Land Use Change on Non-Federal Land in Oregon and Washington

2018 Update

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Executive Summary

Population Growth Drives Demand for Resource Lands

For decades Oregon and Washington have experienced substantial population growth that has driven demand for developable land. In response to growing concern surrounding increasing conversion of irreplaceable resource lands that are critical to ecosystem functionality and service delivery, Oregon enacted the Land Conservation Act and Washington the Growth Management Act.

Oregon and Washington Population Changes

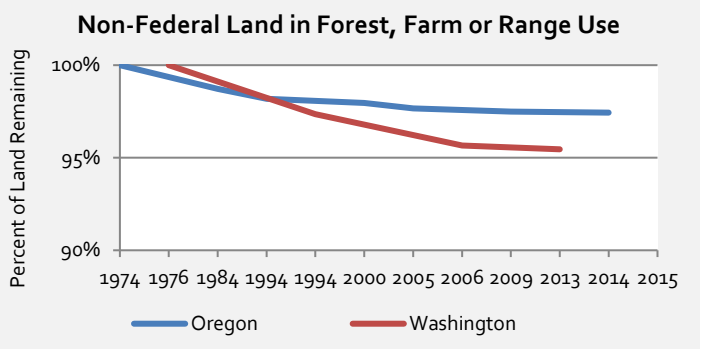
	New Residents	Change	Period
Oregon[1]	1,690,000	+74%	1974 – 2014
Washington[2]	3,247,000	+89%	1976 – 2013

[1]Oregon Office Economic Analysis, 2017, [2]Washington Office Financial Management, 2017

Land Use Laws Retain Resource Lands

Implementation of land use laws in Oregon (1984) and Washington (1994) have improved the retention of resource lands (agricultural, wildland forest, and wildland range).

- 97% of all non-Federal land in Oregon that was in resource land uses (farm, forest, or range) in 1974 remained in these uses in 2014.
- 95% of non-Federal land in Washington in these uses in 1976 remained in 2013.



In the periods following land use implementation there is a distinct slowing of the conversion of resource lands especially in Oregon. Following land use implementation the annual rate of wildland forest conversion in Oregon fell by 66%, range by 23% and intensive agricultural lands by 50%.

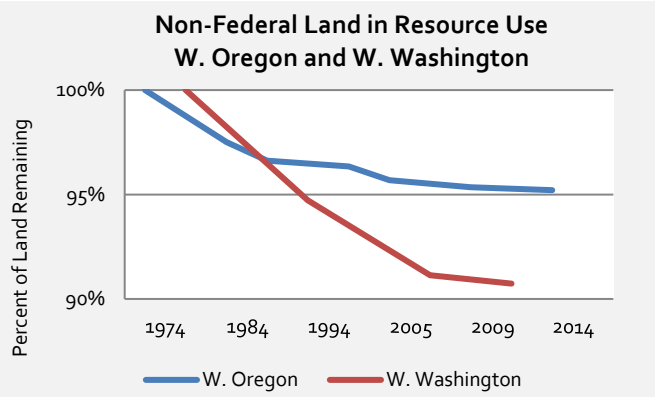
Oregon and Washington Resource Lands Converted Pre and Post Land Use Implementation

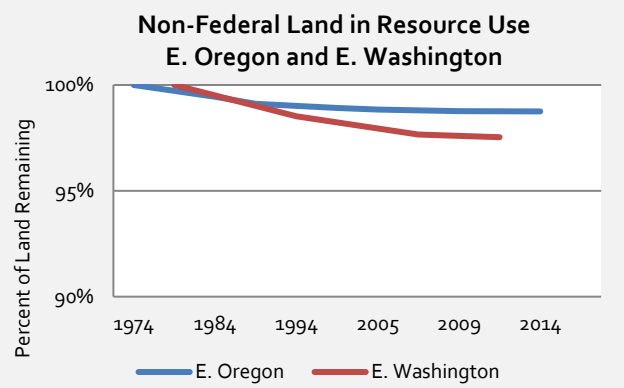
	Oregon, 1974-1984		Washington, 1976-1994		Oregon, 1984-2014		Washington, 1994-2013	
	Pre-Land Use Implementation				**Post** Land Use Implementation			
	Lands Converted	Annual Rate	Lands Converted	Annual Rate	Lands Converted	Annual Rate	Lands Converted	Annual Rate
	Thousand Acres							
Forest	-123	-12	-420	-23	-124	-4	-281	-15
Range	-133	-13	-184	-10	-151	-5	-181	-10
Agriculture	-42	-4	-101	-6	-66	-2	-32	-2
Totals	-298	-30	-705	-39	-341	-11.4	-494	-26

Region Specific Conversion

Conversion of resource lands follows population growth. More-populous western Oregon and western Washington experienced nearly twice as much resource land conversion to developed uses relative to the less-populous eastern portions of the states.

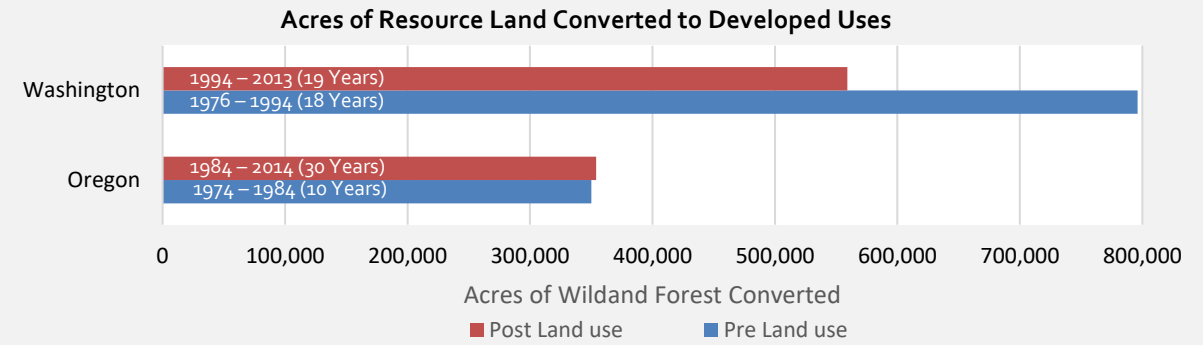
- In western Oregon, 95% of non-Federal land in resource uses in 1974 remained in 2014.
- In western Washington 91% of non-Federal land in resources uses in 1976 remained in in 2013.





Land Use Complements Resource Policy

The ability of land use planning to direct conversion and limit fragmentation of resource lands supports the vitality and productivity of resource lands as well as the functionality of ecosystems and services, social, economic, and ecologic. In this regard, Oregon has demonstrated a higher degree of success in retaining resource lands relative to Washington.



Continued Growth and Demand

Land use change will continue to be a critical concern, as Oregon and Washington's respective offices of economic and financial management predict that in the next 25 years:

- Oregon's population is projected to increase by 1,180,000 people (29 percent) and
- Washington's population is projected to increase by 1,932,000 people (26 percent).

Given this growth, there will be increased demands placed on PNW ecosystems to continue provision of critical services. Prior to land use implementation, conversion of resource lands in Oregon and Washington was vigorous and dispersed. Since implementation, conversion has been directed, supporting continuity and functionality of resource lands to the benefit of ecosystems and communities.

LAND USE CHANGE ON NON-FEDERAL LAND IN OREGON & WASHINGTON, 1974 – 2014

Verdant Resource Lands

The dynamic and varied natural landscape of the Pacific Northwest is the defining aspect of the region in many regards. The region's resource lands (e.g., forest, farm, and range) provide invaluable ecosystem services, sustain diverse renewable enterprises, and advance broad social benefits. Accordingly, there is distinct value in maintaining the integrity and functionality of the region's resource lands to ensure that the benefits they provide persist. This interest is challenged as significant regional population growth threatens to fragment resource lands and disrupt the continuity requisite to their ecological health, productivity, and functionality.

Increasing Population and Demand

Oregon and Washington have experienced significant population growth in recent decades:

State	New Residents	Change	Period
Oregon[1]	1,690,000	+74%	1974 – 2014
Washington[2]	3,247,000	+89%	1976 – 2013

[1]Oregon Office of Economic Analysis, 2017
[2]Washington Office of Financial Management, 2017

With regional growth, demands for resource land to accommodate and sustain new residents intensifies, placing increasing significance on the statutes, rules, and policies that collectively identify resource lands, moderate change, and direct development. In terms of land use statute and rule, Washington and Oregon are similar, however, administration differs in that Oregon exercises a more centralized approach relative to Washington.

