Status and Trends of Land Change in the Western United States—1973 to 2000
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Chapter 20

Central Basin and Range Ecoregion

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This chapter has been modified from original material published in Soulard (2006), entitled “Land-cover trends of the Central Basin and Range Ecoregion” (U.S. Geological Survey Scientific Investigations Report 2006–5288).

Ecoregion Description

The Central Basin and Range Ecoregion (Omernik, 1987; U.S. Environmental Protection Agency, 1997) encompasses approximately 343,169 km² (132,498 mi²) of land bordered on the west by the Sierra Nevada Ecoregion, on the east by the Wasatch and Uinta Mountains Ecoregion, on the north by the Northern Basin and Range and the Snake River Basin Ecoregions, and on the south by the Mojave Basin and Range and the Colorado Plateaus Ecoregions (fig. 1). Most of the Central Basin and Range Ecoregion is located in Nevada (65.4 percent) and Utah (25.1 percent), but small segments are also located in Idaho (5.6 percent), California (3.7 percent), and Oregon (0.2 percent). Basin-and-range topography characterizes the Central Basin and Range Ecoregion: wide desert valleys are bordered by parallel mountain ranges generally oriented north-south. There are more than 33 peaks within the Central Basin and Range Ecoregion that have summits higher than 3,000 m

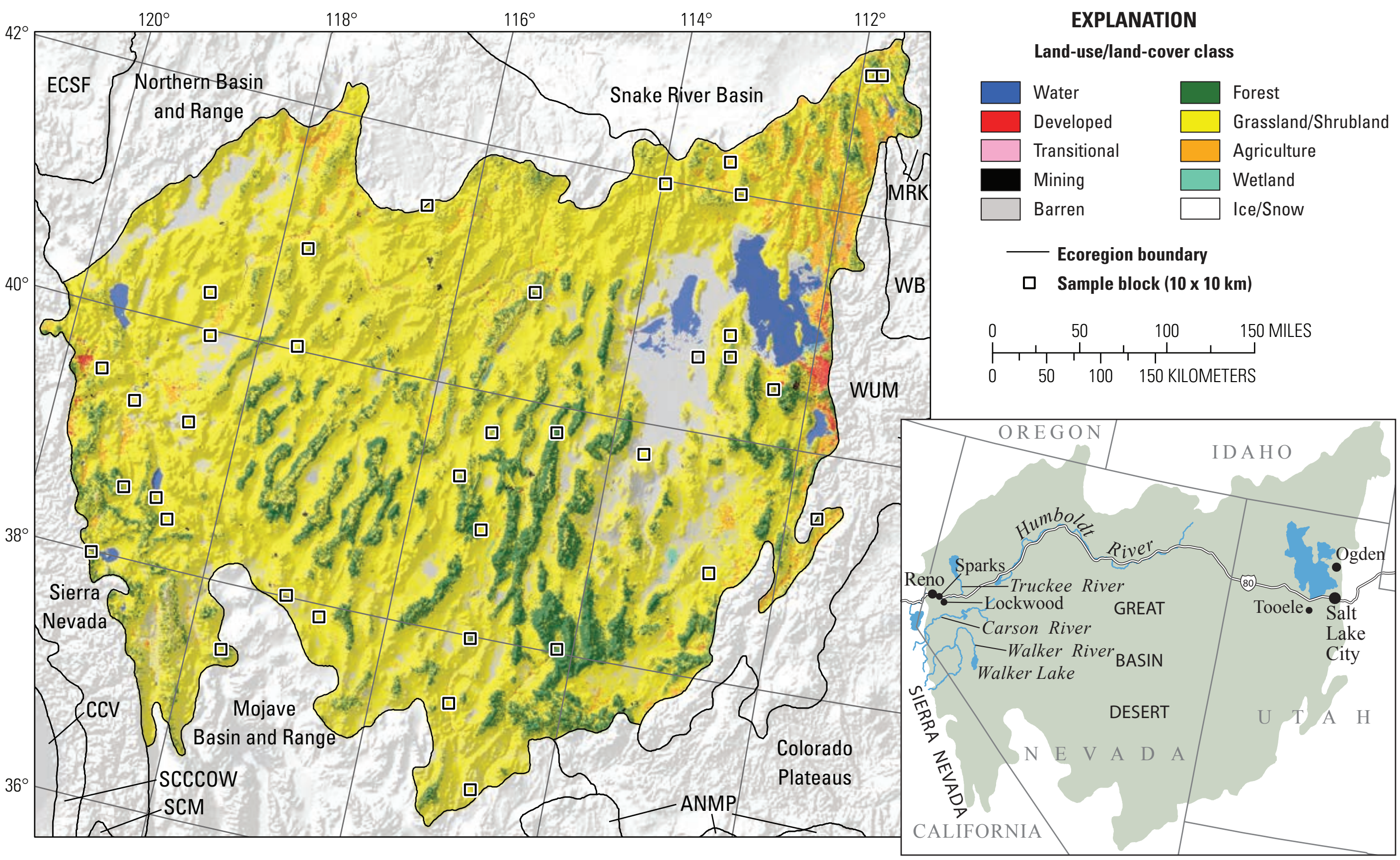

Figure 1. Map of Central Basin and Range Ecoregion and surrounding ecoregions, showing land-use/land-cover classes from 1992 National Land Cover Dataset (Vogelmann and others, 2001); note that not all land-use/land-cover classes shown in explanation may be depicted on map; note also that, for this “Status 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.

(10,000 ft), but valleys in the ecoregion are also high, most having elevations above 1,200 m (4,000 ft) (Grayson, 1993).

