

## Chapter 3

# Willamette Valley Ecoregion

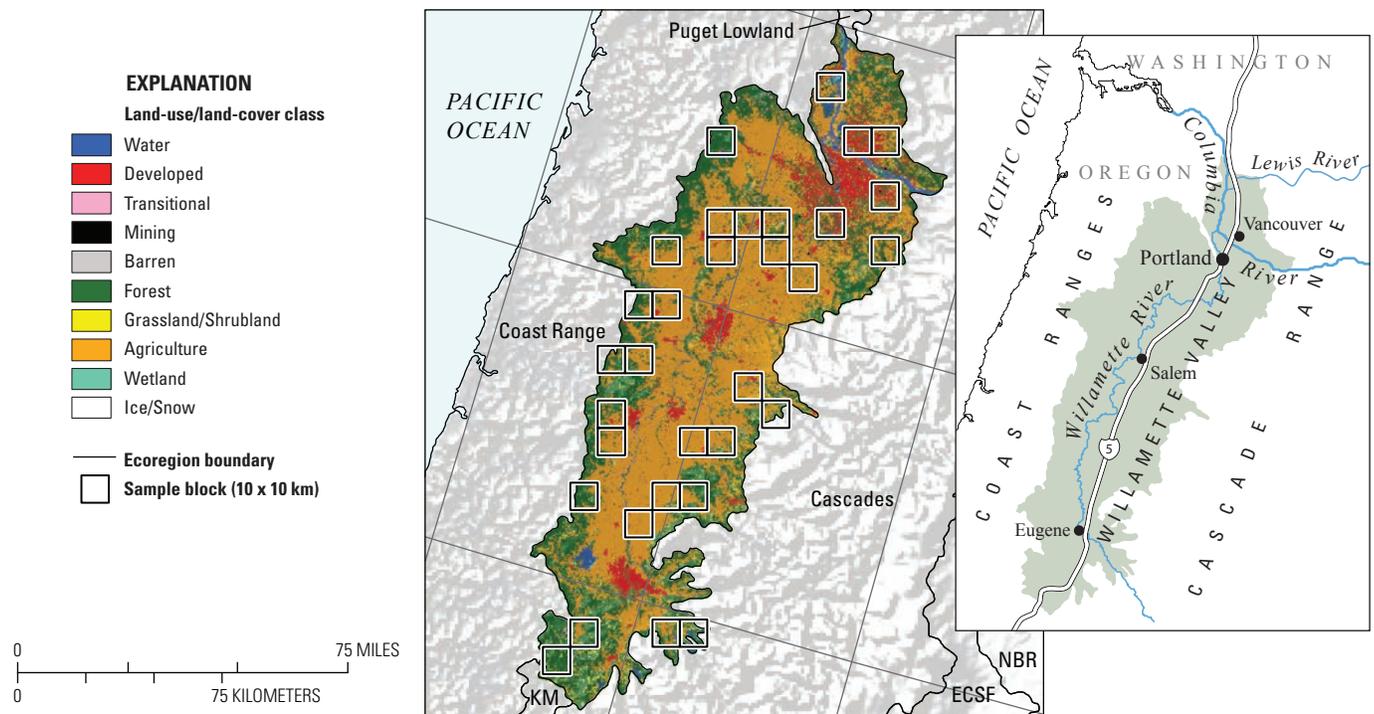
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## Ecoregion Description

The Willamette Valley Ecoregion (as defined by Omernik, 1987; U.S. Environmental Protection Agency, 1997) covers approximately 14,458 km<sup>2</sup> (5,582 mi<sup>2</sup>), making it one of the smallest ecoregions in the conterminous United States. The long, alluvial Willamette Valley, which stretches north to south more than 193 km and ranges from 32 to 64 km wide, is nestled between the sedimentary and metamorphic Coast Ranges (Coast Range Ecoregion) to the west and the basaltic Cascade Range (Cascades Ecoregion) to the east (fig. 1). The Lewis and Columbia Rivers converge at the ecoregion's northern boundary in Washington state; however, the majority of the ecoregion falls within northwestern Oregon. Interstate 5 runs the length of the valley to its southern boundary with the

Klamath Mountains Ecoregion. Topography here is relatively flat, with elevations ranging from sea level to 122 m. This even terrain, coupled with mild, wet winters, warm, dry summers, and nutrient-rich soil, makes the Willamette Valley the most important agricultural region in Oregon. Population centers are concentrated along the valley floor. According to estimates from the Oregon Department of Fish and Wildlife (2006), over 2.3 million people lived in Willamette Valley in 2000. Portland, Oregon, is the largest city, with 529,121 residents (U.S. Census Bureau, 2000). Other sizable cities include Eugene, Oregon; Salem (Oregon's state capital); and Vancouver, Washington.