In addition to law and policy, the relative health of state and local economies is a significant variable in dictating development and land use. The economic recession that followed the financial crisis of 2007 impacted economic growth and land conversion rates in Washington and Oregon. As the recession ended, development and conversion has resumed and increased in both states. The full extent of this increase is difficult to assess given the timelines of when data collection occurs relative to this analysis. New data will be necessary to more fully evaluate and discern the effect of land use laws and policies relative to economic drivers and population growth.

Report Focus

This evaluation seeks to provide an overview of how land use in both states has changed over recent decades. This report provides a macro-scale evaluation of land use change patterns using land use categories sufficient to recognize broad trends and gross policy efficacy. This report does not address micro-scale changes to ecosystem health, continuity, and functioning relative to land changes.

Land Use Policies

Oregon: Land Conservation and Development Act – 1973 (implemented mid- 1980s)

Oregon enacted the Land Conservation and Development Act in 1973, which was fully implemented statewide by the mid-1980s. The Act required all counties and incorporated municipalities to prepare comprehensive land use plans in accordance with 19 statewide planning goals specified in the Act. Resource lands were addressed through goals 3 and 4 which seek to limit and manage the loss of forest, agricultural, and range land consistently statewide.

In the course of implementation, non-Federal lands in Oregon were zoned either for resource uses (largely forest, farm, and range land) or as developable zones that were either already urbanized or adjacent to urbanized areas (predominately areas of low density residential and urban land use). Goal 14 mandated the establishment of urban growth boundaries to promote compact urban growth within these boundaries and to restrict the spread of development into forest and farm land. Development can and does still occur in resource lands through exceptions, but opportunities are limited.

GOAL 3: AGRICULTURAL LANDS
OAR 660-015-0000(3)

To preserve and maintain agricultural lands. Agricultural lands shall be preserved and maintained for farm use, consistent with existing and future needs for agricultural products, forest and open space and with the state's agricultural land use policy expressed in ORS 215.243 and 215.700.

Agricultural Land -- in western Oregon is land of predominantly Class I, II, III and IV soils and in eastern Oregon is land of predominantly Class I, II, III, IV, V and VI soils as identified in the Soil Capability Classification System of the United States Soil Conservation Service, and other lands which are suitable for farm use taking into consideration soil fertility, suitability for grazing, climatic conditions, existing and future availability of water for farm irrigation purposes, existing land-use patterns, technological and energy inputs required, or accepted farming practices. Lands in other classes which are necessary to permit farm practices to be undertaken on adjacent or nearby lands, shall be included as agricultural land in any event.

Washington: Growth Management Act – 1990 (implemented mid-1990s)

Washington passed the Growth Management Act (GMA) in 1990. The GMA was largely implemented by the mid-1990s. It required all counties and incorporated municipalities to conduct land use planning. Initial steps in the planning process required all counties to designate forest, farm, and other natural resource lands (range land was considered farm land in this process) and then to adopt local regulations to protect these lands from development. Additionally, 29 (of 39) counties were required or chose to plan fully by adopting county-wide planning policies based on 14 statewide goals specified in the Act. Each county then used its policies to develop and implement a county-level comprehensive land use plan. Included in these plans was the establishment of urban growth areas.

GOAL 4: FOREST LANDS
OAR 660-015-0000(4)

To conserve forest lands by maintaining the forest land base and to protect the state's forest economy by making possible economically efficient forest practices that assure the continuous growing and harvesting of forest tree species as the leading use on forest land consistent with sound management of soil, air, water, and fish and wildlife resources and to provide for recreational opportunities and agriculture.

Forest lands are those lands acknowledged as forest lands as of the date of adoption of this goal amendment. Where a plan is not acknowledged or a plan amendment involving forest lands is proposed, forest land shall include lands which are suitable for commercial forest uses including adjacent or nearby lands which are necessary to permit forest operations or practices and other forested lands that maintain soil, air, water and fish and wildlife resources.

Land Use Administration in Oregon and Washington

In Washington the GMA framework provides direction to local governments, but allows flexibility regarding the specific content of comprehensive plans and implementation of development regulations. Under the GMA, land use planning at the county and city levels is assumed to be valid unless a constituent petitions a state growth management hearings board and the board rules against the local government. This aspect of the GMA decentralizes implementation and can generate more variable results across the landscape.

By comparison, Oregon's land use process is more centralized. In Oregon, one board (the Land Conservation and Development Commission) and one state agency (the Department of Land Conservation and Development) guide, review, and monitor land use planning throughout the state according to statute and rule. This centralized oversight helps ensure that local comprehensive plans and implementation are consistent with state policy and comply with the statewide planning goals.

Evaluation Methods

This evaluation compares changes in land use on non-Federal land between Oregon and Washington based on eight different land use classes (see Table 1). The study period is from the mid-1970s through 2014. To quantify land use change, interpreters evaluated 82,329 sample points distributed across non-Federal land in Oregon and Washington based on aerial imagery taken at successive dates. Each sample point was assigned one of the eight land use classes at each date. The sample point locations and the evaluation methods are consistent for all time periods. In Oregon, evaluation was carried out based on imagery from 1974, 1984, 1994, 2000, 2005, 2009, and 2014. In Washington evaluation was carried out based on imagery from 1976, 1994, 2006, and 2013.