The Central Basin and Range Ecoregion's high elevation and location between mountain ranges influences regional climate. The Sierra Nevada to the west produces a rain shadow effect that blocks moisture from the Pacific Ocean, and the Rocky Mountains to the east creates a barrier effect that restricts moisture from the Gulf of Mexico (Rogers, 1982). This lack of moisture creates the Great Basin Desert (encompassed within the Central Basin and Range Ecoregion), which is one of the four biologically distinct deserts in North America, along with the Mojave, Sonoran, and Chihuahuan Deserts (Grayson, 1993). The Great Basin has the coldest climate of these deserts. As opposed to the other North American deserts, precipitation within the Great Basin regularly falls in winter as snow (Mac and others, 1998). Because no natural drainages exist within the Central Basin and Range Ecoregion, the little precipitation that does fall either drains to ephemeral or saline lakes by means of streams or disappears through evaporation and (or) absorption into the soil (Grayson, 1993).

Inhospitable conditions, such as harsh climate, infertile soils, and lack of viable resources, have been a formidable barrier to human land use in the Central Basin and Range Ecoregion. These conditions also restrict ecoregion resilience, which results in lasting impacts from most land-use practices. This ecoregion is very sensitive to those land-use changes that do occur (Mac and others, 1998; Pellant and others, 2004; Chambers and Miller, 2004). Much as with the historical land-use legacies of the ecoregion, factors that have driven contemporary change in the ecoregion have the potential to produce long-term consequences. For example, the poor soil quality and low rainfall characteristic of the ecoregion make successful farming difficult. As a way to overcome these obstacles, farmers either establish irrigation-dependent crops near rare riparian segments or rely on groundwater pumping and water diversions. Water diversions from the Carson, Humboldt, Truckee, and Walker Rivers have shifted to accommodate irrigation demand (particularly to support the ranching industry), municipal-water demand in regional cities (for example, Reno, Nevada), and government-mandated water conservation. Shifts in agricultural land use across the Central Basin and Range Ecoregion degrade ecosystems vital to the fitness of many vertebrates and invertebrates. This degradation is manifested as livestock trampling of native vegetation (in wetlands and grasslands) and lowered water tables in places like Walker Lake (Mac and others, 1998).