Despite the large urban areas dotting the length of the Willamette Valley Ecoregion, agriculture and forestry products are its economic foundation (figs. 2,3). The valley is a major producer of grass seed, ornamental plants, fruits, nuts, vegetables, and grains, as well as poultry, beef, and dairy



**Figure 1.** Map of Willamette 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.** Vineyard adjacent to forested foothills in Willamette Valley Ecoregion. Note recovering clearcut hillside (upper left).



**Figure 3.** Livestock grazing in Willamette Valley Ecoregion.

products. The forestry and logging industries also are primary employers of the valley’s rural residents (Rooney, 2008). These activities have affected the watershed significantly, with forestry and agricultural runoff contributing to river sedimentation and decreased water quality in the Willamette River and its tributary streams (Oregon Department of Fish and Wildlife, 2006).

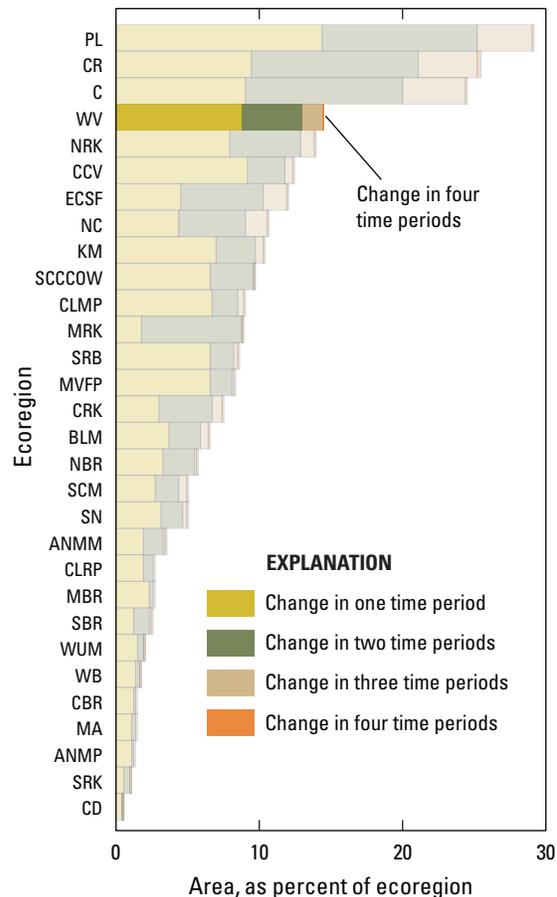
Recent years have seen a marked decline in forest health related to the increased frequency of multiyear droughts. Insect damage and other diseases also are present; however, drought-related water stress is the primary factor in coniferous-tree mortality (Oregon Department of Forestry, 2008). Trees most at risk include Douglas-fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), and western red cedar (*Thuja plicata*). Overstocking by timber companies and planting on sites with poor conditions increase susceptibility. Over time, these problems may lead to changes in planting practices and the use of more drought-tolerant species such as ponderosa pine (*Pinus ponderosa*).

## Contemporary Land-Cover Change (1973 to 2000)

Between 1973 and 2000, the footprint (overall areal extent) of land-use/land-cover change in the Willamette Valley

