Status and Trends of Land Change in the Western United States—1973 to 2000
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Chapter 12

Eastern Cascades Slopes and Foothills Ecoregion

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Ecoregion Description

The Eastern Cascades Slopes and Foothills Ecoregion (Omernik, 1987; U.S. Environmental Protection Agency, 1997) covers approximately 57,329 km² (22,135 mi²) in the states of Washington, Oregon, and California (fig. 1). The ecoregion is bounded on the east by the Columbia Plateau, Blue Mountains, and Northern Basin and Range Ecoregions; on the south by the Sierra Nevada Ecoregion; on the west by the Klamath Mountains and Cascades Ecoregions; and on the north by the North Cascades Ecoregion (fig. 1). Because the Eastern Cascades Slopes and Foothills Ecoregion lies within the rain shadow of the Cascade Range, the annual amount of precipitation varies greatly, from 500 mm in the eastern and southern sections of the ecoregion to 3,000 mm in the area bordering the higher Cascade Range to the west. Precipitation (either rain or snow) falls mostly in the fall, through winter into spring. Elevations range from near sea level at the Columbia River to more than 3,300 m; most of the region is between 900 and 2,000 m high.

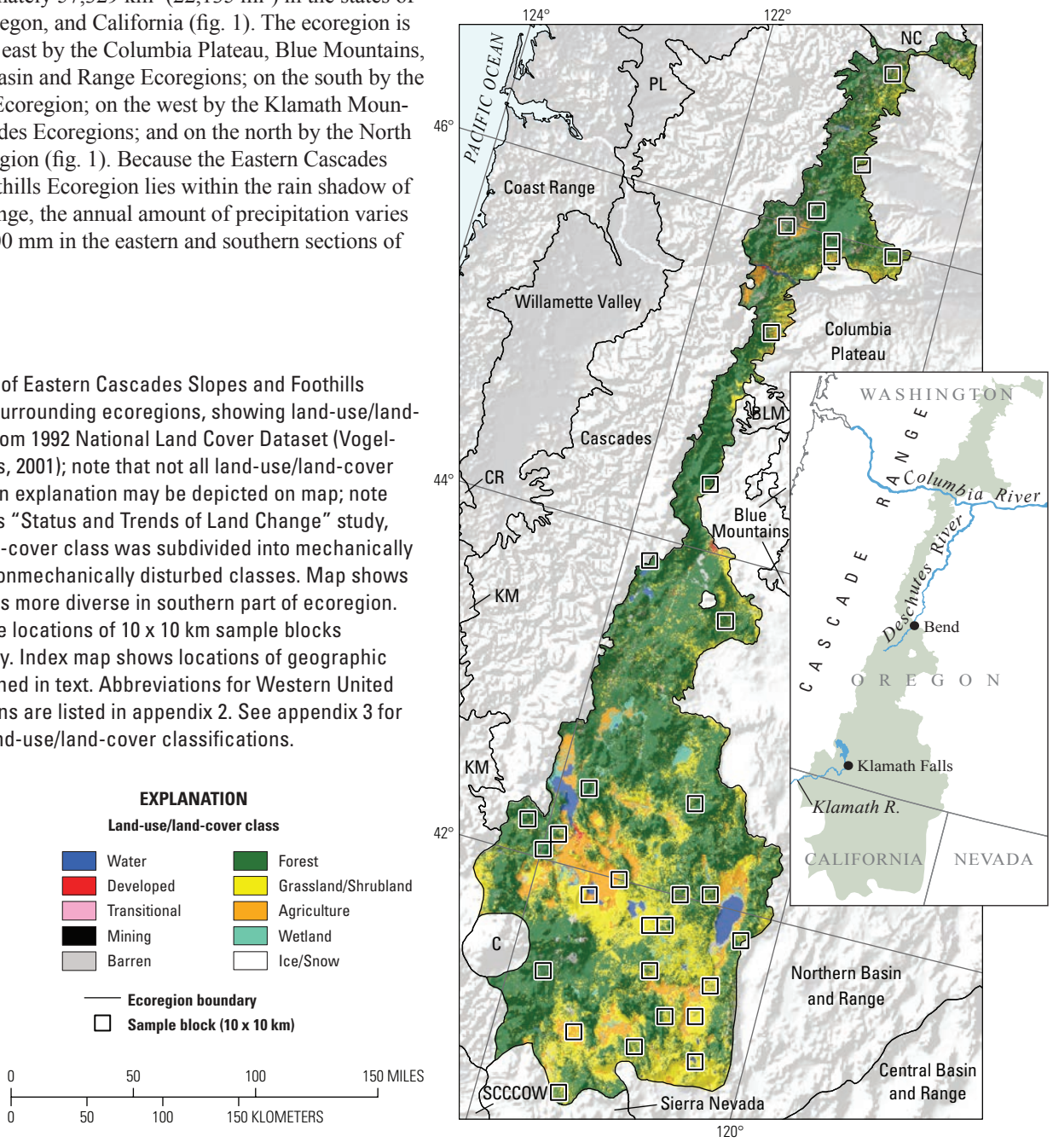

Figure 1. Map of Eastern Cascades Slopes and Foothills Ecoregion and surrounding ecoregions, showing land-use/land-cover classes from 1992 National Land Cover Dataset (Vogelmann and others, 2001); note that not all land-use/land-cover classes shown in explanation may be depicted on map; note also that, for this "Status and Trends of Land Change" study, transitional land-cover class was subdivided into mechanically disturbed and nonmechanically disturbed classes. Map shows that land cover is more diverse in southern part of ecoregion. 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. Grassy meadow and forested hillsides in Eastern Cascades Slopes and Foothills Ecoregion. Dominant land-cover class in Eastern Cascades Slopes and Foothills Ecoregion is forest, although grassland/shrubland makes up about one-third of ecoregion. Forests tend to be at higher elevations, in areas with more precipitation, whereas grassland/shrubland areas are found mostly in valley bottoms and drier locations. Photograph by Terry Sohl.

