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
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Chapter 1
Coast Range Ecoregion

By Terry L. Sohl

Ecoregion Description

The Coast Range Ecoregion, which covers approximately 57,338 km^2 (22,138 mi^2), is a thin, linear ecoregion along the Pacific Coast, stretching roughly 1,300 km from the Olympic Peninsula, in northwest Washington, to an area south of San Francisco, California (fig. 1) (Omernik, 1987; U.S. Environmental Protection Agency, 1997). It is bounded on the east by the Puget Lowland, the Willamette Valley, the Klamath Mountains, and the Southern and Central California Chaparral and Oak Woodlands Ecoregions.

Almost the entire Coast Range Ecoregion lies within 100 km of the coast. Topography is highly variable, with coastal mountain ranges and valleys ranging from sea level to over 1,000 m in elevation (fig. 2). A maritime climate, along with high topographic relief, results in substantial, but regionally variable, amounts of rainfall, ranging from 130 cm to more than 350 cm per year. The favorable climate of the Coast Range Ecoregion has supported forests of Sitka spruce (*Picea sitchensis*) along its northern coast and coast redwoods (*Sequoia sempervirens*) along its southern coast, as well as Douglas-fir (*Pseudotsuga menziesii*), western red cedar (*Thuja plicata*), and western hemlock (*Tsuga heterophylla*) inland (Omernik, 1987). Today, however, much of the forest is heavily managed for logging (fig. 3), although the ecoregion still

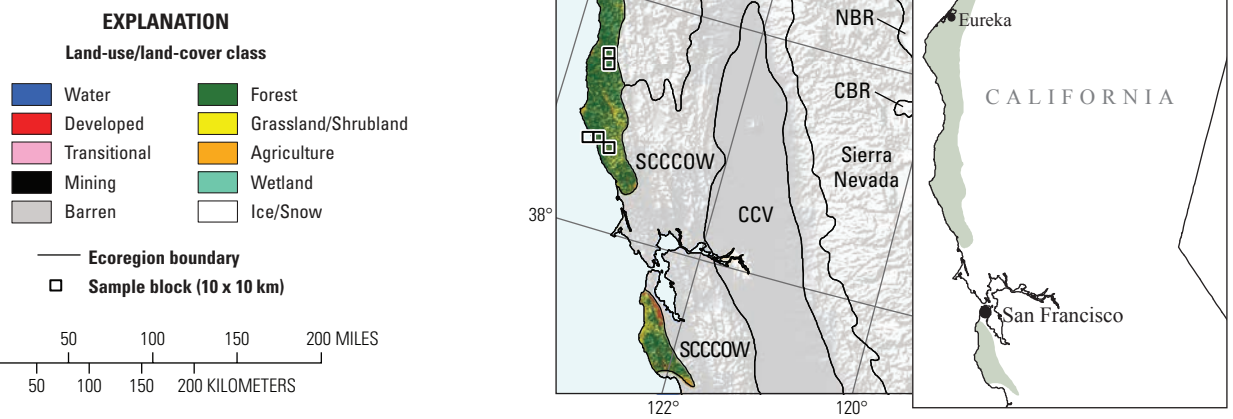

Figure 1. Map of Coast Range Ecoregion and surrounding ecoregions, showing land-use/land-cover classes from 1992 National Land Cover Dataset (Vogelmann and others, 2001); note that not all land-use/land-cover classes shown in explanation may be depicted on map; note also that, for this "Status and Trends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

Figure 2. Pacific Coast and forested coastal mountains of Coast Range Ecoregion.

Figure 3. Clearcut area and subsequent regrowth of planted trees in Coast Range Ecoregion.

