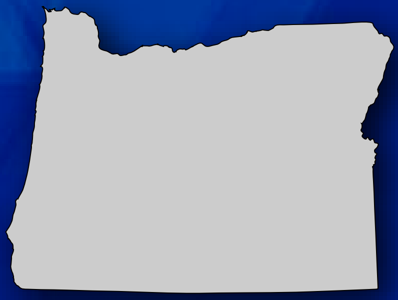
Oregon's Forest Resources, 2001–2005

Five-Year Forest Inventory and Analysis Report



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Cover: Oregon Coast. Photo by Don Gedney.

Abstract

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This report highlights key findings from the most recent (2001–2005) data collected by the Pacific Northwest Forest Inventory and Analysis (PNW-FIA) Program across all ownerships in Oregon. We present basic resource information such as forest area, land use change, ownership, volume, biomass, and carbon sequestration; structure and function topics such as biodiversity, older forests, dead wood, and riparian forests; disturbance topics such as insects and diseases, fire, invasive plants, and air pollution; and information about the forest products industry in Oregon, including data on tree growth and mortality, removals for timber products, and nontimber forest products. The appendices describe inventory methods and design in detail and provide summary tables of data, with statistical error, for the suite of forest characteristics sampled.

Keywords: Biomass, carbon, dead wood, diseases, fire, forest land, insects, invasive plants, inventory, juniper, lichens, nontimber forest products, ozone, timber volume, timberland, wood products.

Contents

1 **Chapter 1: Introduction**

7 **Chapter 2: Indicators of Forest Sustainability and Health**

11 **Chapter 3: Basic Resource Information**

11 Forest Area

16 Land Use Change

17 Juniper Forests

19 Ownership

21 Family-Owned Forests: A Survey

23 Volume

30 Biomass and Carbon

35 **Chapter 4: Forest Structure and Function**

35 Older Forests

39 Lichen and Plant Biodiversity

42 Dead Wood

48 Riparian Forests

51 Tree Crowns, Soil, and Understory Vegetation

59 **Chapter 5: Disturbance and Stressors**

59 Insects, Diseases, and Other Damaging Agents

63 Invasive Plants

66 Air Quality

71 Crown Fire Hazard

76 Fire Incidence

79 The Biscuit Fire

81 FIA BioSum

85 **Chapter 6: Products**

85 Oregon's Primary Forest Products Industry

88 Growth, Removals, and Mortality

90 Removals for Timber Products

93 Nontimber Forest Products

97 **Chapter 7: Conclusions**

97 **Glossary**

107 **Acknowledgments**

108 **Scientific and Common Plant Names**

111 **Metric Equivalents**

111 **Literature Cited**

118 **Appendix 1: Methods and Design**

124 **Appendix 2: Summary Data Tables**

Summary

The growing population of Oregon depends on forests for recreation, clean water, clean air, wildlife habitat, and products. Thus, monitoring and interpreting change in forest conditions over time, the core charge of the U.S. Forest Service, Forest Inventory and Analysis (PNW-FIA) Program, is critical to assuring we conserve and use our natural resources sustainably. This report is a snapshot of conditions on Oregon's diverse and extensive forests in the first half-decade of the 21st century.

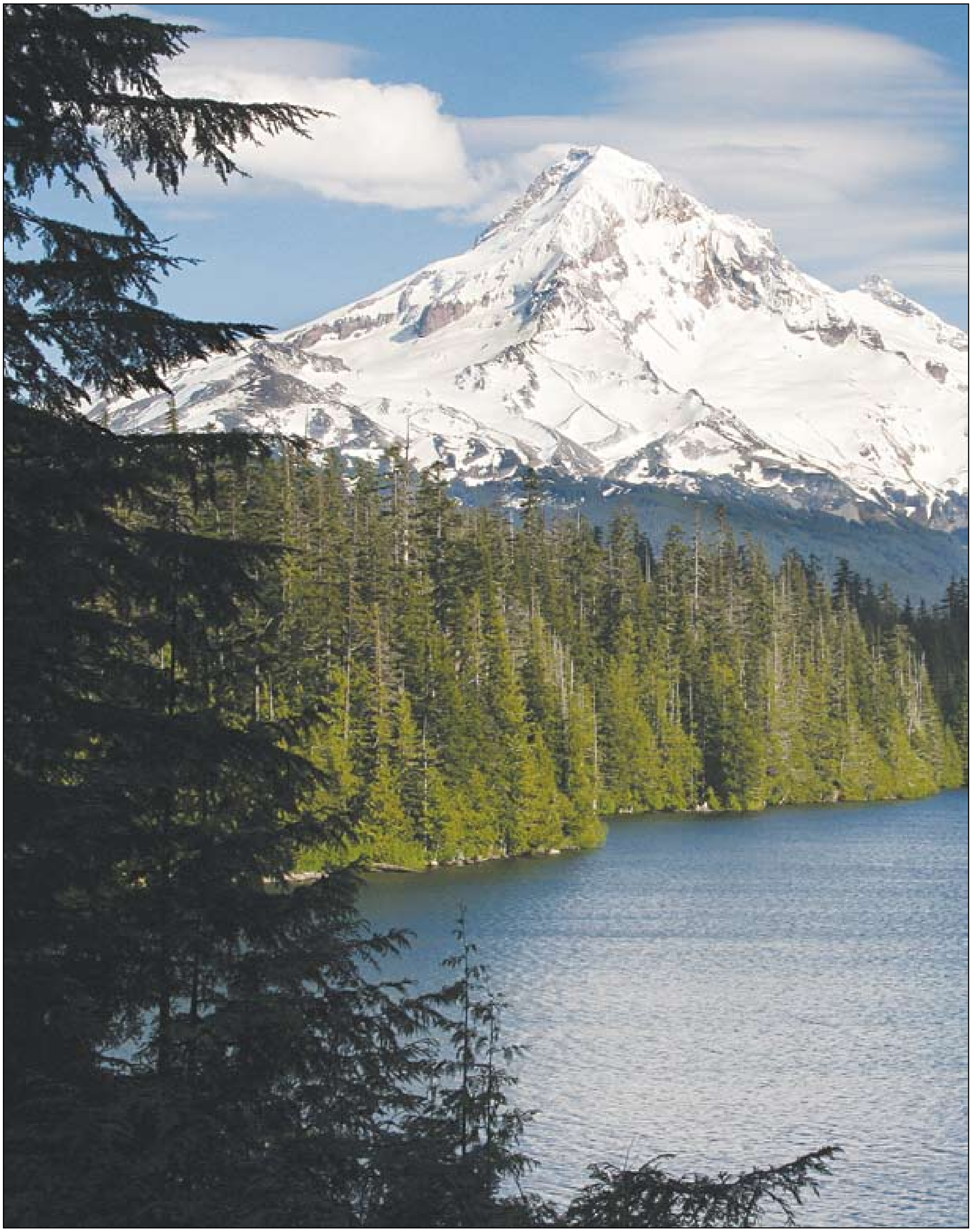
The following summary of key findings shows the importance of monitoring the status and change in our forest resources.

- Oregon's total land area is about 61 million acres, and about 30 million are forested. Forested acreage is divided somewhat evenly between the western and eastern parts of the state, along the Cascade Crest.
- Data spanning 1953 to 1987 show that Oregon experienced a decrease in timberland area and volume over that period, but inventories in the late 1990s and 2001–2005 suggest recent increases in timberland acreage and volume.
- Economic activity also has increased within the forest products industry, with an 8-percent increase in harvest since 2003. Oregon remains a wood products leader; the 2005 Resources Planning Act forecasts increased lumber production from westside Pacific Northwest forests through 2050. And although per-capita lumber consumption in the United States is expected to decline, a growing U.S. population is expected to result in a 38-percent increase in forest products consumption by 2050.
- Oregon's forests are presently a net sink for carbon. Growth of trees significantly exceeds harvest and mortality. Through modeling work by FIA, accumulated forest biomass is being evaluated for its potential to furnish energy and income for rural communities. The rising interest in biomass as an alternative source of energy will accelerate the need to understand how much biomass is available and where it is located.
- As federal forest management has moved toward a greater emphasis on nontimber resources, the job of providing timber now rests with private landowners. Private landowners currently provide most of Oregon's wood products, timber-related employment, and timber revenue. Most noncorporate forest owners are older than 50, suggesting that their lands will change ownership in the next 20 to 40 years. Private forest land generally has a higher proportion of productive land in younger age classes. These immature trees will take time to grow before they are available for timber harvest. Additionally, ownership and land use changes may take significant acreage out of production altogether.

- The character of corporate forest ownership is changing rapidly as some traditional timber companies (those whose primary business is manufacturing forest products) sell their lands to investment companies such as real-estate investment trusts (REITs) and timberland investment management organizations (TIMOs). It is unclear what the ownership shift from forest products companies to TIMOs and REITs means for the management of Oregon's corporate forests and the impact on land use conversion.
- Forest land is being converted to other uses throughout Oregon but particularly near urban areas. The rate of conversion had slowed in the past decade, but it is not clear at this writing what protections will remain on rural forest and agricultural land. The future of Oregon's land use planning program, challenged by a 2004 ballot measure and subsequently amended by voters in 2007, is still uncertain.
- With fragmentation and increased disturbance, forest land and rangeland are increasingly susceptible to invasive exotic and aggressive native organisms. Nonnative invasive plant species already are well established in Oregon's forests. The greatest insect- or disease-related changes in Oregon's forests are likely to come from introduced organisms, although there is concern for native species whose populations and effects are altered by drought, changes in stand densities, or climate.
- Western juniper, an aggressive native species, is proliferating across eastern Oregon's high desert, altering the ecology of the range. Oregon has about 3.1 million acres of juniper forest today and may have as much as 5 million acres in 40 years, given present rates of expansion.
- The majority of old-growth forest is now found on federal land, although the current percentage of total forest in old-growth condition is estimated to be less than half of that existing before Euro-American settlement. The percentage will gradually increase if national forests follow historical successional trends. Changes in climate and disturbance regimes are expected to play important roles in the development of older forest types.
- Larger diameter dead wood is not common in Oregon's forests. Wildlife species that depend on large dead wood for nesting, roosting, or foraging may be limited by the amount of suitable habitat currently available.
- Air quality in and near forests is generally good, although nitrogen pollution is a problem in some west-side forests, as indicated by the occurrence of certain lichen communities. Ozone-sensitive plant species show some signs of damage in the Columbia River Gorge.

- A single fuel-treatment prescription does not fit all landscapes in Oregon. Based on crown fire models, less than half of Oregon's forested lands are predicted to develop crown fires, and an even smaller fraction can be expected to develop active crown fire. Although the total area that may benefit from fuel treatment is substantial, in most cases, treatment may require only the removal of ladder fuels (typically associated with young, smaller diameter stands) rather than thinning of the mature trees in the upper canopy.

The analyses and tools that PNW-FIA continues to develop will help land managers and the public better understand how Oregon's forests are changing. We have implemented a nationally consistent inventory design that will help us to monitor overall forest change and detailed changes in forest structure, species composition, size class, ownership, management, disturbance regimes, and climatic effects.


Tom Iraci

Mount Hood, Oregon.

Chapter 1: Introduction[1]

This report highlights the status of Oregon's forest resources. The work of the field crews at the Pacific Northwest Forest Inventory and Analysis (PNW-FIA) Program forms the core of the information reported here. Our analyses describe the amount and characteristics of Oregon's forests, summarized primarily from field plots measured in the years 2001–2005.

The FIA Program was created within the U.S. Department of Agriculture, Forest Service (Forest Service) in 1928 to conduct unbiased assessments of all the Nation's forested lands for use in economic and forest management planning. It was charged with collecting forest data on a series of permanent field plots, compiling and making data available, and providing research and interpretations from those data. Originally, all plots were assessed within a period of 1 to 3 years with periodic reassessments, typically every 10 years in the West. Four FIA units are now responsible for inventories of all forested lands in the continental United States, Alaska, Hawaii, Puerto Rico, the U.S. Virgin Islands, and several Pacific Island groups.

Starting in 2000, as required by the Agricultural Research Extension and Education Reform Act of 1998 (the Farm Bill), FIA implemented a new standardized national inventory method in which a portion of all plots in each state were measured each year. Appendix 1 explains the differences between the previous and current inventory methods. The effect of the change is that, for the first time in 70 years, all FIA units are using a common plot design, a common set of measurement protocols, and a standard database design for compilation and distribution of data. Under this unified approach, FIA is now poised to provide unbiased estimates of a wide variety of forest conditions over all forested lands in the United States in a consistent and timely manner. The new design will enable FIA units in every state to monitor changes in forest conditions, ownership, management, disturbance regimes, and climate impacts that occur through time.

This report covers all forested lands in Oregon (fig. 1). All estimates are average values for the time between 2001 and 2005. Field crews visited each inventory plot to collect measurements of forest characteristics (fig. 2).

[1] Author: Dale Weyermann.

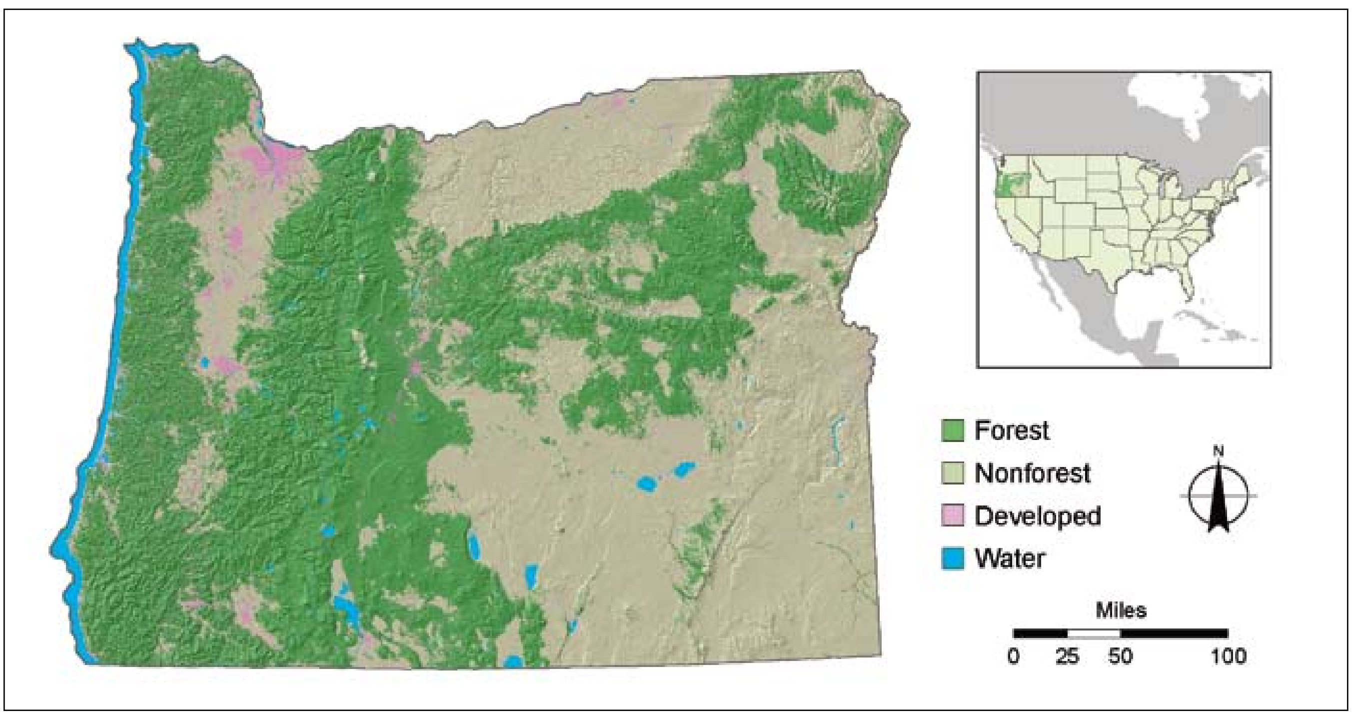


Figure 1—Oregon land cover (forest/nonforest geographic information system (GIS) layer: Blackard et al. 2008; urban/water GIS layer: Homer et al. 2004).

Tom Iraci

Figure 2—Forest Inventory and Analysis (FIA) field crews take many measurements on each forested plot they visit.

Most measurements use national protocols, but several are specific to forest issues in Oregon; these have been developed with input from our clients.

Field plots are spaced at approximate 3-mile intervals on a hexagonal grid throughout forested lands in Oregon (figs. 3 and 4). Plots span both public and privately owned forests, including lands reserved from industrial wood production (for example, national parks, wilderness areas, and natural areas). The annual inventory involves a cycle of measurements for 10 systematic subsamples, or panels; each panel represents about 10 percent of the approximately 6,000 forest land plots in Oregon. A panel takes about 1 year to complete (fig. 3). This report presents the principal findings from the first five panels, which make up 50 percent of the data from the new annual inventory, collected from 2001 through 2005 (fig. 4). Additional information about annual inventories is available in appendix 1 of this report and at http://fia.fs.fed.us/.

The data we collect allow us to present a broad array of findings that address many of Oregon's current forest issues and concerns. This report presents basic resource information, such as forest area and ownership, and describes the composition, structure, and functions of Oregon's forests. It includes data on wildlife habitat, biodiversity, biomass, and riparian areas. Results from monitoring forest disturbance (for example, urbanization, fire, invasive plants, insects, and diseases) are likewise included. We also present information on forest products, including timber volume, mill outputs, and nontimber products. Finally, we include a table relating the topics we cover in this report to two sets of forest sustainability criteria and indicators.

Data are summarized by various geographic and ecological groupings that we felt would be useful to a variety of readers (figs. 5 through 8). Narrative discussions of current topics in forest health and management include background for each topic, key findings from the FIA inventory, and a few interpretive comments. Appendix 2 of this report presents the summarized data in tabular form with error estimates. These tables aggregate data to a variety of levels, including ecological units (e.g., ecological section or ecosection) (Cleland et al. 1997, 2005; McNab et al. 2005), owner group, survey unit, forest type, and tree species, allowing the inventory results to be applied at various scales and used for various analyses. Plot- and tree-level data are also available for download at http://www.fia.fs.fed.us.

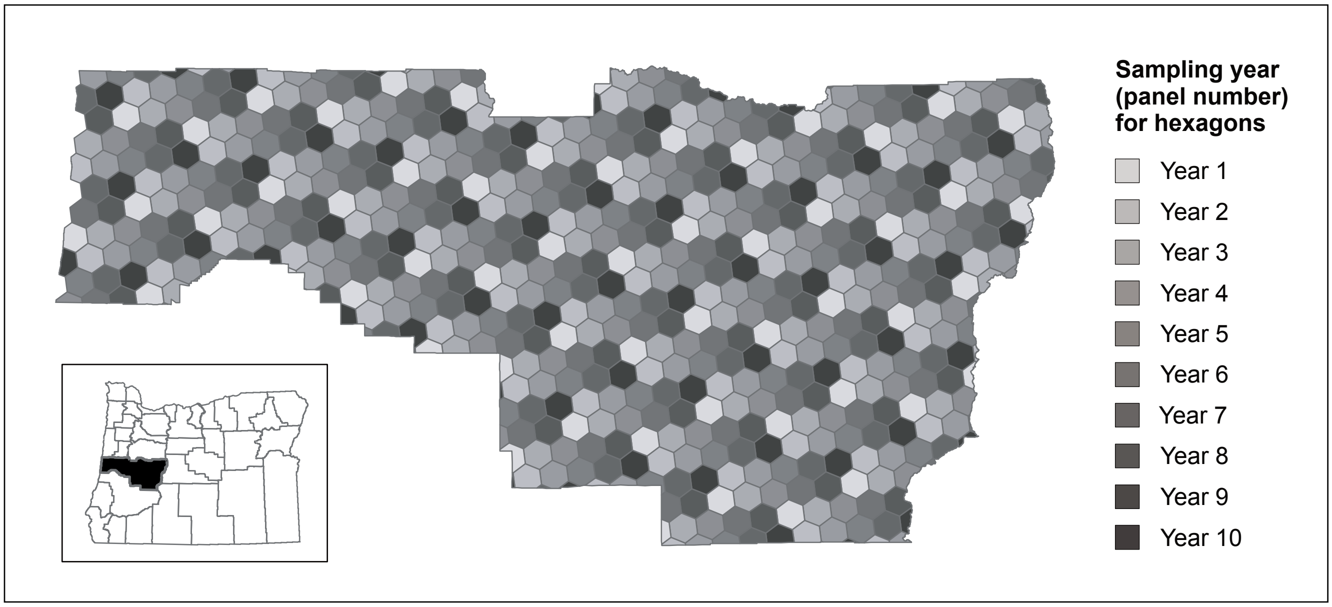


Figure 3—Example of the hexagonal grid and panel system used to locate Forest Inventory and Analysis plots. Although there are over 10,000 phase 2 hexes in Oregon, only about 6,000 of them are forested field plot candidates. One-tenth of the forested plots are visited each year.

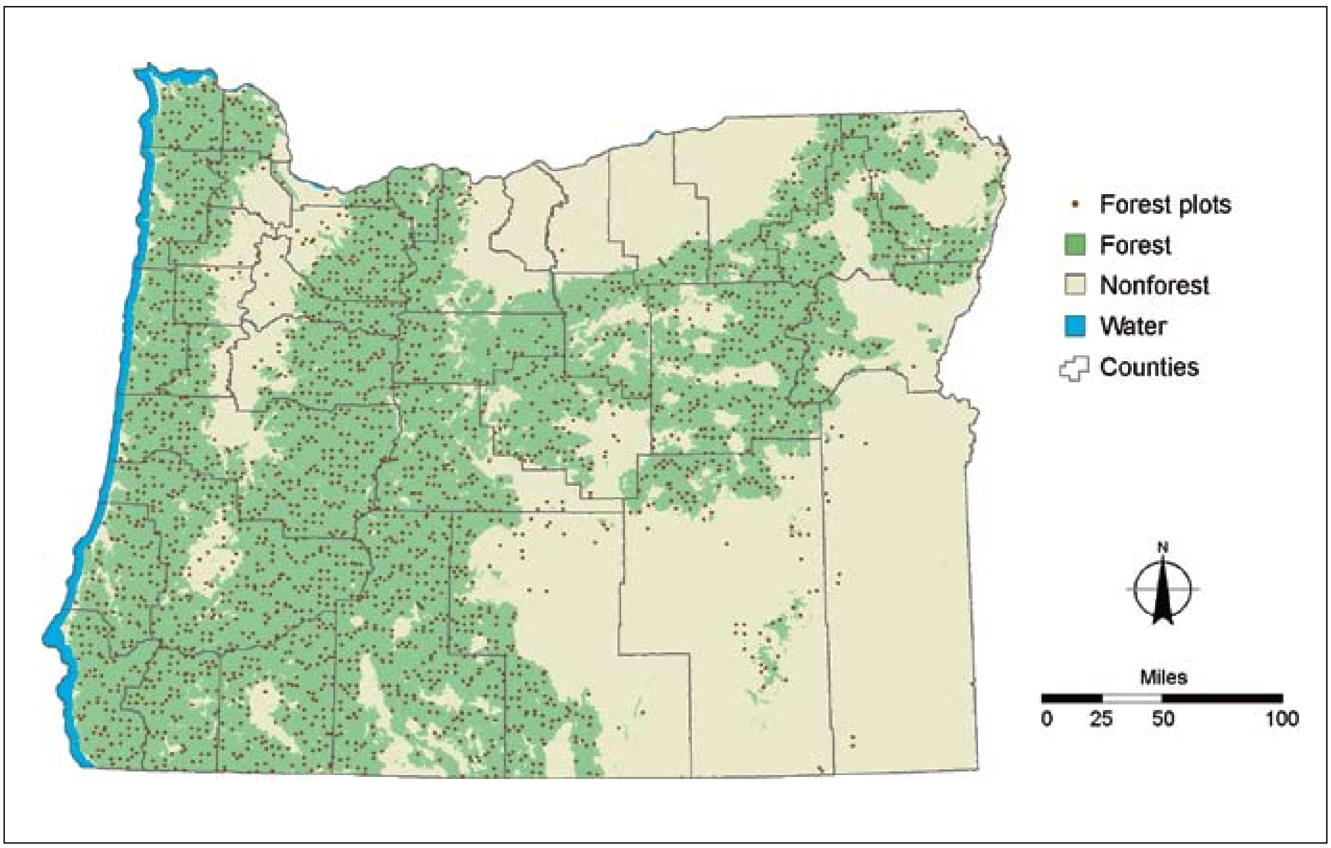


Figure 4—Forested plots measured between 2001 and 2005 provide the data used in this report. Locations are approximate (forest/nonforest geographic information system (GIS) layer: Blackard et al. 2008; urban/water GIS layer: Homer et al. 2004).

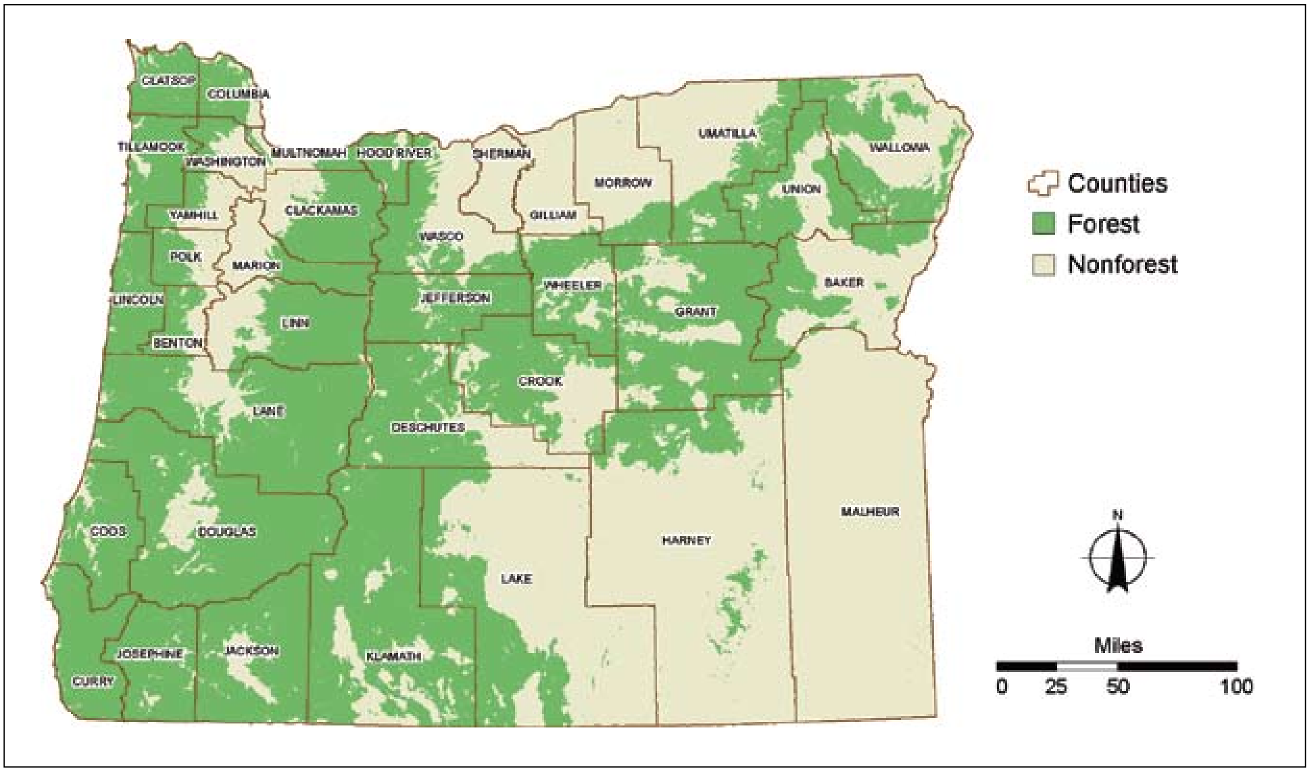


Figure 5—Oregon counties (forest/nonforest geographic information system layer: Blackard et al. 2008).

