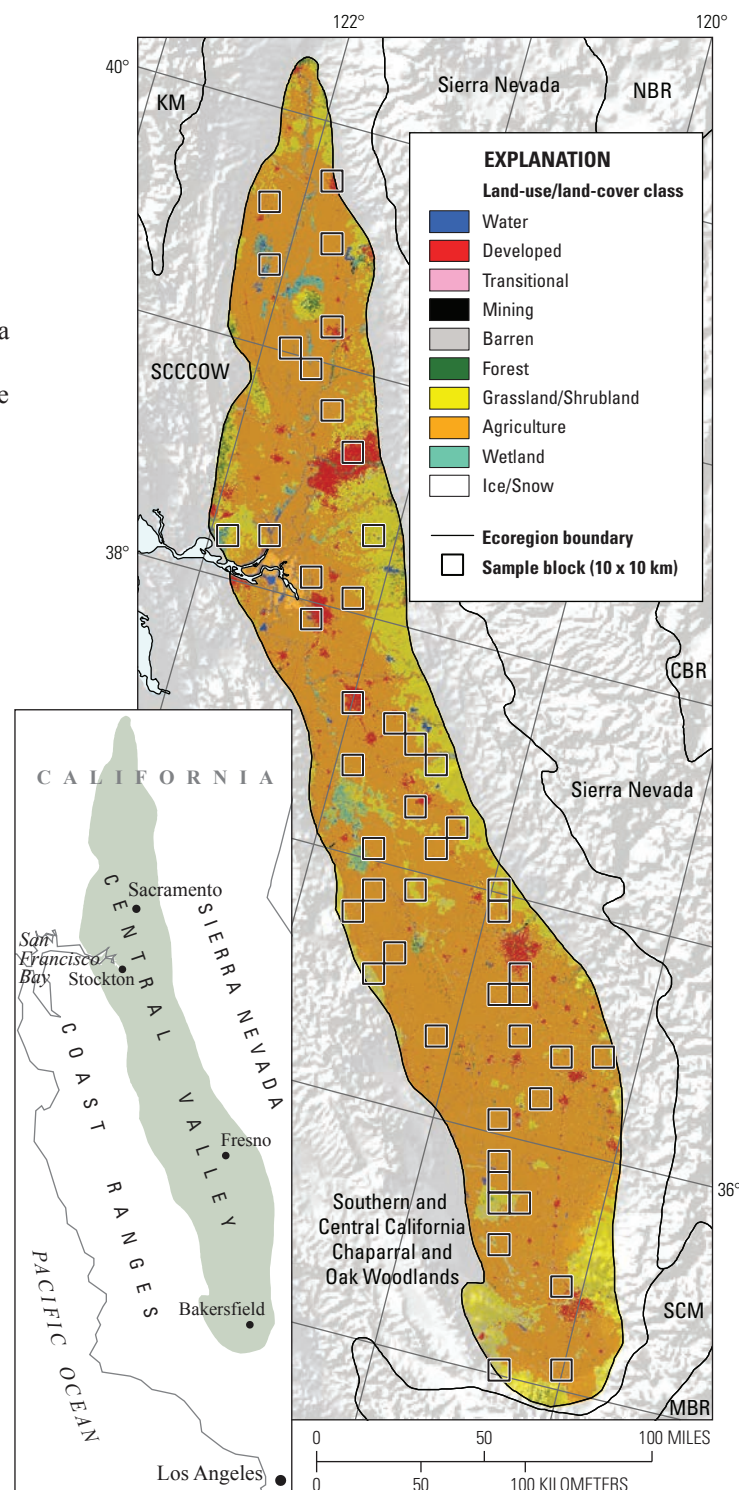
Central California Valley Ecoregion

By Benjamin M. Sleeter

Ecoregion Description

The Central California Valley Ecoregion, which covers approximately 45,983 km² (17,754 mi²), 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. 2A,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.