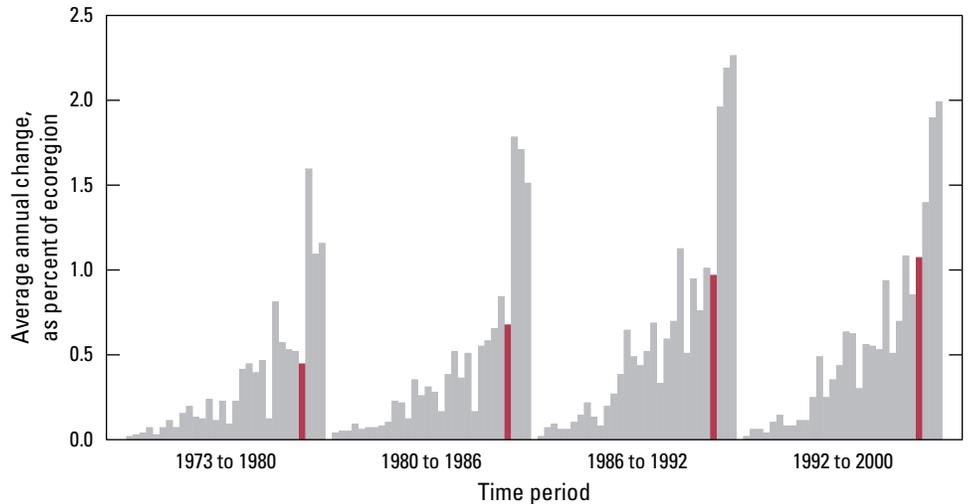
Ecoregion was 14.5 percent, or approximately 2,090 km<sup>2</sup> of area changed (table 1). This change is high when compared to land-cover change in other Western United States ecoregions (fig. 4). The footprint of change can be interpreted as the area that changed during at least one of the four multiyear periods in the 27-year study period. Overall, an estimated 1,240 km<sup>2</sup> in the ecoregion changed in at least one of the time periods, 594 km<sup>2</sup> changed during two time periods, 195 km<sup>2</sup> changed during three periods, and less than 7 km<sup>2</sup> changed in all four time periods (table 1).

The average annual rate of change in the Willamette Valley Ecoregion between 1973 and 2000 was 0.8 percent (table 2). This measurement, which normalizes the results for each period to an annual scale, indicates that the region averaged an estimated 113.6 km<sup>2</sup> of change each year in the 27-year study period. A closer look at successive time periods reveals a steady increase in annual change during the study period (fig. 5). Between 1973 and 1980, the annual rate of



**Figure 4.** Overall spatial change in Willamette Valley Ecoregion (WV; 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 Willamette Valley 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.

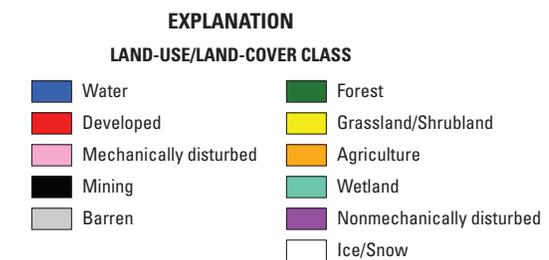
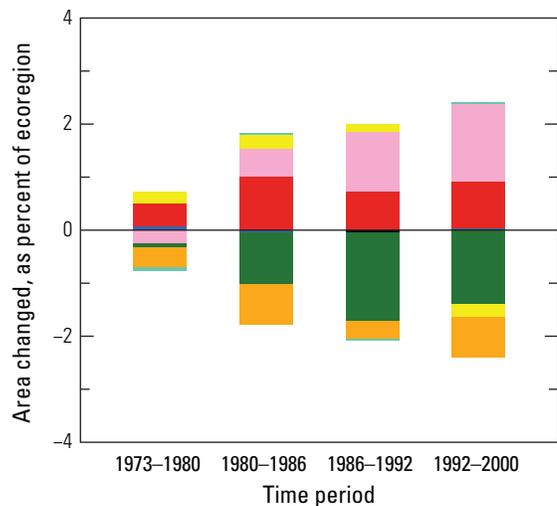
**Figure 5.** Estimates of land-cover change per time period, normalized to annual rates of change for all 30 Western United States ecoregions (gray bars). Estimates of change for Willamette Valley Ecoregion are represented by red bars in each time period.



change was 0.4 percent (65 km<sup>2</sup>), increasing to 0.7 percent (98 km<sup>2</sup>) from 1980 to 1986. This rate continued to rise to 1.0 percent (140 km<sup>2</sup>) between 1986 and 1992 and again to 1.1 percent (155 km<sup>2</sup>) between 1992 and 2000 (table 2).