In the plateaus, elevation generally varies from 60 to 600 m (McNab and Avers, 1994).

The Eastern Cascades Slopes and Foothills Ecoregion formed from tectonic uplift with mountain ranges and valleys oriented north-to-south; it is a relatively young ecoregion with numerous lava flows, volcanic cones, and buttes (U.S. Environmental Protection Agency, 2010). Population is sparse: the two largest cities are Bend, Oregon, with a population of 52,029, and Klamath Falls, Oregon, with 19,462 residents (U.S. Census Bureau, 2000).

Forest is the primary land cover in the Eastern Cascades Slopes and Foothills Ecoregion (figs. 1,2), and fire plays an important role in forest composition. Ponderosa pine (*Pinus ponderosa*) is the dominant tree species, and lodgepole pine (*Pinus contorta*) is common in the drier parts of the ecoregion (Risser, 2000). The bark on older, larger ponderosa pines is thick, providing protection from fires. Ponderosa pines are usually little affected if 50 percent or less of the crown is destroyed by fire, giving them an advantage over less fire-tolerant tree species (Oliver and Ryker, 1990). Lodgepole pines have serotinous or closed cones that only open and release seeds when exposed to extreme heat during a fire. As a result, postfire colonization of burned areas by lodgepole pines is rapid, outpacing most other species (Lotan and Chritchfield, 1990).

The northern part of the Eastern Cascades Slopes and Foothills Ecoregion drains into the Deschutes and Columbia Rivers. Spring-fed tributaries and snow melt provide most of the rivers' water. The southern section is drained by the Klamath River, which is fed by a vast interior wetland. Approximately 75 percent of the historic wetlands of the Klamath Basin have been drained for crops. The most common crops grown in the Eastern Cascades Slopes and Foothills Ecoregion are hay, alfalfa, cereal grains, potatoes, onions, and sugar beets (Risser, 2000).