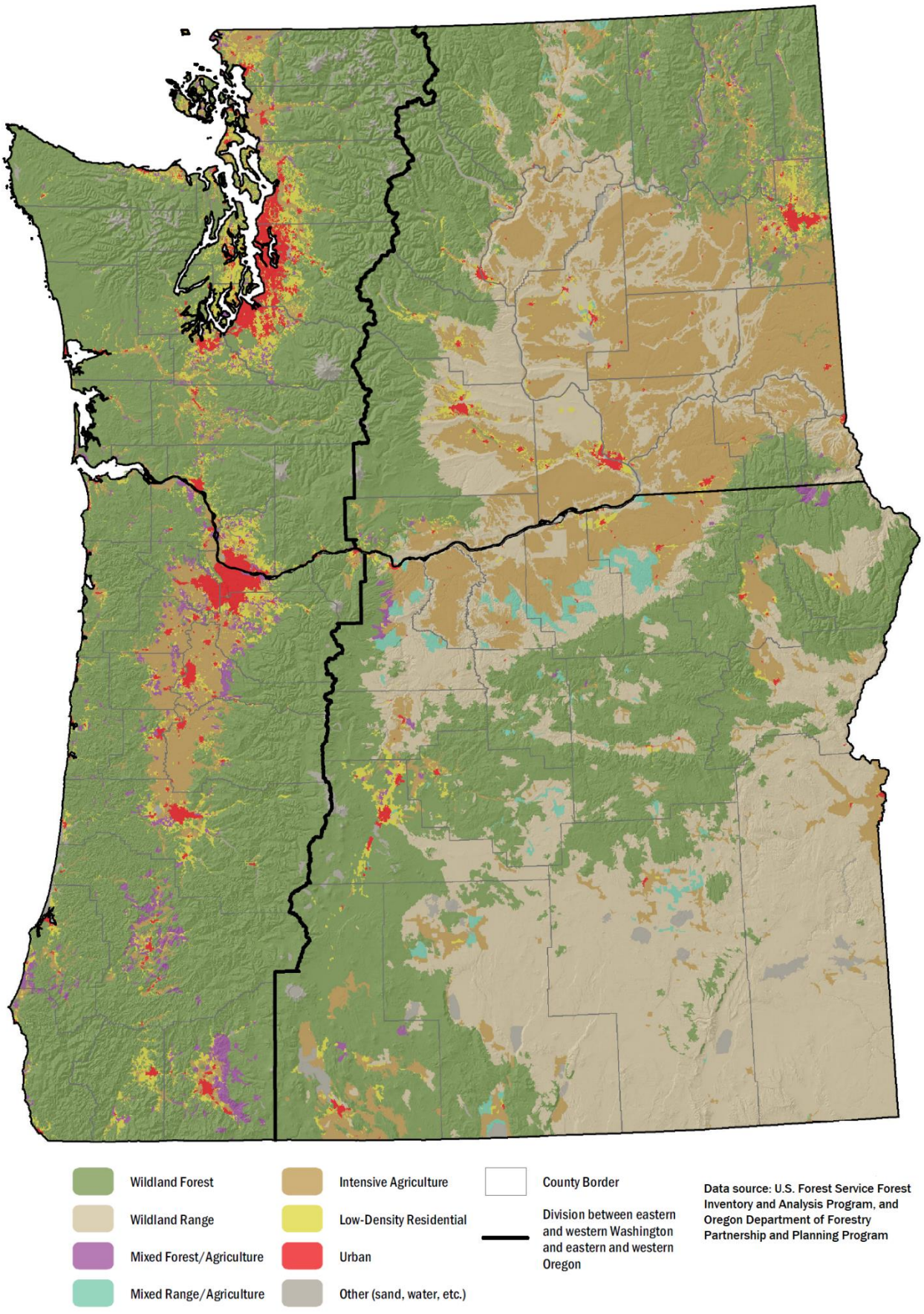
Table 1. Land Use Classes

Land Use Category	Description
Wildland Forest	- Area of land in forest use that is at least 640 acres in size and - Fewer than 5 structures per square mile on average.
Wildland Range	- Area of land in range use that is at least 640 acres in size and - Fewer than 5 structures per square mile on average.
Mixed Forest/Agriculture	- Area of land with intermixed forest and agricultural uses that is at least 640 acres in size and - Fewer than 9 non-farm-related structures per square mile on average.
Mixed Range/Agriculture	- Area of land with intermixed range and agricultural uses that is at least 640 acres in size and - Fewer than 9 non-farm-related structures per square mile on average.
Intensive Agriculture	- Area of land in agricultural use that is at least 640 acres in size and - Fewer than 9 non-farm-related structures per square mile on average.
Low-Density Residential	- An area of any size in rural residential or low-density commercial use that contains 9 or more structures.
Urban	- Area of land that is at least 40 acres in size and - Comprised of commercial, service, or subdivided residential uses with city street patterns and closely-spaced buildings.
Other (sand, rock, water, etc.)	- Area of naturally non-vegetated land that is at least 640 acres in size.

Examples of the eight land classes used in this report are identified in Figure 1 (mixed range/agriculture not shown). Figure 2 shows the distribution of these classes across Oregon and Washington and delineates the boundary between the western and eastern sides of the two states.

Figure 1 — Land Use Classes

Figure 2. Land Use: Washington 2013 and Oregon 2014



Land Use Changes

Oregon and Washington contain comparable areas of non-Federal land, with 28,706,000 acres and 31,600,000 acres respectively (see Figure 3). With growing populations, Oregon and Washington have experienced conversion of resource lands to low-density residential or urban uses.

- In Oregon 704,000 acres (2.6%) of all non-Federal land resource land (wildland forest, wildland range, intensive agriculture, mixed forest/agricultural and mixed range/agriculture uses) shifted to low-density residential or urban uses between 1974 and 2014 (see Figure 3).

- In Washington, 1,334,000 acres (4.5%) of all non-Federal resource land shifted to low-density residential or urban uses between 1976 and 2013 (see Figure 3).

The rate of conversion of resource lands has slowed in both states since implementation of land use laws. However, in this perspective a greater area of resource land conversion has occurred in Washington relative to Oregon (see Figure 4 and Table 2).

Figure 3. Non-Federal Land Conversion

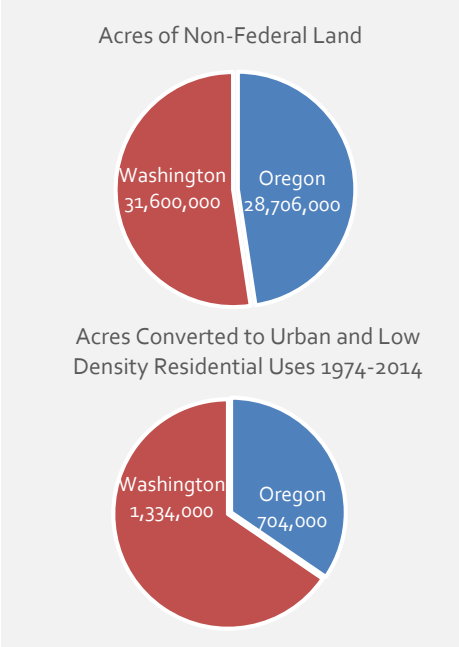
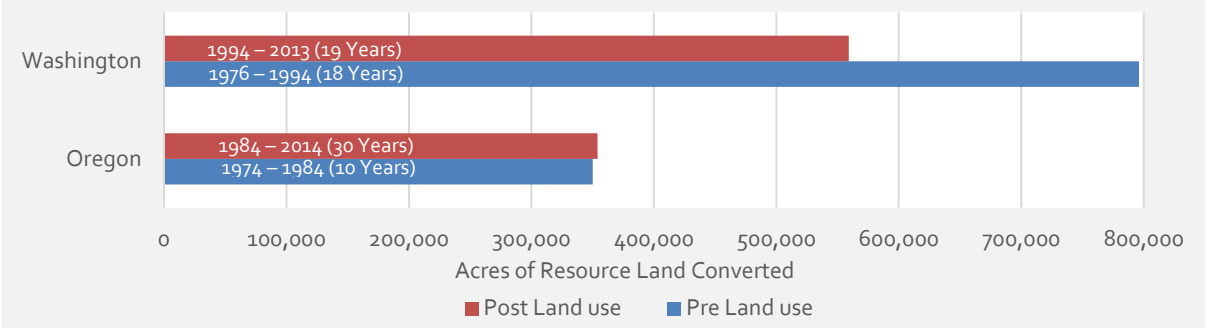


Figure 4. Area of Resource Lands Converted to Low Density Residential and Urban



In Washington, Wildland forest has been the principal resource land subject to conversion. Oregon has also experienced significant conversion of this resource as well (see Figure 5).

Figure 5. Oregon and Washington Land Use Change 1974 – 2014

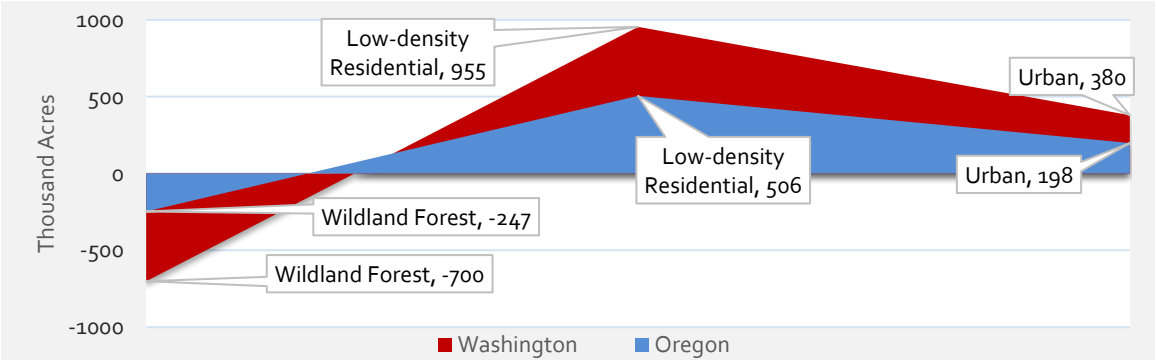


Table 2. Area and Percent of non-Federal Land in Oregon and Washington, by Land Use Class and Year

Oregon: land use class	1974		1984		1994		2000		2005		2009		2014		Change 1974-2014		Change 1984-2014*	
	Thousand acres | Percent of Non-Federal Land																	
Wildland forest	10,693	37.3	10,570	36.8	10,512	36.6	10,497	36.6	10,468	36.5	10,455	36.4	10,446	36.4	-247	- 0.9	-124	-0.4
Wildland range	9,297	32.4	9,164	31.9	9,116	31.8	9,087	31.7	9,045	31.5	9,034	31.5	9,013	31.4	-284	-1.0	-151	-0.5
Mixed forest/agriculture	959	3.3	901	3.1	877	3.1	876	3.1	864	3.0	855	3.0	853	3.0	-105	-0.4	-48	-0.2
Mixed range/agriculture	658	2.3	664	2.3	666	2.3	678	2.4	690	2.4	690	2.4	699	2.4	41	0.1	35	0.1
Intensive agriculture	5,848	20.4	5,806	20.2	5,786	20.2	5,757	20.1	5,747	20.0	5,733	20.0	5,740	20.0	-109	-0.4	-66	-0.2
Low-density residential	785	2.7	1,060	3.7	1,165	4.1	1,196	4.2	1,246	4.3	1,282	4.5	1,291	4.5	506	1.8	231	0.8
Urban	378	1.3	453	1.6	495	1.7	526	1.8	556	1.9	568	2.0	576	2.0	198	0.7	123	0.4
Other	88	0.3	88	0.3	88	0.3	88	0.3	88	0.3	88	0.3	88	0.3	0	0.0	0	0.0

