LAND-USE CHANGE AND NEW HOUSES ON FORESTLAND: CONTRASTING TRENDS OVER 30 YEARS IN OREGON AND WASHINGTON

Andrew N. Gray, Joel L. Thompson, and Gary J. Lettman[1]

Abstract—Conversion of forest, range, and agricultural resource lands to residential and commercial uses affects the available land base, management practices on remaining resource lands, habitat quality, and ecosystem services. The Forest Inventory and Analysis program (FIA) mandate includes monitoring changes in the land area in forest use, and this has proved valuable for policy-makers interested in the effectiveness of laws regulating changes in local land-use. A variety of semi-automated approaches have been used to identify land-use change with imagery, but distinguishing changes in land cover from changes in land use has proven difficult in many vegetation types. We mapped land-use zones across Oregon and Washington and identified houses in 33 ha circles around 81,556 photo-points distributed across non-federal ownerships. Interpretations were done using high-resolution digital NAIP imagery and earlier photography, with summaries and spatial analyses done in GIS. We found that the area of nonfederal land in resource land uses (forest, range, and agriculture) declined by 2 percent between 1974 and 2009 in Oregon and by 4 percent between 1976 and 2006 in Washington. After land-use plan implementation in Oregon, nonfederal land converted from resource land uses decreased from 0.37 to 0.10 ha per new resident. In Washington, the loss remained constant at 0.18 ha per new resident. For lands remaining forestland in both states, housing density approximately doubled over a 30-year period. A substantial portion of the increased housing density on forestlands was in close proximity to public lands, suggesting an attraction of development in rural areas to amenities on public forestland. The Oregon Board of Forestry is using this ongoing study to assess the effectiveness of state conservation policies, establish metrics and indicators for use in limiting of productive forestland, and evaluate proposals to modify land-use laws and plans.

How urban and residential areas develop to accommodate population growth can have varying effects on forest and agricultural resource lands. A common concern with current land use change in the United States is with the expansion of housing and its effects on traditional economic production from rural lands (Kline et al. 2004, Wear et al. 1999) and on natural habitats and the ecosystem services they provide. In response to these concerns, some states in the Western United States have established planning programs to develop and update land use plans, often at the county or multicounty level, to guide the location and nature of development. Consideration in these plans is usually given to maintaining resource land uses while allowing development in appropriate areas.

In Washington State, the Growth Management Act of 1990 required counties to adopt comprehensive plans and regulations to plan for and address the impacts of growth. Oregon enacted the Land Conservation and Development Act in 1973, which was fully implemented statewide by the mid-1980s. Both laws were intended to limit conversion of highly productive resource lands and to plan for the conversion of forest and agricultural lands to urban uses where appropriate.

[1] Research Ecologist, PNW Research Station, USDA Forest Service, 3200 SW Jefferson Way, Corvallis, OR 97331; Forestry Technician, PNW Research Station, USDA Forest Service, 620 SW Main St., Ste. 500, Portland, OR 97205; and Forest Economist, Oregon Department of Forestry, 2600 State St., Salem, OR 97310. ANG is corresponding author: to contact, call 541-750-7299 or email agray01@fs.fed.us.

One of the goals of the Forest Inventory and Analysis (FIA) program is to track changes in the area of forest land, which has been a key part of inventory reports since the 1930s. However, given the low rate of land-use change in most regions of the country (<0.5%/yr), the current density of one plot per 2,400 hectares results in imprecise estimates at sub-state levels. A procedure based on photo-interpretation of FIA Phase 1 points has proved useful for assessing change in relation to geography and landscape context (MacLean and Bolsinger 1997). The objective of this paper is to synthesize results of recent applications of that technique in the states of Oregon and Washington.

METHODS

The study area consisted of all Oregon and Washington counties, but most of the analyses excluded large federal landowners whose mandate is to maintain natural land cover (namely, National Forest Systems, National Park Service, and Bureau of Land Management). All other lands are referred to as "nonfederal" for convenience. Land use classes were defined by a combination of land cover, density and spatial pattern of human structures, road density, and the amount of area in contrasting, contiguous land uses. The minimum mapping unit of resource land uses (either pure or mixed combinations of forest, range, or agriculture) was 260 ha (640 acres). Low-density residential and urban areas could be any size, but had to have at least nine houses in a clumped or dense pattern. The term "house" is meant to represent individual dwellings, thus multiple associated buildings (e.g., barns and sheds) would all count as a single house.