Contemporary Land-Cover Change (1973 to 2000)

Between 1973 and 2000, the areal extent of land-use/land-cover change (the footprint of change, or the area that experienced change at least once during the 27-year study period) in the Eastern Cascades Slopes and Foothills Ecoregion was 12.1 percent, or 6,943 km² (table 1). Compared with other western United States ecoregions, change in the Eastern Cascades Slopes and Foothills Ecoregion was above average (fig. 3). Overall, an estimated 2,637 km² (4.6 percent) of the ecoregion changed in one time period; 3,268 km²

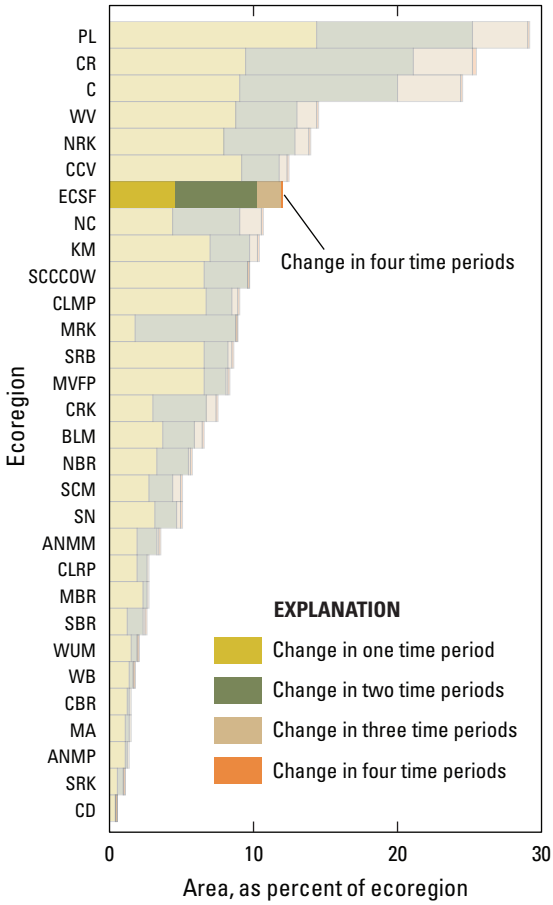

Figure 3. Overall spatial change in Eastern Cascades Slopes and Foothills Ecoregion (ECSF; darker bars) compared with that of all 30 Western United States ecoregions (lighter bars). Each horizontal set of bars shows proportions of ecoregion that changed during one, two, three, or four time periods; highest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

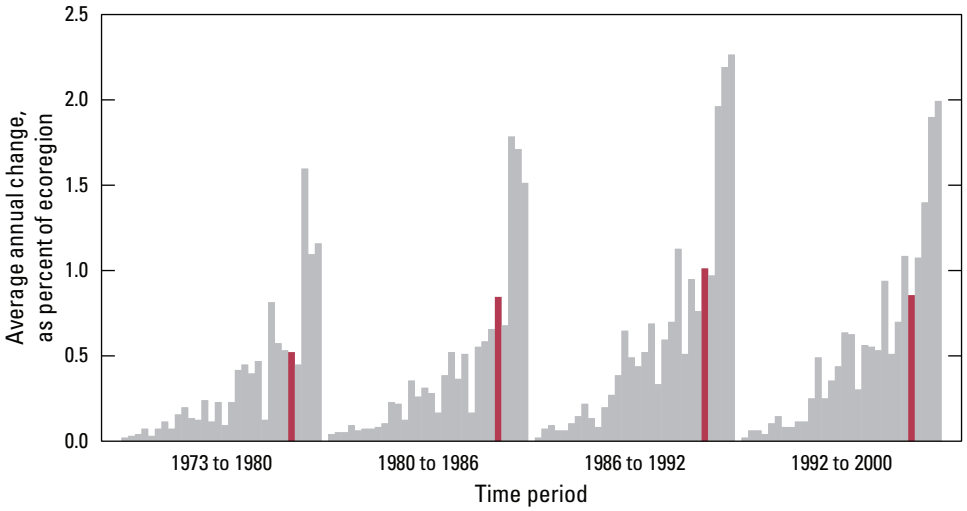

Figure 4. Estimates of land-cover change per time period, normalized to annual rates of change for all 30 Western United States ecoregions (gray bars). Estimates of change for Eastern Cascades Slopes and Foothills Ecoregion are represented by red bars in each time period.