*Oregon's land use laws were largely implemented by 1984

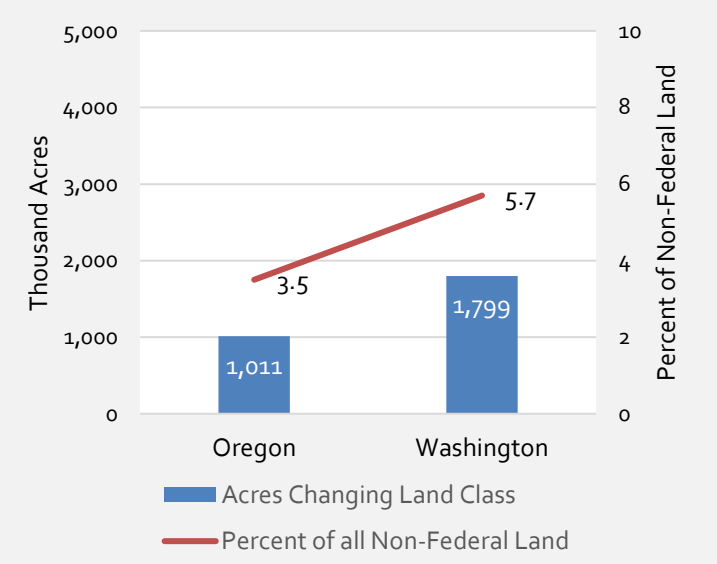
Washington: land use class	1976			1994			2006			2013		Change 1976-2013		Change 1994-2013*	
	Thousand acres | Percent of Non-Federal Land														
Wildland forest	13,653	43.2		13,233	41.9		12,991	41.1		12,952	41.0	-700	-2.2	-281	-0.9
Wildland range	6,170	19.5		5,986	18.9		5,884	18.6		5,805	18.4	-365	-1.2	-181	-0.6
Mixed forest/agriculture	545	1.7		471	1.5		407	1.3		403	1.3	-142	-0.4	-67	-0.2
Mixed range/agriculture	64	0.2		64	0.2		64	0.2		64	0.2	0	0.0	0	0.0
Intensive agriculture	9,059	28.7		8,958	28.3		8,865	28.1		8,926	28.2	-133	-0.4	-32	-0.1
Low-density residential	1,275	4.0		1,853	5.9		2,187	6.9		2,230	7.1	955	3.0	377	1.2
Urban	578	1.8		775	2.5		939	3.0		957	3.0	380	1.2	182	0.6
Other	256	0.8		260	0.8		262	0.8		262	0.8	6	<0.1	2	<0.1

* Washington's land use laws were largely implemented by 1994

A Changing Landscape - Non-Federal Land Use Change

In Washington approximately 1,799,000 acres of non-Federal land changed uses, moving from one category to another either through reduction of resource status or addition of developed use, between 1976 and 2013, (approximately 5.7% of all non-Federal land in the state). In comparison a total of approximately 1,011,000 acres of non-Federal land in Oregon changed uses between 1974 and 2014 (approximately 3.5% of all non-Federal land in the state)(see Figure 6).

Figure 6. Acres Changing Land Classification 1974 - 2014



Resource Land Conversion

Ninety-seven percent of all non-Federal land in Oregon that was in resource land uses (farm, forest, or range) in 1974 remained in these uses in 2014 (Figure 6). Ninety-five percent of non-Federal land in Washington that was in these uses in 1976 remained so in 2013.

In more-populous western Oregon and western Washington, almost twice as much resource land was converted to developed uses than in the less-populous eastern portions of the states (Figure 7). In western Oregon, 95% of non-Federal land that was in resource uses in 1974 remained in these uses in 2014, and in western Washington 91% of non-Federal land that was in resources uses in 1976 remained in these uses in 2013. Less change occurred in the Eastern portions of both states.

Figure 7. Non-Federal Land Remaining in Forest, Farm, or Range Oregon 1974-2014 and Washington 1976-2013

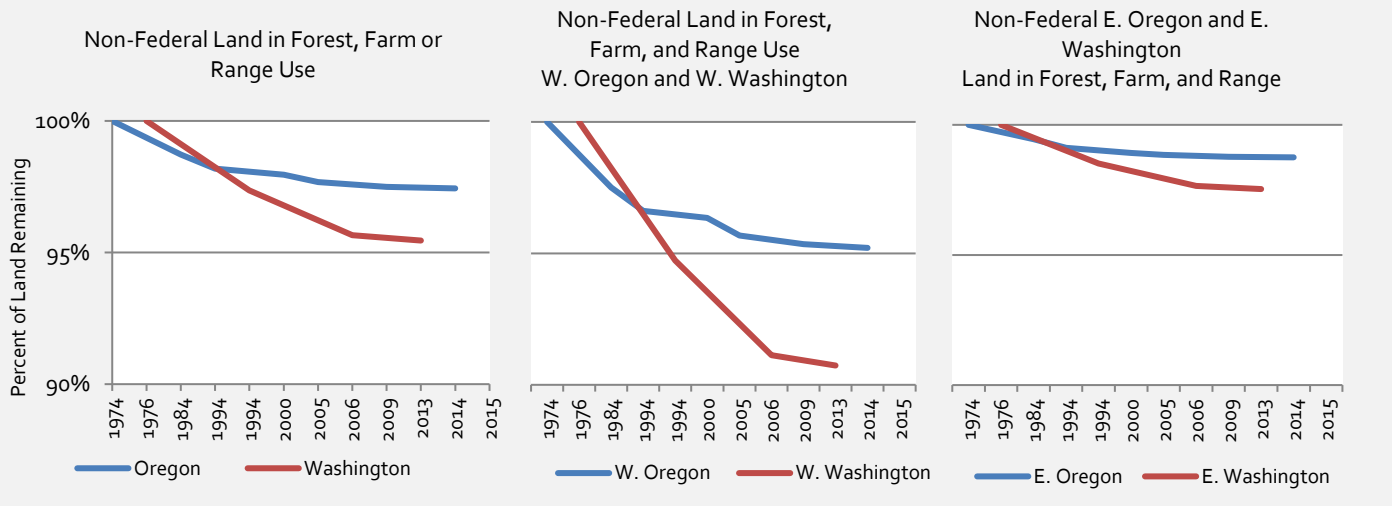
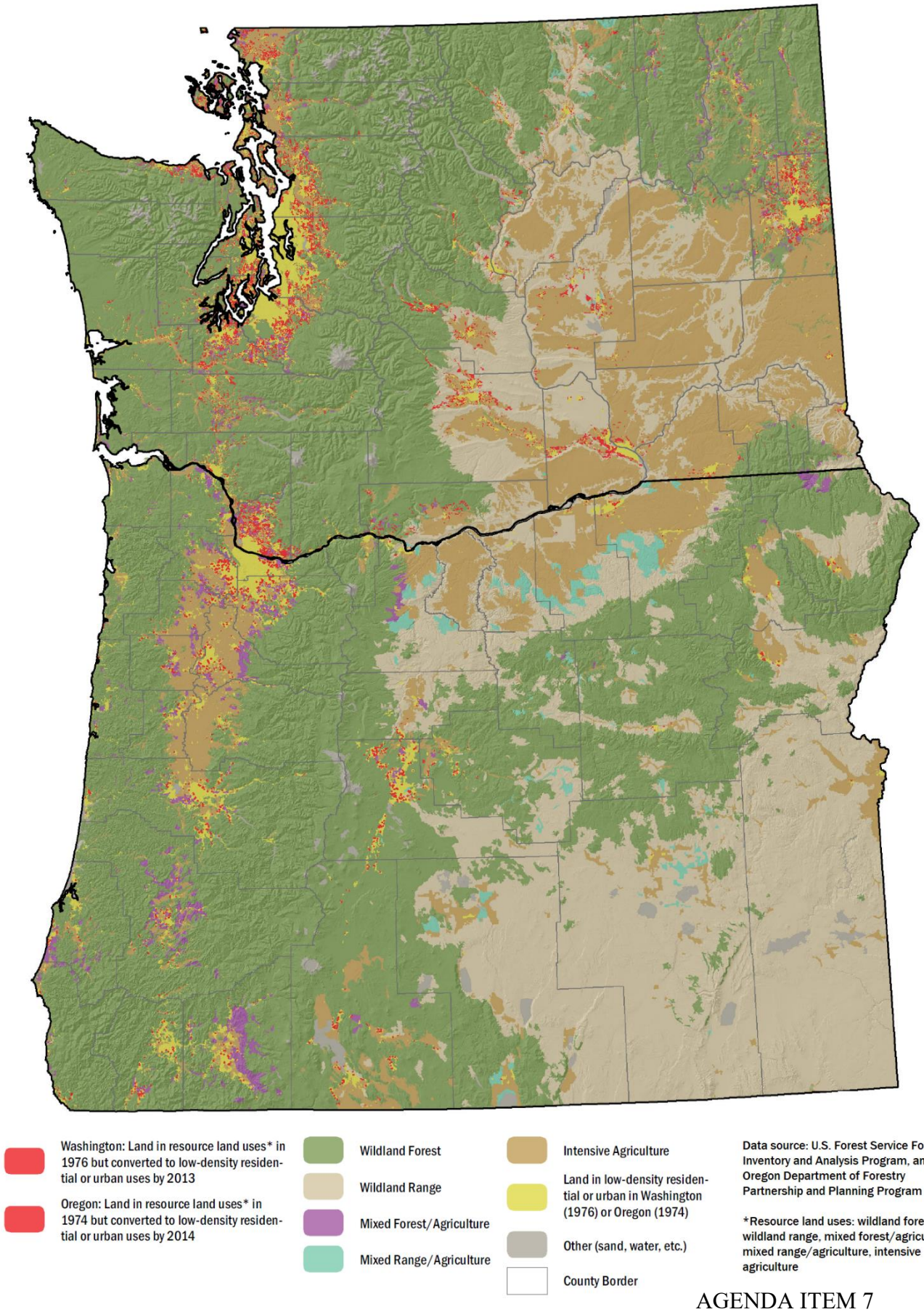