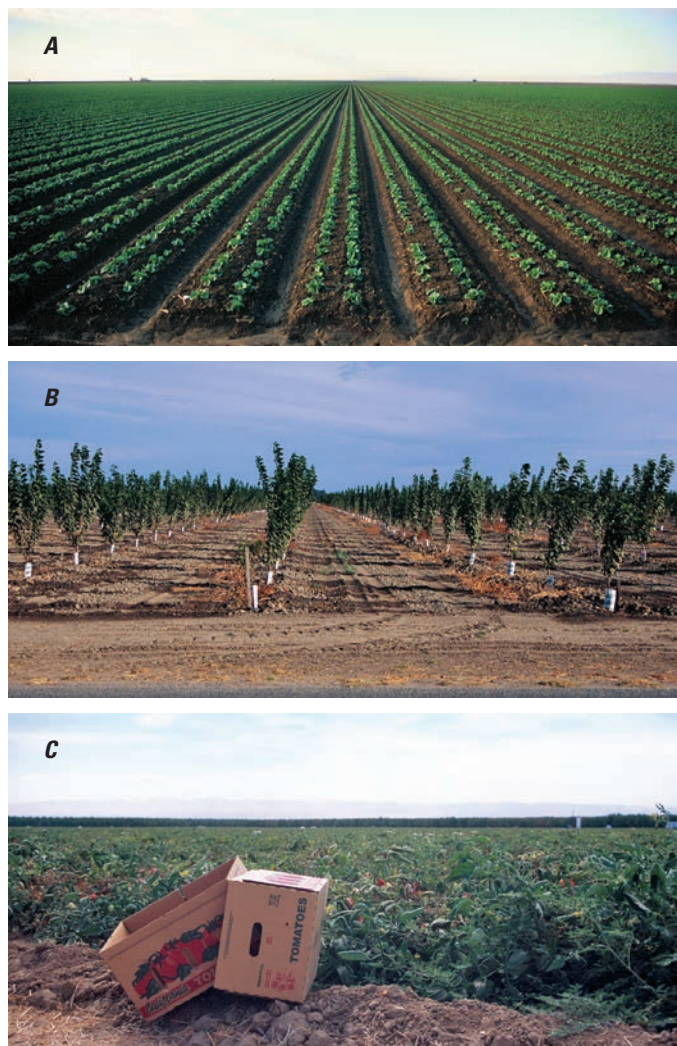


Figure 2. Agriculture in Central California Valley Ecoregion. *A*, Newly planted field. *B*, Young orchard. *C*, Tomato field.

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 km² 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 km² 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 km² (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

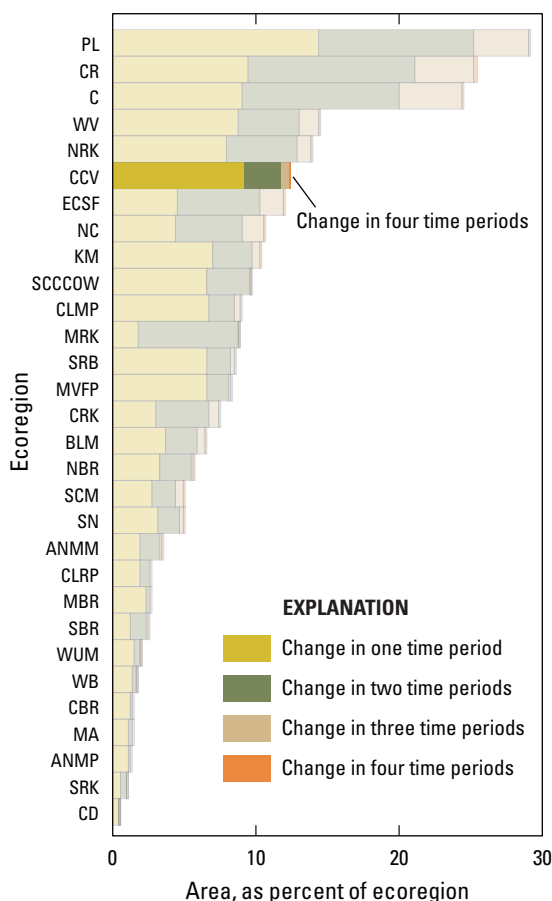


Figure 3. Overall spatial change in Central California Valley Ecoregion (CCV; darker bars) compared with that of all 30 Western United States ecoregions (lighter bars). Each horizontal set of bars shows proportions of ecoregion that changed during one, two, three, or four time periods; highest level 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.