(5.7 percent) changed in two time periods; 1,032 km² (1.8 percent) changed in three periods; and less than 57 km² (0.1 percent) area changed in all four time periods (table 1). The average annual rate of change in the Eastern Cascades Slopes and Foothills Ecoregion between 1973 and 2000 was 0.8 percent (table 2). Average annual change for successive time periods reveals a steady increase during the study period for the first three time periods and a slight decline for the last time period. Between 1973 and 1980, the annual rate of change was 0.5 percent (295 km²), increasing to 0.8 percent (486 km²) between 1980 and 1986. This rate continued to rise to 1.0 percent (580 km²) between 1986 and 1992 and then dropped slightly to 0.9 percent (489 km²) between 1992 and 2000 (fig. 4; table 2).

In 2000, three of the ten land-cover classes in the Eastern Cascades Slopes and Foothills Ecoregion dominate total land cover: forest (53.2 percent), grassland/shrubland (33.3 percent), and agriculture (7.1 percent) (table 3; fig. 1). The remaining seven classes contained the remaining 6.5 percent of the classified landscape in 2000. Each of these classes alone represented less than 2.5 percent of the sampled area. Between 1973 and 2000, the land-cover classes that experienced a measurable net change in relation to the total ecoregion area include net losses of forest (6.8 percent), in addition to net gains in grassland/shrubland (8.7 percent) and mechanically disturbed (7.2 percent) (table 3; fig. 5).

The top four land-cover conversions in the ecoregion for all time periods (except the fourth) were associated with timber harvest and forest regeneration (fig. 6). The principal type of change in all time periods was from forest to mechanically disturbed, caused by forest logging through clearcutting. The timber harvest-to-regeneration process starts after the removal of trees (forest to mechanically disturbed), after

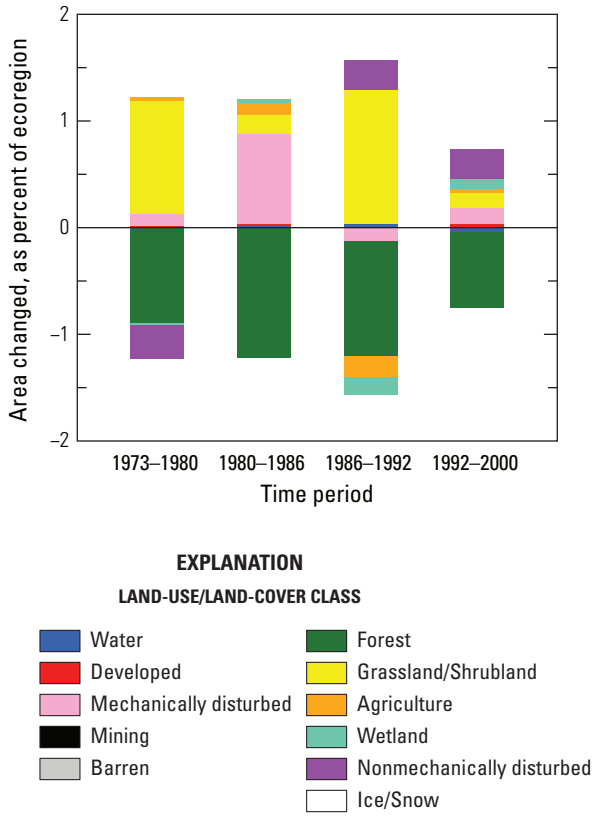

Figure 5. Normalized average net change in Eastern Cascades Slopes and Foothills Ecoregion by time period for each land-cover class. Bars above zero axis represent net gain, whereas bars below zero represent net loss. Note that not all land-cover classes shown in explanation may be represented in figure.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

Figure 6. Clearcutting of forested area. Principal cause of land-cover change in Eastern Cascades Slopes and Foothills Ecoregion was logging and forest regenerations. Photograph by Terry Sohl.

which the area is replanted with tree seedlings or regenerates naturally (mechanically disturbed to grassland/shrubland). The process continues as the seedlings grow tall enough (at least 2 m high) to be classified as trees (grassland/shrubland to forest). In some areas, forest regeneration was rapid, and so the six-to-eight year sampling interval missed the grassland/shrubland stage, which resulted in the apparent conversion from mechanically disturbed directly to forest. Forest cutting and regeneration accounted for almost all the change in the Eastern Cascades Slopes and Foothills Ecoregion, which was between 83 and 88 percent of all periods (table 4).