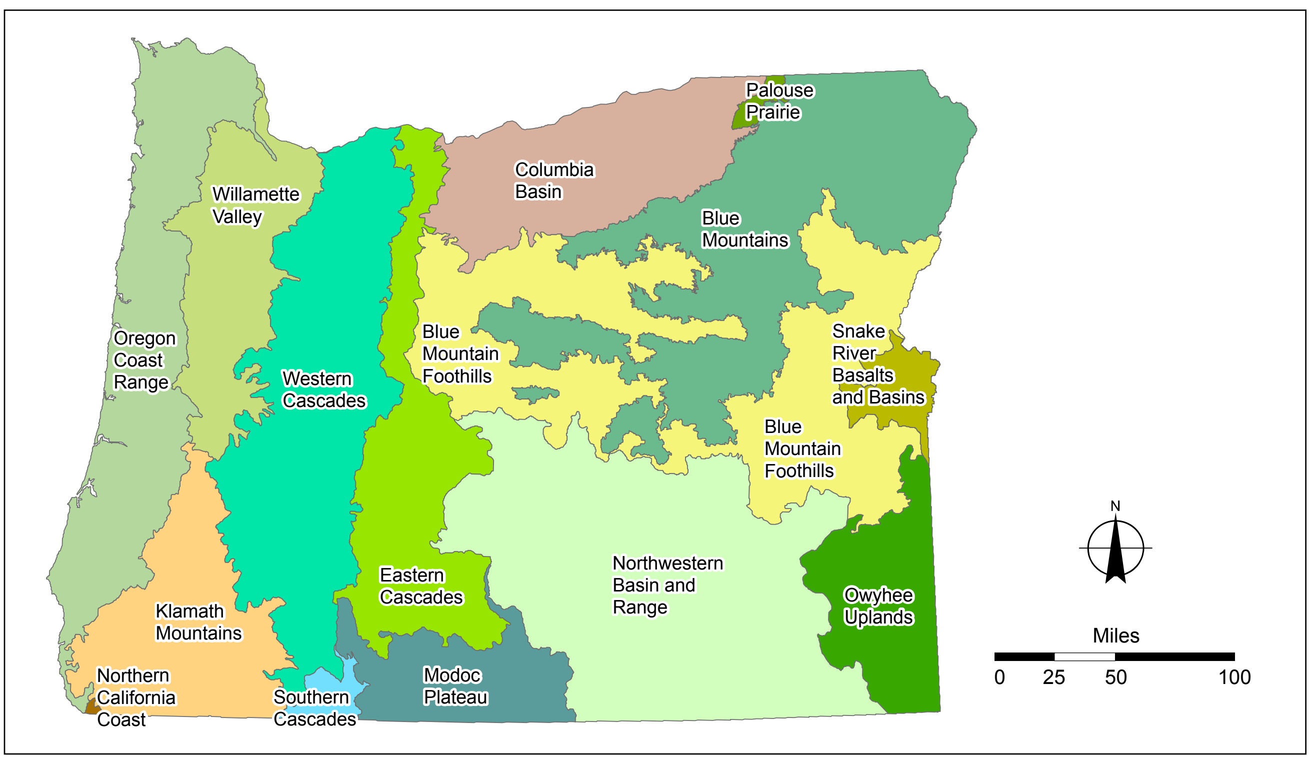


Figure 6—Oregon ecosections (ecosection geographic information system layer: Cleland et al. 2005).

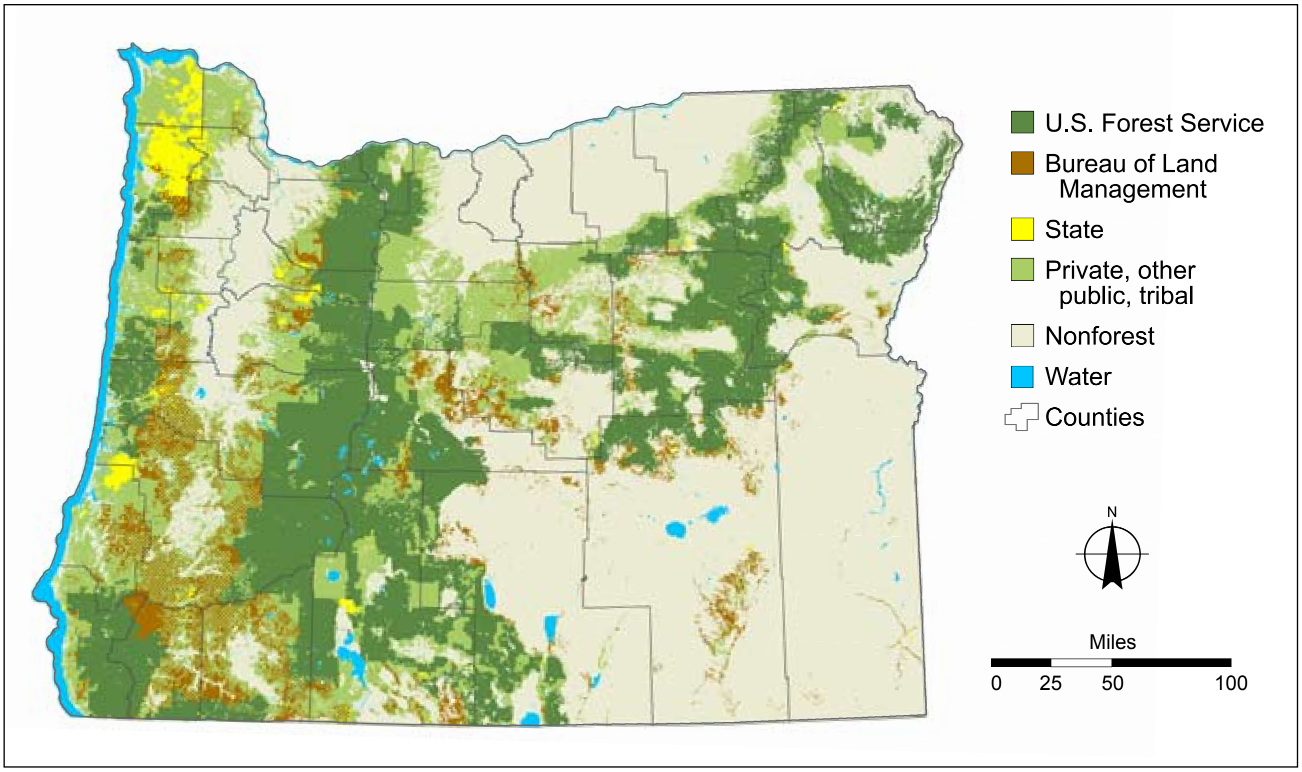


Figure 7—Oregon forest ownership categories (ownership geographic information system (GIS) layer: Oregon Department of Forestry 2006a; urban/water GIS layer: Homer et al. 2004).

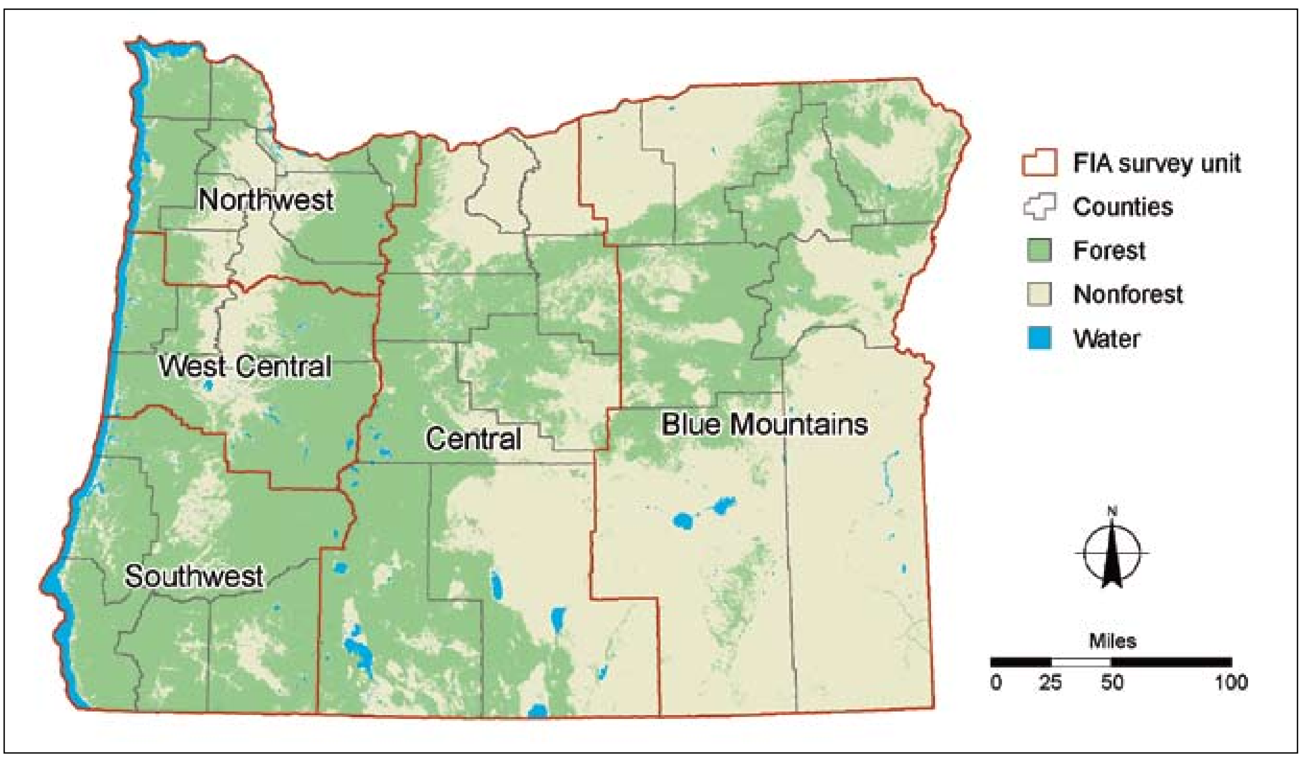


Figure 8—Oregon Forest Inventory and Analysis survey units (county groupings used in this report) (forest/nonforest geographic information system (GIS) layer: Blackard et al. 2008; urban/water GIS layer: Homer et al. 2004).

Tom Iraci

Ponderosa pines and aspens, Fremont National Forest.

Chapter 2: Indicators of Forest Sustainability and Health[1]

Below we have included a tabulation relating the topics we cover in this report to two sets of forest sustainability criteria and indicators: the international Montréal Process Criteria and Indicators for Sustainable Management of Temperate and Boreal Forests (USDA Forest Service 1997), and the Oregon Indicators of Forest Sustainability (Oregon Department of Forestry 2006b). The FIA data used in combination with other information will enable Oregon to chart progress toward achieving its sustainability goals. We demonstrate that FIA data are useful to assess the condition of forests at state and national levels; for some indicators FIA is the only data source that is available across multiple ownerships collected in a consistent manner and national in scope.

[1] Author: Sally Campbell.

Report chapter	Related Montréal Process Criteria and indicators	Related Oregon indicator and metrics
Basic Resource Information: Forest area	Criterion 1: Conservation of biological diversity. Ecosystem Diversity Indicator: (a) extent of area by forest type relative to total forest area	Indicator C.a. Area of nonfederal forest land and development trends. Metric: (a) area of nonfederal wildland forest
	Criterion 2: Maintenance of productive capacity of forest ecosystems. Indicators: (a) area of forest land and forest land available for timber production, (c) area and growing stock of plantations	
Basic Resource Information: Ownership	Criterion 1: Conservation of biological diversity. Ecosystem Diversity Indicator: (c) extent of area by forest type in protected area categories as defined by the International Union for Conservation of Nature or other classification systems	Indicator E.b. Extent of area by forest cover type in protected area categories. Metrics: (a) amount of area for each forest cover type, (b) ownership/protection category

Basic Resource Information: Forest volume	Criterion 2: Maintenance of productive capacity of forest ecosystems. Indicator: (b) total growing stock of all trees species on timberland	
Basic Resource Information: Biomass and carbon	Criterion 5: Maintenance of forest contribution to global carbon cycles. Indicators: (a) total forest ecosystem biomass and carbon pool, (b) contribution of forest ecosystems to the total global carbon budget including absorption and release of carbon (standing biomass, coarse woody debris, peat and soil carbon), (c) contribution of forest products to the global carbon budget	Indicator B.c. Forest ecosystem services contributions to society. Metric: (a) carbon sequestration value
		Indicator G.a. Carbon stocks on forest lands and in forest products. Metrics: (a) status of carbon stocks in various carbon pools, including forest products (mass/area); (b) status of changes in forest carbon stocks where forests and forest products acting as a source or as a sink
Forest Structure and Function: Tree crowns, soil, and understory vegetation	Criterion 4: Conservation and maintenance of soil and water resources. Indicators: (a) area and percentage of forest land with significant soil erosion, (c) area and percentage of forest land with significantly diminished soil organic matter and/or changes in other soil chemical properties, (e) area and percentage of forest land with significant compaction or change in soil physical properties resulting from human activities, (h) area and percentage of forest land experiencing an accumulation of persistent toxic substances	Indicator D.c. Forest road risks to soil and water resources. Metric: (a) percentage of land area in nonforest condition due to roads
	Criterion 3: Maintenance of forest ecosystem health and vitality. Indicator: (c) area and percentage of forest land with diminished biological components indicative of changes in fundamental ecological processes or ecological continuity	
Forest Structure and Function: Understory vegetation	Criterion 1: Conservation of biological diversity. Species Diversity Indicators: (a) number of forest-dependent species, (b) status (rare, threatened, endangered, or extinct) of forest-dependent species at risk of not maintaining viable breeding populations as determined by legislation or scientific assessment	Indicator E.a. Composition, diversity, and structure of forest vegetation. Metrics: (a) vegetation species diversity: richness, evenness; (b) vegetation structure, percentage of cover; (c) vegetation change detection: species composition, area, percentage of cover
Forest Structure and Function: Older forests	Criterion 1: Conservation of biological diversity. Ecosystem Diversity Indicators: (b) extent of area by forest type and by age class and successional stage, (d) extent of area by forest type in protected areas defined by age class or successional stage	

Forest Structure and Function: Lichen and plant diversity	Criterion 1: Conservation of biological diversity. Species Diversity Indicators: (a) number of forest-dependent species, (b) status (rare, threatened, endangered, or extinct) of forest-dependent species at risk of not maintaining viable breeding populations as determined by legislation or scientific assessment	Indicator E.a. Composition, diversity, and structure of forest vegetation. Metrics: (a) vegetation species diversity: richness, evenness; (b) vegetation structure, percentage of cover; (c) vegetation change detection: species composition, area, percentage of cover
Forest Structure and Function: Dead wood	Criterion 5: Maintenance of forest contribution to global carbon cycles. Indicators: (a) total forest ecosystem biomass and carbon pool, (b) contribution of forest ecosystems to the total global carbon budget including absorption and release of carbon (standing biomass, coarse woody debris, peat and soil carbon), (c) contribution of forest products to the global carbon budget	Indicator B.c. Forest ecosystem services contributions to society. Metric: (a) carbon sequestration value
Forest Structure and Function: Riparian forests	Criterion 4: Conservation and maintenance of soil and water resources. Indicator: (b) area and percentage of forest land managed primarily for protective functions (e.g., watersheds, flood protection, avalanche protection, riparian zones)	Indicator D.b. Biological integrity of forest streams. Metric: (a) macro-invertebrate abundance and diversity
Disturbance and Stressors: Insects, diseases, and other damaging agents	Criterion 3: Maintenance of forest ecosystem health and vitality. Indicators: a) area and percentage of forest affected by processes or agents beyond the range of historical variation (e.g., by insects, disease, competition from exotic species, fire, storm, land clearing, permanent flooding, salinization, and domestic animals)	Indicator F.a. Tree mortality from insects, diseases, and other damaging agents. Metrics: (a) tree mortality (volume); (b) current tree mortality from insects and diseases (acres)
Disturbance and Stressors: Invasive species	Criterion 3: Maintenance of forest ecosystem health and vitality. Indicators: (a) area and percentage of forest affected by processes or agents beyond the range of historical variation (e.g., by insects, disease, competition from exotic species, fire, storm, land clearance, permanent flooding, salinization, and domestic animals)	Indicator F.b. Invasive species trends on forest lands. Metrics: (a) biotic stressors: exotic insects and diseases, invasive plants and animals (acres affected); (b) number or percentage of invasive pests on Oregon's 100 most dangerous list excluded or contained in native and urban forests
Disturbance and Stressors: Air quality	Criterion 3: Maintenance of forest ecosystem health and vitality. Indicators: (b) area and percentage of forest land subjected to levels of specific air pollutants (e.g., sulfates, nitrate, ozone) or ultraviolet B, which may cause negative impacts on the forest ecosystem	
Disturbance and Stressors: Crown fire hazard	Criterion 3: Maintenance of forest ecosystem health and vitality. Indicators: (a) area and percentage of forest affected by processes or agents beyond the range of historical variation (e.g., by insects, disease, competition from exotic species, fire, storm, land clearance, permanent flooding, salinization, and domestic animals)	Indicator F.c. Forest fuel conditions and trends related to wildfire risks. Metrics: (a) percentage of forest land in condition class 1, or fire regime IV or V; (b) percentage of forest lands that produce a surface fire type (no passive or active crown fire) at 90th percentile weather and wind for region

Products: Oregon's primary forest products industry	Criterion 6: Maintenance and enhancement of long-term multiple socioeconomic benefits. Indicators: Production and consumption; recreation and tourism; investment in the forest sector; employment and community needs	Indicator B.b. Forest-related employment and wages. Metrics: (a) forest-related employment in rural and urban areas and in forest-dependent communities; (b) forest-related wages and salaries in rural and urban areas and in forest-dependent communities Indicator B.d. Forest products sector vitality. Metrics: (a) sales' value of wood products and forest industry equipment from Oregon manufacturers; (b) production capacity, condition, technology, and investment; (c) net foreign and domestic exports of Oregon wood products
Products: Growth, removals, and mortality	Criterion 2: Maintenance of productive capacity of forest ecosystems. Indicator: (d) annual removal of wood products compared to volume determined to be sustainable	Indicator C.b. Timber harvest trends compared to planned and projected harvest levels and potential to grow timber. Metrics: (a) annual timber harvest volume, compared to volume expected under current plans and potential to grow wood, public lands; (b) annual timber harvest volume, compared to volume expected under current and forecasted economic conditions and potential to grow wood, private lands
Products: Removals for timber products	Criterion 2: Maintenance of productive capacity of forest ecosystems. Indicator: (d) annual removal of wood products compared to volume determined to be sustainable	Indicator C.b. Timber harvest trends compared to planned and projected harvest levels and potential to grow timber. Metrics: (a) annual timber harvest volume, compared to volume expected under current plans and potential to grow wood, public lands; (b) annual timber harvest volume, compared to volume expected under current and forecasted economic conditions and potential to grow wood, private lands
Products: Nontimber forest products	Criterion 2: Maintenance of productive capacity of forest ecosystems. Indicator: (e) annual removal of nontimber forest products compared to the level determined to be sustainable	

Chapter 3: Basic Resource Information

This chapter provides a broad look at the distribution, extent, and ownership of Oregon's forests and the amount of wood (volume and biomass) in them. It lays the groundwork for more-specialized analyses and summaries in the coming chapters. Highlights include discussions of forest ownership and land use change in Oregon, the dramatic expansion of juniper forests, and biomass and carbon accumulation.

Data in this chapter address Montréal Process criterion 1 and indicators pertaining to conservation of biological diversity, criterion 2 and indicators pertaining to maintenance of productive capacity of forest ecosystems, criterion 3 and indicators pertaining to maintenance of forest ecosystem health and vitality, and criterion 5 and indicators pertaining to maintenance of forest contribution to global carbon cycles.

Data in this chapter also address Oregon indicator B pertaining to forest ecosystem services, indicator C pertaining to area of forest land and development trends, indicator E pertaining to the amount of forest by protected category and cover type, and indicator G pertaining to carbon stocks.

Forest Area[1]

Background

The trend in forest area over time is the most basic measure of forest health. The FIA Program's tracking of this trend provides meaningful data for international assessments and for state and national assessments such as the Oregon Department of Forestry's Indicators of Sustainable Forest Management (Oregon Department of Forestry 2006b) and the U.S. Department of Agriculture's Resource Planning Act (Smith et al. 2004).

"Forest land" is defined as land that is at least 10 percent stocked by forest trees of any size, or land formerly having such tree cover and not currently developed for a nonforest use. The minimum area for classification is 1 acre. The distribution of forest land in Oregon is influenced first and foremost by climate, which is in turn shaped by major geographic features such as the Cascade Range, dividing the state into western and eastern portions, as well as the Coast Range paralleling the Pacific coast, the Klamath Mountains in southwestern Oregon, and the Blue

[1] Author: Glenn Christensen.

Mountains to the northeast (fig. 9). These features divide the state into distinctly different ecological sections that support different types of forests (fig. 6). The distribution of forest land is also influenced by human use, and particularly by urban development.

The FIA Program uses a combination of remote sensing (aerial photos or satellite data) and on-the-ground observation to determine the extent of forested area. Field crews determine the proportion of each plot that is forested; these proportions are then expanded and summed to provide an overall estimate of forested acres. Specific information on sampling methodology can be found in the introduction to this volume and in appendix 1. Spatial and temporal trends in forested area are tracked at various levels—survey unit, ecological section, and state as a whole—producing long-term data that informs possible mechanisms of change, whether from human or ecological causes.

Findings

Of Oregon's total land area of 61 million acres, about 30 million are forested. Forested acreage is divided roughly evenly between the western and eastern sides of the state. The Cascade crest bisects the Western and Eastern Cascades ecological sections (fig. 6) and serves as a convenient division for acreage discussion.

Area by land class—

Most forest land in Oregon (about 25 million acres) is classified as timberland—that is, forest land capable of producing more than 20 cubic feet of wood per acre per year and not legally restricted from harvest. Timberland makes up over 40 percent of all acreage in the state (fig. 10). Much of it lies in the southwest and central survey units (fig. 8), 26 and 24 percent, respectively. The majority of timberland is relatively evenly distributed among three ecosections: the Western Cascades (22 percent), the Oregon Coast Range (22 percent), and the Blue Mountains (21 percent).

Tom Iraci

Figure 9—Mountain ranges influence the diversity of forests and their distribution in Oregon.

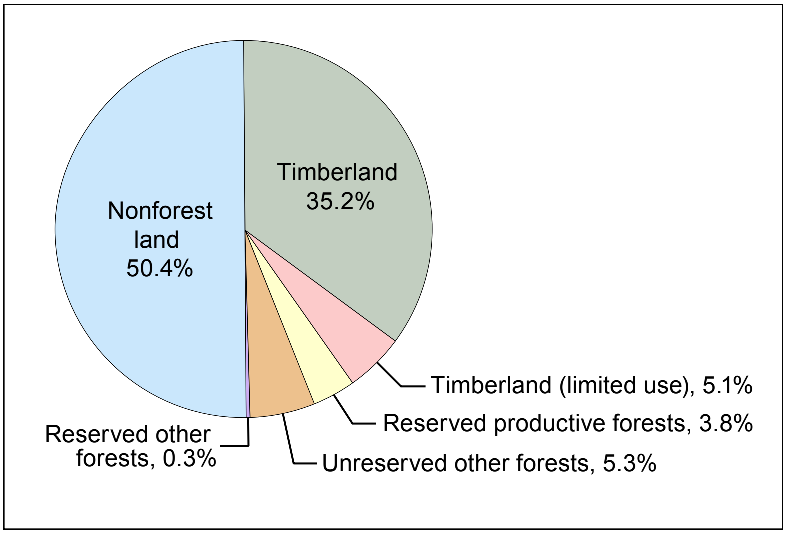


Figure 10—Percentage of area by land class category in Oregon, 2001–2005. Limited-use timberland is not reserved by Congressional act or law, but may be reserved from use for wood production. Examples include riparian corridors, late-successional reserves, administratively withdrawn areas, and adaptive management areas.

Area by forest type group—

The FIA Program classifies forest land based on the predominant live-tree species cover. About 86 percent of Oregon's forests (26 million acres) are softwood conifer forest types. Within these types are three primary forest type groups (that is, combinations of forest types that share closely associated species or productivity requirements). These are Douglas-fir, ponderosa pine, and fir/spruce/mountain hemlock (see "Scientific and Common Plant Names").

Douglas-fir forests cover the largest area, 10 million acres (34 percent of total forest land acres), followed by ponderosa pine forests at 5 million acres (17 percent), and fir/spruce/mountain hemlock mixed forests at 4 million acres (13 percent) (fig. 11). Hardwood forest types account for an additional 3 million acres (12 percent). About 745,000 acres (2 percent) are classified as nonstocked.[2] The most common hardwood forest type group in Oregon is the alder/maple group, which occupies 1 million acres (4 percent) of forested land throughout the state (fig. 12).

Area by productivity class—

Approximately 3 million acres (8 percent) are classified as highly productive (i.e., capable of growing more than 165 cubic feet per acre per year of wood). About 63 percent of this acreage is in the Douglas-fir forest type group (fig. 13). Lands of the next highest productivity class,

[2] "Nonstocked" forest land means land that is less than 10 percent stocked by trees, or, for some woodlands, less than 5 percent crown cover.

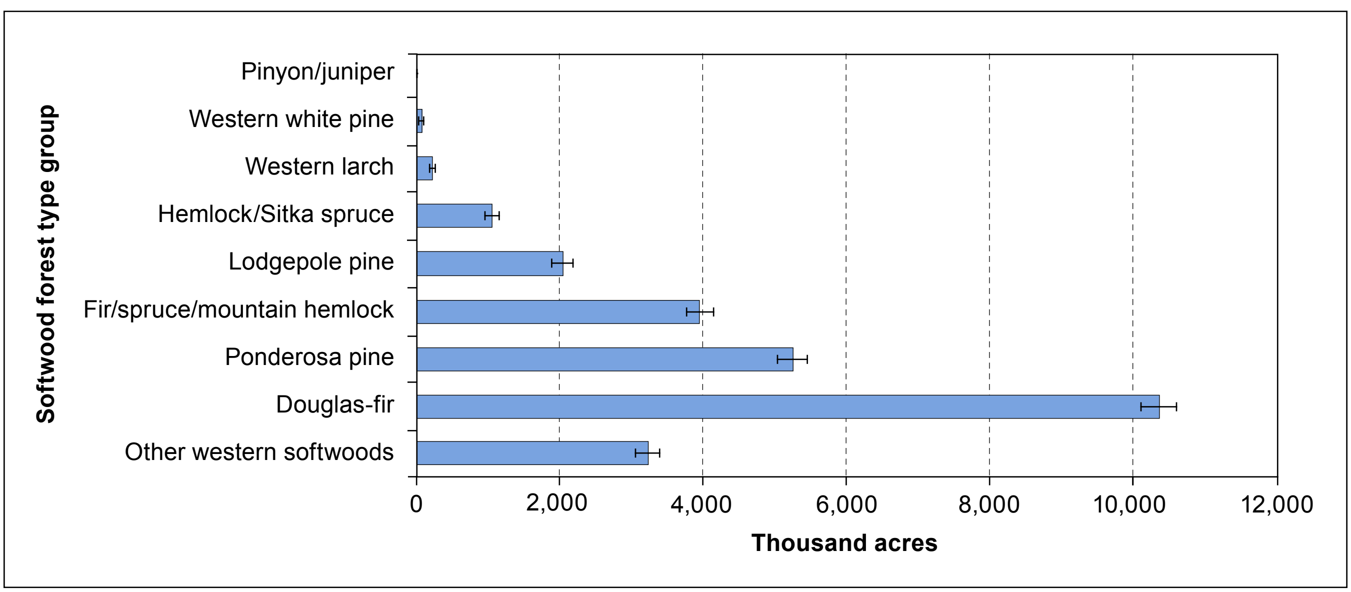


Figure 11—Area of softwood forest type groups on forest land in Oregon, 2001–2005.

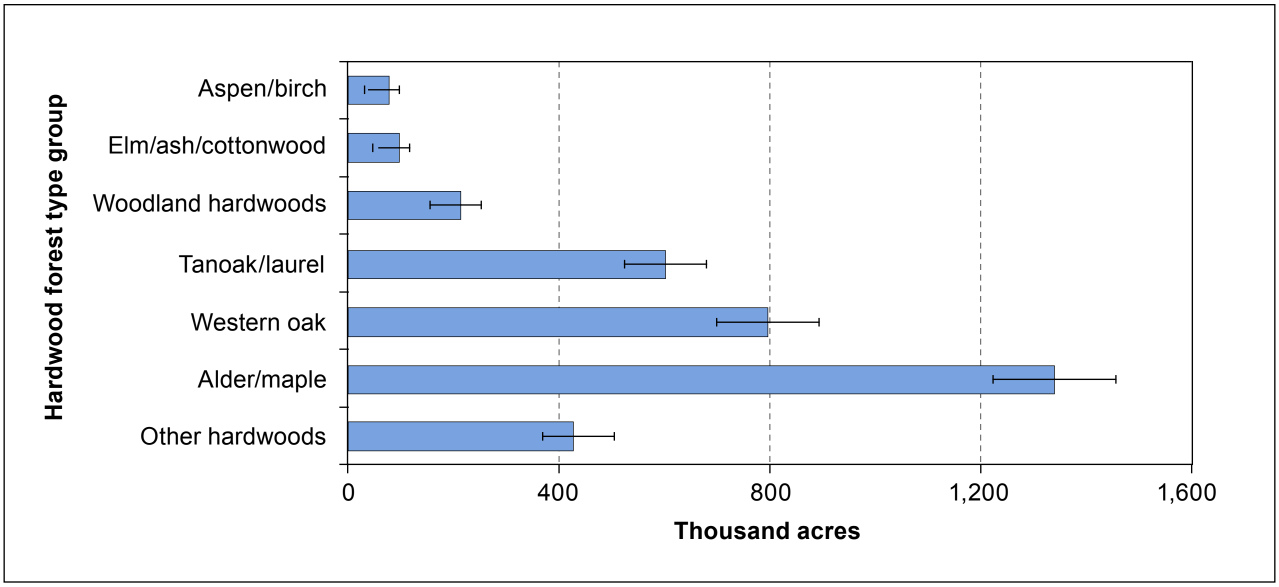


Figure 12—Area of hardwood forest type groups found on forest land in Oregon, 2001–2005.