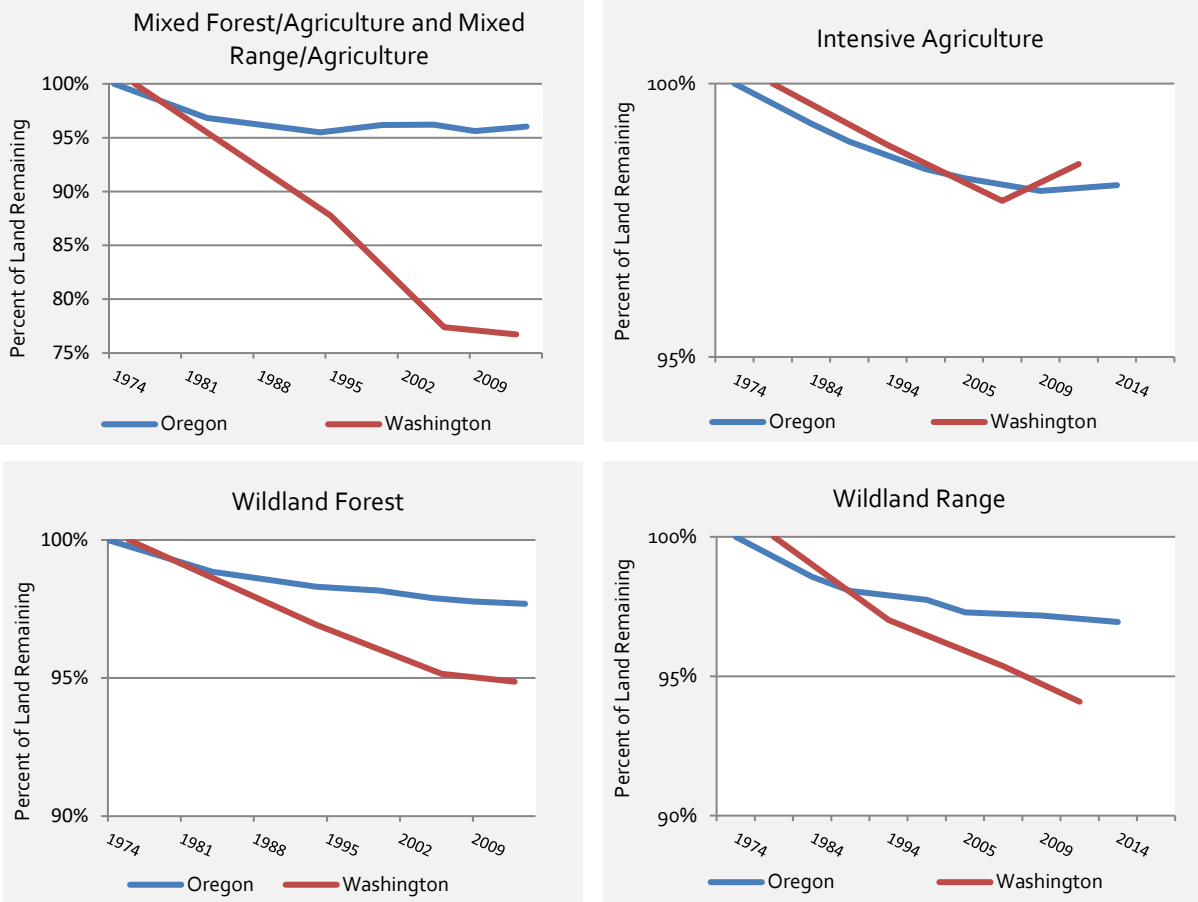
Figure 7. Changes in Land Use on Non-Federal Land: Washington 1976-2013, Oregon 1974-2014



Resource Land Use Changes By Land Use – Oregon and Washington

Both states have experienced ongoing conversion of non-Federal resource lands to more developed uses over the study period (with the exception of intensive and mixed agricultural lands, where a modest increase in agricultural use was observed in the later periods of evaluation). Washington experienced a greater loss of non-Federal resource lands relative to Oregon (Figure 8).

Figure 8. Non-Federal Rand Remaining in Resource Land Uses 1974 – 2014



The largest land use losses in Oregon and Washington occurred in wildland forest and wildland range. Together the two states experienced a combined conversion of 1,597,000 acres, an area larger than the state of Delaware. Conversely the land uses with the largest increases occurred in low-density residential and urban uses (Table 3).

Table 3. Largest Land Use Changes by State (1974-2014)

Land Use Losses			Land Use Gains		
Land Use	*State*	*Change (Acres)*	*Land Use*	*State*	*Change (Acres)*
Wildland Forest	Washington	-700,000	Low-Density Residential	Washington	+955,000
	Oregon	-247,000		Oregon	+506,000
Wildland Range	Washington	-365,000	Urban	Washington	+380,000
	Oregon	-284,000		Oregon	+198,000

Resource Land Conversion

In both states, shifts from resource land uses to low-density residential or urban uses occurred predominately on private land. Low-density residential use accounted for the majority of this conversion, increasing by 1.4 million acres total for both states (Table 4). (This macro-scale evaluation does not differentiate between specific sources of conversion such as industrial development, urban growth boundary incorporations, partitioning of resource parcels, or exceptions to resource land uses which collectively affect and impact the nature of resource lands in terms of habitat, ecosystem dynamics, and other landscape concerns.)

