

Chapter 11

Cascades Ecoregion

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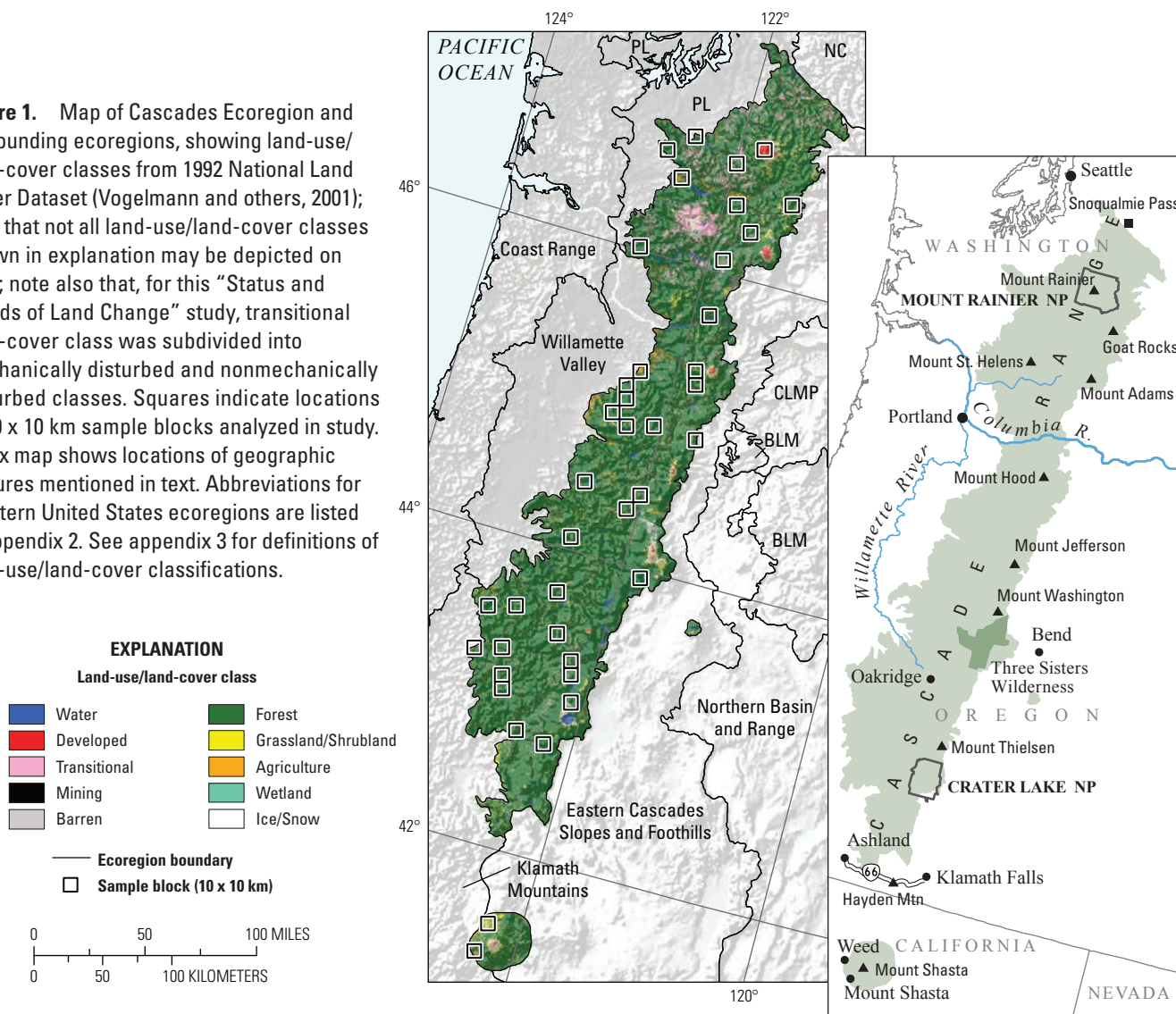
Ecoregion Description

The Cascades Ecoregion (Omernik, 1987; U.S. Environmental Protection Agency, 1997) covers approximately 46,787 km² (18,064 mi²) in Washington, Oregon, and California (fig. 1). The main body of the ecoregion extends from Snoqualmie Pass, Washington, in the north, to Hayden Mountain, near State Highway 66 in southern Oregon. Also included in the ecoregion is a small isolated section south of Bend, Oregon, as well as a larger one around Mount Shasta, California.