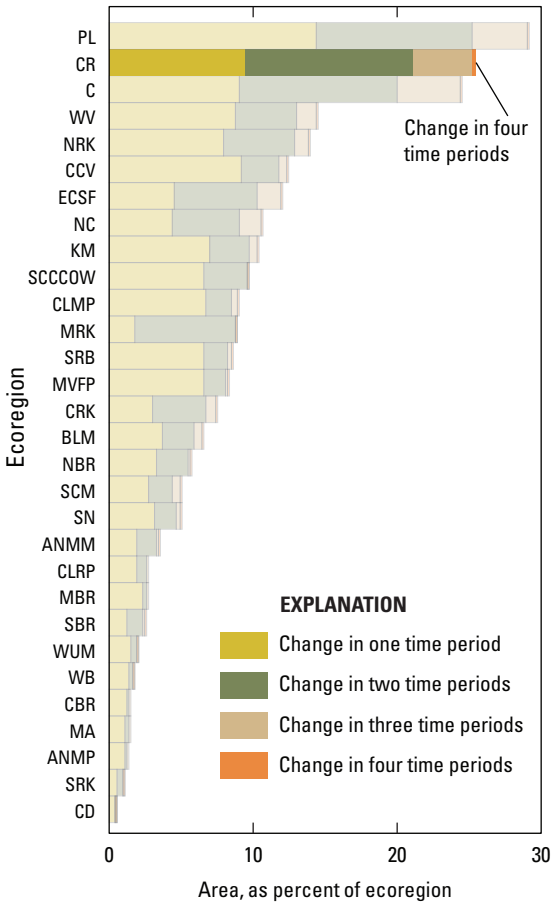

Figure 4. Overall spatial change in Coast Range Ecoregion (CR; darker bars) compared with that of all 30 Western United States ecoregions (lighter bars). Each horizontal set of bars shows proportions of ecoregion that changed during time periods 1, 2, 3, or 4; highest level of spatial change in Coast Range 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.

supports some of the largest remaining areas of old-growth forest in the Pacific Northwest. Agriculture is a minor component of the landscape, present locally in flat lands and valleys near the coast. Urban development is minimal; Eureka, California, is the only urban center in the ecoregion, with a population of over 26,000 (U.S. Census Bureau, 2000).

Contemporary Land-Cover Change (1973 to 2000)

The footprint of change (the percentage of area that changed at least one time between 1973 and 2000) in the ecoregion was 25.5 percent (table 1), indicating that the Coast Range Ecoregion had one of the highest levels of change in the western United States (fig. 4). When normalized to account for varying lengths of study periods, annual rates of change increased through the first three time periods, peaking between 1986 and 1992, and then they declined slightly in the last period, between 1992 and 2000 (table 2; fig. 5).

A statistically significant negative trend was determined for forest land, which had a decline of 5.0 percent between 1973 and 2000 (table 3). Balancing the decline in forest land were corresponding statistically significant positive trends in the mechanically disturbed (51.3 percent) and grassland/shrubland (36.9 percent) classes. However, these gains were not constant over the four time periods. Both mechanically disturbed and grassland/shrubland experienced two periods of net gain and two periods of net loss (fig. 6).

In the Coast Range Ecoregion, the vast majority of mechanically disturbed land and grassland/shrubland were associated with the logging and subsequent replanting and regrowth of forest (fig. 7). Clearcut forest patches are initially mapped as mechanically disturbed. Depending upon local site conditions and the length of time between initial cutting and the next mapped time period, these mechanically disturbed patches typically are mapped either as an intermediate grassland/shrubland class in subsequent time periods or as forest once regrowth has