Table 4. Private Land Use Transitions in Oregon and Washington 1974-2014

Oregon: land use class	1974	2014	Net change 1974-2014	Net change 1974-2014
	Thousand Acres			*Percent*
Western Oregon				
Wildland forest	6,256	6,065	-191	-3.1
Mixed forest/agriculture	774	687	-87	-11.2
Intensive agriculture	1,938	1,754	-184	-9.5
Low-density residential	492	809	317	64.5
Urban	263	408	145	55.2
Eastern Oregon				
Wildland forest	2,950	2,905	-46	-1.6
Wildland range	8,258	8,013	-245	-3.0
Mixed forest/agriculture	128	116	-13	-9.8
Mixed range/agriculture	642	677	34	5.3
Intensive agriculture	3,652	3,714	62	1.7
Low-density residential	226	396	169	74.8
Urban	52	90	38	72.6

Washington: land use class	1976	2013	Net change 1976-2013	Net change 1976-2013
	Thousand Acres			*Percent*
Western Washington				
Wildland forest	5,932	5,421	-511	-8.6
Mixed forest/agriculture	333	225	-108	-32.4
Intensive agriculture	808	625	-182	-22.6
Low-density residential	863	1,406	543	63.0
Urban	331	584	253	76.6
Eastern Washington				
Wildland forest	4,690	4,529	-160	-3.4
Wildland range	5,850	5,487	-363	-6.2
Mixed forest/agriculture	173	145	-29	-16.6
Mixed range/agriculture	63	63	0	0.0
Intensive agriculture	8,161	8,219	58	0.7
Low-density residential	340	730	389	114.4
Urban	191	296	105	54.8

Wildland Forest Changes by Ownership

In both states the area of land in wildland forest use has declined, however the magnitude of conversion has varied by ownership. Industrial (active management entities) and public owners have largely retained land in wildland forest use, while non-industrial owners have accounted for most conversion (Table 5).

Table 5. Change in Area of Non-Federal Wildland Forest Based on Ownership

	Industrial	Non-industrial	Other public
	Change, in percent		
Oregon (1974 – 2014)	0	-7	-1
Western Oregon	0	-10	-1
Eastern Oregon	0	-4	0
Washington (1976 – 2013)	-1	-11	-1
Western Washington	-1	-24	-1
Eastern Washington	-1	-4	-1

Directed Growth and Comprehensive Planning

Land use planning can provide directed systematic development that reflects deliberate use of resources and consideration of dynamic social, economic, and ecological values. These values can be realized when planning and implementation occur in a comprehensive and consistent manner across regions and ecosystems (Costanza et al., 1997; Lubchenco et al., 2000; de Groot et al, 2000; de Groot et al., 2002; de Groot et al., 2003).

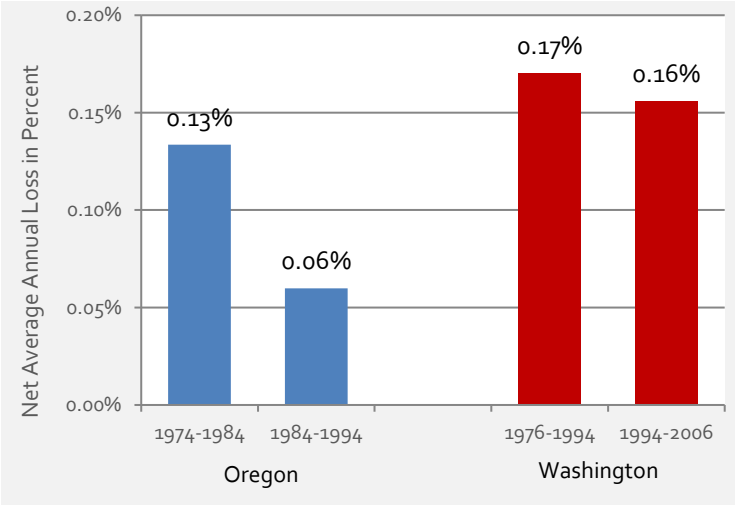
Comprehensive Planning and Conversion Rates

Conversion of private resource lands to low-density or urban land uses has slowed more in Oregon than Washington since implementation of comprehensive land use planning (Figure 9).

- In Oregon, net average annual conversion of private resource land declined by 54% after implementation of land use planning when considering the periods before and after land use plans were implemented in the 1980s.

- In Washington, net average annual conversion of private resource land declined by 6% after implementation of land use planning when considering the periods before and after land use plans were implemented in the 1990s.

Figure 9. Net Average Annual Loss of Private Resource Land Before and After Implementation of Land Use Plans

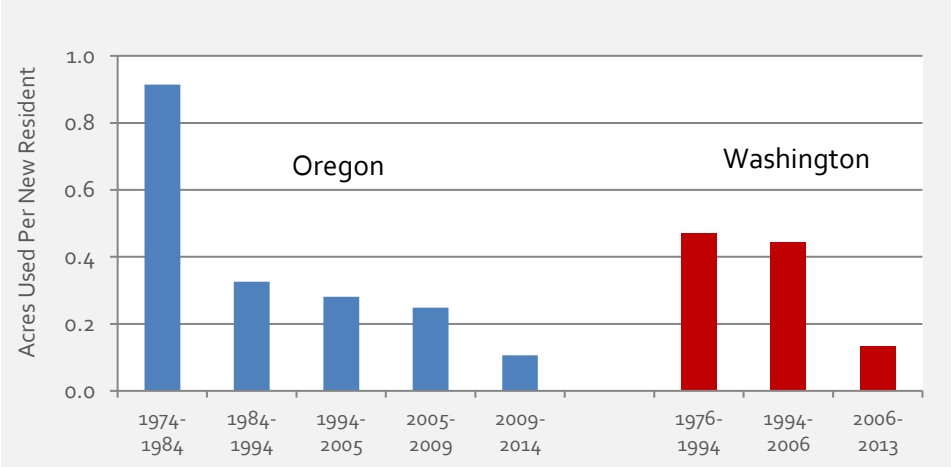


Improving Land Use Efficiency by Limiting Sprawl

Economic conditions and institutional policies are influential factors affecting the pace and nature of land use change. Where institutional policies are present, negative externalities of change, notably "sprawl," can be mediated (Lambina et al, 2001). Sprawl is described as dispersed, low-density growth that is characterized by inefficient resource use that creates social and environmental costs (Kunstler, 1993; Ewing, 1997; Downs, 1998; Burchell et al., 1998; Kahn, 2000; Bhatta and Bandyopadhyay, 2010).

Different methods are used to evaluate growth efficiency and sprawl, including examination of the per capita consumption of land as population increases (Hasse and Lathrop, 2003). In this regard, we consider the area of land shifting from resource to developed uses per new resident in Oregon and Washington. This metric reflects the relative efficiency of the two states over time in accommodating new growth, limiting sprawl, and converting resource lands to more developed uses. Oregon and Washington improved efficiency in accommodating growth with implementation of land use laws (see Figure 10).

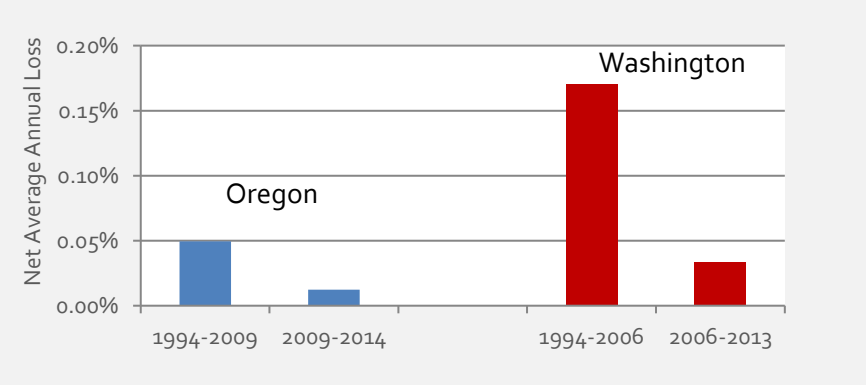
Figure 10. Average Area, Per New Resident, of Non-Federal Land Changing from Resource to Low-Density Residential or Urban Uses, Oregon 1974-2014, Washington 1976-2013



Recessionary Impact

Institutional policy alone does not determine the nature of land use change: regional economic and market conditions also exert influence on change. The most recent period of analysis reflects this conversion of resource lands significantly diminished in conjunction with the Great Recession (Figure 11).

Figure 11. Net Average Annual Loss of Private Resource Land Developed Uses Before and After Recession



Whether there is a rebound in resource land conversion rates with an improved economic environment or whether growth continues to densify cannot be determined until more recent imagery is available. This data should be available in 2019.

Ecosystem and Community Well-Being – Resource Lands and Comprehensive Planning

Human and community well-being is dynamically linked to ecosystem health by provision of ecosystem services (social, economic, and ecological) (Cairns 1993, Chivian, 2001, Chan et al. 2006). As the scale and complexity of human and ecosystem interactions increases, the reliance on resource lands and continued ecosystem functionality is increasingly critical (Chapin et al. 1997). Conversion of resource lands impairs ecosystem functionality and services such as but not limited to: water filtration, carbon and soil cycling, and provision of habitat necessary to maintain biological diversity.