The ecoregion is bounded on the west by the Klamath Mountains, Willamette Valley, and Puget Lowland Ecoregions; on the north by the North Cascades Ecoregion; and on the east by the Eastern Cascades Slopes and Foothills Ecoregion.

The Cascades Ecoregion is a forested, mountainous ecoregion, and it contains a large amount of Cenozoic volcanic rock and many active and inactive volcanoes, especially in the east (McNab and Avers, 1994). Elevations range from near sea level at the Columbia River to 4,390 m at Mount Rainier in Washington, with most of the ecoregion between 645 and 2,258 m. The

Figure 1. Map of Cascades 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.



west side of the ecoregion is characterized by long, steep ridges and wide river valleys. Subalpine meadows are present at higher elevations, and alpine glaciers have left till and outwash deposits (McNab and Avers, 1994). Precipitation in the Cascades Ecoregion ranges from 1,300 to 3,800 mm, falling mostly as rain and snow from October to June. Average annual temperatures range from -1°C to 11°C. The length of the growing season varies from less than 30 days to 240 days (McNab and Avers, 1994).

The dominant vegetation on the lower slopes (below 1,000 m) is Douglas-fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*). At middle elevations (from about 800 to 1,280 m), Pacific silver fir (*Abies amabilis*) and noble fir (*Abies procera*) become prevalent. Lush wildflower meadows can be found in these areas. At higher elevations, mountain hemlock (*Tsuga mertensiana*), subalpine fir (*Abies lasiocarpa*), and Engelmann spruce (*Picea engelmannii*) are common. At elevations as high as 3,350 m are alpine meadows that consist of huckleberry (*Vaccinium L. spp.*) and heath (*Erica L. spp.*) fields, as well as barren areas.

The Cascades Ecoregion contains numerous state and national forests, including the Mount Baker–Snoqualmie, Mount Hood, Deschutes, Willamette, Umpqua, Rogue River–Siskiyou, and Shasta–Trinity National Forests. Wilderness areas include the Goat Rocks, Mount Adams, Mount Hood, Mount Jefferson, Mount Thielsen, Mount Washington, Three Sisters, and Mount Shasta Wildernesses. The ecoregion also contains Mount Rainier and Crater Lake National Parks. Much of the land at middle and higher elevations is held publically in national forests, whereas private ownership (especially by the forest industry) is more common at lower elevations where Douglas-fir and hemlock forests dominate (Risser and others, 2000). Land management on public lands varies from intensive forestry, especially on the lower slopes, to protected wilderness areas (McNab and Avers, 1994).

Before European settlement, natural disturbances, especially fire, were the dominant forces driving land-cover change in the Cascades Ecoregion. The southern part of the ecoregion is prone to frequent lightning-caused fires, having fire return intervals of around 55 years (Sugihara and others, 2006). In the north, fires are less frequent but can be more severe (Risser and others, 2000), with fire return intervals as long as 500 years around Mount Rainier (Agee, 1993). After European settlement in the mid-1800s, forest landscapes were increasingly influenced by anthropogenic disturbance in the form of timber harvesting, as well as fire suppression in the early 20th century. Replanting practices resulted in a more uniform, even-aged forest structure and greater landscape fragmentation (Wallin and others, 1996). Reforestation practices resulted in a simplification of species composition, with Douglas-fir replacing a variety of hardwoods and other softwoods (Alig and others, 2000). These homogenous forests often lack the large trees, snags, downed wood, and tree-species diversity that are needed to promote wildlife diversity (Risser and others, 2000).

The ecoregion is sparsely populated. The largest cities are Mount Shasta, California (population 3,624), Oakridge, Oregon (3,148), and Weed, California (2,978) (U.S. Census Bureau,

2000). With the decline of the timber industry in the Cascades Ecoregion, most small towns that have historically relied on a timber-based economy are now relying more on recreation and other industries to sustain their economy (Jacklet, 2009).

Contemporary Land-Cover Change (1973 to 2000)

Between 1973 and 2000, the areal extent of land-use/land-cover change (area that experienced land-cover change at least once in the 27-year study period) in the Cascades Ecoregion was 24.6 percent, or approximately 11,520 km² (table 1). Compared with other western United States ecoregions, the amount of change was high (fig. 2). Overall, an estimated 4,164 km² (8.9 percent of the total ecoregion area) changed in one of the time periods; 5,240 km² (11.2 percent) changed in one of the time periods; 5,240 km² (11.2 percent) changed