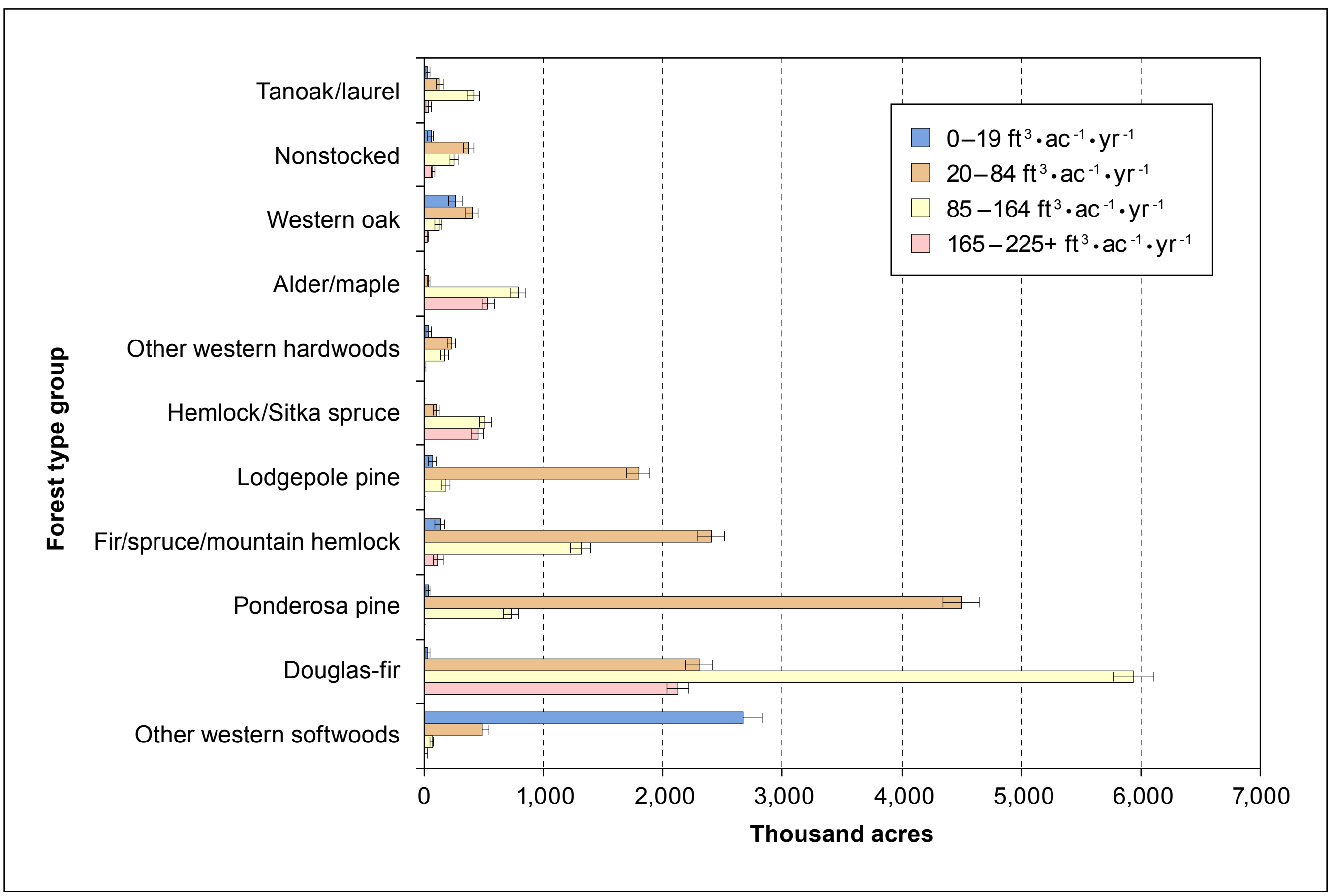


Figure 13—Area of productivity classes by forest type group on forest land in Oregon, 2001–2005.

capable of growing 85 to 164 cubic feet per acre per year, are also dominated by Douglas-fir. Most other forest land (about 13 million acres, or 32 percent) is classified as lower productivity, capable of growing between 20 and 84 cubic feet of wood per acre per year.

Interpretation

Statewide, timberland area declined from the 1953 to the 1987 estimates, and recently timberland acreage appears to have expanded (fig. 14). The most recent estimate is partly confounded by differences between the previous periodic and current annual inventory methods. However, inventories in the 1990s (Campbell et al. 2004) showed the same statewide proportion of forest land (49 percent) as this current inventory.

Research has demonstrated that forest and farm land lying near urban boundaries is being converted to more urbanized uses, effectively taking it out of forest or agricultural production (Azuma et al. 1999, Lettman et al. 2002) (see "Land Use Change" sidebar). We expect continued change in the extent and distribution of forest land, driven by land use legislation, pressures of development, resource demands, shifts in ownership (see "Ownership" section), changing demographics, and climate change.

Forest Area Tables in Appendix 2

Table 1—Number of Forest Inventory and Analysis plots measured from 2001 to 2005, by land class, sample status, ownership group, Oregon

Table 2—Estimated area of forest land, by owner class and forest land status, Oregon, 2001–2005

Table 3—Estimated area of forest land, by forest type group and productivity class, Oregon, 2001–2005

Table 4—Estimated area of forest land, by forest type group, ownership, and land status, Oregon, 2001–2005

Table 5—Estimated area of forest land, by forest type group and stand size class, Oregon, 2001–2005

Table 6—Estimated area of forest land, by forest type group and stand age class, Oregon, 2001–2005

Table 7—Estimated area of timberland, by forest type group and stand size class, Oregon, 2001–2005

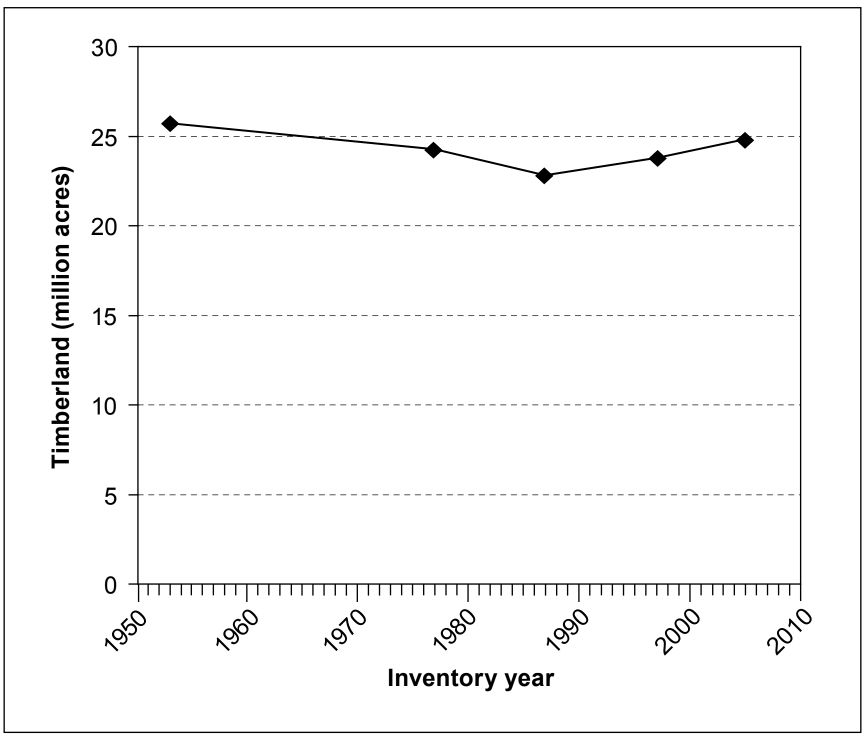


Figure 14—Area of timberland by inventory year in Oregon (Smith et al. 2004), 1953–2005. Note: The 2001–2005 timberland area estimate is based on the annual inventory design and protocols; the previous area estimates are based on periodic inventories with different designs and protocols. Key differences between current and previous estimates, apart from real change, are due in large part to (1) application of plot stockability factors and stockable proportions to different sets of plots in the periodic and annual inventories. Since stockability defines productivity class, it thus influences the classification of a plot as timberland or not and (2) changes in definitions and protocols arising from national standardization of the inventory for qualification as tree, forest land, reserved land, and timberland.

Land Use Change[3]

In 1997, PNW-FIA designed a study in conjunction with Oregon Department of Forestry, Oregon Department of Agriculture, and Oregon Department of Land Conservation and Development to investigate the effects of changes in land use law on nonfederal lands in western Oregon. In this study, 24,000 points were photointerpreted from three sets of aerial photographs taken in 1974, 1982, and 1994. In 2002, these same locations were photointerpreted on aerial photographs taken in 2000.

A comparison of the points revealed a steadily declining rate of conversion of farm and forest land to other uses. The rate of conversion during the second period assessed (1982–1994) was slower than that of the first period (1974–1982), and the rate during the third period (1994 and 2000) was slower than that of the second (Azuma et al. 1999, Lettman et al. 2002).

These two studies suggest that most of the conversion of forest and farm land to other uses over the past few decades has occurred near urban areas (fig. 15), and especially within urban growth boundaries implemented under Oregon's 1980s land use laws. Kline et al. (2003) found a negative correlation between private forest management activities and increasing rural development. Although the rate of conversion slowed generally, the average number of buildings within 80 acres of points identified as wildland forest increased steadily between

(continued on next page)

[3] Author: David Azuma.

David Azuma

Figure 15—Recent legislation will affect the rate of land use change in Oregon.

1974 and 2000, and the proportion of wildland forest in proximity to either urban or low-density use also increased. A similar study was conducted in eastern Oregon (Lettman et al. 2004), adding an additional 13,000 points. Below are results from studies on non-federal land in western and eastern Oregon classified as wildland forest:

Year	Estimated acres	Average 80-acre structure count	Proportion of points <1 mile from highly developed use
	Thousand acres		
Western Oregon:			
1974	7,335	0.23	0.18
1982	7,238	.38	.22
1994	7,200	.47	.25
2000	7,197	.53	.25
Eastern Oregon:			
1975	3,349	.04	.05
1986	3,329	.07	.06
2001	3,307	.11	.07

Ballot Measure 37, passed by Oregon voters in 2004, provided that a private landowner is entitled to compensation when a land use regulation, implemented after the landowner obtains the property, restricts its use and reduces its fair market value. Alternatively, Measure 37 allows governments to modify or waive the regulation. As of January 21, 2007, claimants had filed more than 6,500 claims, many in the northern Willamette Valley. Measure 37 was subsequently amended by Ballot Measure 49 in 2007, which restricted the number of houses that could be built on Measure 37 claims. The resulting changes are not readily apparent, and thus we initiated a new study to capture another snapshot of land use in 2005, prior to anticipated development changes and changes in the law. Results are expected in early 2008.

Juniper Forests[4]

The expansion of western juniper in eastern Oregon (figs. 16 and 17) has been well documented (Azuma et al. 2005, Gedney et al. 1999, Miller and Rose 1995). Cowlin et al. (1942) reported an area of about 420,000 acres of juniper forest, defined as 10 percent crown cover or more, and an additional 1.2 million acres with less than 10 percent crown cover. In 1999, FIA estimated about 3.3 million acres of juniper forest (based on a forest stocking definition) and an additional 3.2 million acres where juniper was present although crown cover was less than 10 percent (Azuma et al. 2005).

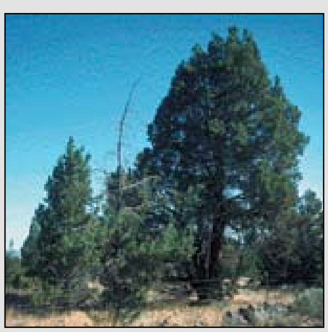

Don Gedney

Figure 16—Older juniper stand in central Oregon.

[4] Author: David Azuma.

The expansion of juniper forest across eastern Oregon rangelands has had a profound and often undesirable effect. Juniper competes with other vegetation for water, sometimes outcompeting other native vegetation and making the land less productive for grazing (Gholtz 1980, Miller et al. 2000). Juniper cover may reduce streamflow and precipitation through-fall (Miller et al. 1987, Young and Evans 1984).

Expansion of juniper forests is believed to be triggered by overgrazing, fire suppression, and climatic shifts (Miller and Wigand 1994). Overgrazing is thought to reduce the amount of fuel available to carry fire, and fire suppression has reduced the occurrence of fires that would otherwise have killed smaller juniper in sparsely populated stands. A relatively drought-free period between 1860 and 1920 coincides with the establishment of many of the present-day juniper stands (Gedney et al. 1999).

(continued on next page)


Don Gedney

Figure 17—Juniper and agricultural land in central Oregon.

Landowners have tried a variety of control measures including burning, spraying, cutting, and chaining (dragging a chain across a stand of juniper to topple the trees). All these methods are relatively expensive, and stands typically require retreatment. In recent years there has been an interest in using juniper biomass as fuel for power generation. However, juniper tends to grow in relatively sparse, uneven-aged stands with generally less than 50 percent crown cover, making harvest inefficient. The low density and small size of the trees may make them uneconomical to use for power generation.

Between 2001 and 2005, FIA crews measured juniper trees on forested plots to assess the current area, volume, and biomass of juniper forest land. Previous inventories of juniper were performed with different methods, such as interpreting aerial photos or using a stratified sample. In the current inventory, the definition of forest land assigns less weight to juniper seedlings than did previous definitions, and thus there is now slightly less land classified as juniper forest than there was in the past.

Findings

We estimate that there are about 3.1 million acres of juniper forest in Oregon, most of it in private and Bureau of Land Management (BLM) ownership. The estimated area of juniper forest and biomass of juniper trees per acre by owner for eastern Oregon for 2001–2005 are shown below:

Owner group	Area	Average biomass
	Thousand acres	*Tons per acre*
National forests	434.0	5.9
Other federal [a]	1,406.5	7.3
State	34.4	3.9
Private	1,294.9	5.6
Total	3,169.8	6.4

[a] Primarily BLM land.

The annual estimates presented here do not account for some areas measured in the 1999 inventory, in which we measured areas with less than 10 percent crown cover that had a minimum of 40 trees per acre. The 1999 inventory also found 300,000 acres of juniper woodland with more than two seedlings present. The presence of seedlings on those lands suggested that juniper was still expanding its range and that juniper forests could be expected to cover 5 million acres within 40 years if those lands remain in the current management regime.

Ownership[5]

Background

The management and use of western forests often depends on their ownership (fig. 18). Management intentions may differ between owners. Federal owners must consider multiple management objectives including water, wildlife, recreation, conservation, biological diversity, and wood products, whereas corporate and other private owners often focus on more specific outcomes, such as aesthetics, wood production, or real estate investment.

Findings

The federal government manages over half of Oregon's nearly 30 million acres of forested land. The National Forest System (NFS) and the BLM administer most of this acreage (fig. 19). On the eastern side of the Cascades, a larger proportion (70 percent) of the land is managed by federal owners (fig. 7) than on the west side.

[5] Author: David Azuma.

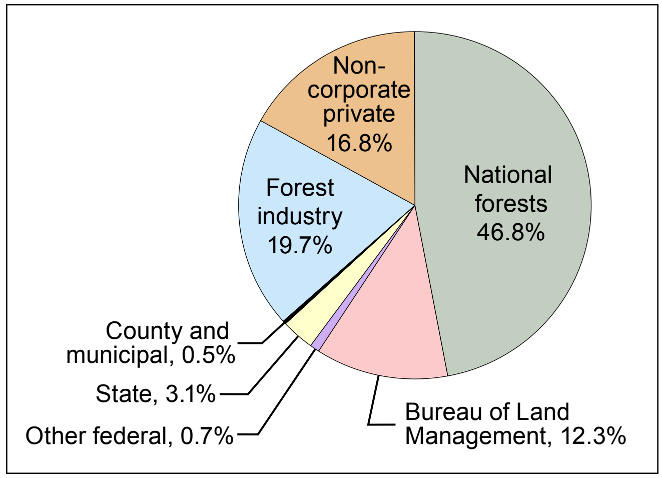


Figure 19—Percentage of forest land area by owner group in Oregon, 2001–2005.

Public ownership—
Land administered by the federal government tends to be at higher elevations and contain older forests (fig. 20). Federal forests typically contain bigger trees on less-productive sites; about 5 percent of federal forest land is considered highly productive, while 18 percent of private lands fall into that category.

David Azuma

Figure 18—Over 10 million acres are privately owned in Oregon.

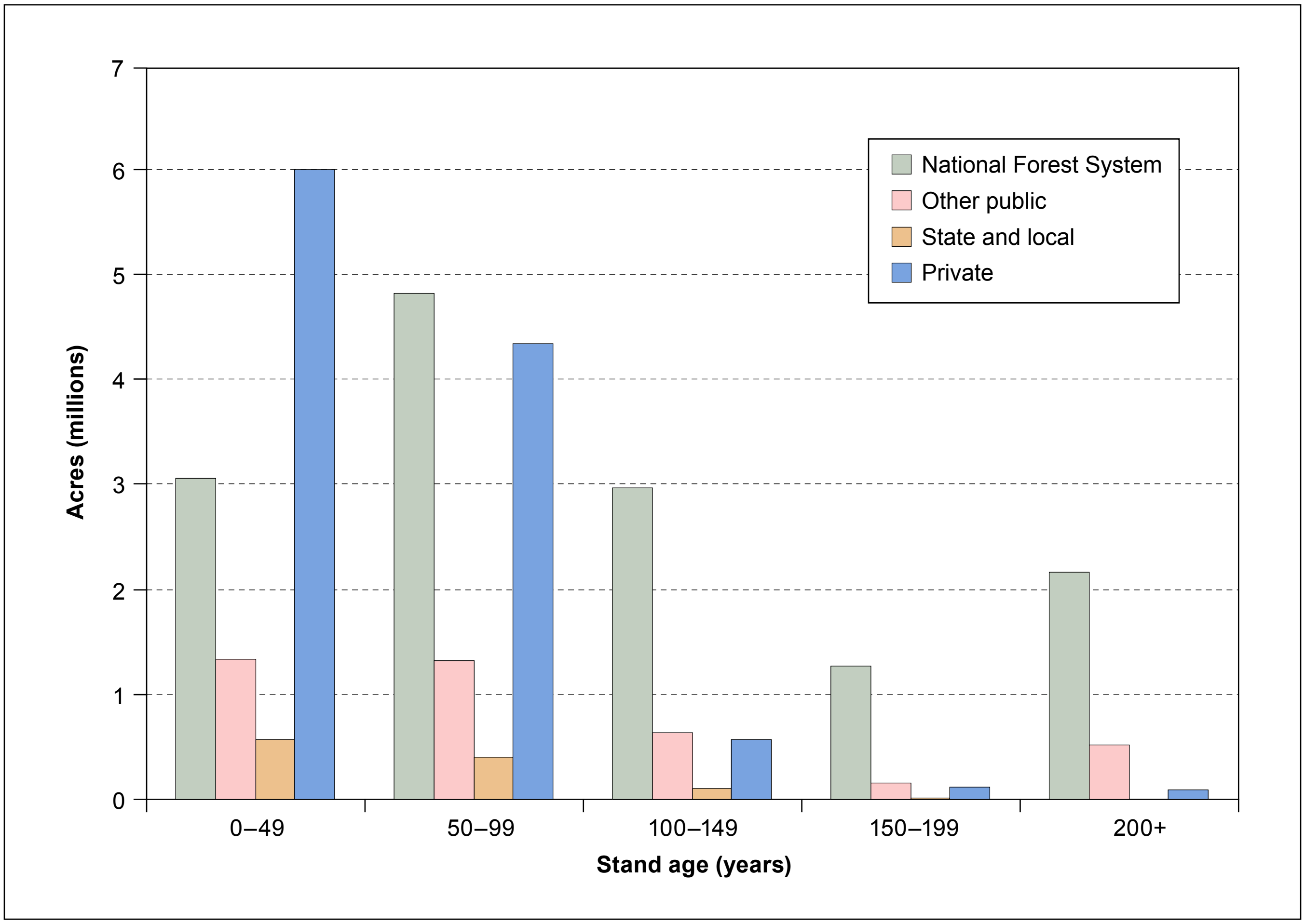


Figure 20—Area of forest land by owner group and stand age class in Oregon, 2001–2005.

Federal owners manage the vast majority of the 2.5 million acres of reserved forest lands (those withdrawn by law from production of wood products). Reserved lands are distributed among Forest Service and BLM wilderness areas, Crater Lake National Park, and state parks. Many of these reserves contain high-elevation forests that are ecologically and scenically unique. The reserved forest tends to be in older age classes; over 60 percent (1.3 million acres) of reserved national forest land contains stands older than 100 years.

Although the majority of federal land does not meet the FIA definition of legally reserved, a substantial fraction of it cannot be considered available for wood production. Congressionally reserved land accounts for 15 percent of the 14.2 million acres of national forest land. Other administratively withdrawn areas within the NFS account for an additional 19 percent, and include riparian reserves and late-successional reserves. These congressionally and administratively withdrawn areas may produce some wood products, but they are managed primarily for other objectives. About 66 percent of all NFS land is administered for multiple uses including wood production.

Beginning in the late 1980s, the management emphasis on federal forests began to shift away from primarily wood production. The average contribution of federal forests to Oregon's total annual harvest decreased from 50 percent in the 1980s to 23 percent in the 1990s, to 7.5 percent between 2000 and 2005 (Oregon Department of Forestry 2006c).

Other publicly owned forest lands include state and county forests and those administered by other federal agencies, such as the U.S. Fish and Wildlife Service, the Bonneville Power Administration, and the National Park

Family-Owned Forests: A Survey[6]

The National Woodland Owner Survey,[7] a questionnaire-based survey conducted by FIA, provides some insight into private family forest owners and their concerns, their current use and management, and their future intentions for their forests (fig. 21) (Butler et al. 2005). In Oregon, 99.6 percent of surveyed family owners own parcels of 500 or fewer acres; these owners account for 72 percent of the family-owned forest land acres (fig. 22). Only about 9 percent of the surveyed owners had written management plans. About 14 percent had harvested timber within the past 5 years; these owners tend to be the larger landholders, owning 43 percent of the acreage. The greatest concerns of respondents were issues of passing land to heirs, fire, and property taxes; other concerns were insects and diseases, exotic species, harvesting regulations, dumping, and trespassing. Future plans for forest land differ; 3 to 15 percent of surveyed owners planned to sell, subdivide, or convert their forests.

Family forest land ownership will certainly change as owners age and pass their land on to heirs who may or may not retain it as forest land. Average parcel size has gotten smaller over the last 20 years and probably will continue to do so. Land use laws and regulations will influence the rate of conversion or subdivision.

The ownership survey revealed the following demographics of Oregon family forest landowners:

- 51 percent are older than 55 years
- 18 percent have earned a bachelor's or graduate college degree
- 76 percent are Caucasian
- 61 percent are male
- 50 percent have owned their land for more than 25 years
- 72 percent use their land as their primary residence
- At least 20 percent have harvested timber, firewood, or nontimber forest products from their land in the 5 years preceding the 2004 survey.

Figure 21—Family forest owners in Oregon manage their lands for a variety of objectives.

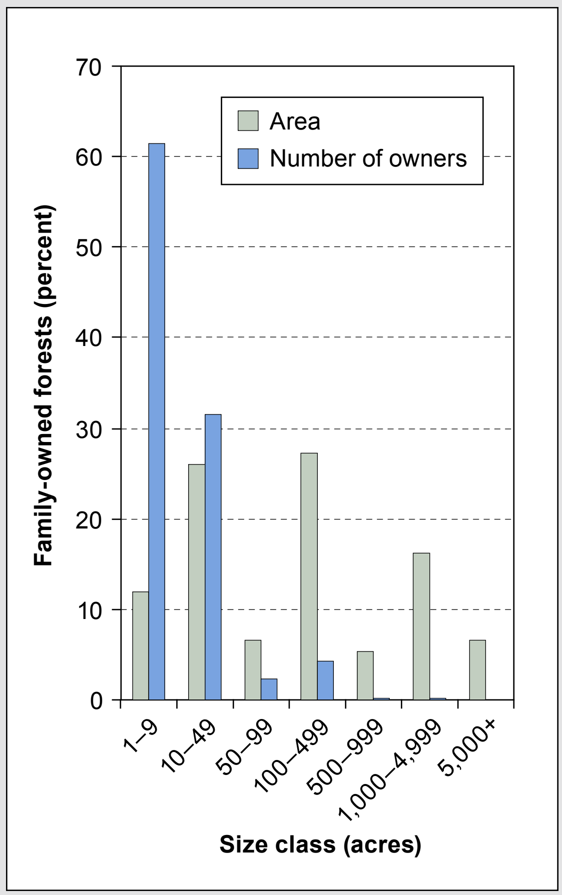


Figure 22—Percentage of area and percentage of the number of family-owned forest holdings by size class in Oregon, 2004.

[6] Author: Sally Campbell.

[7] Another survey of Oregon family forest owners is available: Eiland, T. 2004. Family forestland survey: a report for Oregon Forest Resources Institute. CFM Research, Portland, OR. 31 p.

Service. Probably the most notable in this ownership group are Oregon's state-owned forest lands, managed by the Oregon Department of Forestry, with holdings such as the Tillamook, Clatsop, Elliott, Santiam, and Sun Pass State Forests. The state forest system encompasses 780,000 acres, about 3 percent of Oregon's forested land. Forest lands managed by state and local governments tend to be relatively high-productivity sites, with 36 percent of acres in the highest productivity classes. State-owned lands are managed with the explicit objective of achieving healthy, productive, and sustainable ecosystems that provide a full range of social, economic, and environmental benefits to the people of Oregon (Oregon Department of Forestry 2006b).

Private ownership—

Private owners include families, individuals, conservation and natural resource organizations, unincorporated partnerships, associations, clubs, corporations, and Native American tribes. Excluding the Native American owners, the vast majority of the noncorporate owners own parcels of 500 acres or fewer, and over 70 percent of them use the land as their primary residence. Most noncorporate owners are older than 50, suggesting that these lands will change ownership or be passed to other generations in the next 20 to 40 years. Private lands tend to contain a higher proportion of productive land, and its forests tend to be in younger age classes (fig. 20). Although these lands have no official reserved status, some environmental protection is conferred by various state and federal laws.

The character of corporate forest ownership has changed in recent years. Some large, publicly owned timber companies have transitioned into real estate investment trusts (REITS) and timberland investment management organizations (TIMOS). The REITS and TIMOS own forest land as investment vehicles that compete with and complement alternative investments; these entities may or may not own wood-processing facilities. The difference between them is that REITS directly own forest land, whereas TIMOs manage lands owned by investors. The REITS and TIMOS now own about 6 percent of Oregon's forest lands. Lands classified as industrial forest lands provided 68 percent of Oregon's timber supply in 2005 (Oregon Department of Forestry 2006c), and approximately 27 percent of these lands were owned by REITS and TIMOS.[8]

Interpretation

Because the forest products industry is one of the leading economic drivers in Oregon, the management choices made and the constraints placed on harvest for Oregon's forests significantly affect the state's economy. As the NFS has moved toward a greater emphasis on nonwood resources, timber production has been shifted onto other public and private lands. Because noncorporate forest landowners are aging, and because a high proportion of noncorporate forest lands are used as primary residences, these lands may be less available to provide timber products in the future.

It is unclear what the ownership shift from forest products companies to TIMOS and REITs means for the management of Oregon's corporate forests. As these owners pursue higher returns, it is possible that more land will be converted to nonforest uses. However, because forest land purchases by TIMOS and REITS occurred after Oregon's land use laws were passed, development opportunities are limited for these owners. The level of forestry research funding provided by timber companies may be changing as well. If investment returns can be linked to continued research, companies will likely continue to support research. In this regard, TIMOs and REITS are active members of industry organizations and research cooperatives.