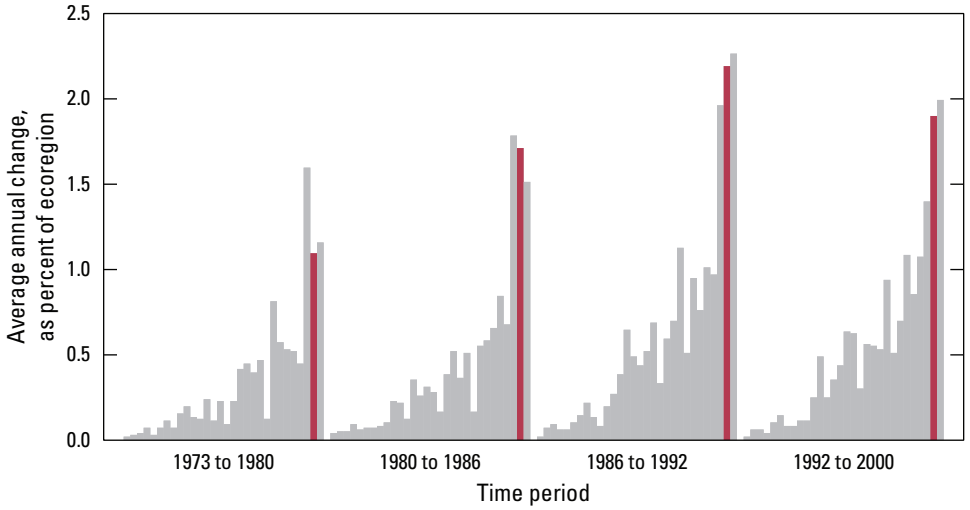

Figure 5. Estimates of land-cover change per time period, normalized to annual rates of change for all 30 Western United States ecoregions (gray bars). Estimates of change for Coast Range Ecoregion are represented by red bars in each time period.

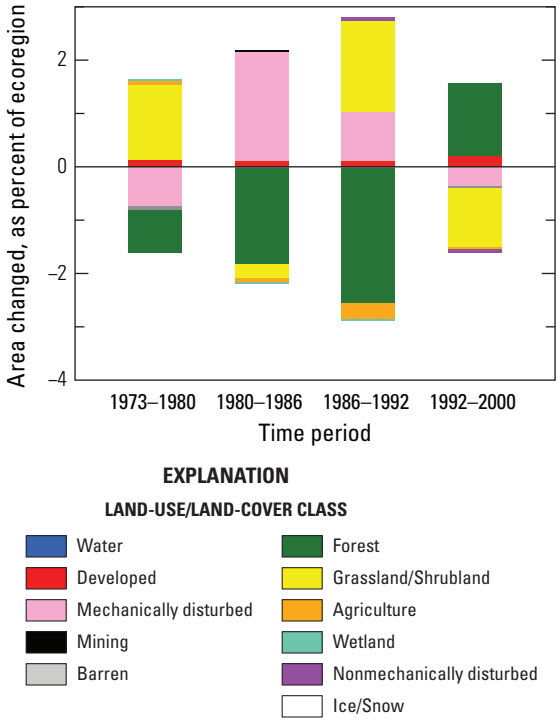

Figure 6. Normalized average net change in Coast Range Ecoregion by time period for each land-cover class. Bars above zero axis represent net gain, whereas bars below zero represent net loss. Note that not all land-cover classes shown in explanation may be represented in figure. See appendix 3 for definitions of land-use/land-cover classifications.

Figure 7. Clearcut (mechanically disturbed) forest in Coast Range Ecoregion and subsequent regrowth.

Figure 8. Lumberyard in Coast Range Ecoregion.

advanced sufficiently. Overall, while per-period trends in forest, mechanically disturbed, and grassland/shrubland land-cover classes fluctuated throughout the study period, total forest use (defined as the sum of forest land, mechanically disturbed land, and grassland/shrubland) remained remarkably constant (table 4).

The timber industry's effect on the landscape dominated the story of change in the ecoregion (fig. 8). For every time period, forest cutting (forest to mechanically disturbed) was the most common type of land-cover change, whereas each of the next three most common changes were related to forest regeneration (mechanically disturbed to grassland/shrubland, mechanically disturbed to forest, or grassland/shrubland to forest) (table 5). For the whole ecoregion, over 95 percent of change was associated with the timber-cutting cycle, with nearly 11,000 km^2 of cutting occurring between 1973 and 2000. Large swaths of forest land in the Coast Range Ecoregion were cut between 1973 and 2000, and they now are in a forest-regeneration stage because of the coalescence of individual patches of cut forest (fig. 9).