Aerial photographic imagery was used for this study, which was either captured digitally or digitized and georeferenced. The most recent imagery was obtained from USDA's National Agricultural Imagery Program (NAIP), which is collecting data across the conterminous US on a 3-year cycle. Land use class polygons were delineated in a GIS over displayed imagery for different dates. Land use calls were assigned to a systematic-random grid of photointerpretation points with a density of one point per 187 ha. Structures were counted in 32-ha circles around each nonurban grid point, in effect sampling 17 percent of the nonurban classes. Houses were individually recorded in a GIS. These photo interpretation procedures were repeated for several dates of imagery.

RESULTS & DISCUSSION

Nonfederal land in resource land uses (forestry, range, and agriculture) declined by 249,000 ha in Oregon (2%), and by 470,000 ha in Washington (4%) from 1976 to 2006. Losses were greatest on the west sides of each state, and the proportional losses of agricultural and mixed forest/agriculture land uses were greater than those of wildland forest (Fig. 1). As might be expected, areas that were converted to urban and residential uses tended to be at lower elevations and more moderate slopes than average (Gray et al. 2013), reflecting that a significant portion of forestland is simply not readily developable.

Land use change in the West is driven by population increases, largely from migration from other areas. While the loss of forestland in western Washington has been greater than that of western Oregon, the number of new residents has been greater as well. Over the 30-year period of the study, the area of development per new resident has been lower in western Washington than in western Oregon (Table 1). In Oregon the rate (area per person) changed dramatically before and after the 1990s from 0.37 to 0.10 ha per new resident, while in Washington, the loss remained at 0.18 ha per new resident (Lettman et al. 2013). Most of the development occurred on the west sides of each state, where the rate over the full 30-year period was remarkably similar at 0.14 ha per new resident (Table 1). It's not clear whether a big pulse of development occurred in Oregon in anticipation of the new laws, or if the geography and economy were more conducive to dispersed development prior to implementation of land-use laws.

Land classified as wildland forest does contain dispersed housing at low densities. The mean density of dispersed housing on forestland increased significantly in both states. The greatest increases were found in eastern Oregon, although overall densities

