Changes in fragmentation of western Washington forest land

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Introduction

FIA monitoring has detected very rapid conversion of forest land to nonforest land uses in western Washington in the last decade, with 5% of private timberland (270,000 acres) being converted between 1990-2000 (**Fig. 1**), following a similar rate of loss in the previous decade (**Fig. 2**). The human population in the state has almost doubled since 1970 (**Figs 3a + 3b**). It is likely, but unknown, whether increased fragmentation of forest land has also occurred. Fragmentation reduces patch size and increases edge environments, with important effects on fire risk, weedy species, timber management, and wildlife habitat. The objective of this project was to evaluate the extent and spatial pattern of forest fragmentation in western Washington and begin to assess its implications.

1

WWA change in non-NFS timberland area

(*thousand acres*)

Timberland 1990	7,397	
Net to NFS	-30	Snoqualmie Pass, Gorge
To reserved	-60	Primarily DNR
To non-forest	-270	4.7% of private area
Timberland 2000	7,037	
Net private to public	148	

(Gray et al. 2005. PNW-RB-246)

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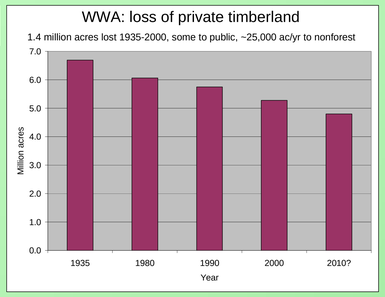

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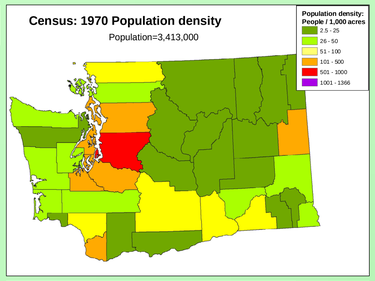

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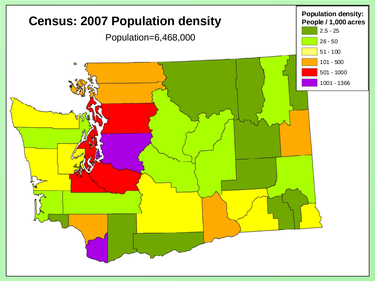

Methods

Imagery from three time periods was acquired—mid-1970s, early 1990s, and 2006—and land cover is being manually classified into GIS polygons of different land use zones for each time period:

Wildland forest: area >=640 ac, <5 dispersed developments per 640 ac, and >80% forest land

Intensive agriculture: area >=640 ac, <9 dispersed developments per 640 ac, and >80% agricultural land.

Mixed forest/agriculture: area >=640 ac; <9 dispersed developments per 640 ac; and mixed forest, range, and agriculture with forest >= 50% of the non-agricultural land.

Low-density residential: area any size with >=9 developments per 640 ac

Urban: area >=40 ac; commercial, service, and residential uses with a city road pattern

Non-vegetated: area >=640 ac covered with water, ice, rock, or sand.

In addition, 44,500 systematically-placed points were identified outside federal lands across the state and man-made structures (e.g., single houses, or houses with barns) in an 80 ac circle around each point are being counted in non-urban land-use zones. Distance to the nearest contrasting land-use is calculated for each point.

We are also assessing changes in tree cover in urban zones. To date we have completed all three time periods for southwest Washington (**Fig. 4**), and are about half-way through the work in northwest Washington.

New houses outside Sequim, Olympic Peninsula

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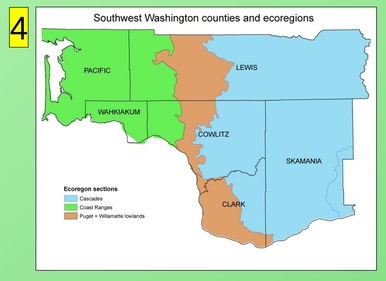

Wildland forest and agriculture land uses, Cowlitz River valley, Lewis County

Loss of forestland

Change in land use varied dramatically by county, with the greatest changes occurring in Clark County, near the Portland metro area (**Figs 5a + 5b**). Between 1976 and 2006, forest, agricultural, and mixed land in Clark county declined by 11, 32, and 25%, while low-density residential and urban land increased by 60 and 124%, respectively. In comparison, forestland loss in Pacific and Wahkiakum counties was 1%. For southwest Washington as a whole, most of the developing low-density residential areas between 1976 and 2006 came from forest land, while most of the developing urban areas came from agricultural and low-density residential land (**Fig 6**).

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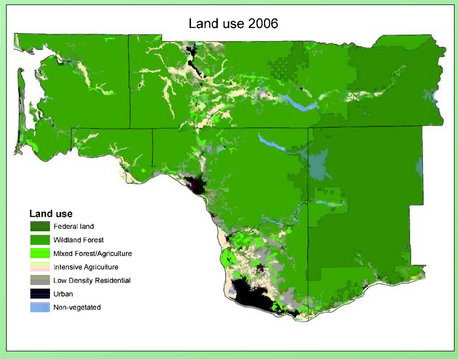

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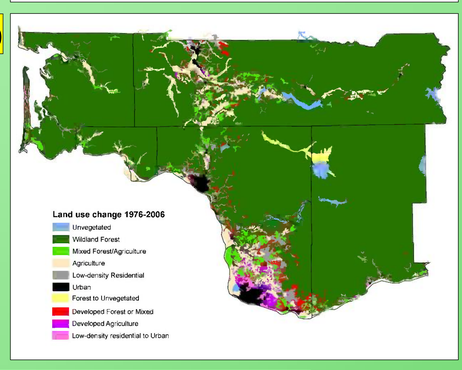