The arid climate and abundance of dry fuel sources also make the ecoregion naturally susceptible to fire. This susceptibility has been magnified since European settlement in the late 1800s. Early settlers changed the composition of grasslands and shrublands by introducing livestock grazing and fire-suppression practices within the sagebrush-dominated landscape. Grazing and fire suppression have continued to the present day and have shaped the grassland/shrubland landscape by degrading sagebrush plant communities and enabling nonnative annual grasses to invade much of the ecoregion (Miller and others, 2001). These grasses, most notably cheatgrass (*Bromus tectorum*), not only contribute to a rise in fire susceptibility across the ecoregion by increasing dry fuel sources but also reestablish themselves more easily than native plants following fires, thereby perpetuating and magnifying the cycle of fires (Pellant and others, 2004). Historical and contemporary land-use practices have produced lasting impacts in the Central Basin and Range Ecoregion by changing the fire regime and making the ecoregion more susceptible to fire. The increased probability of fire poses long-term risks for human and natural systems.

Contemporary Land-Cover Change (1973 to 2000)

Land-use/land-cover change between 1973 and 2000 that was discernable using a 60-m mapping unit was minimal, especially when compared to other ecoregions of the western

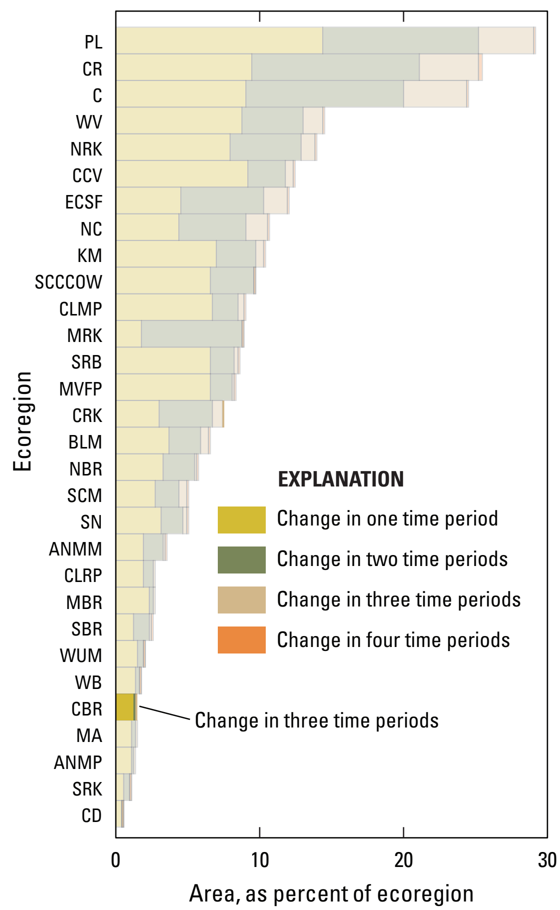

Figure 2. Overall spatial change in Central Basin and Range Ecoregion (CBR; darker bars) compared with that of all 30 Western United States ecoregions (lighter bars). Each horizontal set of bars shows proportions of ecoregion that changed during one, two, three, or four time periods; highest level of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