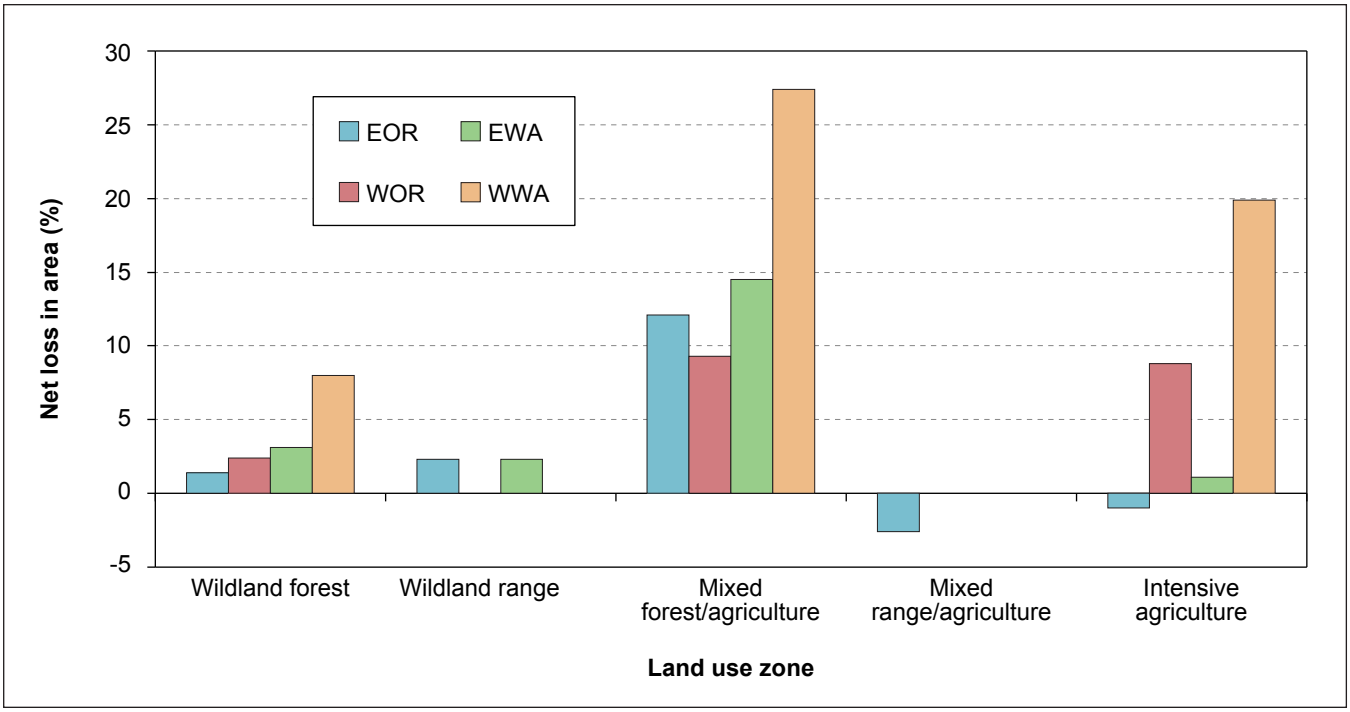

Figure 1—Net loss in area in resource land uses in Oregon and Washington from 1976 to 2006, by East and West side of state.

Table 1—Change in area in resource land uses (forest and agriculture) and change in population, 1976-2006, western Oregon and Washington.

	WOR	WWA
Change in resource land use (ha)	-158,238	-306,389
Change in number of people (N)	1,148,631	2,193,304
Area of change in resource land per new person in state (ha/N)	-0.14	-0.14

Table 2—Change in density of houses in 32-ha circles around points in wildland forest use on nonfederal land in Oregon and Washington, by East and West side of state.

	Number per km²			Change
Area	1976	1994	2006	1976-2006
EOR	0.08	0.19	0.23	300%
WOR	0.39	0.66	0.89	230%
EWA	0.40	0.63	0.83	208%
WWA	1.37	1.93	2.59	189%

were still relatively low (Table 2). Rates of increase were comparable in the other portions of the two states, but the highest house densities throughout the study were found in western Washington. Dispersed development can have important implications for land management. For example, it becomes more difficult and more expensive to try to protect houses from forest fires (Stein et al. 2013). A study of the metropolitan area around Portland (1 county in Washington and 3 in Oregon) found that state-mandated urban growth boundaries did have an effect at constraining development, but the amount of dispersed development varied considerably among counties (Kline et al. 2014).

Federal and state land management can also be affected by development on private lands, because people are often attracted to the amenity values of public lands (Azuma et al. 2013). Over the 30 year period, the density of houses within 1 km of public lands increased in both states, with the greatest increases found near Washington state lands (Fig. 2). State lands in Washington tend to be more dispersed and intermingled with other ownership classes than the other public ownerships are.