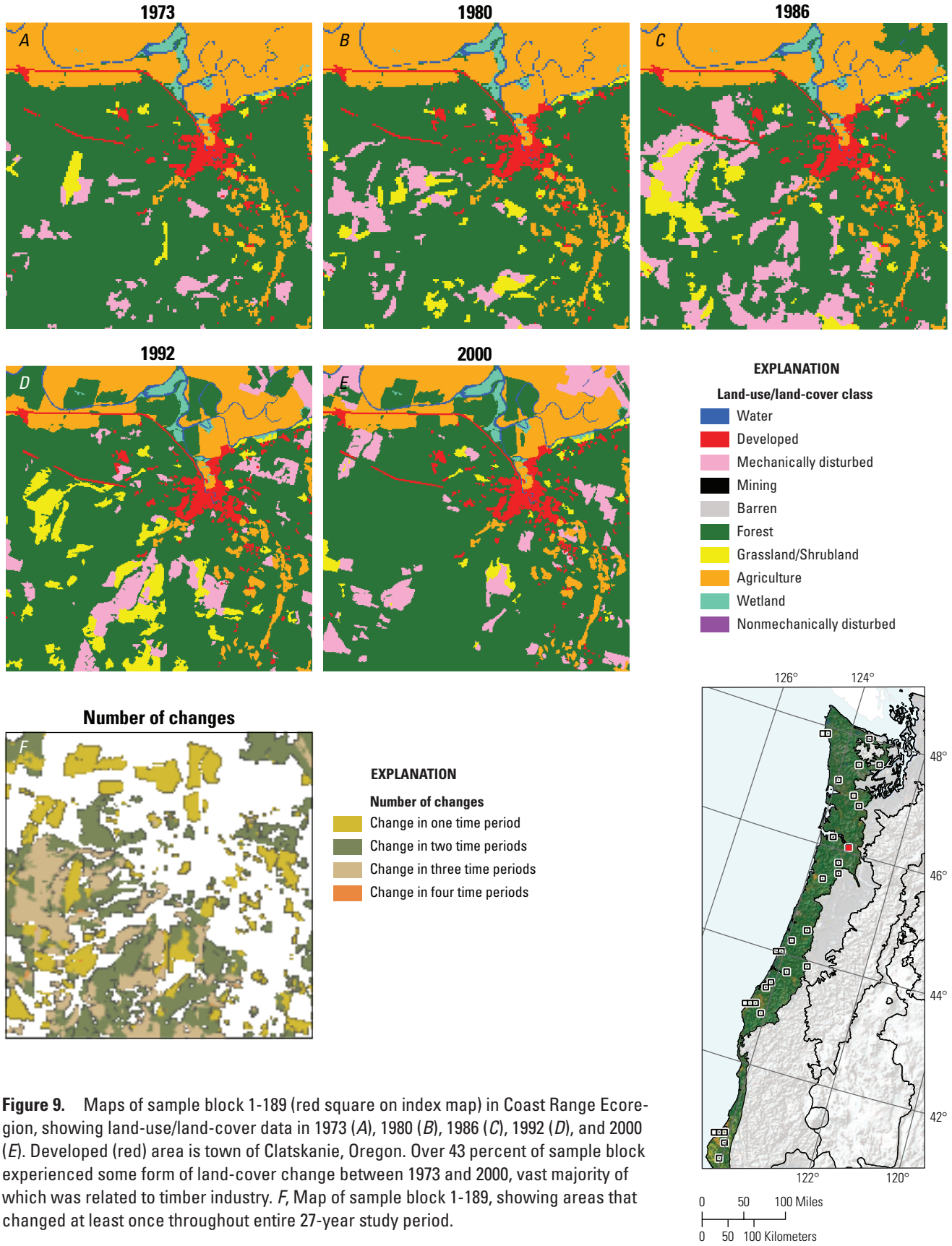

Figure 9. Maps of sample block 1-189 (red square on index map) in Coast Range Ecoregion, showing land-use/land-cover data in 1973 (*A*), 1980 (*B*), 1986 (*C*), 1992 (*D*), and 2000 (*E*). Developed (red) area is town of Clatskanie, Oregon. Over 43 percent of sample block experienced some form of land-cover change between 1973 and 2000, vast majority of which was related to timber industry. *F*, Map of sample block 1-189, showing areas that changed at least once throughout entire 27-year study period.