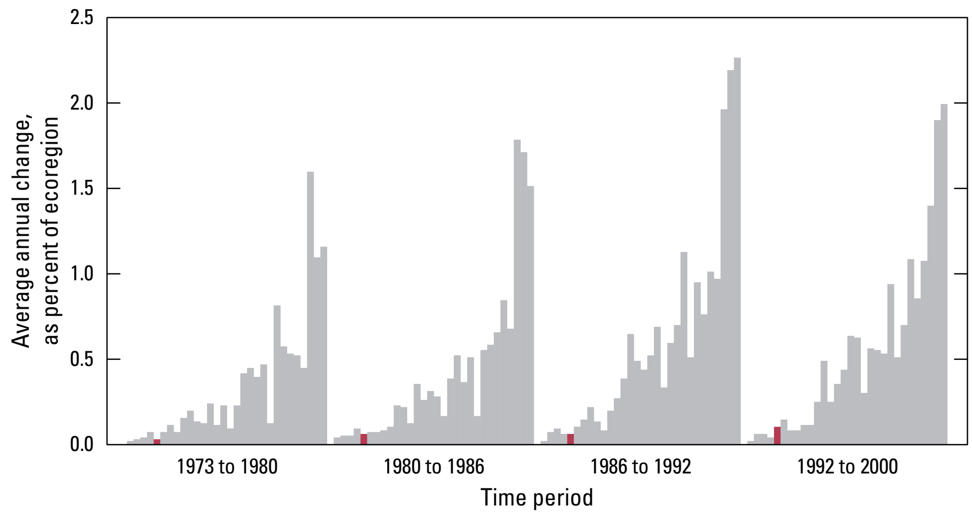

Figure 3. Estimates of land-cover change per time period, normalized to annual rates of change for all 30 Western United States ecoregions (gray bars). Estimates of change for Central Basin and Range Ecoregion are represented by red bars in each time period.

United States (fig. 2). Between 1973 and 2000, the footprint (overall areal extent) of land-cover change in the Central Basin and Range Ecoregion was only 1.5 percent, or 4,979 km². The footprint of change can be interpreted as the area in the Central Basin and Range Ecoregion that experienced change during at least one of the four multiyear periods that make up the 27-year study period; it does not account for the frequency of change in any given location. This overall spatial change translates to 4,461 km² that changed in one period, 343 km² that changed in two periods, and 166 km² that changed in three periods (table 1).

The normalized annual rate of land-cover change in the Central Basin and Range Ecoregion between 1973 and 2000 was less than 0.1 percent per year. This means that the ecoregion averaged less than 0.1 percent (206 km²) of change each year in the 27-year study period. Between 1973 and 1980, the annual rate of change in the Central Basin and Range Ecoregion was less than 0.1 percent per year, while the annual rate of change increased to about 0.1 percent per year between 1980 and 1986, 1986 and 1992, and 1992 and 2000 (table 2; fig. 3).

Of the 11 land-use/land-cover classes, 4 dominated the landscape of the Central Basin and Range Ecoregion in 2000: grassland/shrubland (75.4 percent), forest (15.3 percent), barren (3.9 percent), and agriculture (2.9 percent). The remaining seven classes cumulatively made up the remaining 2.5 percent of the Central Basin and Range Ecoregion landscape in 2000 (table 3).

Between 1973 and 2000, the land-cover classes that experienced a measurable net change include grassland/shrubland (0.8 percent decrease), forest (1.9 percent decrease), developed (43 percent increase), wetland (12.2 percent decrease), mining (159 percent increase, but still representing just 0.2 percent of the ecoregion), and nonmechanically disturbed (which was not present until the 2000 classification, when it occupied 0.5 percent of the sampled area). Net change by temporal period is illustrated in figure 4.