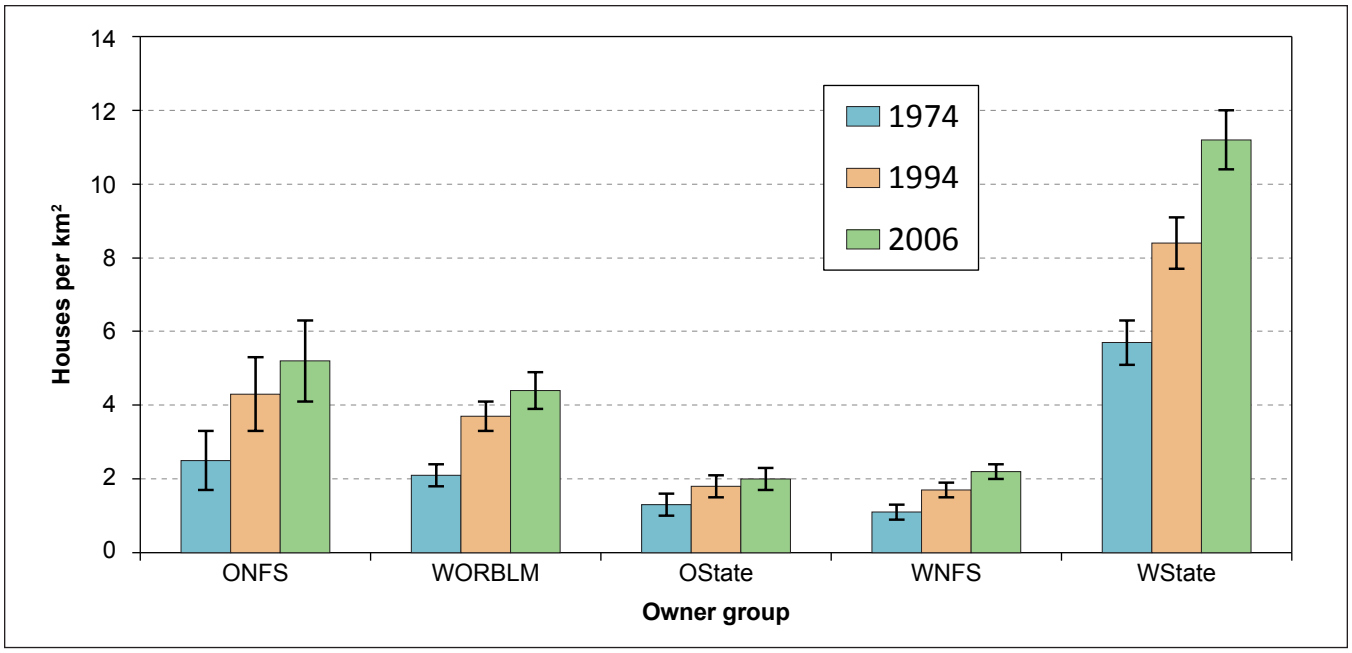

Figure 2—Change in the mean number of houses per square kilometer on private land less than 1 km from public owners in Oregon and Washington (O and W prefixes for National Forest System [NFS] and State land; WORBLM refers to Bureau of Land Management lands in western Oregon).

ACKNOWLEDGMENTS

Thanks to Daniel Stoelb, Tyler Robinson, Erica Hanson, Trevor Gamache, Donnych Diaz, and Dale Weyermann for assistance with image analysis and data collection. Funding for this study was provided by the Pacific Northwest Research Station and Forest Health Monitoring program of the USDA Forest Service.

LITERATURE CITED

Azuma, D.; Thompson, J.; Weyermann, D. 2013. Changes in development near public forest lands in Oregon and Washington 1974-2005: implications for management. Research Paper PNW-RP-596. Portland, Oregon: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 21 p.

Gray, A.N.; Azuma, D.L.; Lettman, G.J.; Thompson, J.L.; McKay, N. 2013. Changes in land use and housing on resource lands in Washington State, 1976-2006. PNW-GTR-881. Portland, Oregon: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 51 p.

Kline, J.D.; Azuma, D.L.; Alig, R.J. 2004. Population growth, urban expansion, and private forestry in western Oregon. Forest Science. 50: 33-43.

Kline, J.D.; Thiers, P.; Ozawa, C.P.; Yeakley, J.A.; Gordon, S.N. 2014. How well has land-use planning worked under different governance regimes? A case study in the Portland, OR-Vancouver, WA metropolitan area, USA. Landscape and Urban Planning. 131: 51-63.

Lettman, G.J.; Gray, A.N.; Herstrom, A.A.; McKay, N.; Thompson, J.L.; Azuma, D.L.; Nicholas, G.; Nichols, R.L.; Tokarczyk, J. 2013. Land Use Change on Non-Federal Land in Oregon and Washington. Salem, OR: Oregon Department of Forestry. 69 p.

MacLean, C.D.; Bolsinger, C.L. 1997. Urban expansion in the forests of the Puget Sound region. Resour. Bull. PNW-RB-225. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 17 p.

Stein, S.M.; Menakis, J.; Carr, M.A.; Comas, S.J.; Stewart, S.I.; Cleveland, H.; Bramwell, L.; Radeloff, V.C. 2013. Wildfire, wildlands, and people: understanding and preparing for wildfire in the wildland-urban interface—a Forests on the Edge report. General Technical Report RMRS-299. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 36 p.

Wear, D.N.; Liu, R.; Foreman, J.M.; Sheffield, R. 1999. The effects of population growth on timber management and inventories in Virginia. Forest Ecology and Management. 188: 107-115.