Results from 2000 illustrate an estimated dominance of four of the ten land-cover classes in the Willamette Valley Ecoregion: agriculture (45.1 percent), forest (33.5 percent), developed (12.5 percent), and mechanically disturbed (4.0 percent) (table 3). These estimates from the sampled area are extraordinarily similar to land-cover percentages reported for the entire ecoregion (Oregon Department of Fish and Wildlife, 2006). The remaining six classes together accounted for the final 4.8 percent of the classified area in 2000, and each of these classes alone represents less than two percent of the sampled area (table 3). Between 1973 and 2000, there were considerable net losses in the areas of forest land (-11.0 percent) and agricultural land (-4.7 percent), along with net gains in developed land (33.4 percent) and mechanically disturbed land (236 percent, from 1.2 to 4.0 percent of the total ecoregion area) (fig. 6).

Net change, however, represents only changes between the first and final time periods, or the difference between land cover in 1973 and that in 2000. Net change is not the best indicator of within-class variability for those classes experiencing spatial and temporal fluctuations. The net-change metric does not reveal dynamics of change within and between time periods. Analysis of gross change (area gained and 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 indicate (Raumann and others, 2007). Classes may experience gains and losses in area between time periods. For example, mechanically disturbed land experienced a net increase of 2.8 percent between 1973 and 2000, but variable rates of forest cutting and other disturbances throughout the study period show a gross change of 3.3 percent. This equates to a net change in mechanically disturbed land of 404.7 km<sup>2</sup> (area in 2000 minus area in 1973) compared with a gross change of 476.3 km<sup>2</sup> over the entire study period.



**Figure 6.** Normalized average net change in Willamette 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.

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 between 1973 and 2000. Nearly 80 percent of land-cover class conversions were related to timber harvest and successional regrowth. The mechanical disturbance of forests accounted for 51.1 percent of the changes related to timber harvesting, with 18.2 percent recovering directly back to forest and 16.3 percent converting

to grassland/shrubland. Overall, the cumulative effect of forest clearing represents 1,254 km<sup>2</sup> of disturbed landscape. The majority of changes occurred along the ecoregion periphery within higher elevation forests. Another important conversion somewhat masked by the dominance of forestry is the loss of agricultural land to developed land (table 4). In the first change period (1973–1980), only 10.3 percent of all changes were from agriculture to developed, but between 1980 and 1986, this land-cover conversion more than doubled to 22.3 percent (132 km<sup>2</sup>).

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

[Most sample pixels remained unchanged (85.5 percent), whereas 14.5 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	8.8	1.7	7.1	10.5	1.2	13.4
2	4.2	1.2	3.0	5.5	0.8	20.0
3	1.4	0.5	0.9	1.9	0.3	23.6
4	0.0	0.0	0.0	0.1	0.0	33.5
Overall spatial change	14.5	3.0	11.5	17.4	2.0	13.9

**Table 2.** Raw estimates of change in Willamette 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	3.1	0.9	2.2	4.1	0.6	20.4	0.4
1980–1986	4.1	1.0	3.1	5.0	0.6	15.9	0.7
1986–1992	5.8	1.4	4.4	7.2	0.9	16.0	1.0
1992–2000	8.6	2.1	6.5	10.6	1.4	16.2	1.1
Estimate of change, in square kilometers							
1973–1980	454	137	317	591	93	20.4	65
1980–1986	590	138	452	728	94	15.9	98
1986–1992	841	198	642	1,039	134	16.0	140
1992–2000	1,238	296	942	1,535	201	16.2	155