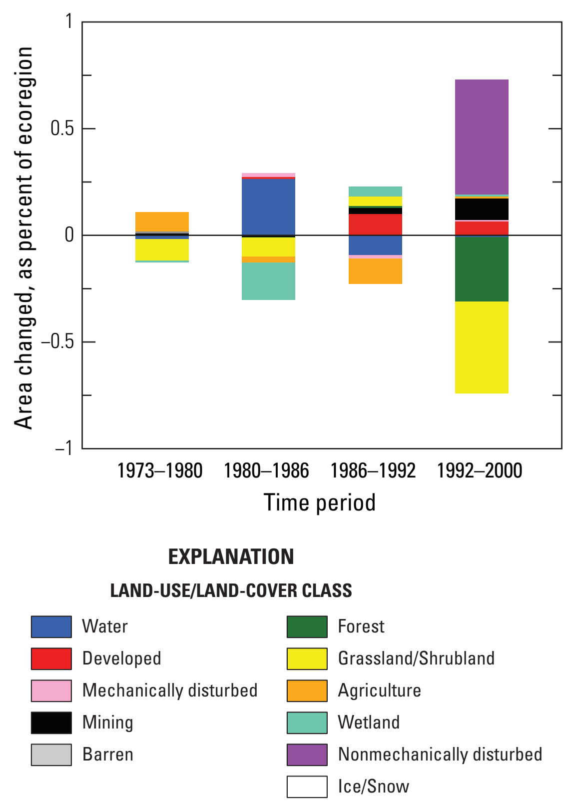

Figure 4. Normalized average net change in Central Basin and Range Ecoregion by time period for each land-cover class. Bars above zero axis represent net gain, whereas bars below zero represent net loss. Note that not all land-cover classes shown in explanation may be represented in figure. See appendix 2 for definitions of land-use/land-cover classifications.

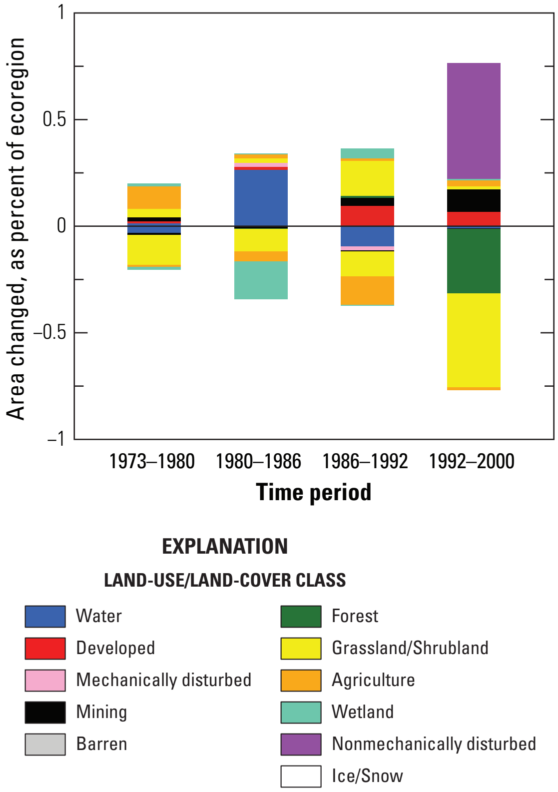

Figure 5. Gross change (area gained and lost) in Central Basin and Range Ecoregion by time period for each land-cover class. Area gained is shown by positive values, and area lost is shown by negative values. Note that not all land-cover classes shown in explanation may be represented in figure. See appendix 2 for definitions of land-use/land-cover classifications.

Figure 6. Instances of agriculture in Central Basin and Range Ecoregion. *A*, Livestock grazing on rangeland. *B*, Irrigated fields growing livestock feed.

Net change, however, is not necessarily the best indicator of within-class variability for those classes experiencing spatio-temporal fluctuations (fig. 5). For instance, areas classified as water fluctuated wildly between 259 km^2 (1980) and 1,168 km^2 (1986) because of the ephemeral nature of desert lakes. Between 1973 and 2000, a net areal gain of 172 percent (518 km^2) in water was measured, but gross change over the entire study period reached 1,420 km^2, nearly five times the area that water occupied in 1973.

The "from class–to class" information afforded by a postclassification comparison was used to identify land-cover class conversions and rank them according to their magnitude. Table 4 illustrates the most frequent conversions for each individual time period and also between 1973 and 2000. Although fieldwork confirmed the presence of many of the conversions listed in table 4, the ability to report these changes on the basis of interpretations was accomplished with varying degrees of uncertainty (as illustrated by the statistical error values in the table). In general, higher uncertainty arose where sampled changes were clustered within certain parts of the ecoregion rather than distributed evenly across the ecoregion.