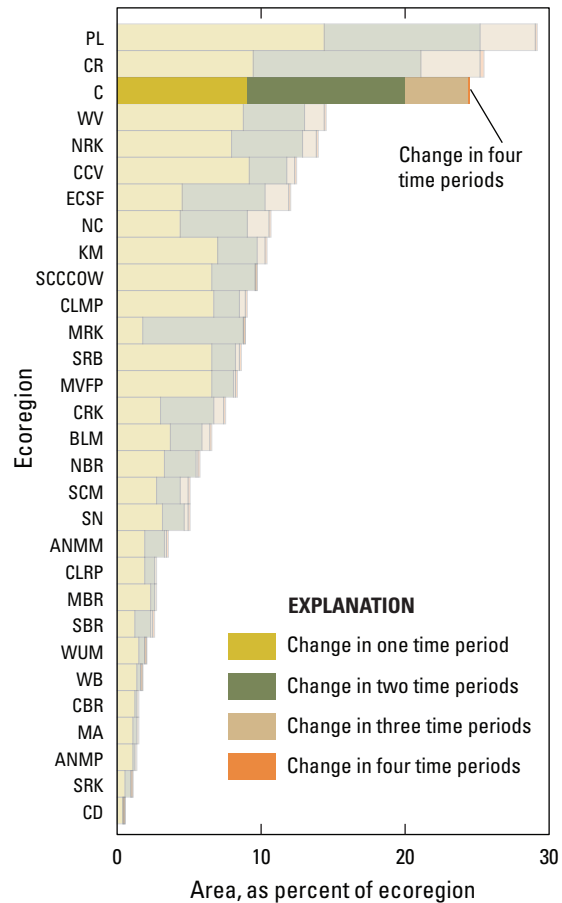
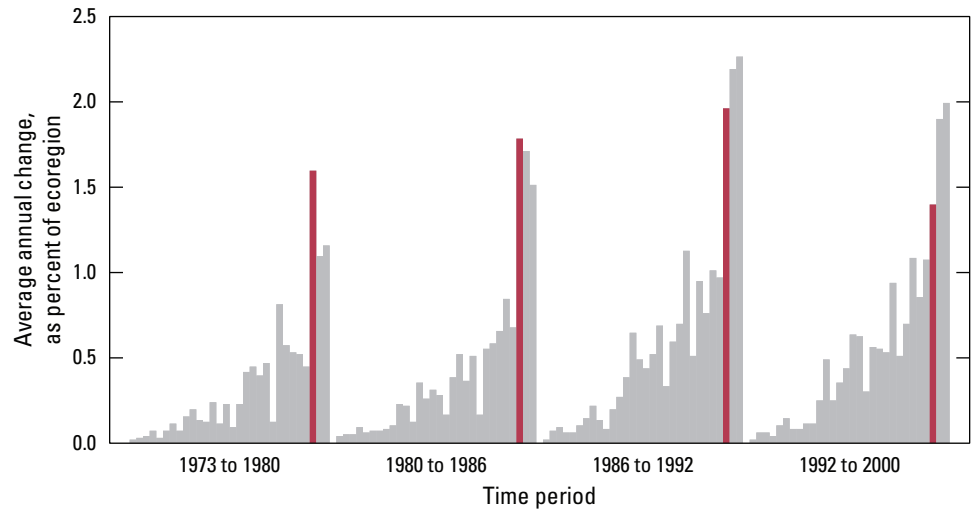


Figure 2. Overall spatial change in Cascades Ecoregion (C; darker bars) compared with that of all 30 all Western United States ecoregions (lighter bars). Each horizontal set of bars shows proportions of ecoregion that changed during one, two, three, or four time periods; highest level of spatial change in Cascades 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 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 Cascades Ecoregion are represented by red bars in each time period.



during two time periods; and 2,012 km² (4.3 percent) changed during three periods. Only 468 km² (0.1 percent) changed in all four time periods (table 1).

The average annual rate of land-cover change in the Cascades Ecoregion was 1.7 percent (795 km²) (table 2). Average annual change for successive time periods reveals a steady increase in rates of land-cover change over the study period for the first three time periods and a slight decline for the last time period. Between 1973 and 1980, the average rate of change was 1.6 percent (749 km²), increasing to 1.8 percent (833 km²) between 1980 and 1986. This rate continued to rise to 2.0 percent (919 km²) between 1986 and 1992, then it declined to 1.4 percent (652 km²) between 1992 and 2000 (fig. 3; table 2).

Forest is the dominant land-cover class in the Cascades Ecoregion (figs. 4,5), accounting for 82.8 percent of the ecoregion in 2000, followed by grassland/shrubland (5.6 percent), mechanically disturbed (3.5 percent), and agriculture (2.1 percent) (table 3). The seven remaining land-cover classes accounted for 6.0 percent of the ecoregion (table 3).

