CHAPTER 9.

Changes in Fragmentation of Western Washington Forest Land (Project WC-EM-08-01)

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INTRODUCTION

Land conversion and forest fragmentation is an important issue across the country. Forest fragmentation is one of the international Montréal criteria and indicators that the Forest Service, U.S. Department of Agriculture, must assess periodically (Riitters and others 2004). Characteristics of increased fragmentation include increases in the amount of forest-nonforest edge, and decreases in the size of forest patches. Edges are associated with greater drying of forest fuels and the spread of weedy species (both plants and animals). As forest patches become smaller and distances between them increase, the number of native species that can survive in them declines. Smaller forest parcels are also less likely to be managed for timber production (Kline and others 2004, Wear and others 1999).

Forest monitoring—by the Forest Inventory and Analysis (FIA) Program of the Forest Service—in western Washington (defined as the 19 counties west of the crest of the Cascade Mountains) has detected rapid conversion of forest land to nonforest land uses in the previous decade, with 5 percent of private timberland (270,000 acres) being converted between 1990 and 2000, following a similar rate of loss in the previous decade (Gray and others 2005). Human population increase in the State is no doubt a contributing factor; population increased from 3.4 million to 6.5 million people between 1970 and 2007 (96 percent), with most of the increase occurring in the western portion of the State. Not surprisingly, homes are often associated with forest fragmentation in Washington. Homes mixed in forest land results in increased cost of fighting wildfire as well as increases in the economic damage caused by fire. The State legislature has prioritized the acquisition of valuable timberlands in danger of conversion, and researchers are developing strategies for identifying and retaining those forest lands.

METHODS

Although some aspects of fragmentation focusing on tree cover are readily assessed with satellite imagery (Riitters and others 2004), a prior study in western Washington indicated that classifying land use and land use change with computer algorithms and low-resolution satellite imagery was not very accurate (Kline and others 2009). This study adopted an approach based on manual image interpretation that has been successfully conducted in Oregon, with the results being built into State sustainable management indicators (Lettman and others 2009). The imagery available for this study was digital photography from 2006 and the early 1990s, and hardcopy photos from 1976 used by FIA for double-sample stratification. Photos from 1976 were scanned and registered with the later imagery, with all analyses conducted in GIS.

Images were classified into the following land-use zones, with polygons mapped across all of western Washington:

Wildland Forest: Polygon ≥ 640 acres, < 5 structures per 640 acres, > 80 percent of area is forest land.

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Intensive Agriculture: Polygon ≥ 640 acres, < 9 structures per 640 acres, > 80 percent of area is agricultural.

Mixed Forest/Agriculture: Polygon ≥ 640 acres, < 9 structures per 640 acres, 20 to 80 percent of area is agricultural and forest land is ≥ 50 percent of the remainder. Improved roads are typically one-half of a mile apart or more.

Low Density Residential/Commercial: Polygon of any size, but must have ≥ 9 structures within it. On average, housing developments are less than 80 acres. Improved road patterns are typically one-quarter of a mile apart or less. House lots are usually > 1 acre. May meet urban qualifications, but is < 40 acres.

Urban: Polygon ≥ 40 acres, commercial, service or residential subdivided area with city road patterns and closely spaced buildings. House lots are usually < 1 acre.

Structures were counted in 80-acre circles around a grid of points outside national forests and national parks; point spacing was approximately one per 470 acres, representing a 17-percent sample of the land area. "Structures" were meant to represent individual dwellings, so multiple associated buildings were only counted once, e.g., an adjoining rural house, barn, shed and pump-house would all count as a single structure. To date, changes in area in forest land use have been calculated and are presented by county, and simple indices of fragmentation have been calculated from mean forest zone polygon size and forest edge-to-area ratio, and are presented by ecoregion section (Cleland and others 2007). An in-depth analysis of land use change is in progress for publication within the next year.

RESULTS AND DISCUSSION

The area in the non-Federal wildland forest land use class in western Washington was 7.82 million acres in 1976 and declined by 490,000 acres (6.3 percent) between 1976 and 2006. The area in the mixed forest/agriculture and intensive agriculture classes declined as well, by 93,000 acres and 160,000 acres, respectively. Although less acreage than for the wildland forest class, these declines represent a 26-percent and 19-percent reduction in the area mixed forest/agriculture and intensive agriculture classes, respectively. Of this 743,000-acre loss of resource lands, two-thirds ended up in the low-density residential class and one-third in the urban class by the end of the 30-year period. The proportional reduction in area in the wildland forest class varied by county, with the highest rates around the Puget Sound and in the southernmost county, Clark County (fig. 9.1).