Several factors were involved in the decline of forest cutting. Lumber and wood exports declined in the 1990s because the primary market for Pacific Northwest wood products (Japan and other Asian counties) experienced an economic downturn that reduced demand. The 1990s saw more wood-producing countries such as Russia, Canada, and New Zealand increase their exports. In addition, the Northwest Forest Plan was implemented in 1996 to protect the threatened Northern Spotted Owl (*Strix occidentalis caurina*), which prefers to roost in old-growth forest that has moderate to high canopy enclosure. Timber sales in protected areas declined from 4 to 5 billion board feet per year to less than a billion board feet per year, and almost 60 percent of Pacific Northwest national forest was taken out of timber production (Daniels, 2005).

The rate of change and dominant land cover for the sample blocks in California (4.5 percent) was lower than that for the rest of the ecoregion (12.1 percent). In 2000, the top three land-cover classes in the California section of the ecoregion were grassland/shrubland (48.0 percent), forest (35.3 percent), and agriculture (10.3 percent), whereas, for the Eastern Cascades Slopes and Foothills Ecoregion as a whole, the percentages for forest, grassland/shrubland, and agriculture were 53.2 percent, 33.3 percent, and,7.0 percent, respectively. Although 50.6 percent of all land-cover change in the California section was the result of logging and forest regeneration, not all of the top land-cover conversions were related to logging. Fire disturbance and recovery (nonmechanically disturbed) was one of the top conversions, as was water-to-wetland conversion (table 4). Further research is needed to explore the cause of land-cover differences in this ecoregion. Possible factors might include elevation, annual precipitation, and varying land-use practices and policies in California, Oregon, and Washington.

Table 1. Percentage of Eastern Cascades Slopes and Foothills Ecoregion land cover that changed at least one time during study period (1973–2000) and associated statistical error.

[Most sample pixels remained unchanged (87.9 percent), whereas 12.1 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	4.6	1.4	3.2	5.9	0.9	20.5
2	5.7	2.0	3.8	7.7	1.3	23.1
3	1.8	0.9	0.8	2.7	0.6	36.4
4	0.1	0.1	0.0	0.1	0.0	57.6
Overall spatial change	12.1	3.5	8.6	15.6	2.4	19.6

Table 2. Raw estimates of change in Eastern Cascades Slopes and Foothills 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	3.6	1.3	2.3	4.9	0.9	25.3	0.5
1980–1986	5.1	1.9	3.2	7.0	1.3	24.9	0.8
1986–1992	6.1	2.2	3.9	8.2	1.5	24.2	1.0
1992–2000	6.8	2.1	4.7	8.9	1.4	21.0	0.9
Estimate of change, in square kilometers							
1973–1980	2,065	771	1,294	2,836	522	25.3	295
1980–1986	2,917	1,074	1,843	3,990	727	24.9	486
1986–1992	3,478	1,243	2,235	4,721	842	24.2	580
1992–2000	3,915	1,212	2,702	5,127	821	21.0	489