Ownership Tables in Appendix 2

Table 2—Estimated area of forest land, by owner class and forest land status, Oregon, 2001–2005

Table 3—Estimated area of forest land, by forest type group ownerships and productivity class, Oregon, 2001–2005

Table 4—Estimated area of forest land, by forest type group, ownership, and land status, Oregon, 2001–2005

[8] Cannon, L. 2006. Personal communication. Director, Forest Resources and Taxation, Oregon Forest Industries Council, P.O. Box 12826, Salem, OR 97309.

Volume[9]

Background

The current volume of live trees provides the foundation for estimating several fundamental attributes of forest land, such as biomass, carbon storage, and capacity for provision of wood products (fig. 23). Forest volume is an indicator of forest productivity, structure, and vigor, which together serve as a broad indicator of forest health. Species-specific equations that include tree diameter and height are used to calculate individual tree volumes; these are summed across all trees to provide estimates for different geographic areas. The net volume estimates provided in this report for live trees do not include volume of any trees with observed defects such as rotten and missing sections along the stem.

[9] Author: Glenn Christensen.

Findings

Oregon has approximately 100 billion net cubic feet (433 billion board feet) of wood volume on forest land with a mean volume of about 3,322 cubic feet (14,204 board feet) per acre. The greatest proportion of this volume is from softwood tree species such as Douglas-fir, true firs, pines, and western hemlock, which collectively make up 93 percent of all live-tree volume on Oregon forest land (fig. 24). The remaining 7 percent of live-tree volume is in hardwood species such as red alder, maple, and oak.

The majority (56 percent) of live-tree volume is on Forest Service land (fig. 25). Most of the remaining is on land owned by corporate (15 percent) and other federal (13 percent) owners. State and federal forest land tends to have more volume per acre, on average, than privately owned forest land (fig. 26).

Tom Iraci

Figure 23—The highest volume of wood is found on older forests on federal lands, such as this ponderosa pine stand on the Ochoco National Forest.

Forest land volume by survey unit—
Most forest land wood volume is in the heavily forested western half of the state (fig. 27). The west-side survey units (Southwest, West Central, and Northwest, fig. 8) account for approximately 75 percent of all live-tree wood volume (cubic feet). The high productivity of these west-side forests is apparent in their high volume-per-acre estimates. Below are the estimated net volumes of live trees on Oregon forest land:

Survey unit	Total volume (percentage of SE)[a]		Percentage of total volume	Mean volume (percentage of SE)[a]	
	Billion cubic feet	*Billion board feet*		*Cubic feet/acre*	*Board feet/acre*
Southwest	32 (4)	131 (6)	31	4,552 (160)	18,770 (861)
West Central	25 (5)	111 (6)	25	5,612 (237)	24,835 (1,335)
Northwest	20 (5)	82 (5)	19	5,147 (232)	21,398 (1,216)
Central	14 (4)	62 (3)	14	1,621 (68)	7,133 (365)
Blue Mountains	11 (4)	47 (2)	11	1,634 (62)	7,236 (323)

[a] Percentage SE is the percentage standard error following totals and means in parentheses.

Forest land volume by diameter class—
For both softwoods and hardwoods, trees 5 to 20.9 inches diameter at breat height (d.b.h.) contain approximately 51 percent of all live-tree volume (fig. 28). An estimated 15 percent of live-tree volume is in the largest diameter class of trees (≥37.0 inches d.b.h.); nearly all these trees are softwoods. Federal lands tend to have a greater proportion of area in the oldest forests (fig. 20; also see "Ownership" section), which contain the highest volumes

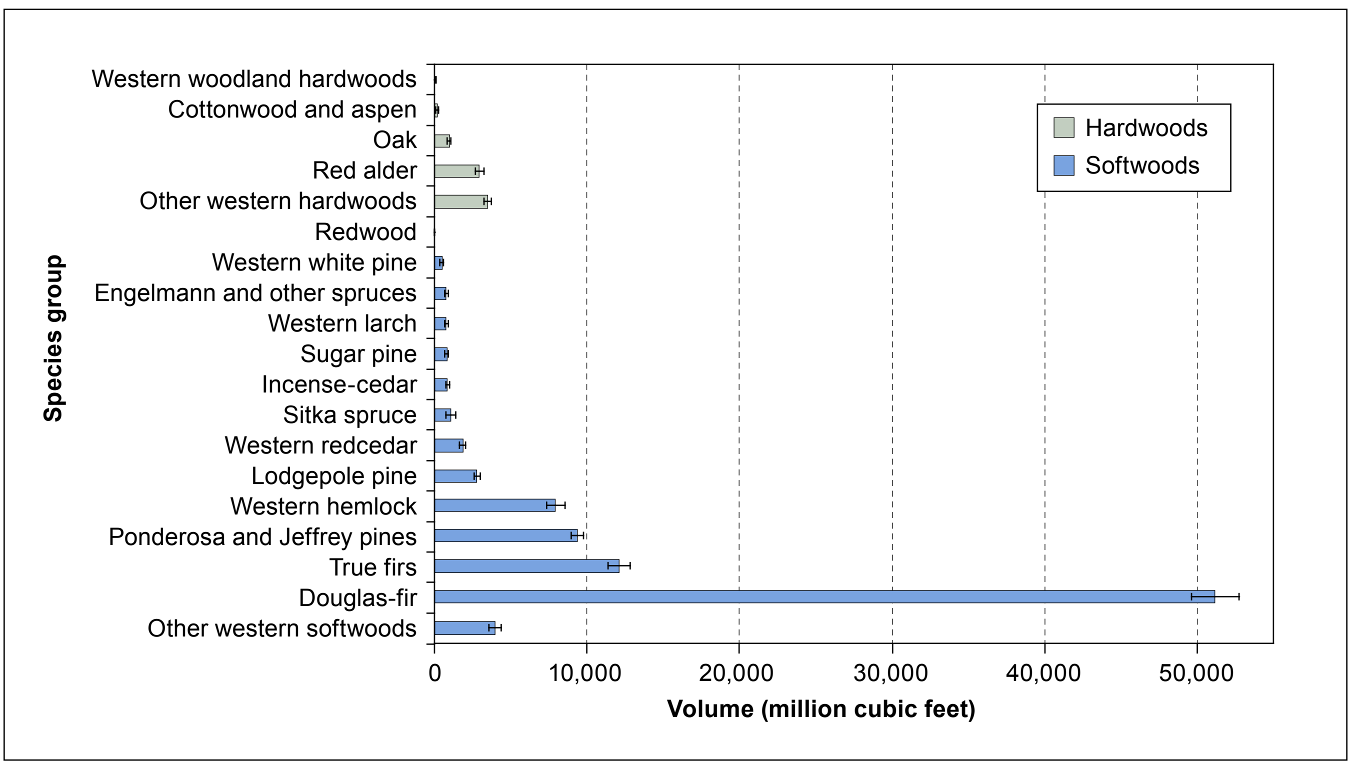


Figure 24—Net volume of all live trees by species group on forest land in Oregon, 2001–2005.

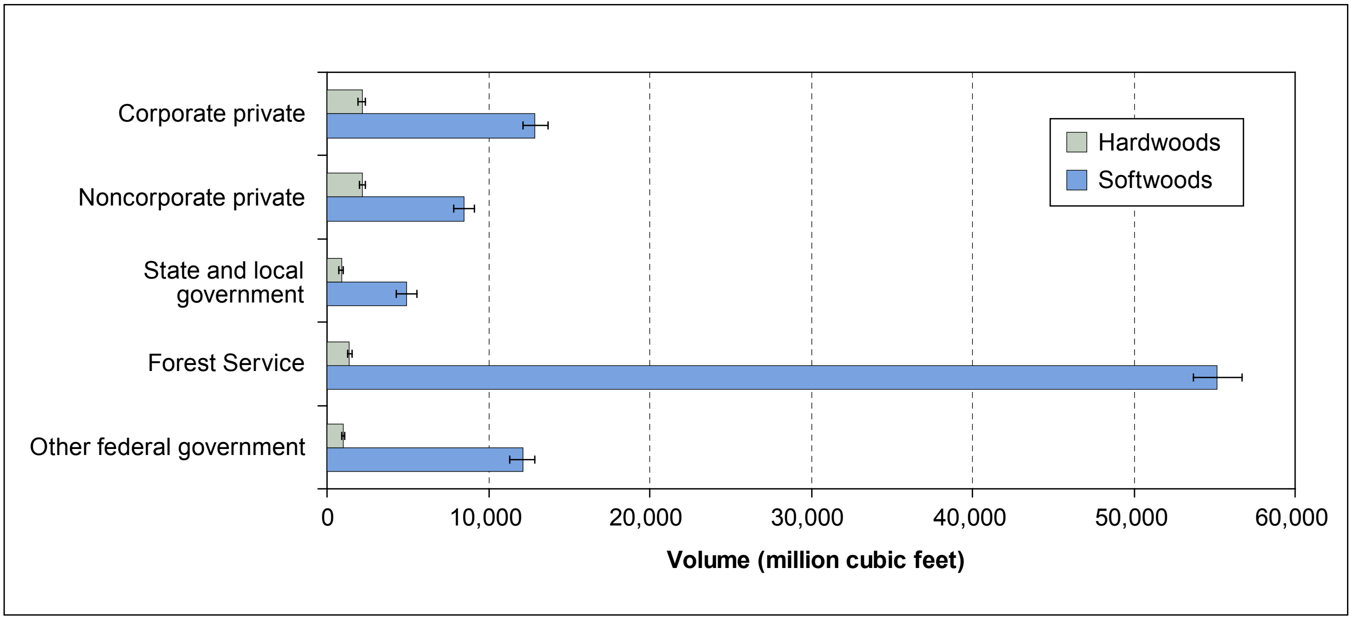


Figure 25—Net volume of all live trees by ownership group on forest land in Oregon, 2001–2005.

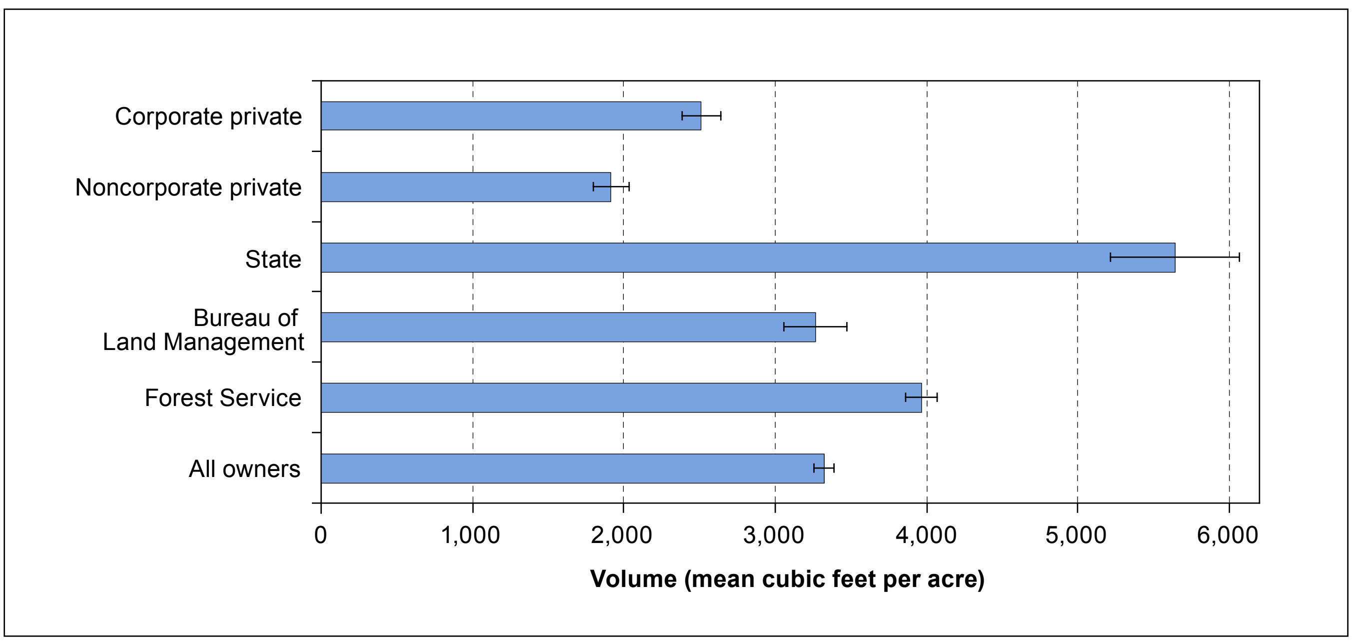


Figure 26—Mean net volume per acre of all live trees by ownership group on forest land in Oregon, 2001–2005.

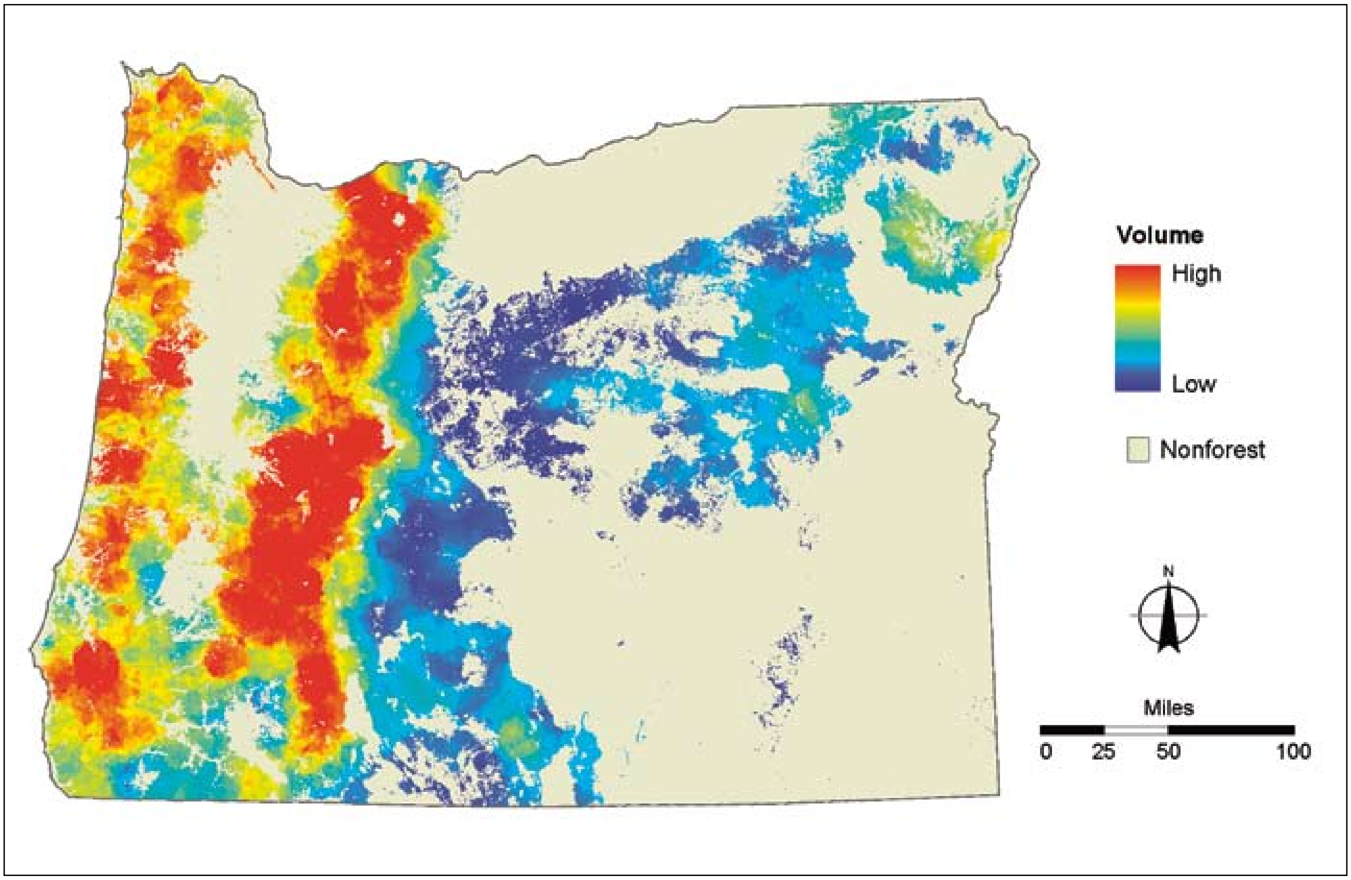


Figure 27—Estimated live-tree volume (net cubic feet per acre), Oregon, 2001–2005. Red color indicates higher predicted per-acre volumes. Estimates are kriged predictions of likely volume per acre on forest land, based on mean net cubic foot volume per plot (forest/nonforest geographic information system layer: Blackard et al. 2008).

of wood. Ownership categories can thus be arrayed along a gradient of diameter class. A similar trend is found for volume: the proportion of volume by ownership changes along the gradient from smaller to larger trees (fig. 29). Within the smallest diameter class, 45 percent of the volume is managed by the Forest Service and 25 percent is owned by the forest industry. In contrast, 72 percent of the volume within the largest diameter class (≥33.0 inches d.b.h) is managed by the Forest Service and 3 percent is owned by the forest industry.

Forest land volume by species group—

Nearly 80 percent of live-tree volume on Oregon's forest land is in four major softwood species groups, Douglas-fir, true firs, ponderosa and Jeffrey pines, and western hemlock. Approximately 51 percent of all live-tree volume is in Douglas-fir (fig. 24). The true fir species group accounts for about 12 percent of live-tree volume, ponderosa and Jeffrey pines together account for about 9 percent, and western hemlock accounts for about 8 percent. Of the hardwood species, red alder accounts for the most volume from a single-species hardwood group; it makes up 3 percent of total cubic foot wood volume and represents about 25 percent of all hardwood volume statewide.

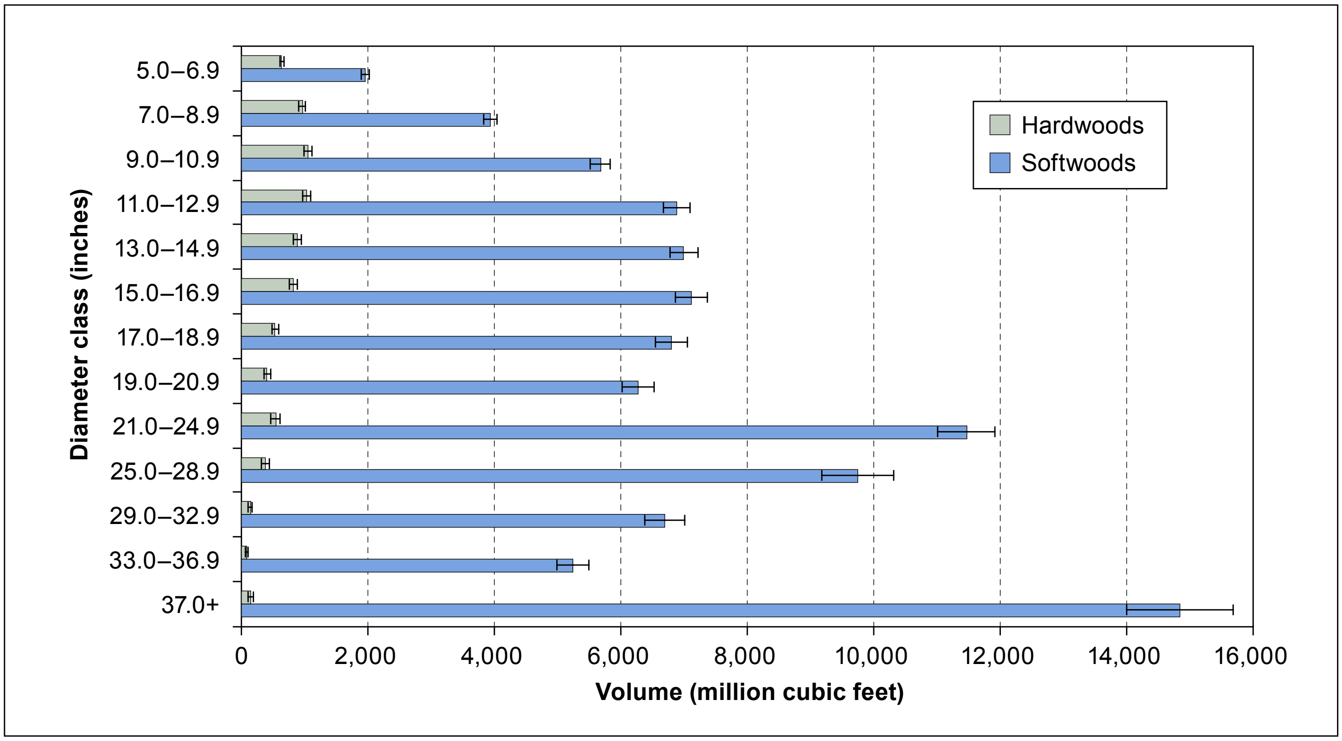


Figure 28—Net volume of all live trees by diameter class on forest land in Oregon, 2001–2005.

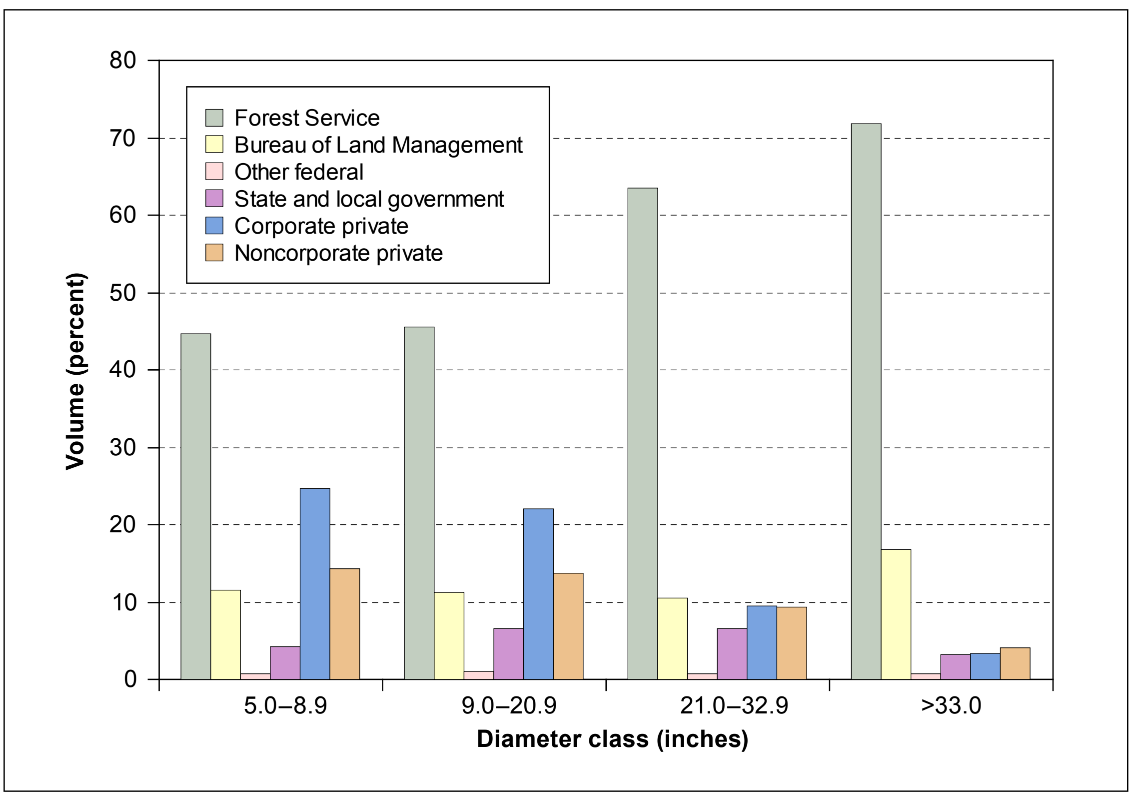


Figure 29—Percentage of net volume of all live trees by diameter class and ownership group on forest land in Oregon, 2001–2005.

Net cubic volume of sawtimber-sized trees on timberland[10]—
Douglas-fir accounts for 57 percent of the net cubic foot volume from sawtimber-sized trees on timberland; the ponderosa/Jeffery pine group and the true fir group each account for 11 percent, and the western hemlock group accounts for 9 percent (fig. 30). This volume is potentially available for manufacturing wood products. Among the hardwood species, red alder contributes the most to sawtimber volume. Red alder makes up about 2 percent of total sawtimber volume in Oregon.

[10] Sawtimber volume is defined as the boles of trees of commercial species that are large enough to produce utilizable logs (9.0 inches d.b.h. minimum for softwoods, 11.0 inches d.b.h. minimum for hardwoods), from a 1-foot stump to a minimum top diameter (7.0 inches outside bark diameter for softwoods, 9.0 inches outside bark diameter for hardwoods).

Interpretation

Statewide estimates of timber volume over the past 50 years show a pattern similar to timberland area: a decline from the 1953 to 1987 inventory dates, followed by a recent increase (fig. 31). As with our estimate of timberland area, the current estimate of volume is partly confounded by differences between the previous periodic and recent annual inventory methods. However, we found no major departures from prior volume estimates grouped according to survey units traditionally used by FIA for Oregon.

Most of the volume is found in the moist forests of the west-side units, the Southwest, West Central, and Northwest (fig. 27). Overall, the trees contributing the majority of forest land volume (Douglas-fir, true firs, ponderosa and Jeffrey pines, and western hemlock) are also the most important commercial species of sawtimber-sized trees.

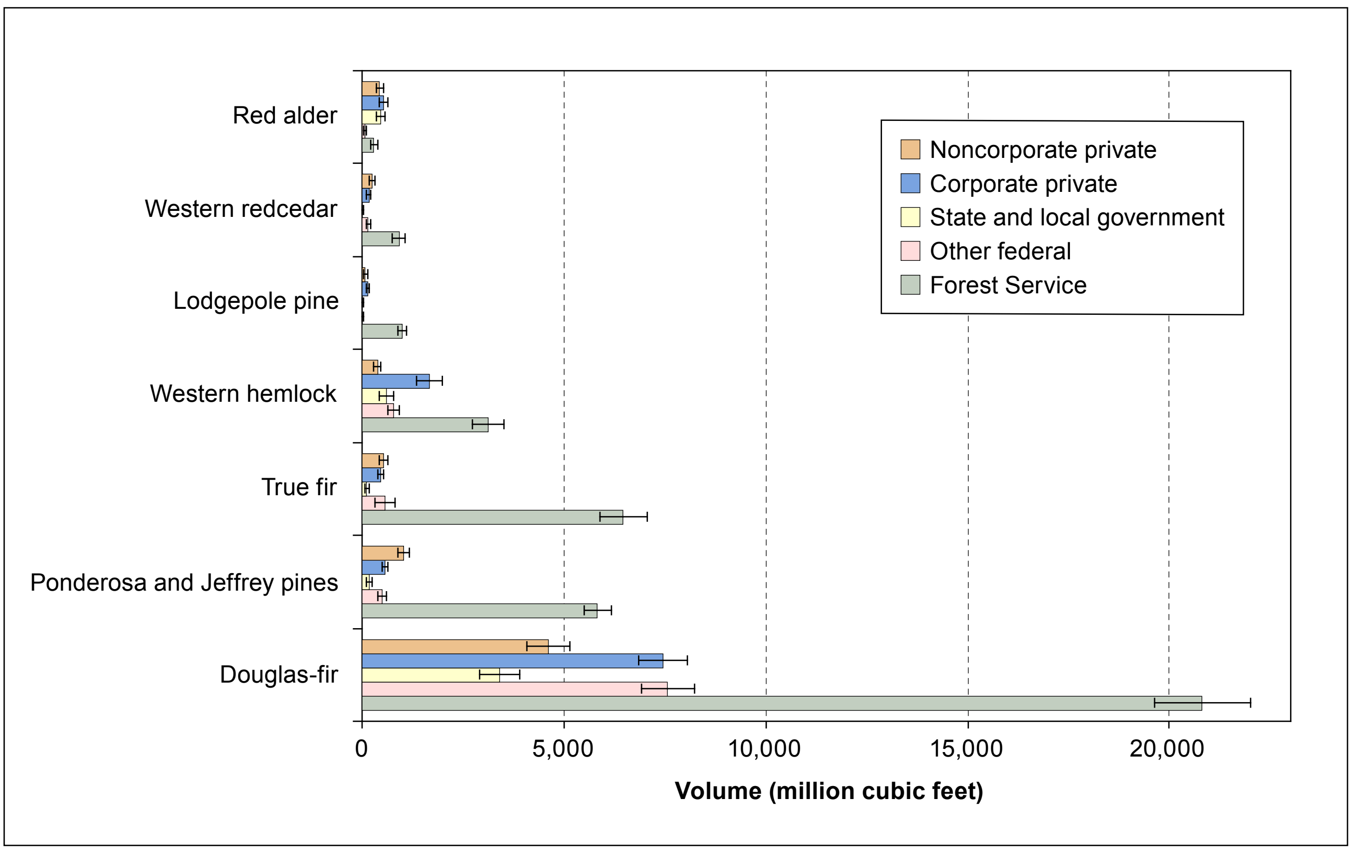


Figure 30—Net volume of sawtimber-sized trees by ownership group on timberland in Oregon, 2001–2005. Excludes miscellaneous mixed softwood and hardwood species groups and species groups that contribute <1 percent of total sawtimber volume.