The leading conversion in all time periods was from forest to mechanically disturbed, the result of clearcut logging (fig. 5). Changes associated with timber harvest and forest regeneration account for over 98 percent of all land-cover conversions, and they represent the top four land-cover conversions in the ecoregion throughout the study period (table 4). The timber-harvest-to-forest-regeneration process starts after the removal of trees (that is, forest to mechanically disturbed), after which the area is replanted with seedlings or regenerates naturally (mechanically disturbed to grassland/shrubland) (fig. 6). The successional process continues as the seedlings grow tall enough (at least 2 m) to be classified as forest (grassland/shrubland to forest). In some areas, forest regeneration is rapid, and so the study's six- to eight-year sampling interval did not capture the grassland/shrubland successional stage, the lack of which resulted in conversions from mechanically disturbed directly back to forest.

Between 1973 and 1992, a net loss of forest occurred in every time period, resulting in a net decline in forest land of approximately 10,800 km². This trend reversed between 1992



Figure 4. Forested hillsides in Cascades Ecoregion, showing logging roads and clearcut scars. Dominant land-cover class in Cascades Ecoregion is forest, which in 2000 made up almost 83 percent of all land cover in ecoregion.



Figure 5. Freshly clearcut hillside in Cascades Ecoregion. Logging, usually clearcutting, was leading driver of land-cover change in Cascades Ecoregion for all time periods.



Figure 6. Aftermath of timber harvest in Cascades Ecoregion, showing that most of slash is removed, burnt, or buried and then seedlings (wrapped in protective mesh) are planted. Some states, such as Washington, have laws that prescribe how soon to replant after tree harvesting to guard against invasive species (Washington State Department of Natural Resources, 2001).

and 2000 with an 11,050 km² gain in forest land, suggesting that the losses in the early years were generally replaced by gains in the last time period (table 3; figs. 7,8). Types of land ownership and land management influenced the changes that occurred. Sample blocks in the Cascades Ecoregion that fell in protected areas experienced the least amount of change, whereas sample blocks in privately held land experienced the greatest amount of change (fig. 9).

Several factors were involved in the decline of forest products from the Pacific Northwest between 1992 and 2000 (fig. 7; table 4). Lumber and wood-product exports from the Pacific Northwest declined in the 1990s because their main markets (Japan and other Asian countries) suffered economic downturns that reduced demand for wood-based commodities. This caused an oversupply of wood products that led to a collapse in prices and the amount of exports (Perez-Garcia and Barr, 2005). The Pacific Northwest also faced increased competition during this time from other wood-producing countries such as Russia, Finland, Canada, and New Zealand (Daniels, 2005). A significant reason for the increase in Canadian exports was the increased harvest rate implemented to avert fires resulting from trees killed by mountain pine beetle and other pests (Perez-Garcia and Barr, 2005).

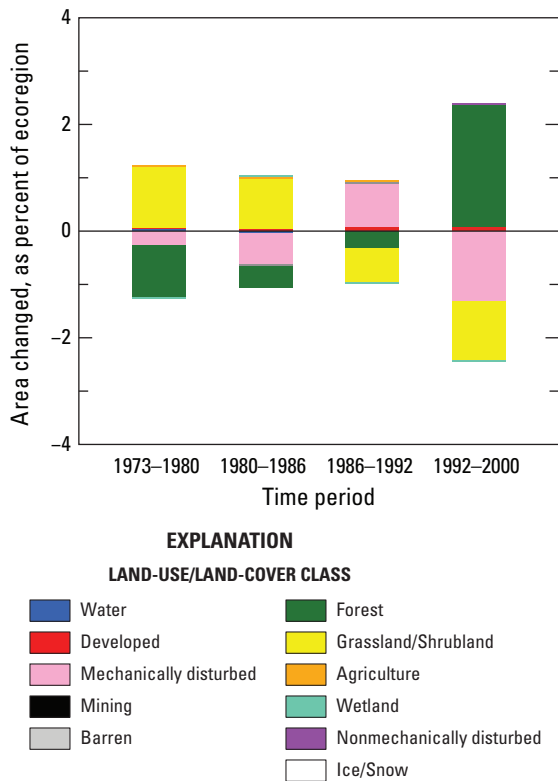


Figure 7. Normalized average net change in Cascades Ecoregion by time period for each land-cover class. Bars above zero axis represent net gain, whereas bars below zero represent net loss. Note that not all land-cover classes shown in explanation may be represented in figure. See appendix 3 for definitions of land-use/land-cover classifications.