Table 3. Estimated area (and margin of error) of each land-cover class in Eastern Cascades Slopes and Foothills 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	1.5	1.1	0.1	0.1	1.4	0.7	0.0	0.0	0.2	0.2	57.1	7.6	30.6	6.7	7.1	3.7	1.6	0.7	0.3	0.4
1980	1.5	1.2	0.1	0.1	1.5	0.7	0.0	0.0	0.2	0.2	56.2	7.4	31.7	6.5	7.2	3.7	1.6	0.7	0.0	0.0
1986	1.5	1.2	0.1	0.1	2.3	1.0	0.0	0.0	0.2	0.2	55.0	7.3	31.9	6.4	7.3	3.7	1.6	0.7	0.0	0.0
1992	1.6	1.2	0.2	0.1	2.2	0.9	0.0	0.0	0.2	0.2	54.0	7.1	33.1	6.3	7.1	3.7	1.5	0.7	0.3	0.3
2000	1.5	1.1	0.2	0.1	2.3	1.0	0.0	0.0	0.2	0.2	53.2	6.9	33.3	6.2	7.1	3.7	1.5	0.7	0.6	0.8
Net change	0.0	0.1	0.1	0.1	1.0	1.0	0.0	0.0	0.0	0.0	−3.9	1.7	2.7	1.7	0.0	0.2	−0.1	0.1	0.2	0.9
Gross change	0.7	0.4	0.1	0.1	6.0	1.9	0.0	0.0	0.0	0.0	6.4	2.2	6.3	2.1	0.6	0.6	0.7	0.4	1.4	1.2
Area, in square kilometers																				
1973	850	652	73	40	781	421	4	4	115	129	32,761	4,385	17,555	3,857	4,093	2,105	917	412	179	257
1980	856	679	78	42	843	414	4	4	115	129	32,247	4,265	18,171	3,723	4,110	2,101	904	412	0	0
1986	870	673	83	45	1,327	586	5	5	115	129	31,550	4,158	18,276	3,692	4,177	2,103	925	419	0	0
1992	889	660	90	49	1,262	541	5	5	114	128	30,930	4,042	18,990	3,583	4,057	2,122	832	383	160	161
2000	867	630	108	65	1,344	589	5	5	114	128	30,525	3,942	19,085	3,531	4,076	2,120	886	392	317	455
Net change	17	53	35	29	563	557	1	1	−1	1	−2,236	955	1,531	986	−17	131	−31	59	138	529
Gross change	377	218	35	29	3,442	1,076	1	1	1	1	3,643	1,281	3,587	1,191	334	336	377	231	816	696

Table 4. Principal land-cover conversions in Eastern Cascades Slopes and Foothills 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	Mechanically disturbed	835	409	277	1.5	40.4
	Mechanically disturbed	Grassland/Shrubland	558	343	232	1.0	27.0
	Mechanically disturbed	Forest	206	163	111	0.4	10.0
	Nonmechanically disturbed	Grassland/Shrubland	165	236	160	0.3	8.0
	Grassland/Shrubland	Forest	85	63	42	0.1	4.1
	Other	Other	216	n/a	n/a	0.4	10.5
		Totals	2,065			3.6	100.0
1980–1986	Forest	Mechanically disturbed	1,310	582	394	2.3	44.9
	Mechanically disturbed	Grassland/Shrubland	594	341	231	1.0	20.4
	Grassland/Shrubland	Forest	378	302	204	0.7	13.0
	Mechanically disturbed	Forest	238	155	105	0.4	8.1
	Grassland/Shrubland	Agriculture	164	222	150	0.3	5.6
	Other	Other	233	n/a	n/a	0.4	8.0
		Totals	2,917			5.1	100.0
1986–1992	Forest	Mechanically disturbed	1,190	538	364	2.1	34.2
	Mechanically disturbed	Grassland/Shrubland	1,011	500	339	1.8	29.1
	Grassland/Shrubland	Forest	384	219	148	0.7	11.0
	Mechanically disturbed	Forest	296	182	123	0.5	8.5
	Agriculture	Grassland/Shrubland	164	232	157	0.3	4.7
	Other	Other	433	n/a	n/a	0.8	12.4
		Totals	3,478			6.1	100.0
1992–2000	Forest	Mechanically disturbed	1,309	587	398	2.3	33.4
	Mechanically disturbed	Grassland/Shrubland	983	484	328	1.7	25.1
	Grassland/Shrubland	Forest	686	432	293	1.2	17.5
	Grassland/Shrubland	Nonmechanically disturbed	268	384	260	0.5	6.8
	Mechanically disturbed	Forest	236	165	112	0.4	6.0
	Other	Other	432	n/a	n/a	0.8	11.0
		Totals	3,915			6.8	100.0
1973–2000 (overall)	Forest	Mechanically disturbed	4,645	1,751	1,186	8.1	37.5
	Mechanically disturbed	Grassland/Shrubland	3,146	1,434	971	5.5	25.4
	Grassland/Shrubland	Forest	1,533	766	519	2.7	12.4
	Mechanically disturbed	Forest	977	591	400	1.7	7.9
	Grassland/Shrubland	Nonmechanically disturbed	316	387	262	0.6	2.6
	Other	Other	1,758	n/a	n/a	3.1	14.2
		Totals	12,375			21.6	100.0

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