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Net changes in area by land use, nonfederal land, 1976 to 2006 (acres)

	Change in:					
	Forest	Mixed	Agriculture	Low-density residential	Urban	Non-vegetated
1976 Area:	2,647,047	121,810	230,137	147,677	49,926	916
Change to/from:						
Forest	0	2,332	1,824	61,463	2,828	5,074
Mixed	-2,332	0	-456	15,511	5,467	0
Agriculture	-1,824	456	0	12,760	16,870	0
Low-density residential	-61,463	-15,511	-12,760	0	15,624	482
Urban	-2,828	-5,467	-16,870	-15,624	0	0
Nonvegetated	-5,074	0	0	-482	0	0
Net Change	-73,520	-18,192	-28,261	73,628	40,788	5,556
2006 Area:	2,573,526	103,618	201,876	221,306	90,714	6,472

Houses in the woods

The number of structures on forest land increased in all southwest counties, ranging from 14 to 72% increase by county, and 56% overall (**Fig. 7**). In Clark County, 29% of the points that were within ½ mile of low-density residential or urban in 1976 changed to low-density residential or urban by 2006 (only 3% of points outside ½ mile changed). Forest that is within ½ mile of low-density residential or urban also has significantly more structures, averaging 3.6 and 7.0 structures/square mile within ½ mile in 1976 and 2006 respectively. Outside ½ mile these averages were 1.8 and 2.6.

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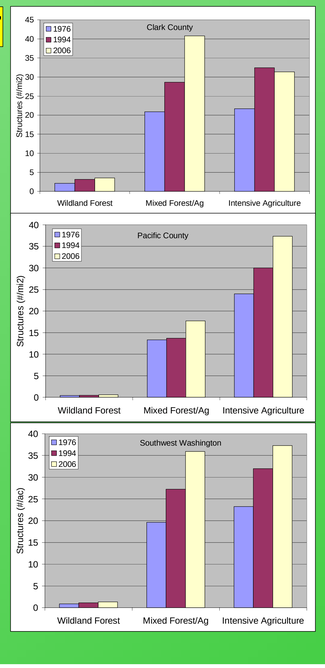

Forest fragmentation

Forest fragmentation increased in all ecoregions in southwest Washington, as indicated by decreases in area-to-perimeter ratios and mean patch size between 1976 and 2006 (**Fig. 8**).

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		Year		
Ecoregion Section	Metric	1976	1994	2006
Cascades	Total area (ha)	1,015,081	1,002,000	994,953
Cascades	Total perimeter (km)	2,167	2,462	2,557
Cascades	Area/Perimeter (ha/km)	468	407	389
Cascades	Mean area (ha)	101,508	100,200	82,913
Coast Ranges	Total area (ha)	430,001	427,090	425,522
Coast Ranges	Total perimeter (km)	1,998	2,016	2,052
Coast Ranges	Area/Perimeter (ha/km)	215	212	207
Coast Ranges	Mean area (ha)	25,294	22,478	22,396
Puget + Willamette lowlands	Total area (ha)	145,318	138,996	133,648
Puget + Willamette lowlands	Total perimeter (km)	2,884	2,980	3,205
Puget + Willamette lowlands	Area/Perimeter (ha/km)	50	47	42
Puget + Willamette lowlands	Mean area (ha)	10,380	8,687	5,346
All SWWA	Total area (ha)	1,590,400	1,568,087	1,554,124
All SWWA	Total perimeter (km)	6,464	6,902	7,291
All SWWA	Area/Perimeter (ha/km)	246	227	213
All SWWA	Mean area (ha)	38,790	34,846	27,752

Policy implications

Similar amounts of development have occurred in both Oregon and Washington in the Portland area (**Fig. 9**). However, development is less dispersed in Oregon, indicating that land-use laws in place since the 1970s have been effective. Preliminary analysis of land value in King county indicates higher assessed value of land close to urban areas (**Fig. 10**), which may indicate pressure to develop those lands over other uses.

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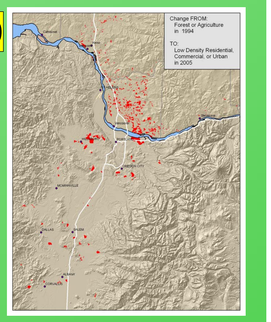

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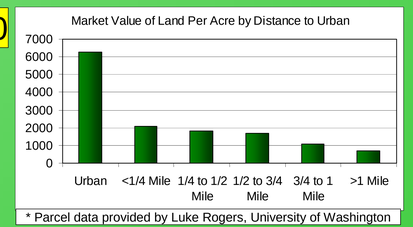

* Parcel data provided by Luke Rogers, University of Washington

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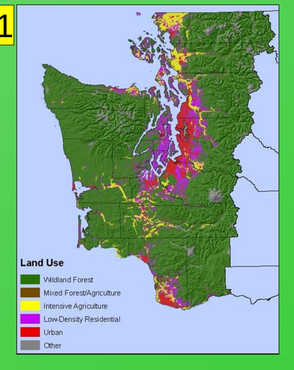

Conclusions

Results to date suggest that forest fragmentation is increasing in southwest Washington; continuing work (e.g. **Fig. 11**) will quantify patterns across the state.

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