Balancing development decisions with consideration of the dynamic ecosystem responses to land use change is paramount to maintaining ecosystem functionality (DeFries et al. 2004). Regionally, there are efforts to consider unique ecosystem features and functionality in land use planning. In Oregon, protection of natural resources on non-Federal land is directed via compliance with land use planning goals, such as Goals 4 and 5 that seek to recognize and retain continuity and vital features associated with unique and dynamic ecosystems such as wildland forest.

Wildland Forest

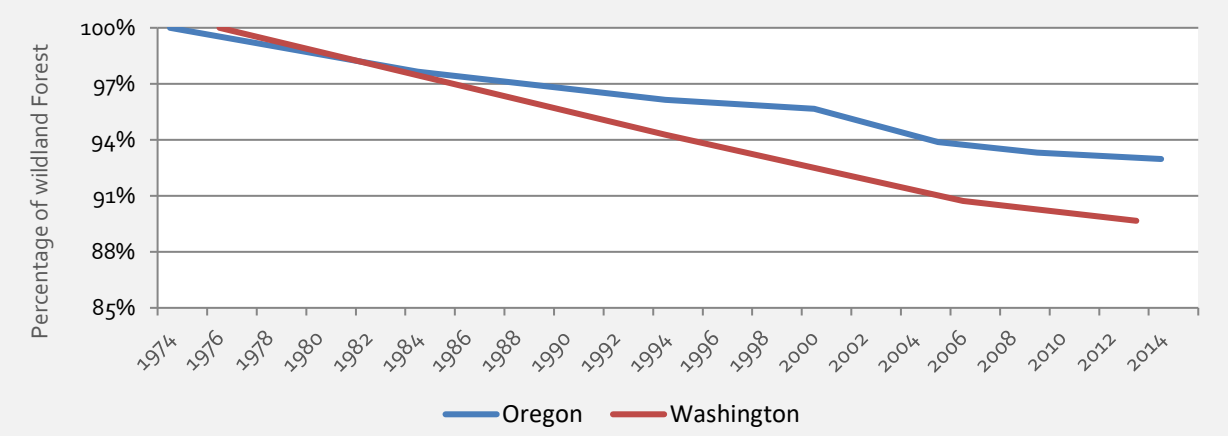
Wildland forest provides a range of services to communities, including but not limited to:

- Ecological benefits such as habitat, fertile soil, clean air, and water cycling and filtration;
- Economic goods including timber and other forest products;
- Social benefits such as recreation and existence values.

The extent and intensity to which these services are provided is dependent on maintaining continuity and limiting fragmentation as development (both suburban and exurban) challenges the ecological processes and functionality of wildland forest (Kahn, 2000; Marzluff and Ewing, 2001).

The density of residential developments is one metric for distinguishing relatively less-developed wildland forest zones from relatively more-developed wildland forest zones. In both Oregon and Washington, the amount of undeveloped and less-developed wildland forest has declined over the study period. The area of non-Federal land in wildland forest use with less than 10 residents per square mile declined by 7 percent (693,000 acres) in Oregon, and by 10 percent (1,280,000 acres) in Washington over the study period (Figure 12).

Figure 12. Non-Federal Land Remaining in Wildland Forest Use With Less Than 10 Residents per Square Mile, Oregon 1974-2014, Washington 1976-2013



This indicates that in both states, the area of wildland forest impacted by dispersed residential development is greater than the area of wildland forest that was converted to non-forest uses. Conversion and fragmentation of wildland forest impairs functionality via creation of new challenges:

- Increased conflict relative to resource management;
- Diminished value proposition for active management as cohesiveness and ability to operate is constrained;
- Increased ignition of wildfire and cost to manage wildfire;
- Diminished provision of ecosystem services: habitat, air, geochemical, and water cycling.

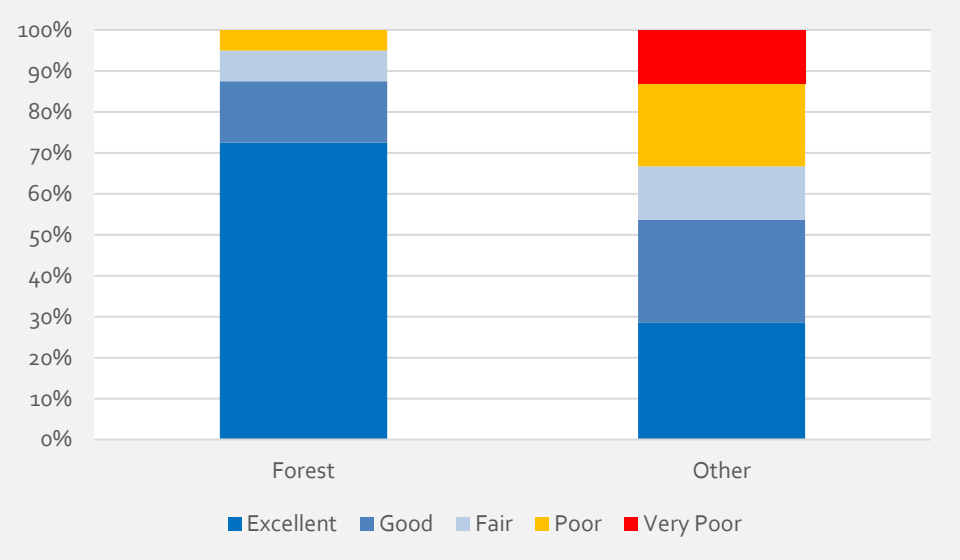
Maintaining resource continuity limits these and other negative externalities and ensures critical services such as clean water are sustained.

Resource Lands – Ecosystem Services

Water quality is inextricably linked to ecosystem and community health. Diminished water quality compromises ecosystem functioning and interactions such that habitat is undermined, biodiversity is challenged, and overall ecosystem health and resilience are undermined. Conversion of resource lands disrupts natural processes, surface area and flow, degrades water quality, and reduces vegetation cover and diversity. The changes made to the landscape through development tend to be permanent, and restoration to a natural state is difficult (Oregon Conservation Strategy, 2016).

A review of Oregon Department of Environmental Quality (DEQ) water quality index scores for sample points according to land use classification for the years 1996-2015 (Figure 13) demonstrates the relationship between land use and water quality. In particular, the prevalence of high water quality on forest lands indicates value of forest land use in this regard, and underlines the importance of avoiding conversion to alternative uses that cause deleterious effects on water quality.

Figure 13. Water Quality on non-Federal Land by Forest and Other Land Uses, Oregon 2015*



*DEQ water quality sampling point data was attributed according to land use classification, water quality scores were averaged for each point and allocated to water quality classes and land uses (1996-2015).

Recognizing the importance of wildland forest to maintaining water quality, both Oregon and Washington recognize the value of protecting this resource from development. To this end, the Oregon Board of Forestry has a stated policy to "Promote the maintenance of forestland in forest uses and promote the establishment of new forests as key elements in promoting high quality water and protection of soil productivity," and the Washington Department of Natural Resources Forest Legacy Program states that "Keeping land in traditional forest uses also aids protection of water quality, fish and wildlife habitat, cultural resources, and recreation opportunities."

Resource Lands – Ecosystem Functionality

Habitat availability and quality is a reflection of ecosystem capability as trophic cascades are a critical facet of ecosystem functionality (Ripple and Beschta, 2005). Resource lands benefit broader ecosystem functionality as their contiguous presence supports delivery of ecosystem benefits, habitat quality and quantity, and maintains connectivity, all key components of terrestrial and aquatic resource management.

In the Pacific Northwest, freshwater aquatic systems are essential habitat to multiple species, including important spawning and rearing habitat for salmonids and breeding habitat for amphibians, and invertebrates. The nature of land use in areas adjacent to aquatic systems can severely affect functionality and capability to provide adequate habitat depending on the nature of use (e.g. impermeable surfaces, pollutants, flow diversion, etc.). Where forests and other resource lands persist, habitat requirements such as water quality are more likely to be met (see Figure 13).

Beyond water quality, connectivity between aquatic habitats is an important part of garnering successful and healthy populations. Many species rely on the ability to move throughout the landscape to fulfill their needs for survival or complete their life cycles. Some species move seasonally, following food resources, moving to areas more suitable for raising young, or surviving the winter. This may mean moving north and south across thousands of miles, or higher and lower in elevation. Human-caused changes to the landscape can affect the ability of wildlife to move across terrestrial landscapes by adding obstacles, impacting critical stopover sites, and increasing habitat fragmentation (Oregon Conservation Strategy, 2016).