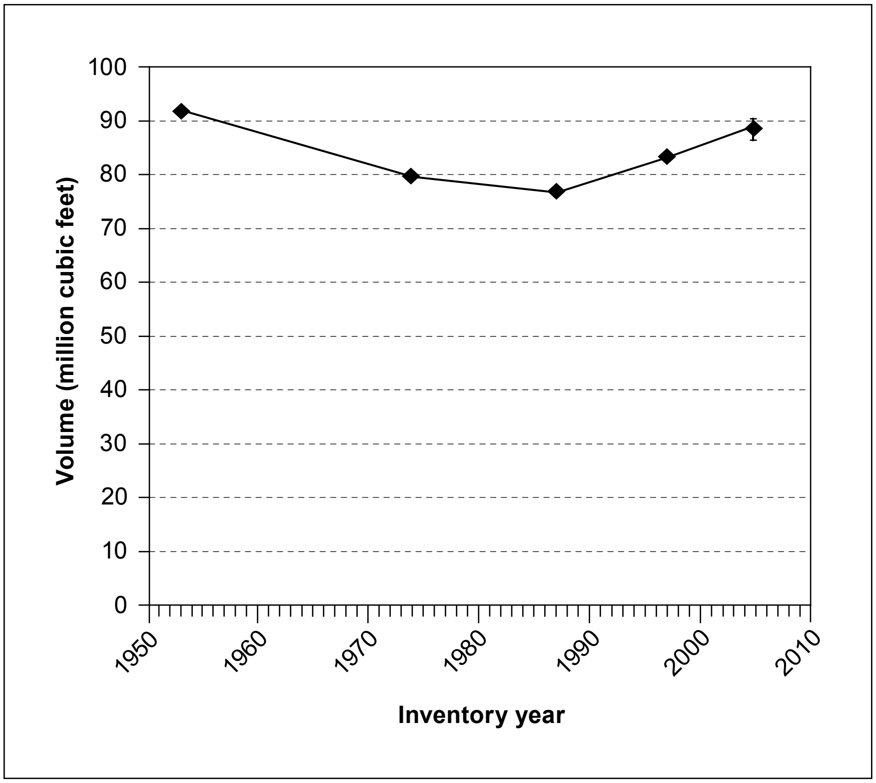


Figure 31—Net volume of growing stock on timberland by inventory year in Oregon (Smith et al. 2004), 1953–2005. Note: The 2001–2005 timberland volume estimate is based on the annual inventory design and protocols; the previous volume estimates are based on periodic inventories with different designs and protocols. Key differences between current and previous estimates, apart from real change, are due in large part to (1) application of plot stockability factors and stockable proportions to different sets of plots in the periodic and annual inventories (as stockability defines productivity class, it thus influences the classification of a plot as timberland or not) and (2) changes in definitions and protocols arising from national standardization of the inventory for qualification as tree, forest land, reserved land, and timberland.

Continued measurement of FIA plots will allow tracking of forest volume estimates that are useful for monitoring a wide variety of resource attributes.

Volume Tables in Appendix 2

Table 8—Estimated number of live trees on forest land, by species group and diameter class, Oregon, 2001–2005

Table 9—Estimated number of growing-stock trees on timberland, by species group and diameter class, Oregon, 2001–2005

Table 10—Estimated net volume of all live trees on forest land, by owner class and forest land status, Oregon, 2001–2005

Table 11—Estimated net volume of all live trees on forest land, by forest type group and stand size class, Oregon, 2001–2005

Table 12—Estimated net volume of all live trees on forest land, by species group and ownership, Oregon, 2001–2005

Table 13—Estimated net volume of all live trees on forest land, by species group and diameter class, Oregon, 2001–2005

Table 14—Estimated net volume of growing-stock trees on timberland, by species group and diameter class, Oregon, 2001–2005

Table 15—Estimated net volume of growing-stock trees on timberland, by species group and ownership, Oregon, 2001–2005

Table 16—Estimated net volume (International ¼-inch rule) of sawtimber trees on timberland, by species group and diameter class, Oregon, 2001–2005

Table 17—Estimated net volume (Scribner rule) of sawtimber trees on timberland, by species group and diameter class, California, 2001–2005

Table 18—Estimated net volume (cubic feet) of sawtimber trees on timberland, by species group and ownership, Oregon, 2001–2005

Biomass and Carbon[11]

Background

Forest biomass and carbon accumulate in live trees, snags, and down wood in a mosaic of patterns across Oregon (fig. 32). During forest succession (the aging and maturing of a forest stand) plant biomass builds up at different rates, sequestering atmospheric gases, principally carbon dioxide, and soil nutrients into woody tree components over time (Perry 1994). Biomass estimates from comprehensive forest inventories are essential for quantifying the amount and distribution of carbon stocks, evaluating forests as a source of sustainable fuel (biomass for energy production), and conducting research on net primary productivity (Houghton 2005, Jenkins et al. 2001, Whittaker and Likens 1975).

In this section we focus on the aboveground live-tree components of forest biomass and make brief comparisons with dead-wood biomass, which is addressed more fully in the "Dead Wood" section. Cubic foot volume and specific gravity constants for each species were used to compute the dry weight of the entire tree stem (all references to weight in this section are in bone-dry, or oven-dry, tons). Stem biomass was combined with branch biomass to compute the total aboveground dry weight of the tree. Carbon mass was estimated by applying conversion factors to the biomass estimates. The discussion that follows focuses on an analysis of total aboveground (including whole stem and branches) biomass and carbon of live trees on forest land in Oregon.

[11] Author: Karen Waddell.

Karen Waddell

Figure 32—Biomass estimates are useful for analysis of productivity, carbon sequestration, and utilization studies, and for general reporting to various criteria and indicator assessments.

Findings

Over 2 billion tons of biomass and 1 billion tons of carbon have accumulated in live trees (≥1 inch d.b.h.), primarily on unreserved forest land. The majority of this biomass (56 percent) is found on land owned by the U.S. Forest Service (fig. 33), where over 80 percent is growing on productive timberland. Reserved forest land, such as wilderness areas and national parks, contains about 229 million tons of biomass, just over 11 percent of the state total. Statewide, softwood forest types have 10 times the amount of biomass and carbon as hardwood types, with biomass estimates ranging from a low of 2 million tons in the western white pine type to a high of 1.1 billion tons in the Douglas-fir type (fig. 34). The dominant hardwood types were the alder/maple type and the tanoak/laurel type, accounting for 78 and 42 million tons of live-tree biomass, respectively.

Because Douglas-fir is the most abundant tree species in Oregon, it is no surprise that it dominates the biomass and carbon figures. The more than 1 billion tons of Douglas-fir biomass represents about 573 million tons of carbon sequestered in live trees. Live biomass is heavily concentrated in trees larger than 21 inches d.b.h. (fig. 35), a trend especially pronounced for softwood species. As a group, softwoods have almost 50 percent of the live tree biomass in this class alone. In contrast, most of the biomass in hardwood species is contained in smaller trees, those between 7 and 13 inches d.b.h., while only 15 percent of the total biomass is contained in the larger 21-inch class (fig. 35).

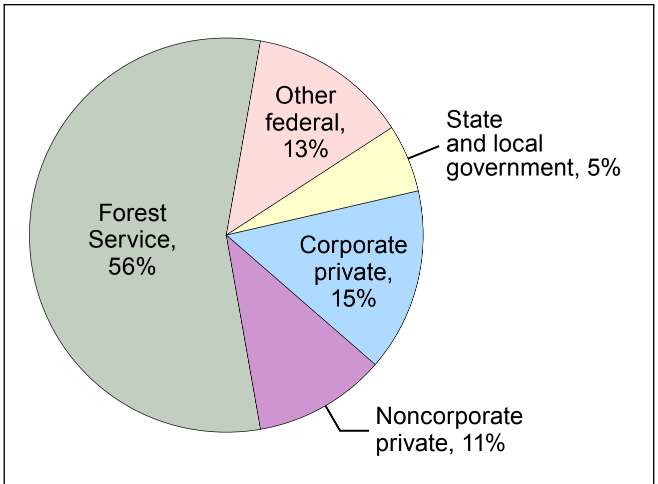


Figure 33—Aboveground live tree biomass by owner group on forest land in Oregon, 2001–2005.

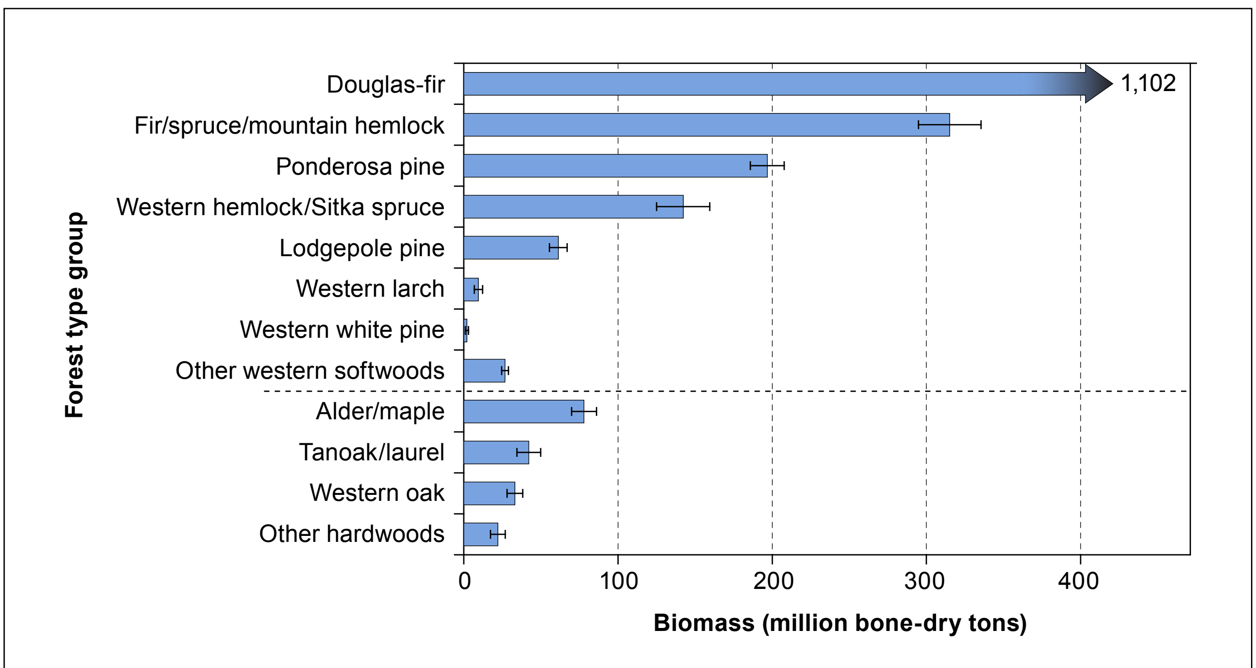


Figure 34—Aboveground live tree biomass by forest type group on forest land in Oregon, 2001–2005.

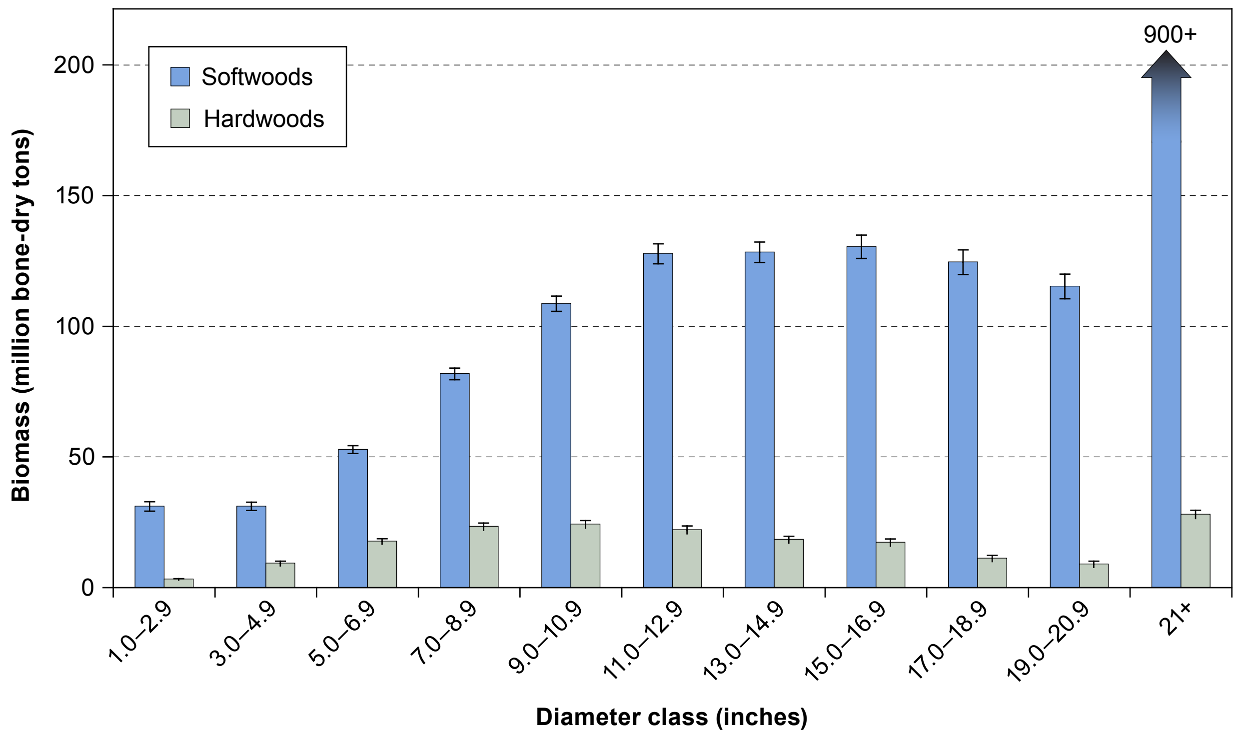


Figure 35—Aboveground live tree biomass by diameter class on forest land in Oregon, 2001–2005.

A comparison of live trees and dead wood biomass shows that snags ≥5 inches d.b.h. add 183 million tons, coarse woody material (CWM, defined as material ≥3 inches in diameter at the large end) adds 367 million tons of biomass, and fine woody material (FWM, defined as material <3 inches in diameter at the point of intersection with the sample transect) adds 127 million tons of biomass to the forest. Total estimated biomass in live trees and dead wood across Oregon is 2.7 billion tons.

Stored carbon was about half that amount (1.41 billion tons), with about 1 billion tons found in live trees, almost 95 million tons found in snags, and 254 million tons stored as down wood (CWM and FWM combined). Softwood types store about 1.2 billion tons of carbon, of which 79 percent is in live trees, 14 percent in CWM, and 7 percent in snags (fig. 36). The bulk of carbon is stored in the Douglas-fir forest type, and the smallest amount is in the aspen/birch hardwood type.

On average, the combined live and dead (snags and CWM) biomass amounted to an estimated 85 tons per acre, and the carbon mass amounted to about 44 tons per acre (fig. 37). The western hemlock/Sitka spruce type had more than twice the state average, with a mean of over 176 tons per acre of biomass and 91 tons per acre of carbon.

Interpretation

Substantial quantities of forest biomass and carbon have accumulated in Oregon forests. The current rising interest in biomass as an alternative source of energy will accelerate the need to understand how much source material is available and where it is located. The FIA inventory shows that there is almost three times as much live-tree biomass as dead-wood biomass. This is important because the preferred source of material for energy production comes from components of the live-tree resource, such as wood residues from harvest operations and sawmills, forest thinning, and biomass plantations. For example, in northern California,

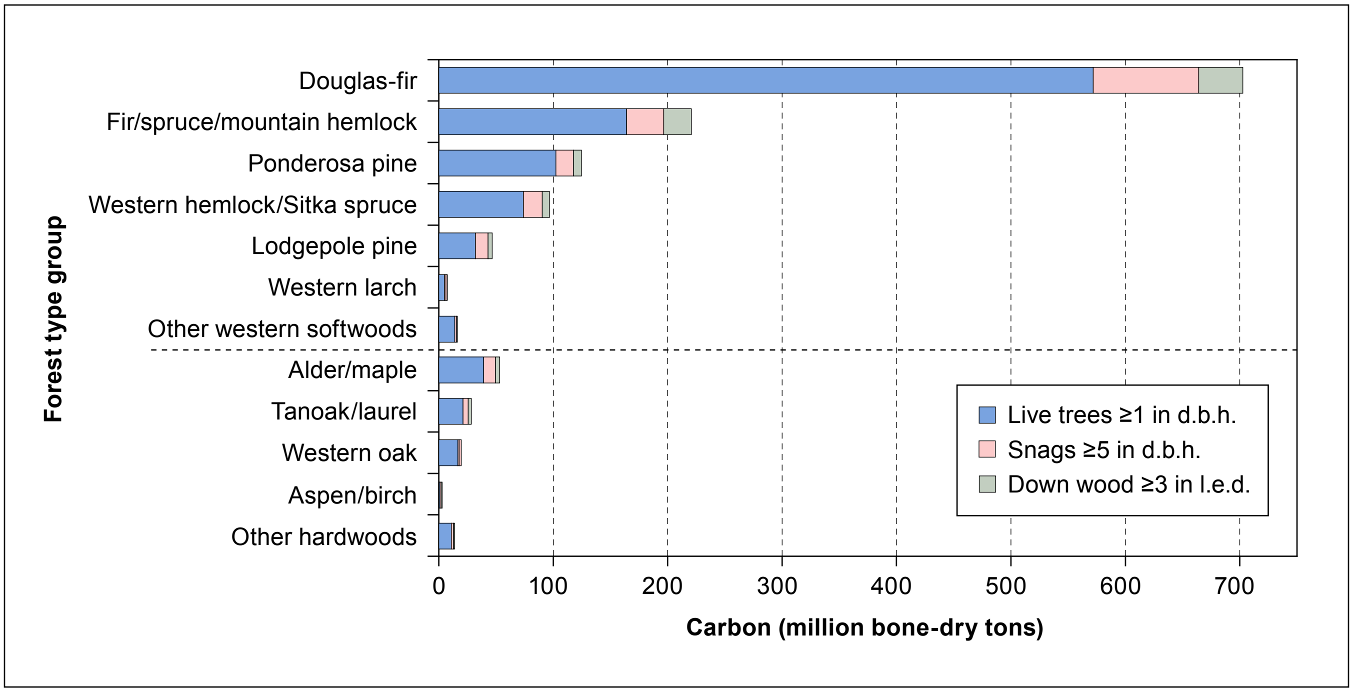


Figure 36—Carbon mass of live trees, snags, and down wood (coarse woody material) by forest type group on forest land in Oregon, 2001–2005; d.b.h. = diameter at breast height; l.e.d. = large end diameter.

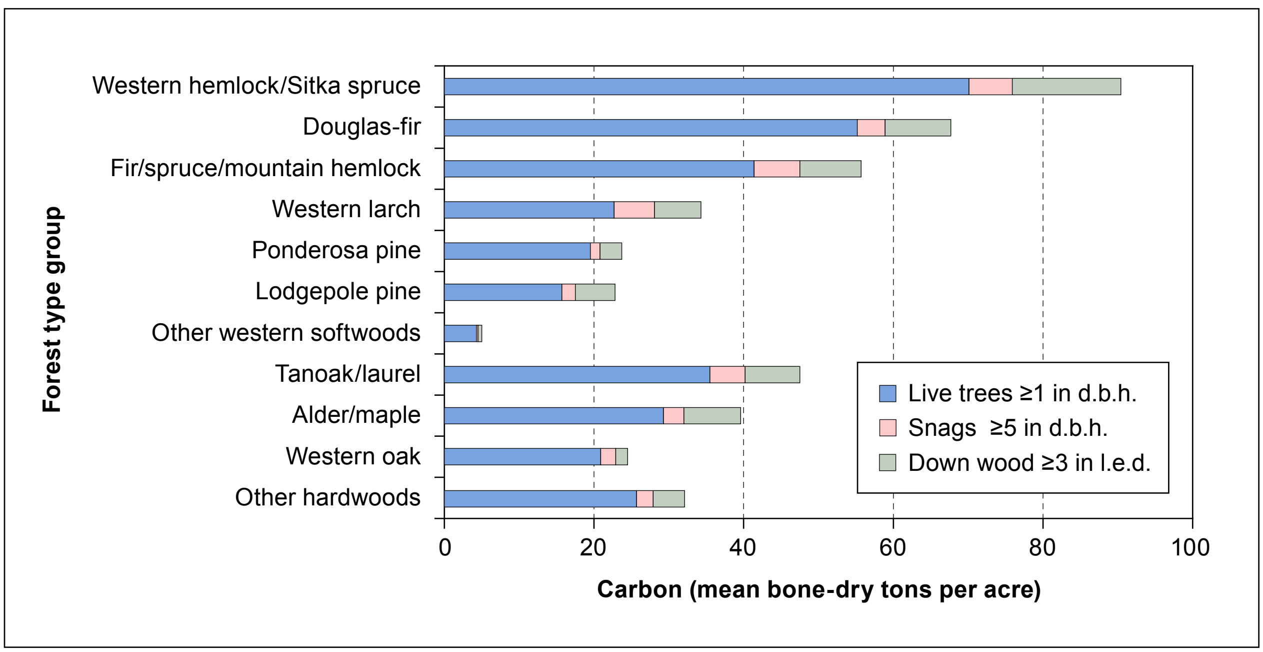


Figure 37—Mean carbon mass of live trees, snags, and down wood (coarse woody material) by forest type group on forest land in Oregon, 2001–2005; d.b.h. = diameter at breast height; l.e.d. = large end diameter.

a small energy company operates a wood-fired powerplant that uses local mill wastes, chips, and unmerchantable whole logs (culls up to 6 feet in diameter) to generate over 375 million kWh of electricity per year.

As a market in carbon credits develops, the amount of carbon stored in young, actively growing forests may be used to help offset carbon released from urban or industrial sites. For such a system to function effectively, it will be important to monitor the various carbon pools and make adjustments (such as planting trees or improving forest health) if live-tree carbon stocks are lost to forest conversion, or to an extensive insect outbreak, fire, harvest, or some other disturbance. When trees are harvested for solid wood products, monitoring activities must recognize this shift in carbon storage and account for the carbon sequestered indefinitely within buildings, furniture, and other structural materials. Over time, the desired outcome is that Oregon's forests become a net sink of stored carbon.

Biomass Tables in Appendix 2

Table 19—Estimated aboveground biomass of all live trees on forest land, by owner class and forest land status, Oregon, 2001–2005

Table 20—Estimated aboveground biomass of all live trees on forest land, by species group and diameter class, Oregon, 2001–2005

Table 21—Estimated mass of carbon of all live trees on forest land, by owner class and forest land status, Oregon, 2001–2005

Table 22—Estimated biomass and carbon mass of live trees, snags, and down wood on forest land, by forest type group, Oregon, 2001–2005

Table 23—Average biomass and carbon mass of live trees, snags, and down wood on forest land, by forest type group, Oregon, 2001–2005

Don Gedney

Mount Hood National Forest.

Chapter 4: Forest Structure and Function

The diverse topics presented in this chapter share a common objective: to characterize the structure and function of Oregon’s forests. These forests are vital habitat for a wide variety of plant and animal species, and they provide many other ecological values. The Pacific Northwest Forest Inventory and Analysis Program (PNW-FIA) data help describe plant biodiversity in Oregon’s forests, characteristics of special habitat types such as old-growth forests and riparian corridors, and status of forest components such as dead wood, tree crowns, soils, and understory vegetation.

Data in this chapter address Montréal Process criterion 1 and indicators pertaining to conservation of biological diversity, criterion 3 and indicators pertaining to maintenance of forest ecosystem health and vitality, criterion 4 and indicators pertaining to conservation and maintenance of soil and water resources, and criterion 5 and indicators pertaining to maintenance of forest contribution to global carbon cycles.

Data in this chapter also address Oregon indicator B pertaining to forest ecosystem services (carbon sequestration); indicator D pertaining to protecting, maintaining, and enhancing soil and water resources; and indicator E pertaining to the composition, diversity, and structure of forest vegetation.

Older Forests[1]

Background

Forests in later stages of successional development are an important part of the forest land matrix, contributing special habitat, aesthetics, functional resources, and ecological services not available in younger forests (Franklin et al. 1981). Older forests are not simply forests where little or no disturbance has occurred for long periods; disturbance is the norm in all forests and has helped shape old forests by creating openings and patches of older, resilient survivors.

[1] Author: Joseph Donnegan.

The term "old" is relative; it depends on whose definition is used, the type of forest being considered, and the regional climate. Because many complex, interacting variables can be used to describe them, older forests are not easily defined. Typically, in Pacific Northwest forests, the structure, species composition, and functional attributes of older forests are attained by the age of 175 to 250 years (Franklin et al. 1981). In this section we have purposely oversimplified the definition for older forests, reporting acreage by forest type for stand ages in the 160-year-old-plus and the 200-year-old-plus categories. More complex definitions for old-growth forests often cite a minimum age of 200 years, but definitions also depend on productivity classes and forest type (Franklin et al. 1981, Old-Growth Definition Task Group 1986, Bolsinger and Waddell 1993).

Our summary uses stand age as the basis for estimates of area and age distribution. The FIA field crews estimate stand age based on the average age of predominant overstory trees, assessed by counting the tree rings on a pencil-sized sample of wood (core) extracted with an increment borer (fig. 38). It is not possible to determine the age of some trees, however, because of internal rot or because the sheer size of the tree limits the length of core that can be extracted, and some species are not cored because the core wound might make them susceptible to pathogens.

Joseph Donnegan

Figure 38—Increment cores are extracted from trees to determine the age of dominant trees in each forested stand that is sampled by Forest Inventory and Analysis.

Findings

Approximately 12 percent (3.6 million acres) of forest stands across Oregon are older than 160 years; and slightly fewer than 7 percent (1.9 million acres) are older than 200 years. The vast majority of older forest is found on publicly owned land in national forests and national parks (see"Ownership" section). The Douglas-fir and ponderosa pine forest types make up the majority of the older forest acreage in Oregon. Douglas-fir stands older than 160 years account for 4.4 percent of total forest acreage, and ponderosa pine stands older than 160 years account for 1.4 percent of total forest acreage (fig. 39). The remaining combined forest types with stand ages in excess of 160 years make up less than 7 percent of total forest area.

Western white pine leads all forest types in proportion of its acreage in older stands; 55 percent of Oregon's white pine is older than 160 years, although the total acreage occupied by older white pine is relatively small, about 52,000 acres (fig. 40). Although Douglas-fir leads all forest types in total acreage in older stands, these stands represent only about 14 percent of the Douglas-fir forest type. That is because there is great diversity in the structure of Douglas-fir forests, with tree diameters covering a broad range of classes (fig. 41). Seedlings and saplings are the most abundant size class, although larger diameter classes are well represented.