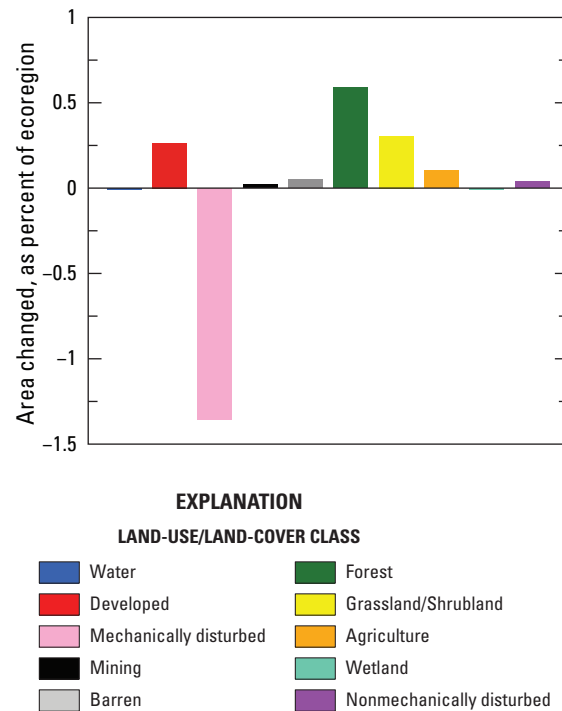


Figure 8. Estimated cumulative change in Cascades Ecoregion for each land-cover class between 1973 and 2000. Bars above zero axis represent overall gain, whereas bars below zero represent overall loss. Mechanically disturbed class experienced largest decrease, while grassland/shrubland and forest classes had highest gains. No change was detected for ice/snow class.

In the 1990s, the Northwest Forest Plan (Espy and Babbitt, 1994) was developed to protect the habitat of the threatened Northern Spotted Owl (*Strix occidentalis caurina*) (Daniels, 2005). Under this plan, timber harvest was banned or reduced on 10 million of the 17 million acres (40,469 of 68,797 km²) of national forests in the Pacific Northwest. Before the Northwest Forest Plan, timber sales from these national forests were about 4 to 5 billion board feet per year. After 1990, sales dropped to less than a billion board feet per year (Daniels, 2005). A consequence of the reduced harvest in national forests in the Pacific Northwest was an increase in harvesting from privately owned land. On public land, stand replacement after timber harvest was 2 to 10 times more likely to occur than stand replacement (full or partial) as a result of wildfire (Alig and others, 2000).

Figure 9. Federal land ownership and cumulative land-use/land-cover change (as percent of sample-block area) from 1973 to 2000 in Cascades Ecoregion. Sample blocks that fell on wilderness areas witnessed least amount of change. Most sample blocks that saw highest amount of change fell on privately held land at lower elevations. Land-ownership data from National Atlas of the United States (2006). See appendix 2 for abbreviations for Western United States ecoregions.