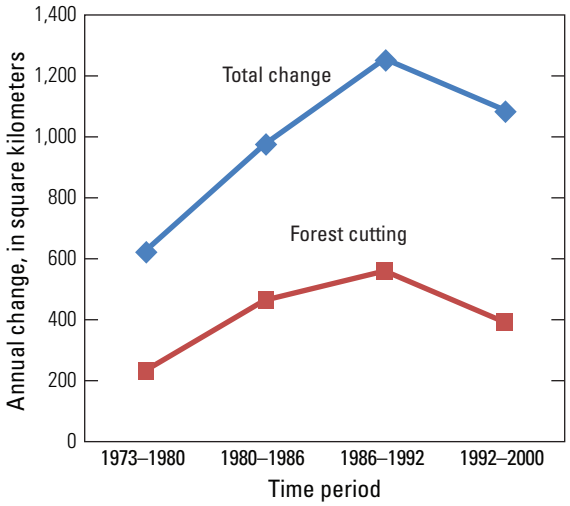

Figure 10. Annual land-cover change related to forest cutting in Coast Range Ecoregion, compared to that of total land-use/land-cover changes, for each of four time periods. Both change related to forest cutting and total change peaked between 1986 and 1992 and then declined between 1992 and 2000.

From the 1940s through the 1980s, forestry activity in the area generally focused on the cutting of natural forests and the establishment of Douglas-fir plantations on these lands (Swanson and Franklin, 1992). The annual rate of forest cutting steadily rose during the first three time periods, peaking between 1986 and 1992, and then declined between 1992 and 2000 (fig. 10). Although multiple drivers are responsible for the declines in forest cutting after 1992, the status and protection of the Northern Spotted Owl (*Strix occidentalis caurina*) likely had the biggest influence. In 1990, the Northern Spotted Owl was listed as "threatened" under the Endangered Species Act. In February 1991, an interagency scientific committee published a report addressing conservation of the Northern Spotted Owl (Thomas and others, 1990), leading U.S. District Court Judge Dwyer to block timber sales in national forest lands in the area to protect the species. In December 1994, Judge Dwyer accepted the Northwest Forest Plan, a comprehensive document directing coordinated management activities for lands administered by the U.S. Forest Service and the Bureau of Land Management. The plan permitted the cutting of 1 billion board feet of timber from public lands per year, only one-fourth the timber-harvest levels of the 1980s (Espy and Babbitt, 1994).

Another contributing factor responsible for the 1990s decline in forest cutting was the very high rate of logging in the 1980s, which may have been unsustainable over the long term given the 40- to 60-year cutting cycle that is typical for Douglas-fir in the ecoregion. In addition, Pacific Northwest forestry as a whole has been increasingly outcompeted by forestry operations in the southeastern United States and the interior of Canada, and the ecoregion has been at a competitive disadvantage for providing wood products to markets in the eastern and southern United States. Siberian larch (*Larix sibirica*) and Norway spruce (*Picea abies*) from Russian plantations, as well as Monterey pine (*Pinus radiata*) from more recently established plantations in New Zealand and Chile, also strongly increased their presence in the softwood lumber market in the 1990s (Gataulina and Waggener, 1998; Center for International Trade in Forest Products, 1993). At the same time, once-strong Pacific Northwest exports of wood products to large Asian markets (primarily Japan, South Korea, and China) declined throughout the 1990s (fig. 11). Changes in the Japanese housing industry, along