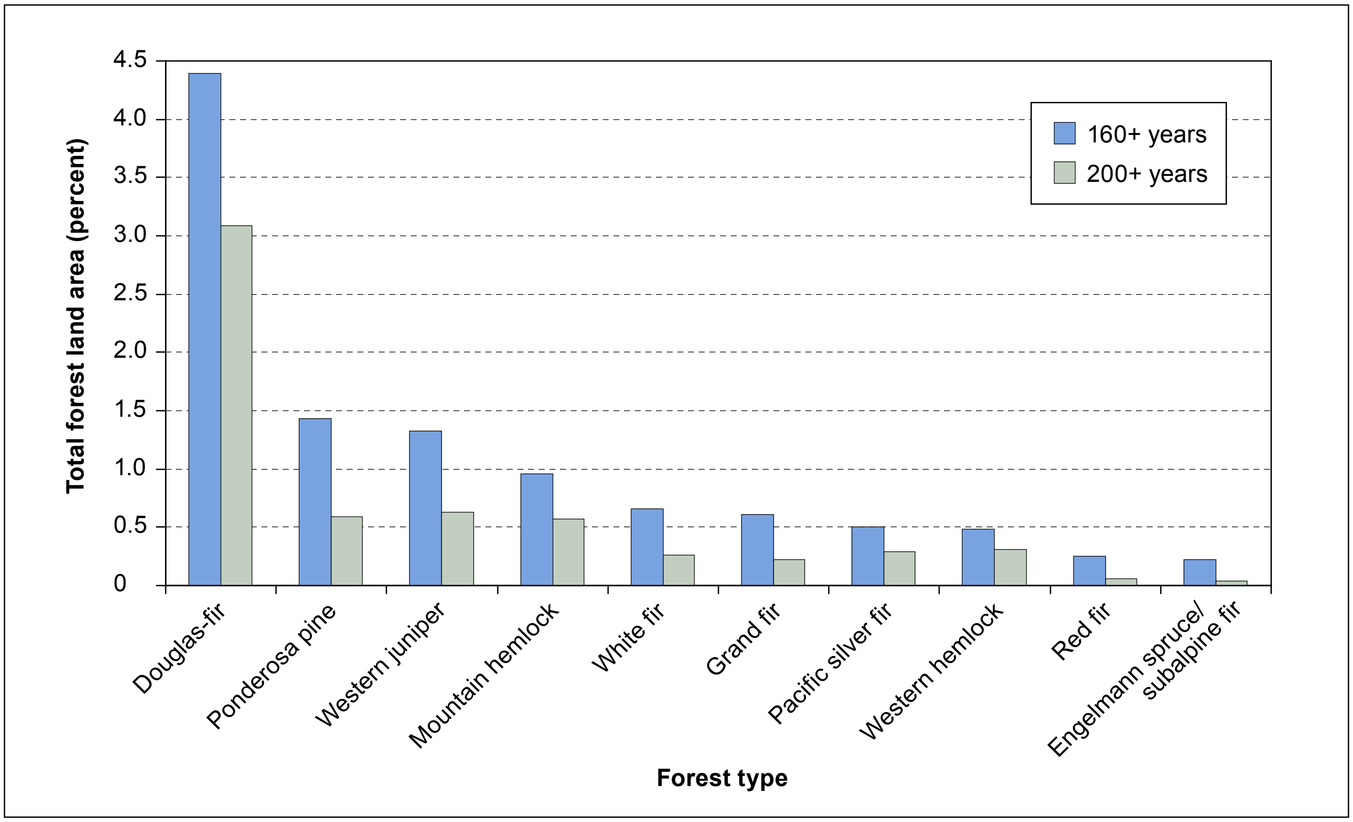


Figure 39—Percentage of total forest land area by forest type for stands 160+ and 200+ years old in Oregon, 2001–2005.

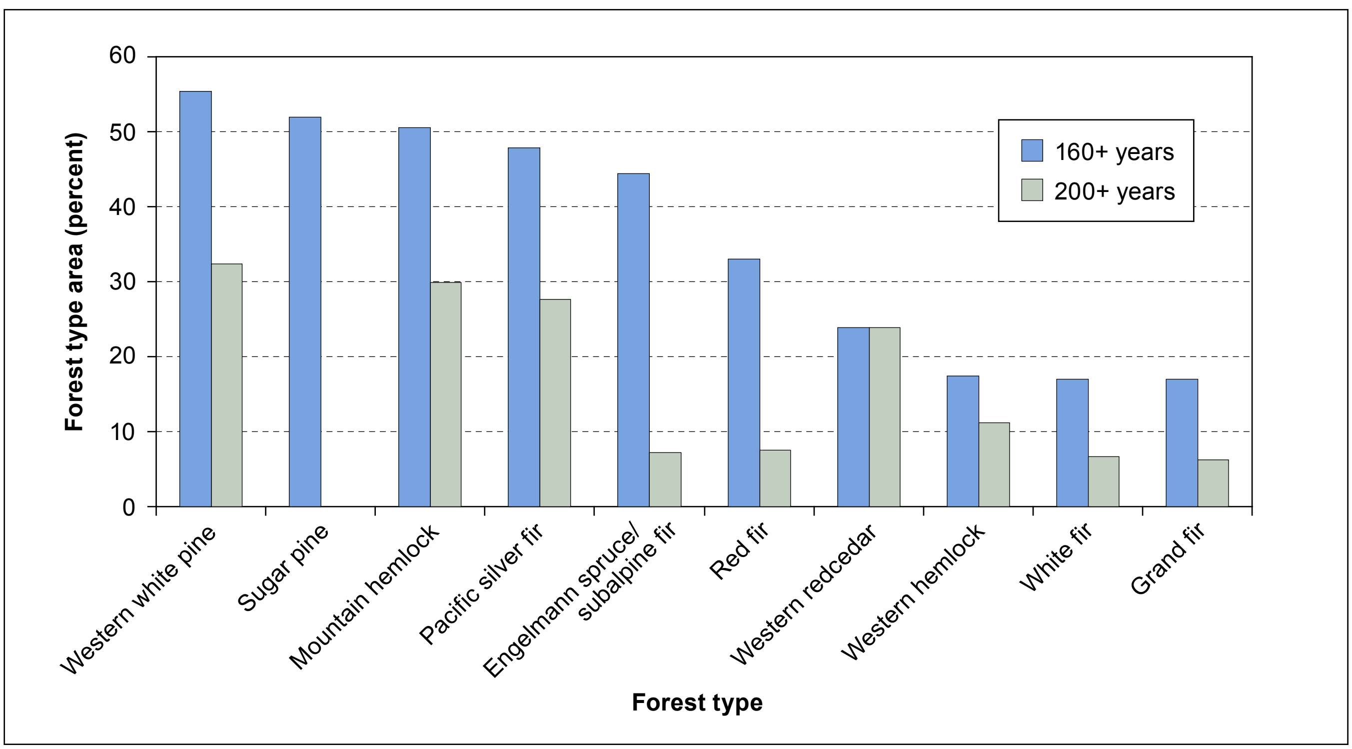


Figure 40—Percentage of area of each forest type in older forest in Oregon, 2001–2005.

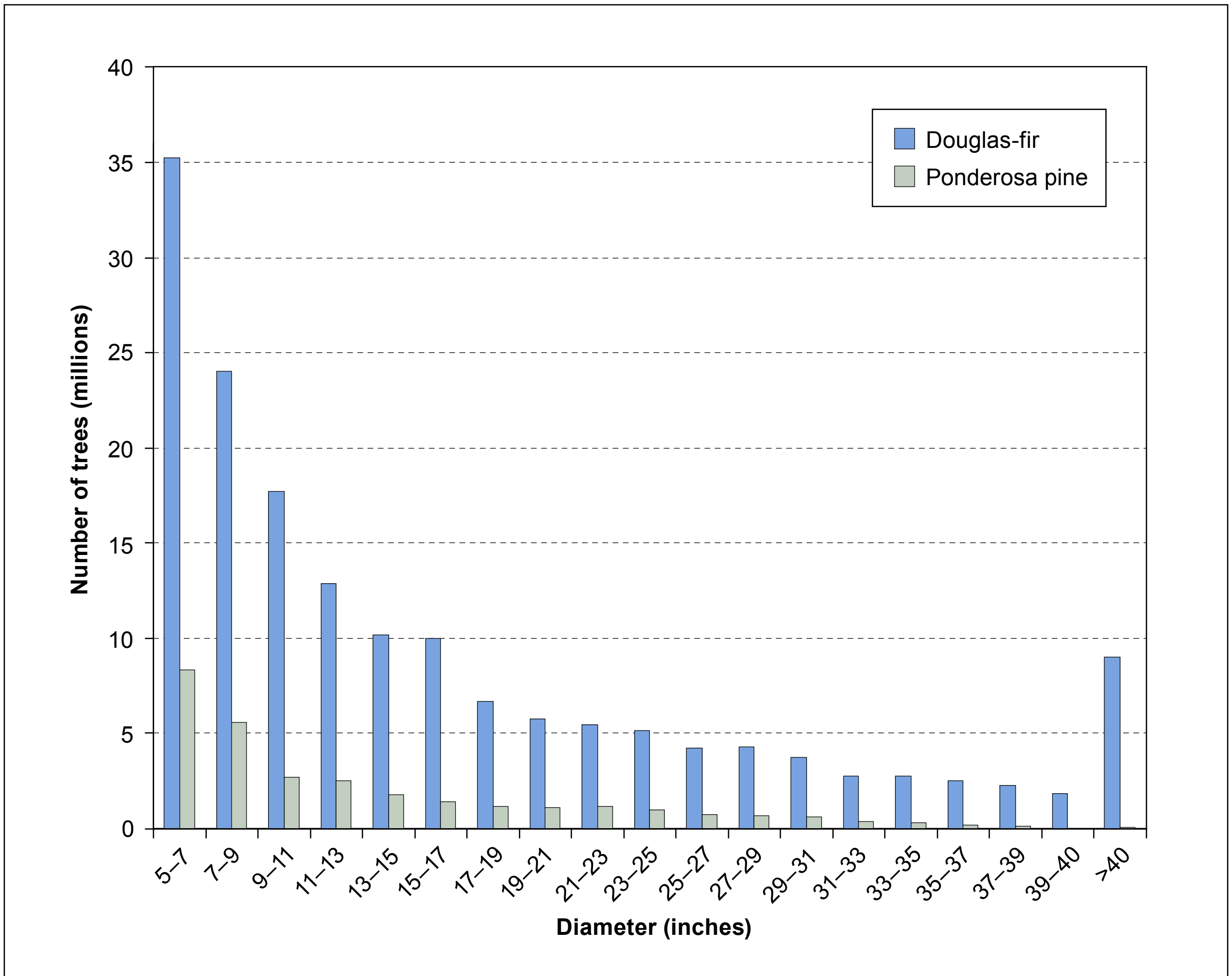


Figure 41—Number of trees by diameter class in older (≥160 years old) Douglas-fir forests on forest land in Oregon, 2001–2005.

Interpretation

Prior to the widespread logging of old forests (before the mid-1800s), these forests had been changing through time from disturbances such as fire and insect outbreaks of varying severity, recurrence intervals, and disturbance synchrony across the landscape (Winter et al. 2002). The area and distribution of older forests was highly variable through time. Estimates of the area of old-growth forest existing in the Oregon Coast Range prior to Euro-American settlement range from about 25 to 75 percent of total forest area (Booth 1991, Ripple 1994, Teensma et al. 1991, Wimberly et al. 2000). Current estimates of the extent of old-growth place it at less than half the lowest prelogging estimate. However, the proportion of older forest will increase if stands on national and state forests, established after widespread logging and stand-replacing fires during the 1930s and 1940s, continue to mature. The size diversity seen in older Douglas-fir stands (fig. 41) suggests that disturbance and regeneration will continue to play a vital role in shaping older forests.

This preliminary summary is based on approximately half the sample planned for the inventory. Additional data will add to the accuracy of our initial findings.

Lichen and Plant Biodiversity[2]

Background

Diversity of lichens and vascular plants is included among the FIA suite of forest health indicators (Gray and Azuma 2005, Jovan 2008). These organisms serve many basic and vital functions in forest ecosystems: they provide wildlife sustenance and habitat, influence stand microclimate, and contribute to nutrient dynamics. Individual species or groups of species are intimately linked to forest health. For example, invasive nonnative plants can have important economic impacts on land use, as well as ecological impacts on ecosystem function (Vitousek et al. 1996). Similarly, cyanolichens (fig. 42) are a specialized group of native lichens that fix nitrogen (N) and may make substantial contributions to forest fertility in N-limited stands of the Pacific Northwest (Antoine 2004).

The FIA crews surveyed for epiphytic (tree-dwelling) lichens on all phase 3 plots between 1998 and 2003 and recorded the abundance of each species occurring within a 0.93-acre area. Vascular plant species were recorded for a pilot study of method repeatability and data utility on 110 plots in 2000 and 2001. Plant species cover was estimated for each species on each 24-foot radius subplot and on three 3.28 square feet quadrats per subplot.

Abundance codes used in lichen community surveys are shown in the following tabulation:

Code	Abundance
1	Rare (1 to 3 thalli)[3]
2	Uncommon (4 to 10 thalli)
3	Common (>10 thalli; species occurring on less than 50 percent of all boles and branches in plot)
4	Abundant (>10 thalli; species occurring on greater than 50 percent of boles and branches in plot)

[2] Authors: Andrew Gray and Sarah Jovan.

[3] A lichen body is known as a thallus (plural = thalli).

Figure 42—An oak trunk thickly coated with lungwort lichen (*Lobaria pulmonaria*), a cyanolichen.

Findings

The diversity of lichen and vascular plant communities differed widely by mapped ecological unit (ecosection) (figs. 43 and 44). A total of 182 lichen species were recorded in Oregon, a sizeable portion (88 percent) of the diversity found for the entire Pacific Northwest (Jovan 2008). In contrast, 535 vascular plant species were detected, a small portion of the 3,400 estimated to occur in all habitats in Oregon. The Willamette Valley is a prominent biodiversity hotspot that supports, on average, the highest diversity of lichens (25 species) and vascular plants (56 species) of all forested ecosections. However, species richness alone should not be considered an incontrovertible sign of good forest health; 30 percent of the plants identified to species on each plot in the Willamette were of nonnative species, and the lichen inventory contained several species indicative of N pollution (see "Air Quality" section in "Disturbance and Stressors" chapter).

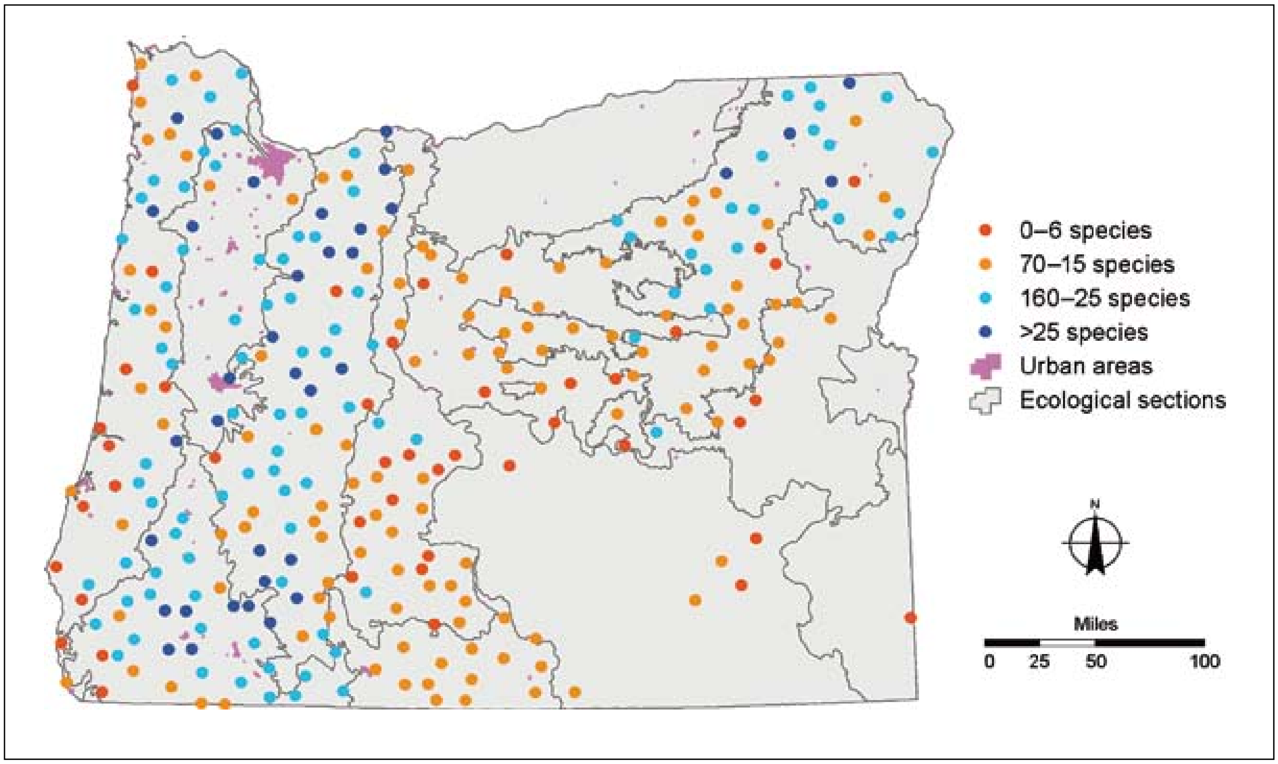


Figure 43—Lichen species richness index, Oregon forest land, 1998–2003 (ecosection geographic information system (GIS) layer: Cleland et al. 2005; Urban GIS layer: U.S. Geological Survey 2001).

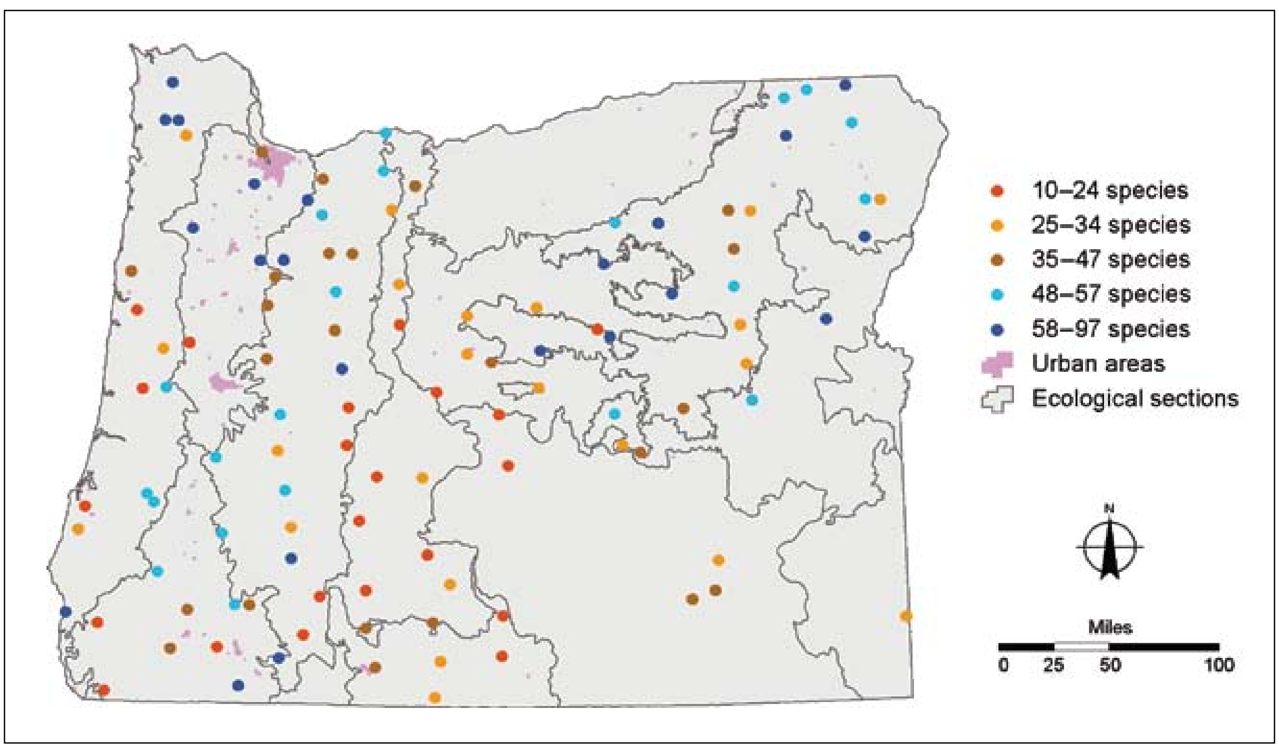


Figure 44—Vascular plant species plot-level richness index by ecoregions, Oregon forest land, 2001–2005 (ecosection geographic information system layer: Cleland et al. 2005).

The crest of the Oregon Cascades demarcates a conspicuous shift in lichen and plant communities. Generally speaking, forests on the wetter west side tend to be richer in lichen species (averaging 19 species per plot) than on the dry east side (12 species per plot). West-side sites also include a considerable variety of large N-fixing cyanolichens such as *Lobaria* and *Pseudocyphellaria* spp., owing in part to the high moisture demands of these species’ physiology (fig. 42). A total of 22 nongelatinous cyanolichen species were found on the west side, but only three on the east side.

Vascular plant diversity was also relatively high across west-side ecosections, averaging 37 to 56 species per plot. The most common west-side plant species recorded were Douglas-fir, trailing blackberry, and swordfern (47, 40, and 39 out of 54 plots, respectively; fig. 45).

Sampling intensity is low across parts of the east side, notably the Northwestern Basin and Range and Owyhee Uplands (figs. 6, 43, and 44), where shrubland and grassland predominate. Lichen and plant species were especially few in these low-rainfall areas. Lowest plant diversity was recorded for the Modoc Plateau (27) and Owyhee Uplands (30). Farther to the northeast lies another biodiversity hotspot for plants; plot-level richness found for the Blue Mountains (47) was similar to that of the western Cascades (46). About 10 percent of plant species identified on each plot in this region were nonnative. The most common east-side plants encountered were common yarrow, bottlebrush squirreltail, and ponderosa pine (39, 39, and 36 out of 56 plots, respectively) (see “Scientific and Common Plant Names”).

Andrew Gray

Figure 45—Trailing blackberry is one of the most common plant species in Oregon.

Interpretation

A low diversity of plants or lichens is not necessarily unnatural, nor is a high diversity inherently good. Biodiversity patterns in Oregon are driven by a multitude of factors, some human-caused (i.e., timber harvest, air quality), some natural (i.e., differences in moisture and temperature regime and herbivory pressure between east and west sides), and some of mixed origin (i.e., forest fires). As illustrated by the proportion of nonnative plants found in the species-rich Willamette Valley and Blue Mountains, implications of diversity patterns are often best analyzed in concert with other indicators that may be extracted from the vegetation and lichen data.

Our inventory of species richness tends to underestimate diversity, both because surveys are time-constrained and because the low density of plots can result in severe underestimation of the total number of species at the ecosection level. The diversity data presented here provide a baseline for temporal monitoring surveys; major shifts in diversity will be investigated as needed.

Biodiversity Tables in Appendix 2

Table 24—Index of vascular plant species richness on forest land, by ecological section, Oregon, 2005

Table 25—Index of lichen richness on forest land, by ecological section, Oregon, 1998–2001, 2003

Table 26—Summary of lichen community indicator species richness on forest land, Pacific Northwest and Oregon, 1998–2001, 2003

Dead Wood[4]

Background

Dead wood contributes to the structural complexity and biological diversity of forests throughout Oregon. In this report we define "dead wood" as snags (standing dead trees) (fig. 46) and down wood (dead woody material on the forest floor) of various dimensions and stages of decay (fig. 47). The presence of dead wood in a forest improves wildlife habitat, enhances soil fertility through nutrient cycling and moisture retention, adds to fuel loads, provides substrates for fungi and invertebrates, and serves as a defining element in old-growth forests (Harmon et al. 1986, Laudenslayer et al. 2002, Rose et al. 2001). Because of this, the dead wood resource is often analyzed from a variety of perspectives—too much can be viewed as a fire hazard and too little can be viewed as a loss of habitat.

The amount of dead wood in a forest can differ with habitat type, successional stage, species composition, management activities, and geographic location (Harmon et al. 1986, Ohmann and Waddell 2002). Here, we analyze data on snags and down wood collected by FIA crews on more than 2,600 field plots in the state. Dead wood is described in broad terms at the statewide level, with comparisons between western Oregon and eastern Oregon when relevant.

Dead trees leaning less than 45 degrees and ≥5 inches diameter at breast height (d.b.h.) were tallied as snags and measured under the same protocol as live trees. Down wood was sampled along linear transects on each plot under protocols that differed by diameter size class. Information was collected on fine woody material (FWM; pieces of wood <3 inches in diameter at the point of intersection with the transect) and on coarse woody material (CWM; branches and logs ≥3 inches in diameter at the point of intersection). Dead trees leaning more than 45 degrees were tallied as down wood. Estimates of density, volume, biomass, and carbon were developed from these data and are the basis for the analysis that follows.

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[4] Author: Karen Waddell.

Karen Waddell

Figure 46—Snags provide critical habitat and structural diversity in Oregon's forests. Birds and other mammals use snags as roosting and foraging sites and occupy cavities for nesting and cover.

Figure 47—Dead wood accumulates on the forest floor, providing habitat, soil stability, and long-term carbon storage.

Findings

Dead wood was found in every forest type sampled in Oregon. We estimated almost 677 million tons (all references to weight refer to bone-dry tons) of dead wood biomass on forest land in the state, with about 73 percent attributable to down wood alone (CWM and FWM). Volume of snags and CWM was about 54 billion cubic feet, which is just over half the total live-tree volume recorded in Oregon. About 95 million tons of carbon are sequestered in snags, compared to 256 million tons stored in down wood (CWM = 191; FWM = 65). We estimated more than 7 billion down logs (CWM) and 500 million snags in forests statewide. Dead wood was most abundant and had the largest dimensions in western Oregon, where temperate forests have high productivity rates and produce heavy accumulations of biomass.

Assessment of dead wood attributes becomes more meaningful when expressed at the per-acre level. Statewide, biomass (also known as fuel loading) of down wood averaged 16 tons per acre and differed by forest type and diameter class (fig. 48).

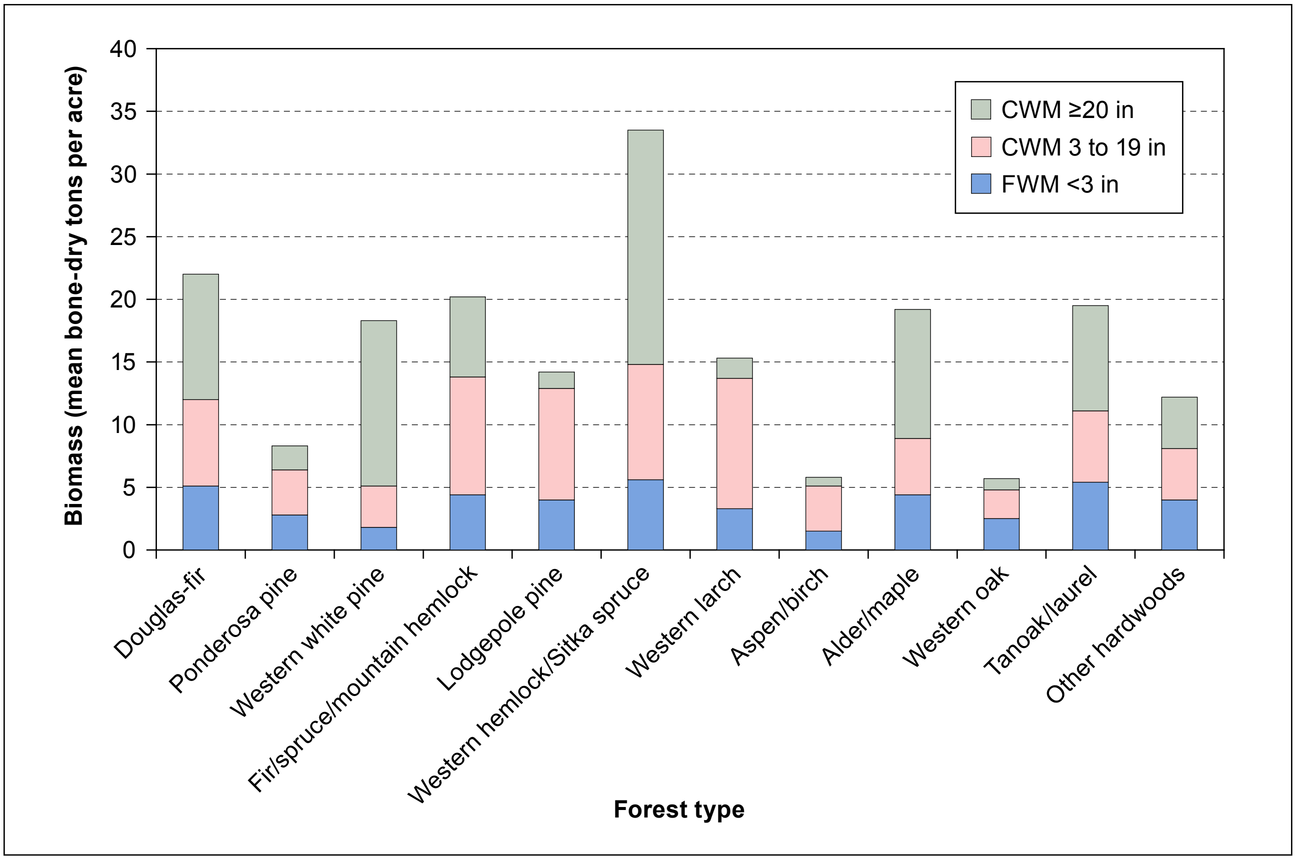


Figure 48—Mean biomass of down wood by forest type and diameter class on forest land in Oregon, 2001–2005; CWM = coarse woody material; FWM = fine woody material.