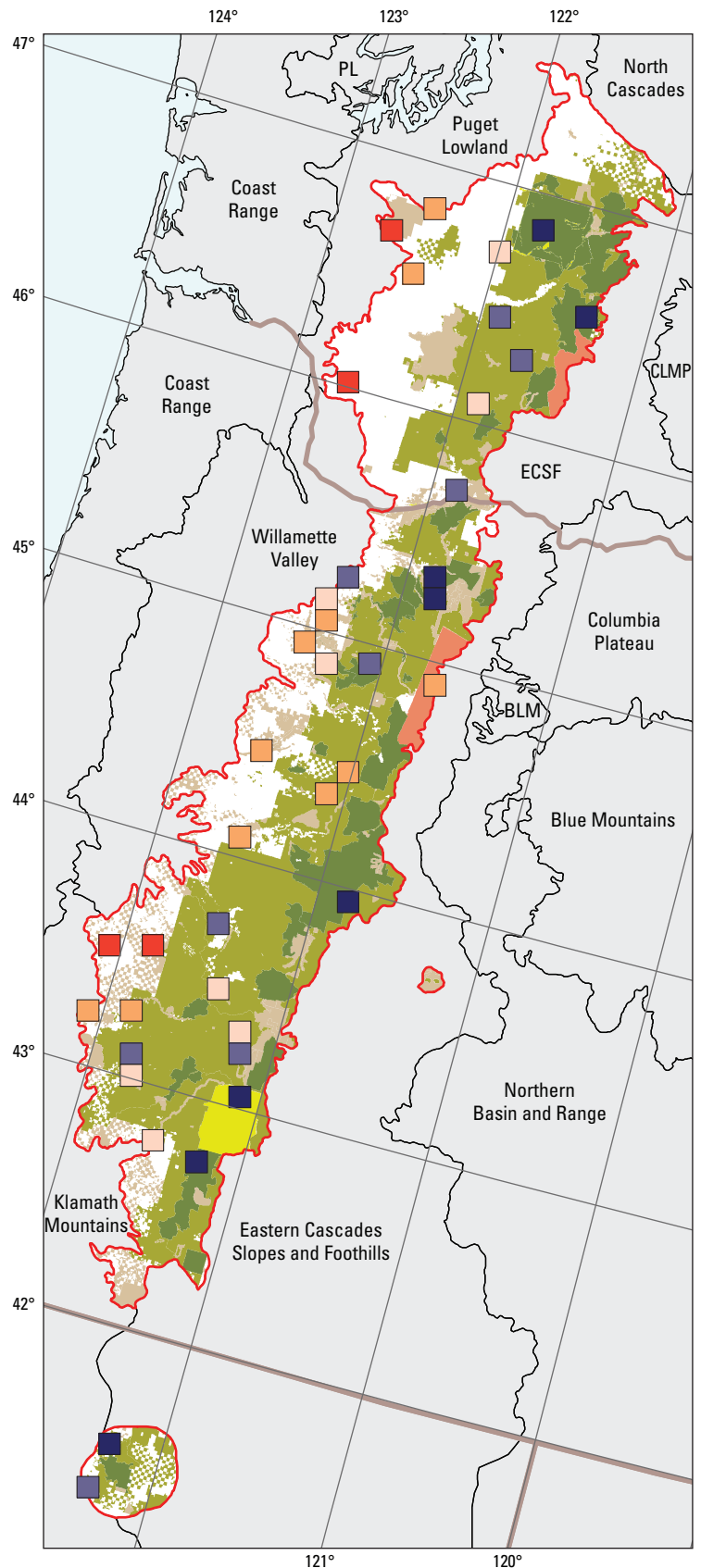
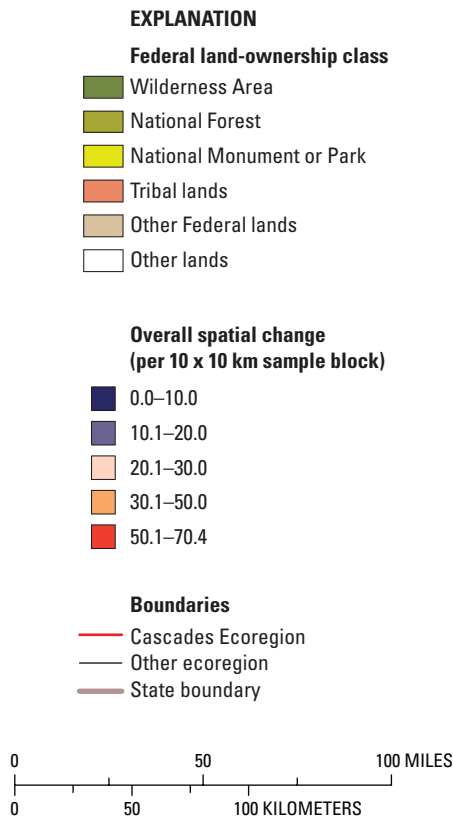


Table 1. Percentage of Cascades Ecoregion land cover that changed at least one time during study period (1973–2000) and associated statistical error.

[Most sample pixels remained unchanged (75.4 percent), whereas 24.6 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	9.0	1.7	7.4	10.7	1.1	12.6
2	11.2	1.6	9.5	12.8	1.1	10.0
3	4.3	0.9	3.4	5.2	0.6	13.9
4	0.1	0.0	0.1	0.2	0.0	18.3
Overall spatial change	24.6	3.7	20.9	28.3	2.5	10.2

Table 2. Raw estimates of change in Cascades 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	11.2	2.1	9.2	13.3	1.4	12.5	1.6
1980–1986	10.7	1.9	8.8	12.6	1.3	12.1	1.8
1986–1992	11.8	1.7	10.0	13.5	1.2	10.1	2.0
1992–2000	11.1	2.1	9.1	13.2	1.4	12.5	1.4
Estimate of change, in square kilometers							
1973–1980	5,242	960	4,283	6,202	654	12.5	749
1980–1986	4,998	889	4,108	5,887	606	12.1	833
1986–1992	5,515	817	4,698	6,333	557	10.1	919
1992–2000	5,214	959	4,254	6,173	653	12.5	652