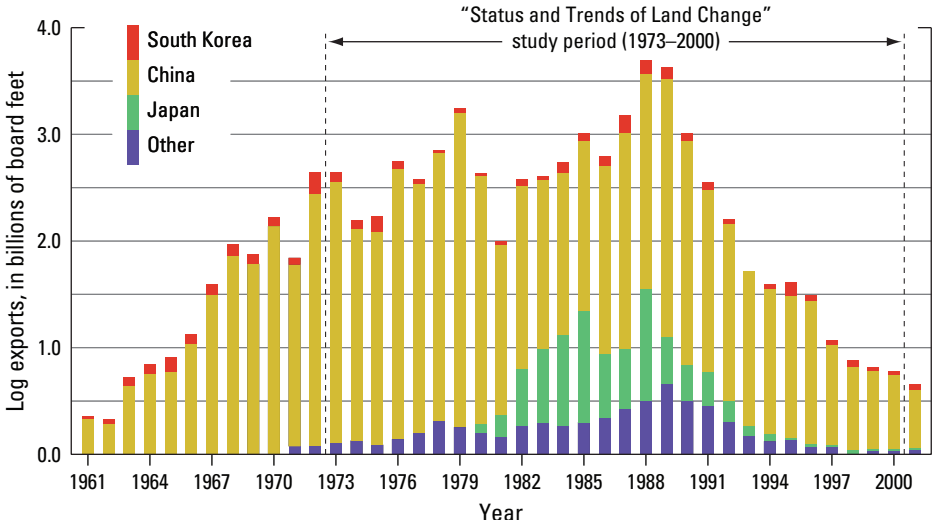

Figure 11. Exports of Pacific Northwest logs between 1961 and 2001 (from Daniels, 2005). Note how exports to all areas fell dramatically during 1990s.

with the Asian economic collapse of the 1990s, were major factors in declining exports (Daniels, 2005).

Land-cover changes in the ecoregion, other than those related to logging, were relatively minor. A statistically significant trend occurred in developed lands, which increased from 2.5 to 3.1 percent of the ecoregion between 1973 and 2000 (table 3). Most of the observed development was associated with the largest cities in the ecoregion: Eureka, California (population over 26,128 in 2000); Aberdeen, Washington (population, 16,461 in 2000); and Coos Bay, Oregon (population, 15,374) (U.S. Census, 2000). In addition, scattered high-value developments were found in areas with recreational amenities.

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

[Most sample pixels remained unchanged (74.5 percent), whereas 25.5 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	9.5	1.5	7.9	11.0	1.0	10.9
2	11.6	1.9	9.7	13.5	1.3	11.1
3	4.2	1.1	3.1	5.4	0.8	18.2
4	0.2	0.1	0.1	0.3	0.1	27.5
Overall spatial change	25.5	3.9	21.7	29.4	2.6	10.3

Table 2. Raw estimates of change in Coast 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 time 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	7.6	1.2	6.4	8.8	0.8	10.6	1.1
1980–1986	10.3	2.0	8.2	12.3	1.4	13.4	1.7
1986–1992	13.1	2.3	10.9	15.4	1.5	11.8	2.2
1992–2000	15.2	2.9	12.3	18.1	2.0	13.0	1.9
Estimate of change, in square kilometers							
1973–1980	4,380	688	3,692	5,068	465	10.6	626
1980–1986	5,880	1,168	4,712	7,047	789	13.4	980
1986–1992	7,535	1,312	6,223	8,848	887	11.8	1,256
1992–2000	8,700	1,668	7,032	10,369	1,128	13.0	1,088

Table 3. Estimated area (and margin of error) of each land-cover class in Coast 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	5.1	3.0	2.5	1.3	3.7	0.9	0.0	0.0	1.2	0.6	76.2	4.1	4.6	1.4	5.7	2.1	1.0	0.7	0.0	0.0
1980	5.1	3.0	2.6	1.3	3.0	0.5	0.0	0.0	1.1	0.6	75.4	4.2	6.0	1.0	5.7	2.1	1.0	0.7	0.0	0.0
1986	5.1	3.0	2.8	1.4	5.0	1.2	0.0	0.0	1.1	0.6	73.5	4.1	5.7	1.1	5.7	2.1	1.0	0.7	0.0	0.0
1992	5.1	3.0	2.9	1.4	6.0	1.2	0.0	0.0	1.1	0.6	71.0	3.9	7.4	1.2	5.4	2.0	1.0	0.7	0.1	0.1
2000	5.1	3.0	3.1	1.5	5.6	1.4	0.0	0.0	1.0	0.5	72.4	4.0	6.3	1.2	5.4	2.0	1.0	0.7	0.0	0.0
Net change	0.0	0.0	0.6	0.3	1.9	1.5	0.0	0.0	−0.2	0.1	−3.8	1.9	1.8	1.0	−0.3	0.4	0.0	0.0	0.0	0.0
Gross change	0.1	0.0	0.6	0.3	10.4	2.1	0.0	0.0	0.2	0.1	12.9	2.1	8.2	2.1	0.8	0.5	0.0	0.0	0.1	0.2
Area, in square kilometers																				
1973	2,941	1,696	1,438	744	2,142	493	18	17	673	364	43,676	2,349	2,627	782	3,245	1,215	562	406	0	0
1980	2,937	1,695	1,516	770	1,723	314	21	17	641	348	43,208	2,382	3,422	595	3,288	1,211	565	407	0	0
1986	2,941	1,699	1,579	789	2,890	698	23	19	633	335	42,165	2,368	3,284	610	3,247	1,181	558	406	0	0
1992	2,940	1,699	1,647	823	3,423	688	25	19	614	329	40,720	2,226	4,270	672	3,087	1,136	557	406	39	56
2000	2,947	1,707	1,772	845	3,227	794	25	20	584	307	41,504	2,270	3,636	680	3,073	1,139	553	398	0	0
Net change	7	15	334	162	1,085	850	7	6	−89	79	-2,172	1,074	1,009	594	−172	246	-9	10	0	0
Gross change	38	23	335	162	5,977	1,203	8	6	120	79	7,397	1,177	4,719	1,194	445	287	20	13	77	111