Patterns of land use and development within and adjacent to aquatic systems and streams supporting salmon differ between Oregon and Washington. In the 1994 – 2013 period for Washington and the 1994 – 2014 period for Oregon, stream availability for salmon within areas of wildland forest diminished, challenging connectivity and habitat serviceability and quality (see Table 6).

Table 6. Land Use Changes Along Salmon Streams, Washington (1994-2013) and Oregon (1994-2014)

	Washington	Oregon
Land Use Category	*Percentage change of fish stream length within land use category*	
Wildland Forest	-1.5	-0.6
Low Density Residential	+13.7	+7.5
Urban	+18.3	+7.3

Beyond areas proximate to streams and rivers, conversion throughout drainage basins can impact basin functioning as cumulative changes disrupt and impact the collective ecological processes associated with water movement as basin functionality and by extension ecosystem capability is influenced by multiple factors such as topography, shape, size, and soil type. Accordingly, land use change can impact drainage basin functionality where conversion introduces discordant disturbance, disrupted drainage, sources of pollution and other encumbrances (Forman, 1995).

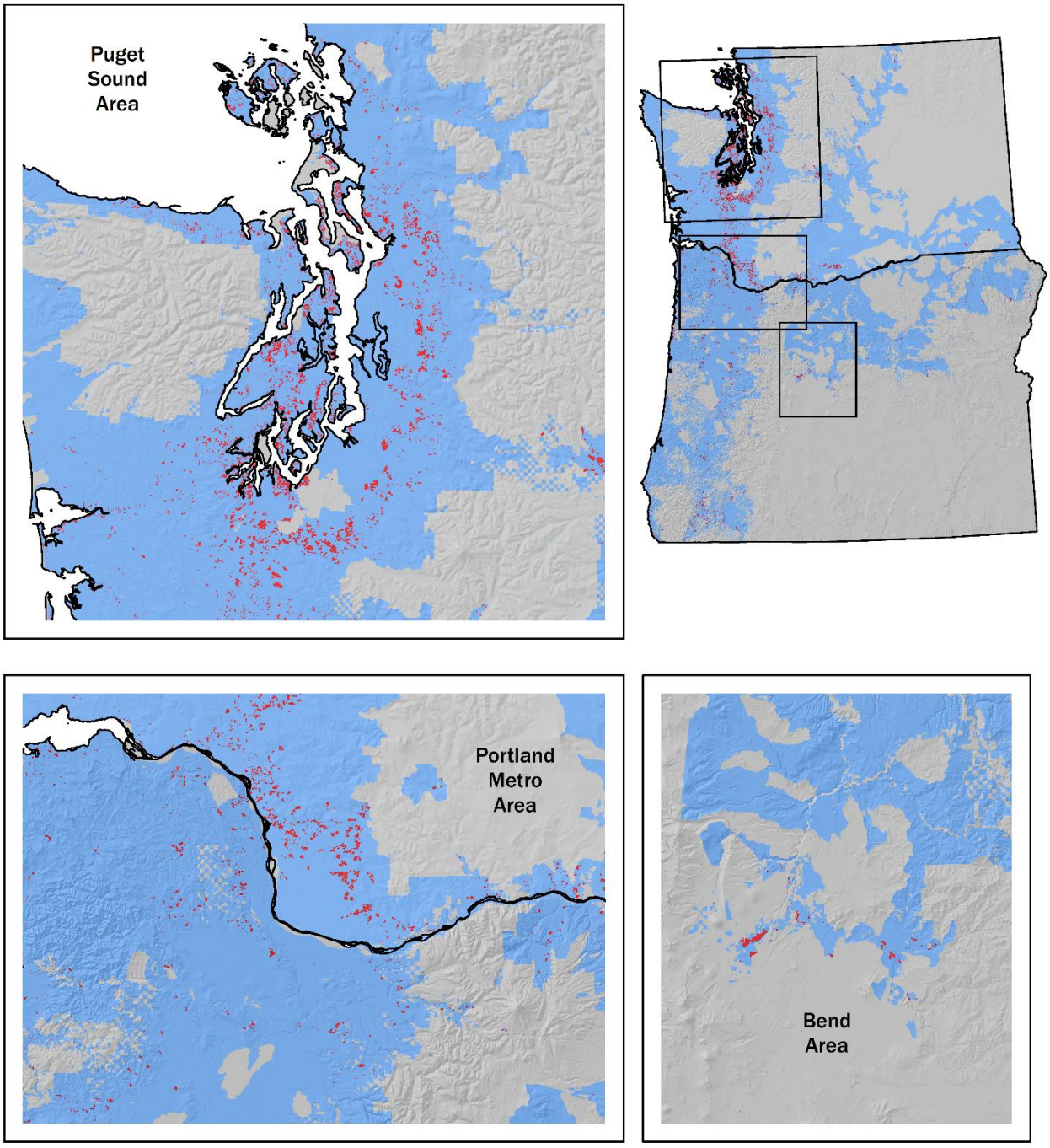
Using 1994 as baseline (change from 1994 – 2014 in Oregon and 1994 – 2013 in Washington) Washington has experienced more land use changes in drainage basins with currently utilized salmon habitat streams relative to Oregon on non-Federal land (see Table 7). Land use changes considered include loss of wildland forest to more developed land uses (low density residential and urban). These factors are important as wildland forest provides essential functions of connectivity and air and water filtration, while developed lands introduce ecosystem disturbances (Forman, 1995).

Table 7. Land Use Change on non-Federal Land Within Drainage Basins With Currently Used Salmon Streams, Washington (1994-2013) and Oregon (1994-2014)

	Washington	Oregon
	Percentage change within basins with currently used salmon streams	
Wildland Forest	-2.4	-0.6
Low Density Residential	18.6	9.9
Urban	26.1	13.6

Water quantity and quality is a critical component of a functioning ecosystem upon which species and communities are dependent. Erosion and loss of habitat challenges ecosystem functionality and the continued provision of goods, tangible and intangible. Conversion of resource lands is an inevitable function of population growth, however the subsequent impacts can be directed to minimize effects on resource and ecosystem functionality. Figure 14 highlights the breadth of land use change across drainage basins with currently used salmon streams and underlines the difference between Oregon and Washington in terms of basin area impacted.

Figure 14. Non-Federal Wildland Forest Changing to more Developed Uses in Drainage Basins of Streams with Chinook, Coho, and/or Steelhead Habitat: Washington 1994-2013, Oregon 1994-2014



Population Growth and Ecosystem Considerations

Prior to implementation of land use planning, conversion of nonfederal resource lands in Oregon and Washington was vigorous and dispersed. Since implementation, conversion in both states has been more directed, supporting retention, continuity, and functionality of resource lands. While multiple factors affect the rate, frequency, and nature of land use change, comprehensive planning holds capacity to inform and direct change to the benefit of resource lands and ecosystem functionality.

Land use change and consideration of how change impacts ecosystems will continue to be a critical concern. Oregon and Washington's respective offices of economic and financial management predict that in the next 25 years, Oregon's population is projected to increase by 1,180,000 people (29 percent) and Washington's population, by 1,932,000 people (26 percent). Given this projected growth, there will be increased demands and pressure placed on PNW ecosystems to continue provision of critical services upon which all are reliant. This underline the need to continue collect and evaluate land use change and further reinforces the value of comprehensive planning in terms of directing efficient growth, minimizing externalities, and maintaining the resource lands that are essential to ecosystem functionality.

Where to Find More Information

More detailed information about the data and techniques used in this report is available:

Forests, Farms and People: Land Use Change on Non-Federal Land in Western Oregon 1974-2009 (Lettman and others 2011) is available at http://www.oregon.gov/ODF/Documents/ForestBenefits/ForestsFarmsAndPeople1974_2009PublishedJuly2011.pdf.

Changes in Land Use and Housing on Resource Lands in Washington State, 1976-2006 (Gray and others 2013) is available at http://www.fs.fed.us/pnw/pubs/pnw_gtr881.pdf.

The Oregon Conservation Strategy: A blueprint for conservation in Oregon (2016) is available at *http://www.oregonconservationstrategy.org/*

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