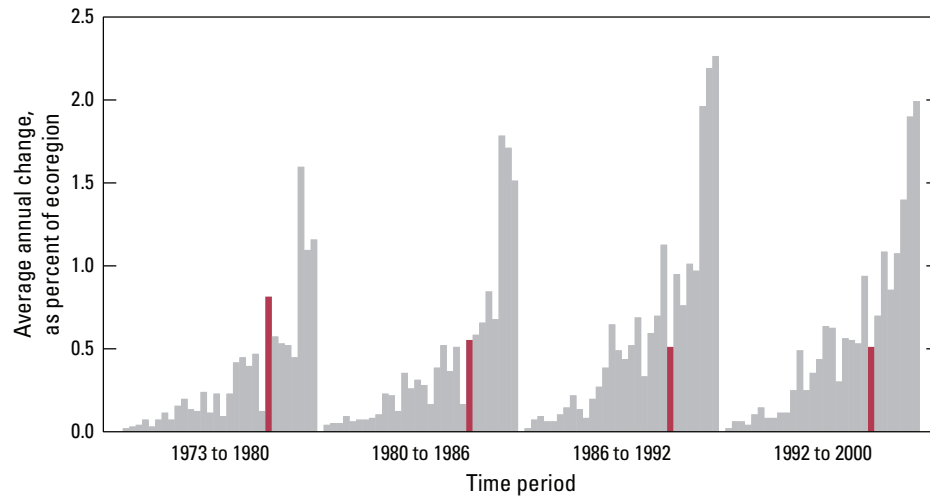
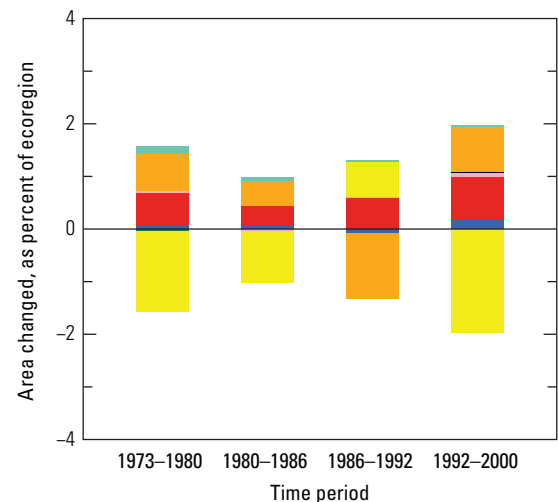


Figure 4. Estimates of land-cover change per time period, normalized to annual rates of change for all 30 Western United States ecoregions (gray bars). Estimates of change for Central California Valley Ecoregion are represented by red bars in each time period.

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. 8A,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



EXPLANATION
LAND-USE/LAND-COVER CLASS

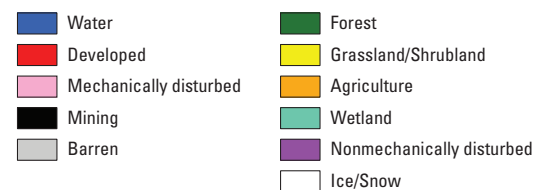


Figure 5. Normalized average net change in Central California Valley Ecoregion by time period for each land-cover class. Bars above zero axis represent net gain, whereas bars below zero represent net loss. Note that not all land-cover classes shown in explanation may be represented in figure. See appendix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

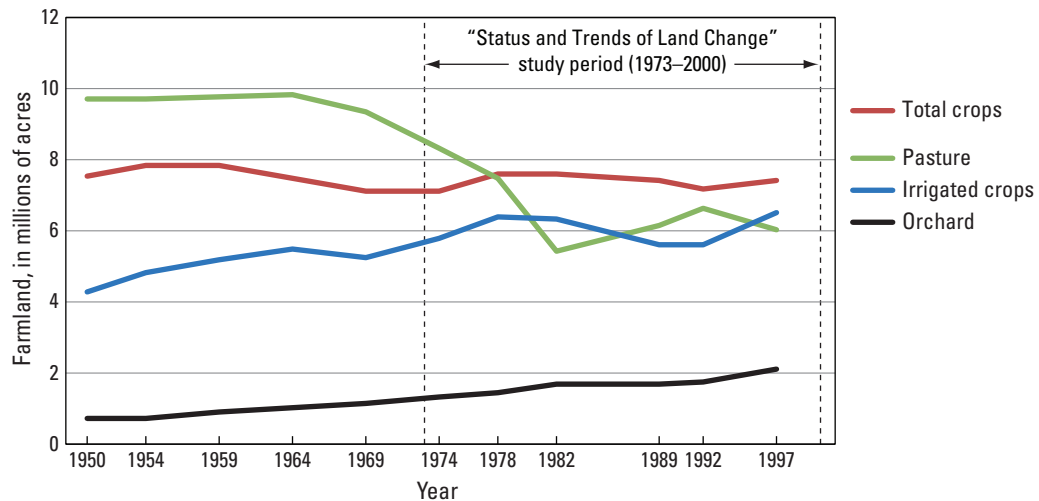


Figure 10. Changes in California agriculture (total crops, irrigated crops, pasture, and orchards) between 1950 and 1997 (U.S. Department of Agriculture, 2004).

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 km² 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

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

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

³Information 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
					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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