Table 4. Percentages of forest use, defined as sum of forest, mechanically disturbed, and grassland/shrubland land-cover classes, in Coast Range Ecoregion, showing that forest use remained remarkably constant over study period.

Year	Forest use (% of ecoregion)
1973	84.5
1980	84.3
1986	84.3
1992	84.4
2000	84.4

Table 5. Principal land-cover conversions in Coast 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 (km^2)	Margin of error (+/– km^2)	Standard error (km^2)	Percent of ecoregion	Percent of all changes
1973–1980	Forest	Mechanically disturbed	1,638	282	191	2.9	37.4
	Mechanically disturbed	Grassland/Shrubland	1,195	309	209	2.1	27.3
	Mechanically disturbed	Forest	863	288	195	1.5	19.7
	Grassland/Shrubland	Forest	451	228	154	0.8	10.3
	Forest	Agriculture	60	63	42	0.1	1.4
	Other	Other	174	n/a	n/a	0.3	4.0
		Totals	4,380			7.6	100.0
1980–1986	Forest	Mechanically disturbed	2,796	686	464	4.9	47.6
	Grassland/Shrubland	Forest	1,094	304	206	1.9	18.6
	Mechanically disturbed	Grassland/Shrubland	920	215	146	1.6	15.6
	Mechanically disturbed	Forest	734	177	120	1.3	12.5
	Agriculture	Forest	61	59	40	0.1	1.0
	Other	Other	274	n/a	n/a	0.5	4.7
		Totals	5,880			10.3	100.0
1986–1992	Forest	Mechanically disturbed	3,362	675	456	5.9	44.6
	Mechanically disturbed	Grassland/Shrubland	1,801	543	367	3.1	23.9
	Mechanically disturbed	Forest	1,049	344	232	1.8	13.9
	Grassland/Shrubland	Forest	911	203	137	1.6	12.1
	Agriculture	Forest	124	142	96	0.2	1.6
	Other	Other	288	n/a	n/a	0.5	3.8
		Totals	7,535			13.1	100.0
1992–2000	Forest	Mechanically disturbed	3,147	780	527	5.5	36.2
	Mechanically disturbed	Forest	2,173	557	376	3.8	25.0
	Grassland/Shrubland	Forest	1,847	560	378	3.2	21.2
	Mechanically disturbed	Grassland/Shrubland	1,178	327	221	2.1	13.5
	Forest	Developed	92	45	31	0.2	1.1
	Other	Other	263	n/a	n/a	0.5	3.0
		Totals	8,700			15.2	100.0
1973–2000 (overall)	Forest	Mechanically disturbed	10,943	1,973	1,334	19.1	41.3
	Mechanically disturbed	Grassland/Shrubland	5,093	1,116	755	8.9	19.2
	Mechanically disturbed	Forest	4,820	975	659	8.4	18.2
	Grassland/Shrubland	Forest	4,303	926	626	7.5	16.2
	Forest	Developed	236	117	79	0.4	0.9
	Other	Other	1,100	n/a	n/a	1.9	4.2
		Totals	26,495			46.2	100.0

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