The two most prominent conversions reflect the natural, or nonmechanical, disturbance of natural land cover by fire. Cumulatively, the effect of nonmechanical disturbance on grassland/shrubland and forest resulted in 1,872 km^2 (32.5 percent of all changes) loss of vegetated land cover. As discussed earlier, the increase in fire seen within the Central Basin and Range Ecoregion is largely attributable to the invasion of annual grasses like cheatgrass (*Bromus tectorum*), which has increased dry fuels on the landscape. The changes in the agriculture and water classes represent other common conversions. Prominent changes in agricultural lands include 527 km^2 of conversion from grassland/shrubland to agriculture and 503 km^2 from agriculture to grassland/shrubland (fig. 3). Similarly, the water class experienced a variety of conversions within the Central Basin and Range Ecoregion, including 640 km^2 from wetland to water, 255 km^2 from water to grassland/shrubland, 222 km^2 from grassland/shrubland to water, and 178 km^2 from water to wetland (note that water conversions account for changes in both natural and manmade water bodies). Ultimately, these land-use dynamics vary across the ecoregion and, as noted earlier, are associated with irrigation demand (to support the ranching industry), municipal-water demand in cities (for

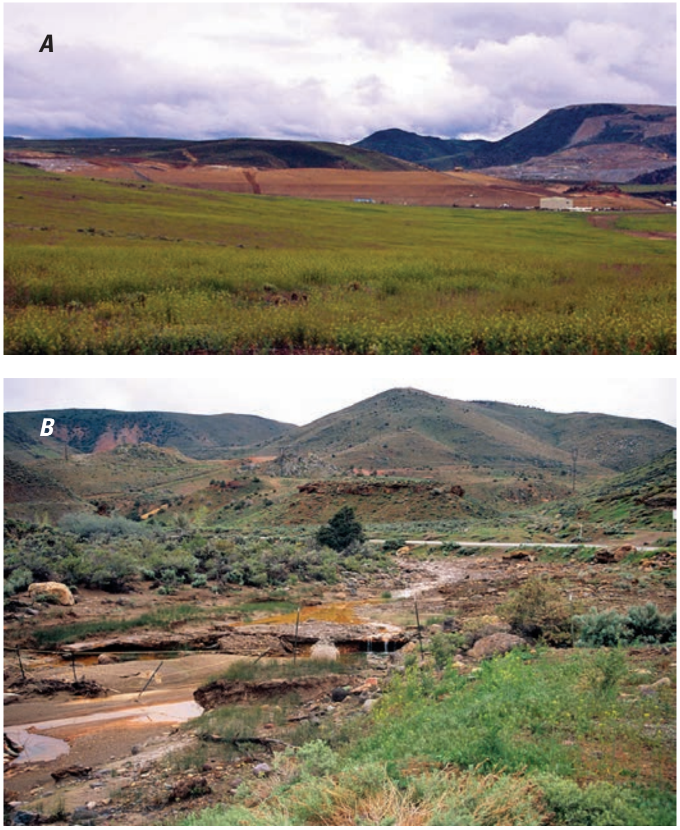

Figure 7. Hillside municipal-waste facility (*A*) and its downhill stream drainage (*B*) near Lockwood, Nevada.

example, Reno, Nevada), and government-mandated water conservation. Changes from grassland/shrubland to both developed (538 km²) and mining (526 km²) were predominantly unidirectional and permanent (figs. 6,7,8).

Contemporary land-use/land-cover change has been minimal throughout the Central Basin and Range Ecoregion. However, landscape changes that result from increased fire frequency, rising demand for water and mineral resources, and growing highway development can have far-reaching consequences despite the small spatial extent of change. For example, increased fire frequency in the Central Basin and Range Ecoregion has ultimately contributed to the loss of sagebrush plant communities in favor of invasive annual grasses (Miller and others, 2001), resulting in possible impacts on biological diversity and human health. Much of the wildlife that depends on this vegetated landscape may become more vulnerable as a result of loss of habitat following a fire. Fire also directly threatens human communities and indirectly affects humans by jeopardizing traditional ranging practices (U.S. Geological Survey, 2003). Agricultural and developed land-use changes also have possible impacts, including pollution from agricultural and municipal sources as well as mechanical disturbances associated with water and mineral-resource use. Although wildlife has proven to be resilient to anthropogenic land use, the loss of natural vegetation resulting