The down wood component of Oregon's total fuel load (amount of potentially combustible material) can be expressed as the average tons per acre within fuel hour-classes:

Location	1-hour class	10-hour class	100-hour class	1,000-hour class
		Mean tons/acre		
Western Oregon	0.2	1.3	3.7	17.0
Eastern Oregon	0.1	.8	2.3	7.0
Total	0.2	1.0	2.8	12.1

The range in classes from 1 to 1,000 hours corresponds to the diameters of down wood pieces as follows: 1-hour (0.1 to 0.24 inches), 10-hour (0.25 to 0.99 inches), 100-hour (1 to 2.9 inches), and 1,000-hour (≥3 inches). Each class refers to how fast dead woody material will dry and burn relative to its moisture content.

The dimensions of down logs and snags are important when evaluating ecological characteristics of the forest. Although large logs (≥20 inches diameter) represented the greatest mean volume and biomass per acre, they were present in significantly fewer numbers, with a mean of 11 logs per acre, compared to 225 logs per acre for small logs (3 to 19 inches). Western Oregon forests had five times as much biomass in large logs as those in eastern Oregon (fig. 49).

Snags represented a mean biomass of 6 tons per acre and a mean density of 19 trees per acre across the state. Almost 90 percent of the snags were <20 inches d.b.h.; only 0.3 snags per acre were >40 inches d.b.h. Softwood forest types had the most biomass and the largest proportion of large-diameter snags (>20 inches d.b.h.) (fig. 50).

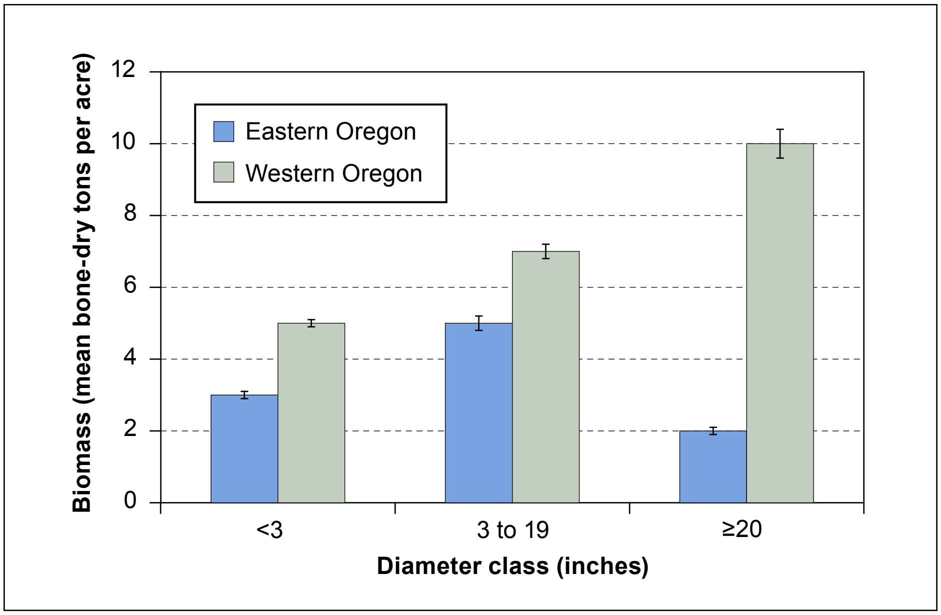


Figure 49—Mean biomass of down wood by diameter class on forest land in eastern and western Oregon, 2001–2005.

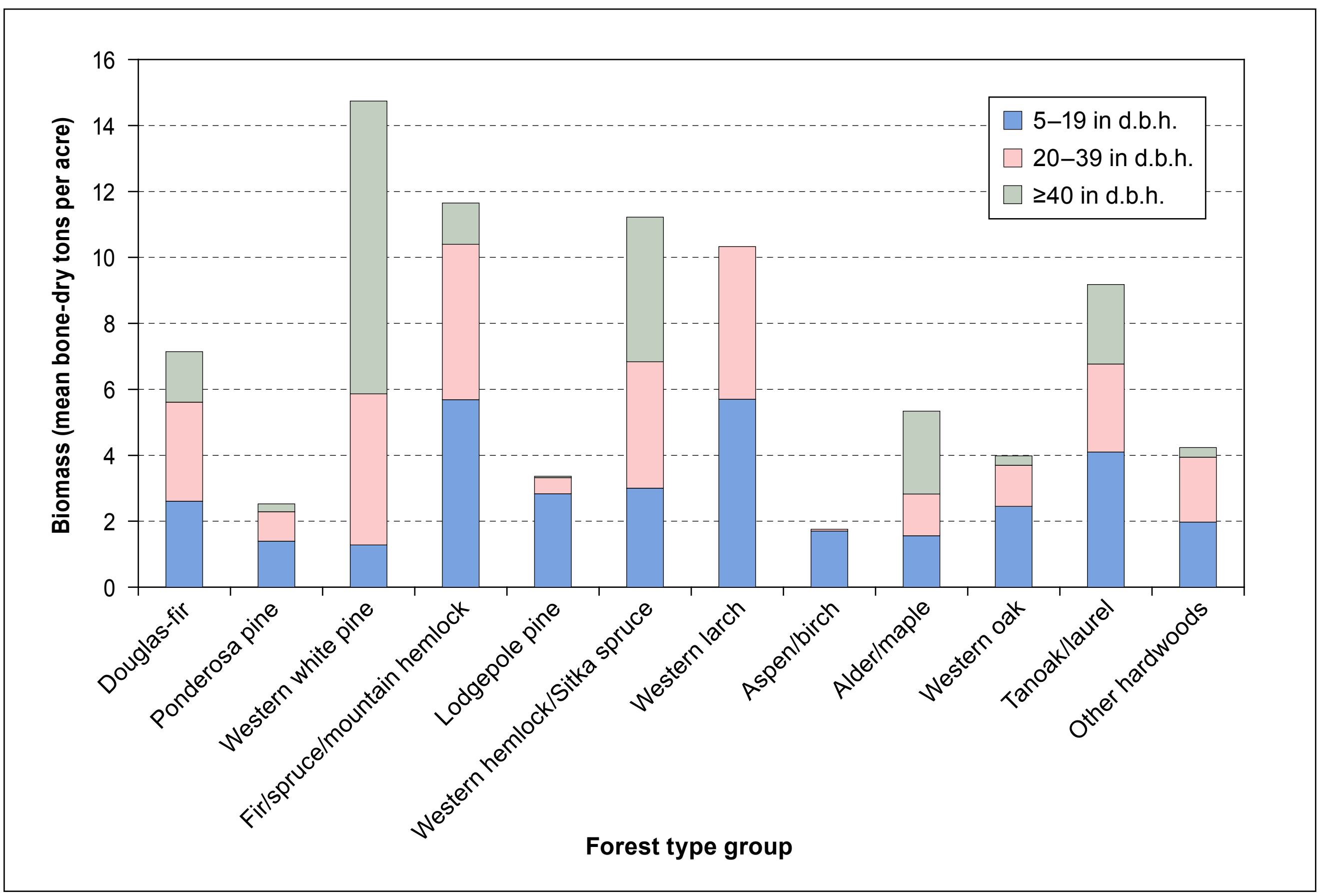


Figure 50—Mean biomass of snags by forest type and diameter class on forest land in Oregon, 2001–2005.

Although the total amount of dead wood present in a forest differs over time, the mean density of large-diameter (>20 inches) snags and down logs generally increases with stand age (fig. 51), as shown below:

Stand age in years	Snags		Down wood	
	Diameter classes			
	5 to 19 in	≥20 in	3 to 19 in	≥20 in
	Mean trees/acre		*Mean logs/acre*	
1 to 50	11.1	1.0	253.1	15.5
51 to 100	17.7	1.4	213.0	6.7
101 to 150	25.3	3.2	220.4	7.2
151 to 200	23.7	4.3	195.7	11.1
201 to 250	19.6	5.6	220.3	13.0
251 to 300	13.8	5.2	186.6	16.4
300 plus	16.2	7.0	196.1	26.9
Total	16.7	2.0	225.1	10.9

Large snags ranged from a mean of 1 tree per acre in young stands to 7 trees per acre in stands older than 300 years. In contrast, young stands appear to start out with a higher level of large down wood, which is most likely a remnant from a stand-initiating event (e.g., fire or harvest). Stands 51 to 100 years old had about half the density of large down wood that younger stands had, which increased to as many as 26.9 logs per acre in very old stands.

Interpretation

Dead wood accumulates in different patterns across the wide variety of forest types in Oregon, creating a mosaic of habitats and fuels across the landscape. Many factors influence the size, abundance, and stage of decay of dead wood. The higher fuel loading observed in western Oregon forests is likely due in part to the higher overall primary productivity rates west of the Cascades. These heavier fuel loads may suggest that forests in western Oregon represent a greater fire hazard than those on the east side, but the moist climatic conditions on the west side tend to temper the effect of large accumulations of fuels.

In general, wildlife species that use dead wood for nesting, roosting, or foraging prefer larger diameter logs and snags (>20 inches). Although we tallied dead wood in this size class throughout Oregon, the estimated density may not be sufficient for some wildlife species. For

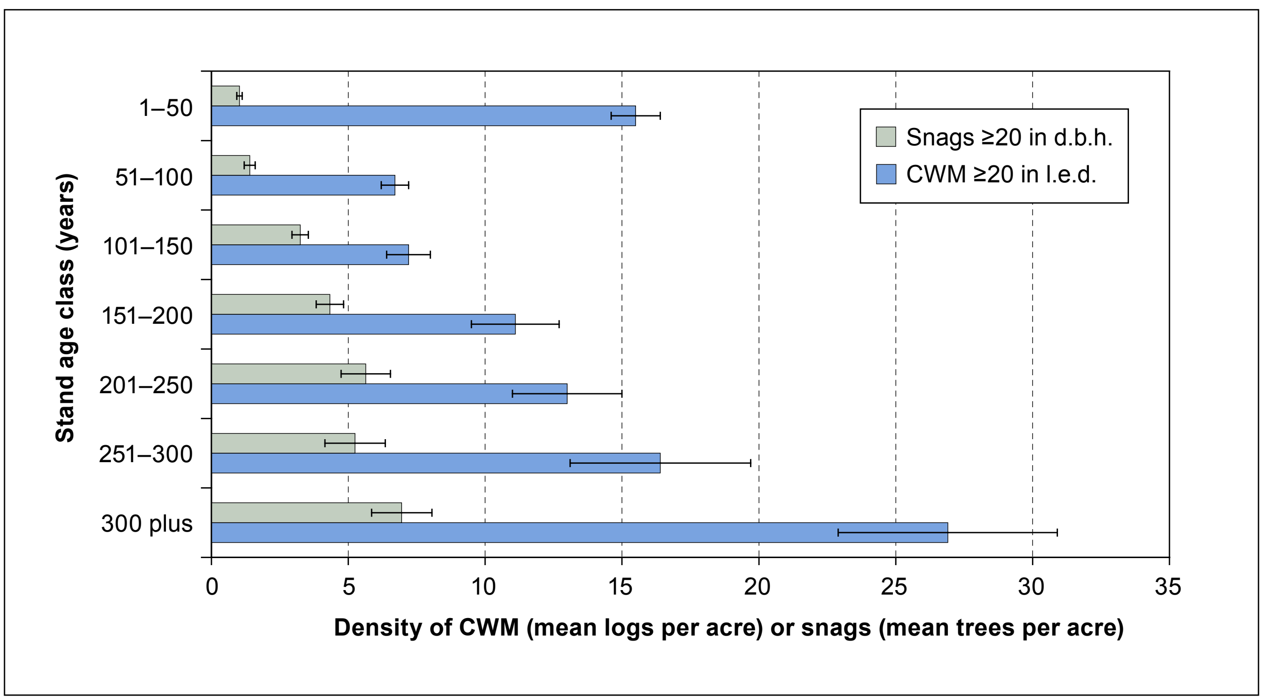


Figure 51—Mean density of large-diameter (≥20 in) coarse woody material (CWM) and snags by stand age class on forest land in Oregon, 2001–2005; d.b.h. = diameter at breast height; l.e.d. = large end diameter.

example, inventory results show a mean of almost 3 snags per acre in this size class in western Oregon and 1 per acre in eastern Oregon. This may indicate that large-diameter snags are currently uncommon in Oregon habitat and that management may be necessary to produce a greater density of large snags.

Various types of disturbance can radically change the attributes of a forest by shifting the balance of live and dead trees or FWM and CWM. Biologists and land managers may want to monitor these changes to determine whether the density, size distribution, and decay characteristics of dead wood are adequate for local management objectives, such as managing for the needs of a particular wildlife species. In addition, understanding the amount of biomass and carbon stored in dead wood will allow us to address requests pertaining to global carbon cycles.

There is a substantial amount of information about dead wood in FIA databases and summary tables that can be used for a more indepth analysis of this resource, including estimates of density, biomass, volume, and carbon for all dead wood components.

Dead Wood Tables in Appendix 2

Table 27—Estimated average biomass, volume, and density of down wood on forest land, by forest type group and diameter class, Oregon, 2001–2005

Table 28—Estimated biomass and carbon mass of down wood on forest land, by forest type group and owner, Oregon, 2001–2005.

Table 29—Estimated average biomass, volume, and density of snags on forest land, by forest type group and diameter class, Oregon, 2001–2005

Table 30—Estimated biomass and carbon mass of snags on forest land, by forest type group and owner, Oregon, 2001–2005

Riparian Forests[5]

Background

Riparian forests are forested areas adjacent to streams, lakes, and wetlands (fig. 52). Riparian forests typically make up a small portion of the total land base, but they play a very important role in maintaining the health and function of a watershed. The composition and structure of riparian forests tend to be different from those of upland forests, and thus these forests provide a unique habitat for many plant and wildlife species. Riparian forests help stabilize streambanks, reduce sediment inputs, and provide shade, nutrients, and large woody debris to the water body. Because of the critical role of riparian forests for fish and wildlife habitat and water quality, agencies have prescribed specific management rules on riparian areas, including requiring retention of certain levels of vegetation and restricting harvest and forest operations.

In this report, we examine the extent and attributes of riparian forests, defined as accessible forest land within 100 feet of a permanent water body, including rivers, streams, lakes, marshes, and bogs. Distance from each subplot center to permanent water features was estimated in the field by FIA crews.

Findings

Regional distribution of riparian forest area and volume—
On average, riparian forests cover an estimated 7.1 percent of all forest land area and hold 9.8 percent of the net volume of live trees in the state. The abundance of riparian forest differs dramatically within the state (fig. 53). In western Oregon, 10.4 percent of the total forest area is estimated to be riparian forest, whereas 3.7 percent of forest in eastern Oregon is estimated to be riparian. Riparian forests account for about 11.0 and 6.0 percent of the total net volume of the west and east sides of the state, respectively (fig. 54).

[5] Author: Vicente Monleon.

Figure 52—Riparian forests along the Metolius River, central Oregon.

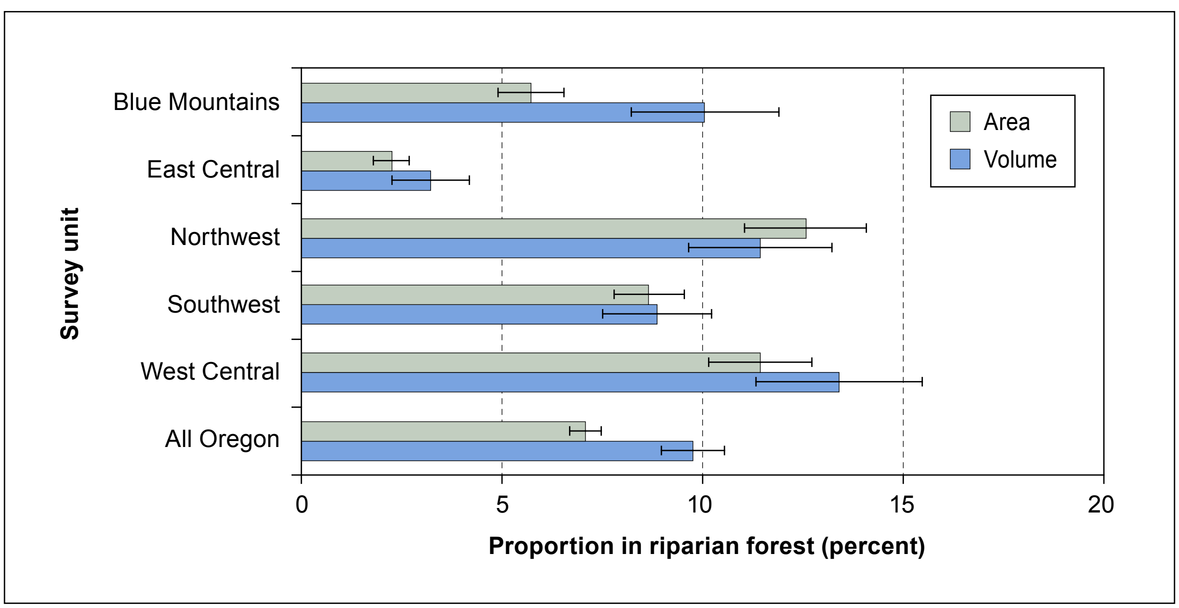


Figure 53—Riparian forest land area and net tree volume, as a percentage of forest land area and volume, by survey unit in Oregon, 2001–2005.

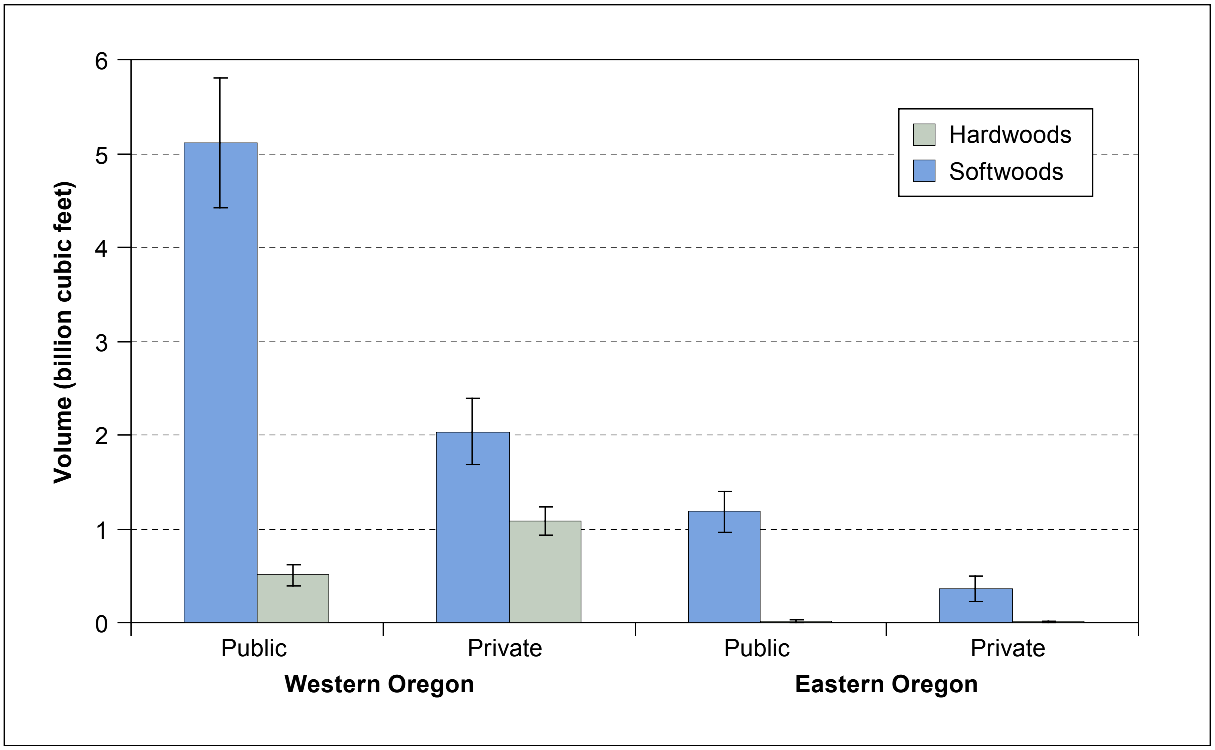


Figure 54—Net tree volume in riparian forests by region, ownership, and species group in Oregon, 2001–2005.

Across the state, riparian forests tend to hold a greater timber volume per unit area than upland forests. However, most of this difference may be attributed to eastern Oregon's drier climate, which may limit the most productive forests to areas next to streams. Below is the estimated mean net volume density of live trees in western and eastern Oregon:

	Riparian forests		Upland forests	
Region	**Volume density**	**SE**	**Volume density**	**SE**
	Cubic feet per acre			
Western Oregon	5,499	369	5,189	138
Eastern Oregon	2,750	319	1,674	55
Total	4,773	295	3,367	75

Ownership and species composition of riparian forests—In relative terms, the extent and net volume of riparian forests is greater on private than on public land. On private forest lands, 7.9 percent of the area and 13.4 percent of the timber volume is estimated to be in riparian areas, whereas on public lands, 6.6 percent of the area and 8.6 percent of the volume is estimated to be in riparian areas. This difference may result from a greater private ownership of valley bottoms and a greater proportion of private land in western Oregon, where riparian forests are more abundant.

Riparian forests account for an estimated 20.1 percent of the total net volume of hardwood species, but only 8.9 percent of the total net volume of softwood species. The difference is even greater on private lands, where 24.7 percent of the net volume of hardwood species occurs within riparian forests. Although hardwood species are more abundant on average in riparian forests than in upland forests, softwood species dominate riparian areas and account for most of the tree volume. The net timber volume of hardwood species is estimated to be 15.7 percent of the total volume in riparian forests, but only 6.4 percent of the total volume in upland forests (standard errors are 1.8 and 0.3, respectively).

Interpretation

The distribution of riparian forests follows the broad climatic patterns of the state. Riparian abundance and net volume are much greater in the moister northwestern region than in the drier eastern region. Climatic pattern may also explain some of the differences in structure and productivity between riparian and upland forests, such as the difference in volume per unit area and proportion of hardwood species. Currently, riparian forests are subject to special management regulations. Data collected by FIA may be used to examine the effectiveness and impact of those regulations at a broad scale. However, detailed information for small areas may be limited by the small sample size. Further, FIA does not collect information about stream characteristics, such as fish use, that may be important for evaluating existing regulations.

Riparian Forests Tables in Appendix 2

Table 31—Estimated area and net volume of live trees on riparian forest land, by location, Oregon, 2001–2005

Table 32—Estimated area of riparian forest land, by forest type group, owner, and location, Oregon, 2001–2005

Table 33—Estimated net volume of live trees on riparian forest land, by species group, owner, and location, Oregon, 2001–2005

Tree Crowns, Soil, and Understory Vegetation[6]

Background

This section highlights three important FIA forest health indicators, tree crowns, soil, and understory vegetation. All are ecologically important as structural components in forest ecosystems. For example, the amount and vertical layering of different plant life forms (e.g., trees, shrubs, forbs, or grasses) are key determinants of wildlife habitat, fire behavior, erosion potential, and plant competition (MacArthur and MacArthur 1961, National Research Council Committee 2000). Tree-crown density, transparency, and dieback are indicators of tree vigor, impacts from disease or other stressors, and potential for mortality (Randolph 2006). Soil structure and nutrient status contribute to the diversity and vigor of vegetation across Oregon (Franklin and Dyrness 1973). Because soil development is a slow process (Jenny 1941), protecting soil from erosion, compaction, and nutrient loss is crucial to sustaining forest products and ecosystem services.

The FIA crews visually estimated crown density, foliage transparency, and dieback on phase 3 plots across Oregon. Crown density is the percentage of the area within an outline of a full crown that contains branches, foliage, and reproductive structures when viewed from the side. Transparency is the percentage of the live foliated portion of the tree's crown with visible skylight. Crown dieback is the percentage of the foliated portion of a crown consisting of recent branch and twig mortality in the upper and outer portions of the crown (Randolph 2006).

Soils also were sampled on phase 3 plots for both physical and chemical properties (fig. 55) (O'Neill et al. 2005). Crews recorded forest floor thickness, soil texture, and indicators of erosion and soil compaction. Soil samples were sent to a laboratory and analyzed for moisture content, percentage coarse fragments, bulk density, carbon (C) and N content, pH, and the amounts of extractable phosphorus (P), sulfur (S), manganese, iron, nickel, copper, zinc, cadmium, lead, as well as exchangeable levels of sodium, potassium, magnesium, calcium, and aluminum.

Crews sampled understory vegetation on each phase 2 FIA subplot on forest land. Total cover was estimated for tree seedlings and saplings <5 inches d.b.h., shrubs, forbs, and graminoids. Total cover of all four of these life forms and of bare mineral soil also was estimated. Crews also collected information on dominant plant species; those data are presented in other sections of this report.

The full functionality of these indicators cannot be fully realized with these first 5 years of data, and so the current status of each indicator is summarized only briefly below, to establish baselines for Oregon's forests and to educate clients about the development of FIA forest health indicators. A major benefit of these indicators is that they will enable future tracking of deviations from baseline conditions.

[6] Authors: Glenn Christensen, Joseph Donnegan, and Andrew Gray.

Joseph Donnegan

Figure 55—Forest soils are sampled with a soil coring device driven by an impact hammer.

Findings

Crown density ranged from 31 to 50 percent among species groups, with a mean of 43 percent. Mean foliage transparency was 21 percent and was greater for hardwoods than for softwoods (fig. 56). Recent crown dieback was detected in only 2.1 percent of the trees examined. Only three species groups had more than 5 percent of all trees with more than slight (i.e., 10 percent) crown dieback: western hardwoods (mostly mountain mahogany, with 21 percent of all trees having more than 10 percent dieback), other western softwoods (mostly western juniper, with 13 percent), and Engelmann and other spruces (with 6 percent).

Carbon and N in the top 7.9 inches of soil were positively correlated ($r^2 > 0.74$) with one another. Their abundance differed greatly across the state and was not significantly related to elevation, latitude, or soil moisture (figs. 57 and 58). Visual signs of soil compaction were evident on 34 percent of the plots in a variety of forests across Oregon (fig. 59). The mean compacted area for those plots was 9 percent. Bulk density was not significantly related to compaction on plots (logistic regression and chi square test), possibly because bulk density is sampled off the plot, whereas evidence of compacted trails, ruts, and other areas is visually assessed on the plot. Bare soil cover was greatest in the drier areas, particularly the south-central portion of the state.