Table 3. Estimated area (and margin of error) of each land-cover class in Cascades 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	1.1	0.7	1.1	0.5	4.8	1.1	0.0	0.0	1.4	1.2	82.2	3.5	5.3	1.3	2.0	1.3	0.5	0.2	0.0	0.0
1980	1.2	0.7	1.2	0.5	4.6	1.0	0.1	0.0	1.4	1.2	81.3	3.5	6.4	1.3	2.0	1.3	0.5	0.2	0.0	0.0
1986	1.1	0.7	1.2	0.6	4.0	0.7	0.1	0.0	1.4	1.2	80.9	3.6	7.4	1.4	2.0	1.3	0.5	0.2	0.0	0.0
1992	1.1	0.7	1.3	0.6	4.8	0.8	0.1	0.0	1.4	1.2	80.5	3.6	6.8	1.3	2.0	1.3	0.5	0.2	0.0	0.0
2000	1.1	0.7	1.4	0.6	3.5	1.3	0.1	0.1	1.4	1.2	82.8	3.6	5.6	1.2	2.1	1.3	0.5	0.2	0.0	0.0
Net change	0.0	0.0	0.3	0.1	-1.4	1.5	0.0	0.0	0.1	0.0	0.6	1.2	0.3	1.0	0.1	0.1	0.0	0.0	0.0	0.0
Gross change	0.1	0.1	0.3	0.1	10.6	2.0	0.0	0.0	0.1	0.1	10.7	1.9	8.0	1.6	0.1	0.1	0.0	0.0	0.0	0.0
Area, in square kilometers																				
1973	529	338	529	240	2,254	497	21	14	641	560	38,479	1,621	2,490	603	916	601	221	94	0	0
1980	544	346	547	249	2,130	482	24	18	646	559	38,019	1,646	3,017	599	933	602	219	94	0	0
1986	527	337	570	259	1,854	341	25	18	643	560	37,828	1,667	3,465	662	949	602	220	95	0	0
1992	524	339	616	277	2,226	384	29	21	659	559	37,686	1,663	3,162	615	958	610	219	94	0	0
2000	523	340	650	287	1,620	591	31	24	666	559	38,755	1,677	2,634	577	964	616	219	95	16	17
Net change	-6	12	121	54	-634	695	11	11	25	23	276	557	144	472	48	37	-2	6	16	17
Gross change	63	49	121	54	4,956	928	11	11	40	25	4,994	869	3,734	750	58	40	6	6	16	17

Table 4. Principal land-cover conversions in Cascades 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	2,134	486	331	4.6	40.7
	Mechanically disturbed	Grassland/Shrubland	1,412	389	265	3.0	26.9
	Mechanically disturbed	Forest	975	263	179	2.1	18.6
	Grassland/Shrubland	Forest	710	196	134	1.5	13.5
	Forest	Agriculture	20	11	8	0.0	0.4
	Other	Other	-9	n/a	n/a	0.0	-0.2
		Totals	5,242			11.2	100.0
1980–1986	Forest	Mechanically disturbed	1,830	337	230	3.9	36.6
	Mechanically disturbed	Grassland/Shrubland	1,418	363	247	3.0	28.4
	Grassland/Shrubland	Forest	954	217	148	2.0	19.1
	Mechanically disturbed	Forest	716	205	139	1.5	14.3
	Water	Mechanically disturbed	19	24	16	0.0	0.4
	Other	Other	60	n/a	n/a	0.1	1.2
		Totals	4,998			10.7	100.0
1986–1992	Forest	Mechanically disturbed	2,209	380	259	4.7	40.1
	Grassland/Shrubland	Forest	1,379	332	226	2.9	25.0
	Mechanically disturbed	Grassland/Shrubland	1,078	214	146	2.3	19.6
	Mechanically disturbed	Forest	745	189	129	1.6	13.5
	Forest	Developed	36	17	12	0.1	0.7
	Other	Other	68	n/a	n/a	0.1	1.2
		Totals	5,515			11.8	100.0
1992–2000	Forest	Mechanically disturbed	1,613	592	403	3.4	30.9
	Mechanically disturbed	Forest	1,434	348	237	3.1	27.5
	Grassland/Shrubland	Forest	1,315	263	179	2.8	25.2
	Mechanically disturbed	Grassland/Shrubland	777	135	92	1.7	14.9
	Forest	Developed	29	14	10	0.1	0.6
	Other	Other	46	n/a	n/a	0.1	0.9
		Totals	5,214			11.1	100.0
1973–2000 (overall)	Forest	Mechanically disturbed	7,786	1,344	915	16.6	37.1
	Mechanically disturbed	Grassland/Shrubland	4,686	869	592	10.0	22.3
	Grassland/Shrubland	Forest	4,358	775	528	9.3	20.8
	Mechanically disturbed	Forest	3,870	820	559	8.3	18.5
	Forest	Developed	98	45	30	0.2	0.5
	Other	Other	172	n/a	n/a	0.4	0.8
		Totals	20,969			44.8	100.0