Figure 8. Different elements of mining in Central Basin and Range Ecoregion. *A*, Gravel-extraction site near Tooele, Utah. *B*, Piles of gravel aggregate awaiting transport. *C*, Mineral-processing facility along Interstate 80 near Reno, Nevada. *D*, Old tailings pile undergoing reestablishment of vegetation.

from the afore-mentioned changes has both eliminated and polluted ecosystems used by endangered species such as the Greater Sage Grouse (*Centrocercus urophasianus*).

The growth of human populations in the Reno–Sparks and Salt Lake City–Ogden metropolitan areas will likely dictate the rate of future land-use conversions in the Central Basin and Range Ecoregion. The findings from the present study can be used in conjunction with existing literature to explore how, and to what extent, current land-use/land-cover trends will affect the Central Basin and Range Ecoregion into the future, and they also can provide insights into how policy change may alter current landscape conditions.

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

[Most sample pixels remained unchanged (98.5 percent), whereas 1.5 percent changed at least once throughout study period. Two dashes (--) indicate that, because zero pixels changed four times during study period, relative error is not calculable]

Number of changes	Percent of ecoregion	Margin of error (+/– %)	Lower bound (%)	Upper bound (%)	Standard error (%)	Relative error (%)
1	1.3	0.7	0.6	1.9	0.4	35.0
2	0.1	0.1	0.0	0.2	0.1	59.7
3	0.0	0.0	0.0	0.1	0.0	65.9
4	0.0	0.0	0.0	0.0	0.0	--
Overall spatial change	1.5	0.7	0.7	2.2	0.5	34.2

Table 2. Raw estimates of change in Central Basin and Range 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	0.2	0.1	0.1	0.3	0.1	48.2	0.0
1980–1986	0.3	0.3	0.0	0.7	0.2	69.5	0.1
1986–1992	0.4	0.2	0.2	0.5	0.1	34.1	0.1
1992–2000	0.8	0.6	0.2	1.3	0.4	49.4	0.1
Estimate of change, in square kilometers							
1973–1980	698	495	202	1,193	337	48.2	100
1980–1986	1,163	1,190	–27	2,354	808	69.5	194
1986–1992	1,254	629	624	1,883	428	34.1	209
1992–2000	2,638	1,918	721	4,556	1,303	49.4	330

Table 3. Estimated area (and margin of error) of each land-cover class in Central Basin and Range 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	0.1	0.1	0.4	0.4	0.0	0.0	0.1	0.1	3.9	3.6	15.6	5.1	75.9	5.7	2.9	2.1	1.0	0.7	0.0	0.0
1980	0.1	0.1	0.4	0.4	0.0	0.0	0.1	0.1	3.9	3.6	15.6	5.1	75.8	5.7	3.0	2.2	1.0	0.7	0.0	0.0
1986	0.3	0.4	0.5	0.4	0.0	0.0	0.1	0.1	3.9	3.6	15.6	5.1	75.8	5.7	3.0	2.2	0.8	0.7	0.0	0.0
1992	0.2	0.3	0.6	0.4	0.0	0.0	0.1	0.1	3.9	3.6	15.6	5.1	75.8	5.7	2.9	2.1	0.9	0.7	0.0	0.0
2000	0.2	0.3	0.6	0.4	0.0	0.0	0.2	0.2	3.9	3.6	15.3	4.8	75.4	5.6	2.9	2.1	0.9	0.7	0.5	0.6
Net change	0.2	0.3	0.2	0.1	0.0	0.0	0.1	0.1	0.0	0.0	−0.3	0.4	−0.6	0.5	0.0	0.1	−0.1	0.2	0.5	0.6
Gross change	0.4	0.5	0.2	0.1	0.0	0.1	0.2	0.1	0.0	0.0	0.3	0.4	1.0	0.5	0.3	0.2	0.2	0.3	0.5	0.6
Area, in square kilometers																				
1973	302	278	1,510	1,256	0	0	312	317	13,320	12,282	53,407	17,337	260,616	19,717	10,060	7,371	3,509	2,405	0	0
1980	259	246	1,530	1,261	0	0	345	307	13,323	12,282	53,407	17,337	260,266	19,706	10,401	7,401	3,506	2,403	0	0
1986	1,168	1,219	1,581	1,262	61	89	336	280	13,323	12,282	53,384	17,341	259,975	19,699	10,302	7,396	2,906	2,281	0	0
1992	847	968	1,922	1,308	0	0	454	328	13,323	12,282	53,400	17,343	260,129	19,580	9,905	7,150	3,055	2,281	0	0
2000	820	930	2,159	1,368	12	18	806	520	13,323	12,282	52,366	16,615	258,664	19,382	9,932	7,131	3,082	2,283	1,872	1,916
Net change	518	925	649	484	12	18	494	349	3	5	−1,041	1,471	−1,952	1,580	−128	434	−428	628	1,872	1,916
Gross change	1,420	1,575	649	484	134	179	570	375	3	5	1,074	1,470	3,311	1,578	1,150	629	782	1,133	1,872	1,916