**Table 3.** Estimated area (and margin of error) of each land-cover class in Willamette 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	1.8	0.8	9.4	3.6	1.2	0.5	0.2	0.1	0.0	0.0	37.7	6.0	0.8	0.4	47.3	6.2	1.6	0.9	0.0	0.0
1980	1.8	0.8	9.8	3.8	0.9	0.4	0.2	0.1	0.0	0.0	37.6	6.0	1.1	0.3	47.0	6.3	1.5	0.8	0.0	0.0
1986	1.8	0.8	10.9	4.0	1.4	0.4	0.2	0.1	0.0	0.0	36.6	5.9	1.3	0.4	46.2	6.3	1.5	0.8	0.0	0.0
1992	1.8	0.8	11.6	4.3	2.6	0.8	0.2	0.1	0.0	0.0	34.9	5.6	1.5	0.4	45.9	6.3	1.5	0.8	0.0	0.0
2000	1.8	0.8	12.5	4.5	4.0	1.2	0.2	0.1	0.1	0.0	33.5	5.3	1.2	0.4	45.1	6.3	1.5	0.8	0.0	0.0
Net change	0.1	0.1	3.1	1.4	2.8	1.0	0.0	0.0	0.0	0.0	-4.1	1.4	0.4	0.6	-2.2	1.2	-0.1	0.1	0.0	0.0
Gross change	0.2	0.1	3.1	1.4	4.8	1.3	0.1	0.0	0.0	0.0	6.1	1.4	2.6	0.8	3.1	1.1	0.2	0.1	0.0	0.0
Area, in square kilometers																				
1973	253	116	1,359	524	172	76	29	13	6	4	5,450	870	120	59	6,842	902	226	123	0	0
1980	264	116	1,422	544	136	53	31	15	6	4	5,440	874	153	50	6,790	908	216	118	0	0
1986	260	116	1,574	579	207	60	32	14	6	4	5,298	853	189	55	6,676	904	216	117	0	0
1992	261	115	1,681	615	371	110	30	14	6	4	5,051	813	210	58	6,631	905	216	117	0	0
2000	265	116	1,813	651	578	180	31	14	7	4	4,851	770	174	59	6,521	905	218	117	0	0
Net change	12	13	454	205	407	142	2	5	1	1	-600	196	54	80	-322	175	-8	15	0	0
Gross change	25	18	454	205	694	193	12	5	4	4	876	207	376	115	444	161	28	14	0	0

**Table 4.** Principal land-cover conversions in Willamette 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 <sup>2</sup> )	Margin of error (+/- km <sup>2</sup> )	Standard error (km <sup>2</sup> )	Percent of ecoregion	Percent of all changes
1973–1980	Forest	Mechanically disturbed	127	53	36	0.9	28.0
	Mechanically disturbed	Grassland/Shrubland	85	42	28	0.6	18.8
	Mechanically disturbed	Forest	85	44	30	0.6	18.6
	Grassland/Shrubland	Forest	52	38	26	0.4	11.4
	Agriculture	Developed	45	26	18	0.3	10.0
	Other	Other	60	n/a	n/a	0.4	13.2
	Totals			454			3.1
1980–1986	Forest	Mechanically disturbed	201	59	40	1.4	34.1
	Agriculture	Developed	132	81	55	0.9	22.3
	Mechanically disturbed	Grassland/Shrubland	94	35	23	0.6	15.9
	Grassland/Shrubland	Forest	60	30	20	0.4	10.2
	Mechanically disturbed	Forest	34	23	15	0.2	5.7
	Other	Other	70	n/a	n/a	0.5	11.8
	Totals			590			4.1
1986–1992	Forest	Mechanically disturbed	360	110	74	2.5	42.8
	Mechanically disturbed	Grassland/Shrubland	119	39	27	0.8	14.2
	Grassland/Shrubland	Forest	102	45	30	0.7	12.1
	Agriculture	Developed	77	35	24	0.5	9.2
	Mechanically disturbed	Forest	73	30	20	0.5	8.7
	Other	Other	109	n/a	n/a	0.8	13.0
	Totals			841			5.8
1992–2000	Forest	Mechanically disturbed	566	182	123	3.9	45.7
	Mechanically disturbed	Forest	256	96	65	1.8	20.7
	Grassland/Shrubland	Forest	138	51	35	1.0	11.1
	Mechanically disturbed	Grassland/Shrubland	101	37	25	0.7	8.2
	Agriculture	Developed	93	39	27	0.6	7.5
	Other	Other	84	n/a	n/a	0.6	6.7
	Totals			1,238			8.6
1973–2000 (overall)	Forest	Mechanically disturbed	1,255	369	250	8.7	40.2
	Mechanically disturbed	Forest	447	176	120	3.1	14.3
	Mechanically disturbed	Grassland/Shrubland	399	126	86	2.8	12.8
	Grassland/Shrubland	Forest	352	131	89	2.4	11.3
	Agriculture	Developed	347	164	111	2.4	11.1
	Other	Other	322	n/a	n/a	2.2	10.3
	Totals			3,122			21.6

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