References Cited

- Agee, J.K., 1993, Fire ecology of Pacific Northwest forests: Washington, D.C., Island Press, p. 229.
- Alig, Ralph J., Zheng, Daolan, Spies, Thomas A., and Butler, Brett J., 2000, Forest cover dynamics in the Pacific Northwest west side—Regional trends and projections: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Research Paper PNW-RP-522, 22 p. (Available at <http://www.treearch.fs.fed.us/pubs/2935>.)
- Daniels, J.M., 2005, The rise and fall of the Pacific Northwest log export market: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-624.
- Espy, M., and Babbitt, B., 1994, Record of decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the Northern Spotted Owl: U.S. Department of Agriculture and U.S. Department of the Interior Northwest Forest Plan, 74 p. (Available at <http://www.blm.gov/or/plans/nwfpnepa/FSEIS-1994/NWFPTitl.htm>.)
- Jacklet, Ben, 2009, Trouble in Timber Town—Decades after an industry downfall, towns still grapple with what's next: Oregon Business. (Available at <http://www.oregonbusiness.com/articles/72-november-2009/2478-trouble-in-timber-town>.)
- McNab, W. Henry, and Avers, Peter E., 1994, Cascade mixed forest – Coniferous forest – Alpine meadow, *in* Ecological subregions of the United States: U.S. Department of Agriculture, Forest Service, WO-WSA-5, chap. 25. (Available at <http://www.fs.fed.us/land/pubs/ecoregions/ch25.html>.)
- National Atlas of the United States, 2006, Federal Lands of the United States: National Atlas of the United States database, accessed February 19, 2006, at <http://nationalatlas.gov>.
- Omernik, J.M., 1987, Ecoregions of the conterminous United States: *Annals of the Association of American Geographers*, v. 77, p. 118–125.
- Perez-Garcia, John, and Barr, J. Kent, 2005, Forest products export trends update for the Pacific Northwest region: Seattle, University of Washington, College of Forest Resources, Northwest Environmental Forum. (Available at <http://www.nwenvironmentalforum.org/science/papers.html>.)
- Risser, Paul G., 2000, Cascade Mountains Ecoregion, *in* Oregon State of the Environment Report 2000—Statewide Summary: State of the Environment Report Science Panel, Oregon Progress Board, chap. 4.3, accessed June 28, 2011, at <http://www.oregon.gov/DAS/OPB/docs/SOER2000/Ch4.3.pdf>.
- Sugihara, Neil G., van Wagtenonk, Jan W., Shaffer, Kevin E., Fites-Kaufman, JoAnn, and Thode, Andrea E., eds., 2006, Fire in California's ecosystems: Berkeley, University of California Press, p. 215.
- U.S. Census Bureau, 2000, U.S. Census, 2000: U.S. Census Bureau database, accessed September 28, 2009, at <http://factfinder.census.gov>.
- U.S. Environmental Protection Agency, 1997, Descriptions of level III ecological regions for the CEC report on ecological regions of North America: U.S. Environmental Protection Agency database, accessed April 12, 2006, at http://www.epa.gov/wed/pages/ecoregions/na_eco.htm#Downloads.
- Vogelmann, J.E., Howard, S.M., Yang, L., Larson, C.R., Wylie, B.K., and van Driel, N., 2001, Completion of the 1990s National Land Cover Data Set for the conterminous United States from Landsat Thematic Mapper data and ancillary data sources: *Photogrammetric Engineering & Remote Sensing*, v. 67, p. 650–662.
- Wallin, D.O., Swanson, F.J., Marks, B., Cissel, J.H., and Kertis, J., 1996, Comparison of managed and pre-settlement landscape dynamics in forests of the Pacific Northwest, U.S.A.: *Forest Ecology and Management*, v. 85, p. 291–310.
- Washington State Department of Natural Resources, 2001, Reforestation: Washington State Department of Natural Resources, Title 222 WAC - Forest practices rules, chap. 222-34 WAC, p. 34-2.