Table 4. Principal land-cover conversions in Central Basin and Range 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 (km²)	Margin of error (+/– km²)	Standard error (km²)	Percent of ecoregion	Percent of all changes
1973–1980	Grassland/Shrubland	Agriculture	352	353	240	0.1	50.5
	Water	Grassland/Shrubland	101	148	101	0.0	14.5
	Grassland/Shrubland	Mining	62	51	34	0.0	8.9
	Wetland	Water	39	57	38	0.0	5.5
	Grassland/Shrubland	Wetland	37	55	37	0.0	5.3
	Other	Other	106	n/a	n/a	0.0	15.2
		Totals	698			0.2	100.0
1980–1986	Wetland	Water	600	874	594	0.2	51.6
	Grassland/Shrubland	Water	202	234	159	0.1	17.3
	Agriculture	Water	108	158	107	0.0	9.3
	Grassland/Shrubland	Agriculture	55	57	39	0.0	4.8
	Grassland/Shrubland	Developed	51	46	31	0.0	4.4
	Other	Other	147	n/a	n/a	0.0	12.7
		Totals	1,163			0.3	100.0
1986–1992	Agriculture	Grassland/Shrubland	399	320	218	0.1	31.8
	Grassland/Shrubland	Developed	243	193	131	0.1	19.4
	Water	Grassland/Shrubland	154	225	153	0.0	12.3
	Water	Wetland	149	214	145	0.0	11.9
	Grassland/Shrubland	Mining	126	117	79	0.0	10.1
	Other	Other	182	n/a	n/a	0.1	14.5
		Totals	1,254			0.4	100.0
1992–2000	Forest	Nonmechanically disturbed	1,005	1,471	1,000	0.3	38.1
	Grassland/Shrubland	Nonmechanically disturbed	867	1,269	862	0.3	32.9
	Grassland/Shrubland	Mining	328	252	171	0.1	12.4
	Grassland/Shrubland	Developed	224	198	135	0.1	8.5
	Grassland/Shrubland	Agriculture	85	124	84	0.0	3.2
	Other	Other	130	n/a	n/a	0.0	4.9
		Totals	2,638			0.8	100.0
1973–2000 (overall)	Forest	Nonmechanically disturbed	1,005	1,471	1,000	0.3	17.5
	Grassland/Shrubland	Nonmechanically disturbed	867	1,269	862	0.3	15.1
	Wetland	Water	640	932	633	0.2	11.1
	Grassland/Shrubland	Developed	538	386	262	0.2	9.4
	Grassland/Shrubland	Agriculture	527	413	281	0.2	9.2
	Other	Other	2,177	n/a	n/a	0.6	37.8
		Totals	5,753			1.7	100.0

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