On average, the smallest wildland forest polygons, and those with the lowest area-perimeter ratios, were found in the Puget Trough and Willamette Lowland ecoregions (table 9.1). The North Cascades had the largest mean polygon area, whereas the Southern Cascades had the largest area-perimeter ratios. Although the amount of intact forest is high in both ecoregions, the higher elevations and extensive alpine areas in the North Cascades is

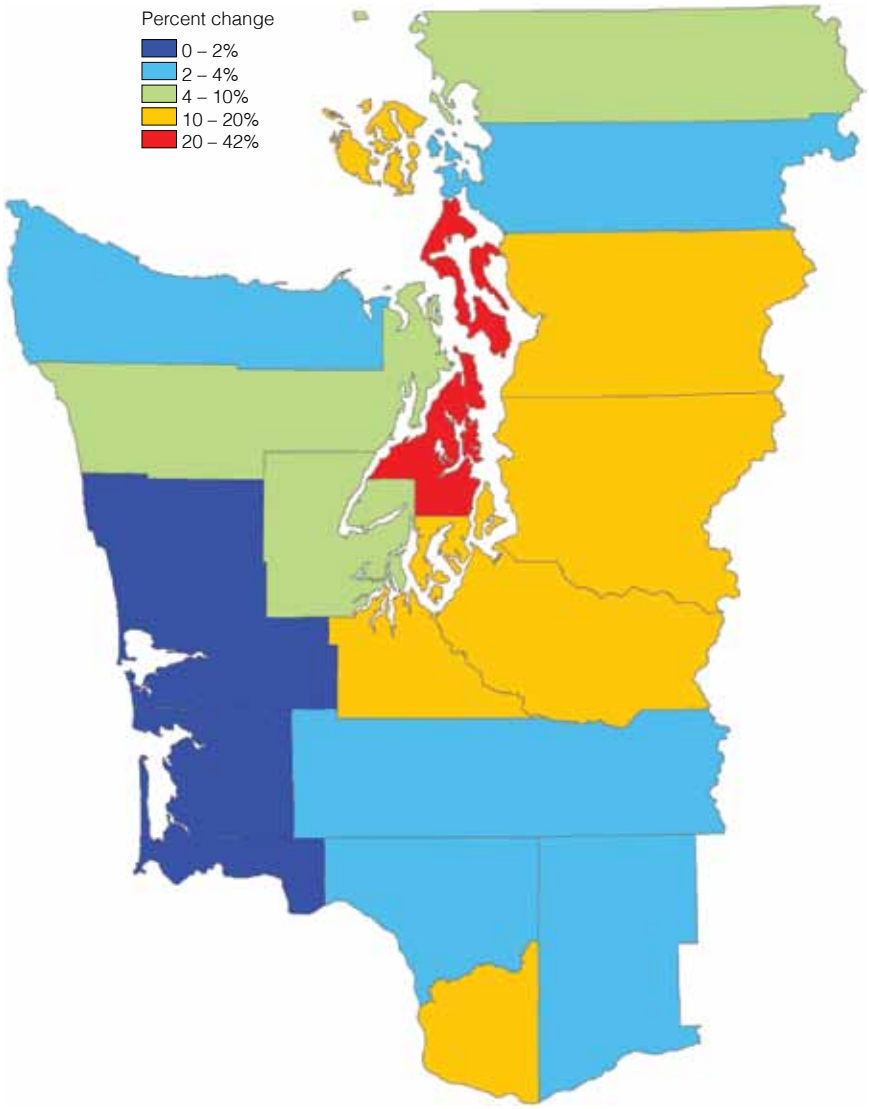

Figure 9.1—Loss of area in the wildland forest land use class between 1976 and 2006 in western Washington.

a likely source of natural fragmentation. Mean polygon areas are substantially smaller in the Coast Ranges than in the Cascades, but area-perimeter ratios are slightly higher than the North Cascades, suggesting a substantial portion of interior forest despite the relatively small size. The forest class area-perimeter ratio decreased for all ecoregions between 1976 and 2006, indicating an increase in edge conditions. Mean polygon area decreased over time for the Puget Trough and Willamette Lowlands, and southern Cascades ecoregions, but were relatively stable in the other ecoregions.

CONCLUSIONS

The area of non-Federal land in the wildland forest land class in western Washington has declined over the last 30 years. The same has occurred for agricultural lands, with resource lands being converted to residential and urban land uses. The remaining forest land class areas have become more fragmented over time, with greater edge to interior proportions, and generally smaller patch sizes. Ongoing work will complete the analysis for the rest of the State and investigate additional measures of forest fragmentation.

Table 9.1—Wildland forest land use fragmentation metrics by ecoregion and year for western Washington

		Year		
Ecoregion section	Metric	1976	1994	2006
Coast Ranges	Total area (ha)	1 731 361	1 724 978	1 721 180
Coast Ranges	Total perimeter (km)	5 473	5 732	5 866
Coast Ranges	Area/Perimeter (ha/km)	316	301	293
Coast Ranges	Mean area (ha)	21 114	20 294	20 490
Northern Cascades	Total area (ha)	1 203 997	1 201 562	1 200 651
Northern Cascades	Total perimeter (km)	3 748	3 852	3 881
Northern Cascades	Area/Perimeter (ha/km)	321	312	309
Northern Cascades	Mean area (ha)	401 332	400 521	400 217
Puget + Willamette lowlands	Total area (ha)	882 813	781 461	727 166
Puget + Willamette lowlands	Total perimeter (km)	15 658	16 090	16 319
Puget + Willamette lowlands	Area/Perimeter (ha/km)	56	49	45
Puget + Willamette lowlands	Mean area (ha)	4 184	3 869	3 513
Southern Cascades	Total area (ha)	1 383 101	1 370 864	1 363 656
Southern Cascades	Total perimeter (km)	2 953	3 374	3 486
Southern Cascades	Area/Perimeter (ha/km)	468	406	391
Southern Cascades	Mean area (ha)	138 310	97 919	85 228

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See also fhm.fs.fed.us/posters/posters09/changes_fragmentation_wa_forest_land.pdf.

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