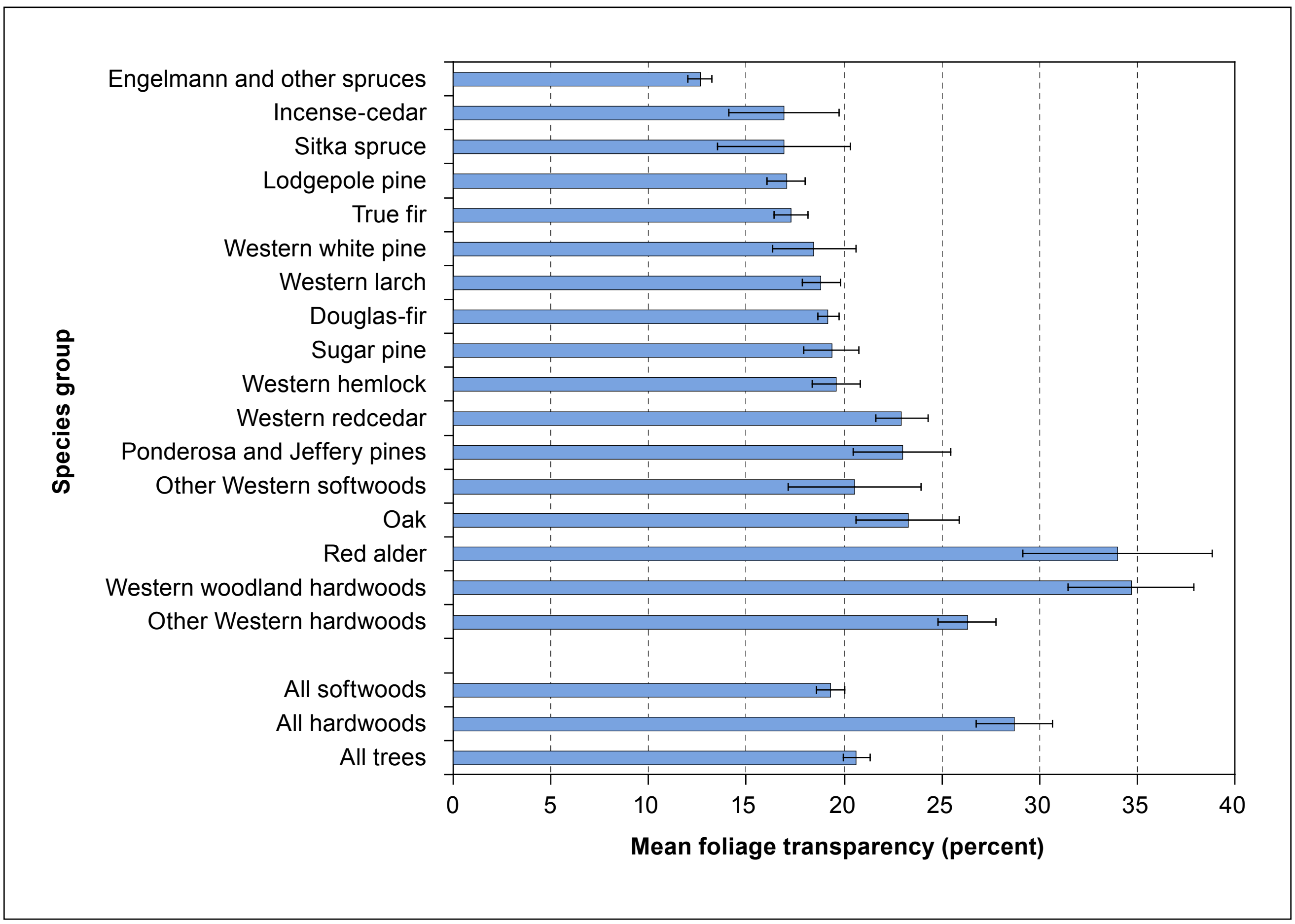


Figure 56—Mean foliage transparency by species group on forest land in Oregon, 2001–2005.

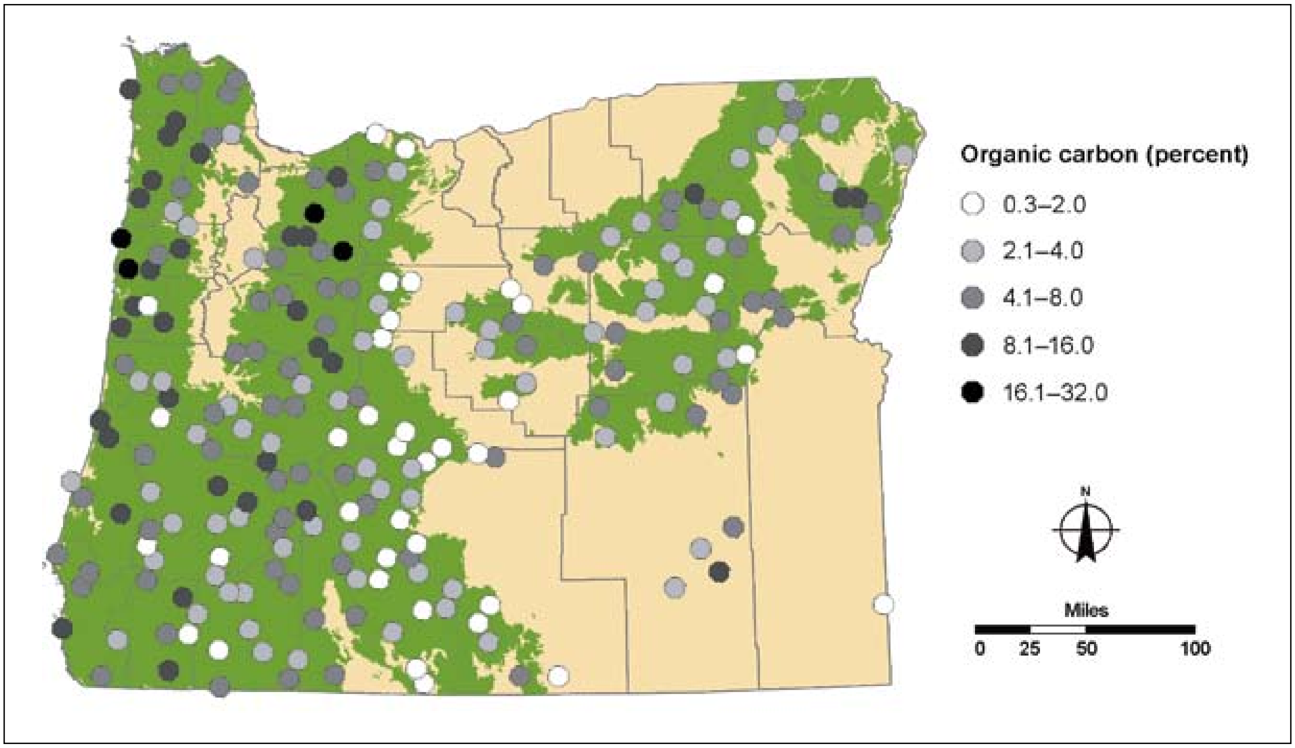


Figure 57—Distribution of soil carbon on forest land in Oregon, 2001, 2003–2005 (forest/nonforest geographic information system layer: Kagan and Caicco 1992).

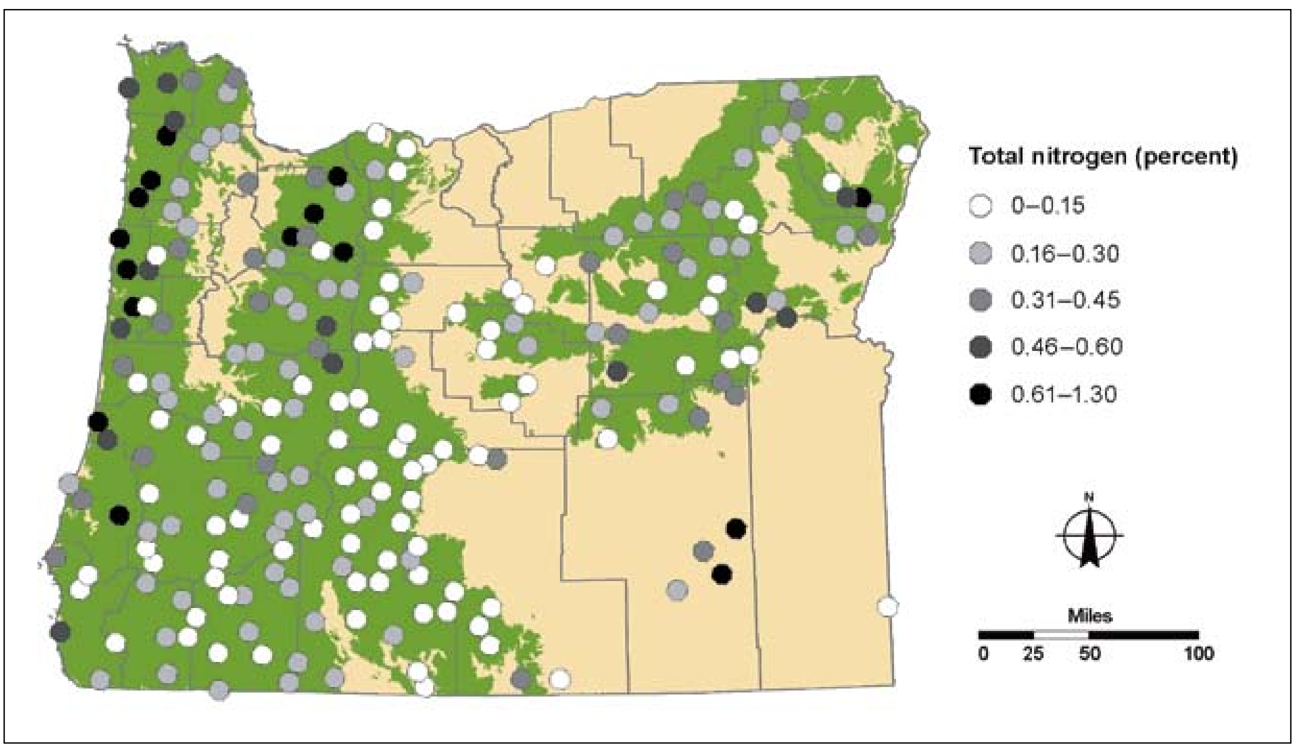


Figure 58—Distribution of soil nitrogen on forest land in Oregon, 2001, 2003–2005 (forest/nonforest geographic information system layer: Kagan and Caicco 1992).

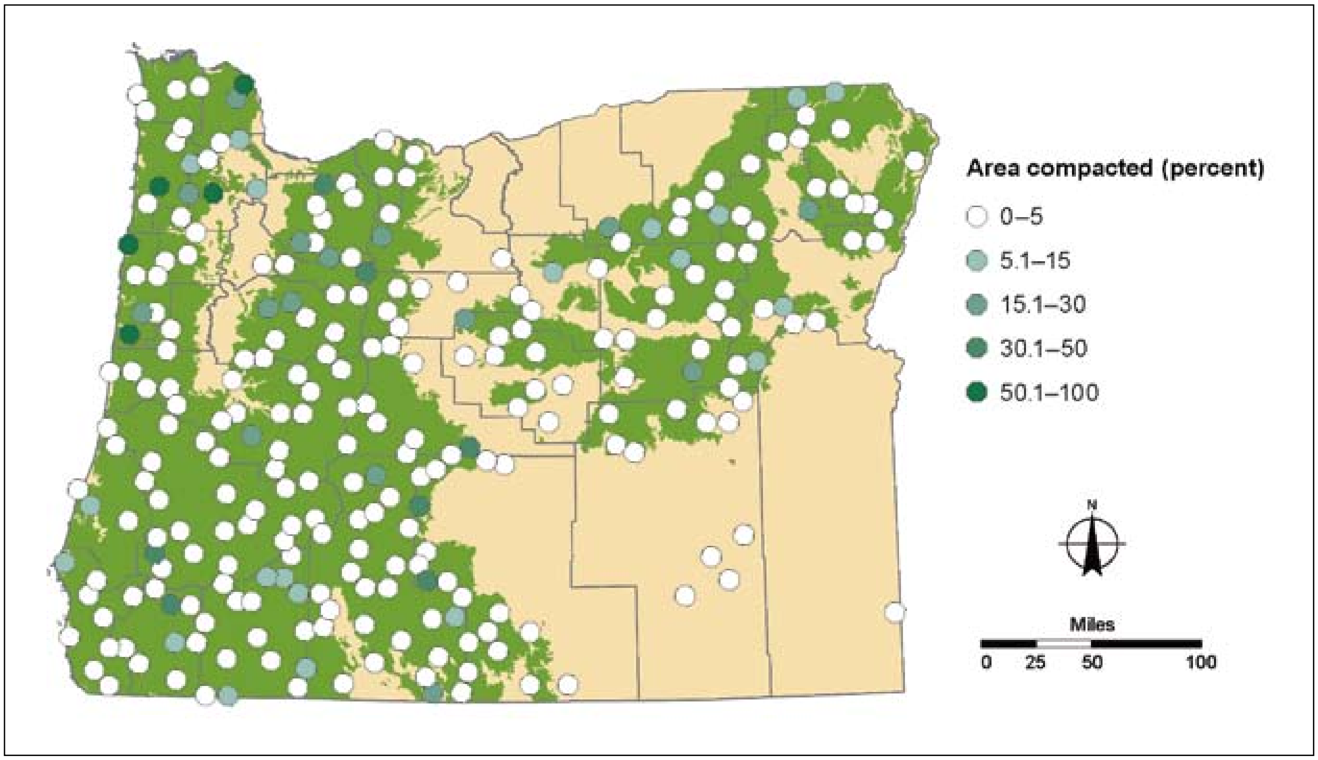


Figure 59—Evidence of compaction on forest land in Oregon, 2001, 2003–2005 (forest/nonforest geographic information system layer: Kagan and Caicco 1992).

Cover of understory vegetation in Oregon was greater in hardwood forests than in softwood forests (fig. 60). Within each type, shrub cover was highest in the higher-moisture forest type groups: elm and alder/maple, and Douglas-fir and hemlock/spruce (fig. 61). Graminoid cover was generally highest in the drier oak and pine groups. Forb cover was greatest in the hemlock and alder/maple groups. Understory cover declined initially with increasing age class (primarily owing to declines in shrub cover), but was quite similar among stands over 40 years of age (fig. 62).

Interpretation

Initial results suggest crown decline is not widespread in Oregon, with most dieback found on dry forest types in the southeastern part of the state. Future remeasurements will provide more-precise estimates of changes in crown health over time.

The abundance of C and N was correlated but highly variable across the forests of Oregon. Soils high in organic C are generally associated with higher levels of microbial activity and of key nutrients, including N, S, and P (Mengel et al. 2001). Soils in wet, cool environments tend to be high in organic C, although this pattern was not clear in the data collected to date. Soil compaction was widely dispersed. Compaction can be caused by heavy machinery, repeated use of vehicles, and trampling by humans or livestock; can inhibit plant growth by decreasing soil pore space; and can lead to increased erosion during high-precipitation events.

The amount and composition of understory vegetation differed greatly among the forest types and forest age classes of Oregon. Although all life forms were represented in all forest types to some extent, their abundance appeared to differ according to forest type. Shrubs and graminoids

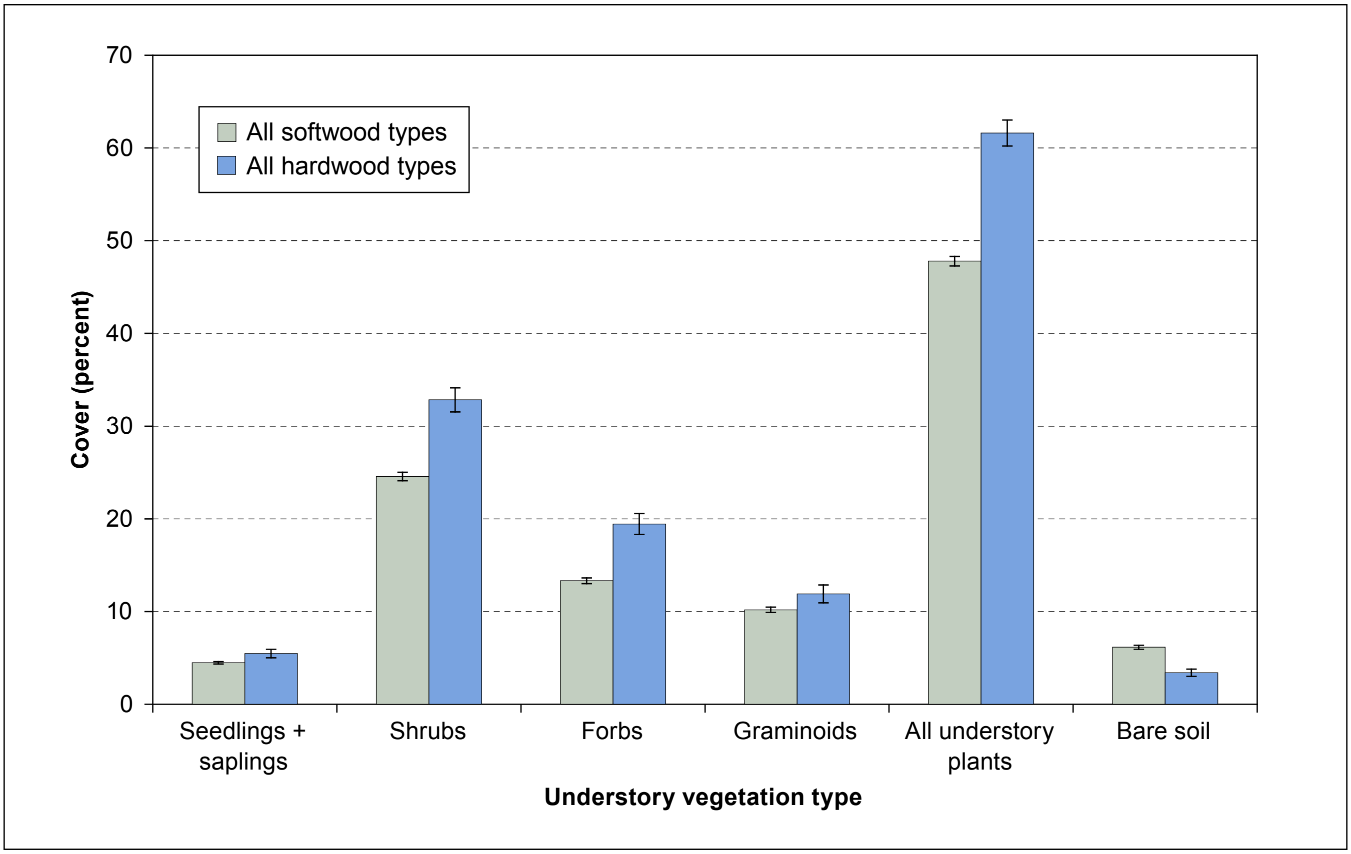


Figure 60—Cover of vegetation life forms and bare soil by hardwood or softwood forest type group on forest land in Oregon, 2001–2005.

Figure 61—Dense understory cover of forbs and shrubs in a Douglas-fir forest.

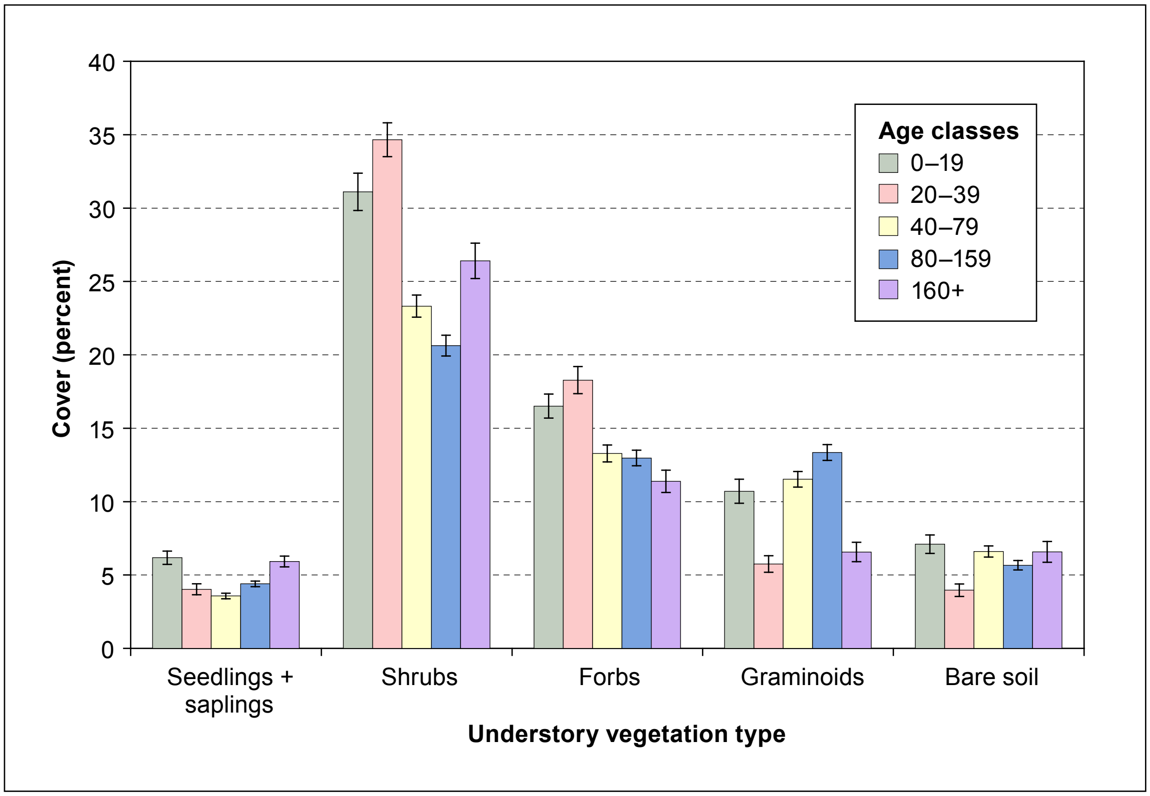


Figure 62—Cover of vegetation life forms and bare soil, by forest age class in Oregon, 2001–2005.

appeared to be particularly sensitive to the overstory tree type (softwood or hardwood) as well as moisture availability within different forest type groups. Although vegetation abundance differed with age class, the conventional wisdom that dense young forests have very low cover of understory plants does not appear to be valid across Oregon.

Crown, Soil, and Understory Vegetation Tables in Appendix 2

Table 34—Estimated mean crown density and other statistics for live trees on forest land, by species group, Oregon, 2001–2005

Table 35—Mean foliage transparency and other statistics for live trees on forest land, by species group, Oregon, 2001–2005

Table 36—Mean crown dieback and other statistics for live trees on forest land, by species group, Oregon, 2001–2005

Table 37—Properties of the forest floor layer on forest land, by forest type, Oregon, 2001, 2003–2005

Table 38—Properties of the mineral soil layer on forest land, by depth of layer and forest type, Oregon, 2001, 2003–2005

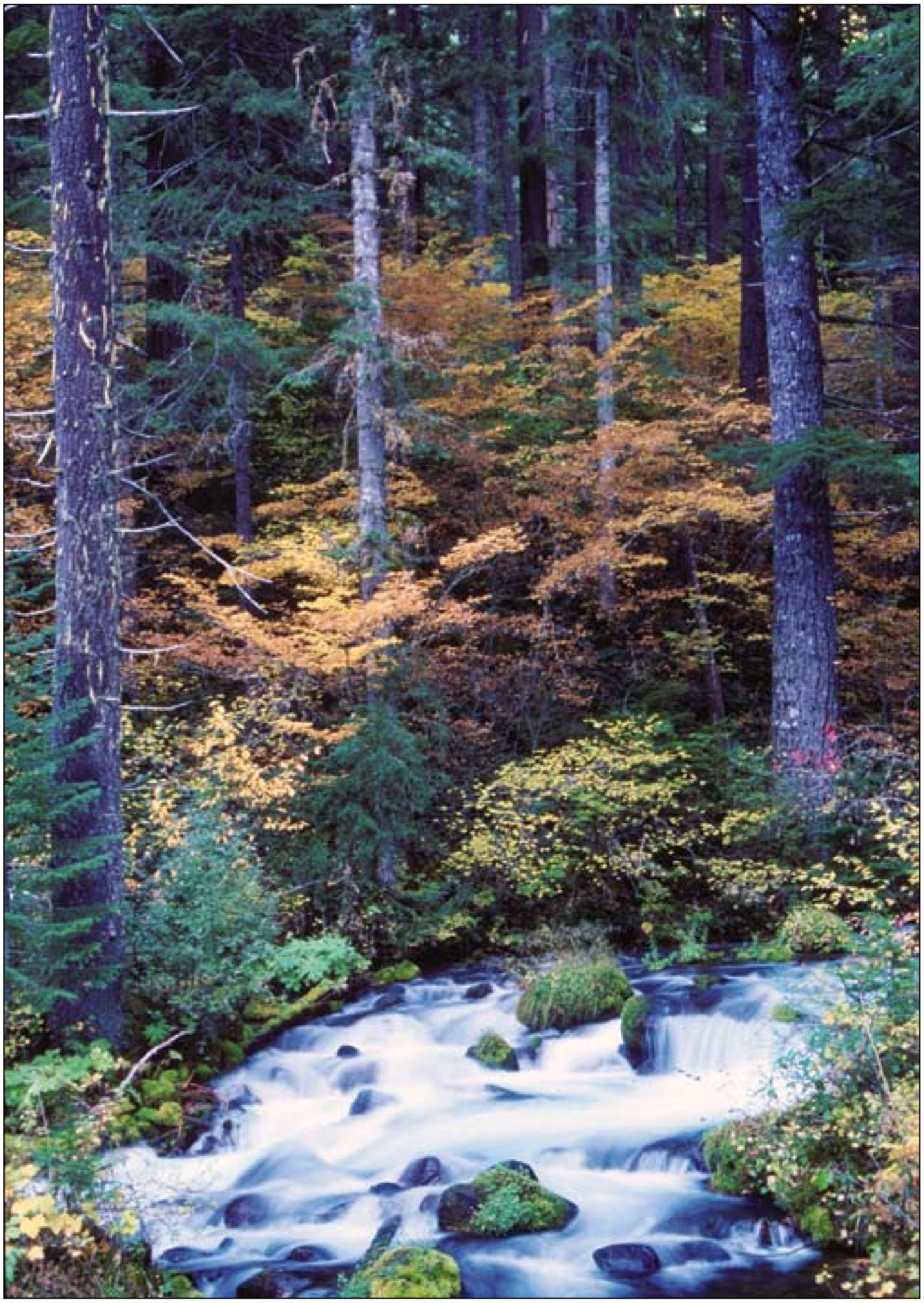
Table 39—Chemical properties of mineral soil layers on forest land, by depth of layer and forest type, Oregon, 2001, 2003–2005.

Table 40—Chemical properties (trace elements) of mineral soils on forest land, by forest type, Oregon, 2001, 2003–2005

Table 41—Compaction, bare soil, and slope properties of forest land, by forest type, Oregon, 2001, 2003–2005

Table 42—Mean cover of understory vegetation on forest land, by forest type group and life form, Oregon 2001–2005

Table 43—Mean cover of understory vegetation on forest land, by forest type class, age class, and life form, Oregon, 2001–2005



Tom Iraci

Willamette National Forest.

Chapter 5: Disturbance and Stressors

Major disturbance agents and stressors such as insects, diseases, invasive plant species, air pollution, and fire are among the most powerful influences on the structure, species composition, and ecological function of forests. We explore the influence of these agents through analysis of both Pacific Northwest Forest Inventory and Analysis (PNW-FIA) plot data and predictive risk models.

Data in this chapter address Montréal Process criterion 3 and indicators pertaining to maintenance of forest ecosystem health and vitality.

Data in this chapter also address Oregon indicator F pertaining to protecting, maintaining, and enhancing the health of Oregon's forests within a context of natural disturbance and active management.

Insects, Diseases, and Other Damaging Agents[1]

Background

Insects, diseases, and other damaging agents can have both detrimental and beneficial effects on forest ecosystems (fig. 63). The frequency and severity of damage to trees by biotic agents, such as insects or diseases, or abiotic agents, such as fire or weather, are influenced by a number of factors, ranging from the existing composition and structure of the forest to management policies and activities (Hessburg et al. 1994). Effects from damaging agents include defoliation, decay, reduced growth, increased susceptibility to other

[1] Authors: Sally Campbell and David Azuma.

Figure 63—Dwarf mistletoe on lodgepole pine in eastern Oregon.

stressors (e.g., other insects and diseases or drought), and mortality. These impacts can affect ecosystem structure, composition, and function. Introduced insects and diseases such as balsam woolly adelgid (*Adelges piceae* (Ratzeburg)) or white pine blister rust (*Cronartium ribicola* Fisch.) often have more rapid and intense impacts than native organisms.

The PNW-FIA Program collects data on damaging agents for each measured live tree, and also maps root disease, if present, on each plot. These ground-based data complement localized ground surveys and the annual aerial survey conducted by the Oregon Department of Forestry (ODF) and the Forest Health Protection (FHP) Program of the U.S. Forest Service; the aerial survey maps defoliation and mortality observed from the low-altitude flights. The FIA plot-based sampling protocol allows estimation of acres, trees per acre, basal area, and volume affected by each agent or agent group for forest types and for individual tree species. Our information on damaging agents is most reliable for those that are common and broadly distributed; it is less reliable for unevenly distributed, less common agents such as newly established nonnative pests.

Findings

About 27 percent of live trees greater than 1 inch in diameter showed signs or symptoms of insects or diseases; damage by animals, weather, or fire; or physical defects such as a dead or missing top, crack, check, fork or crook. Fifteen percent of Douglas-fir and 32 percent of ponderosa pine had some damage recorded. Overall damage levels were higher in eastern Oregon than in western Oregon, and they were higher on public lands than on private lands. More than 15 million acres had greater than 25 percent of forest basal area affected by one or more damaging agents. The volume of live trees ≥5 inches diameter at breast height (d.b.h.) affected by one or more damaging agents was 35.1 billion cubic feet. Root disease and dwarf mistletoe, which cause significant growth loss and mortality, were recorded on 4.4 and 7.5 percent of softwoods, respectively. Of all the biotic agents recorded, these two affected the most volume and area of both softwoods and hardwoods (figs. 64 and 66). For abiotic agents, physical defects affected the most volume and area (fig. 65).

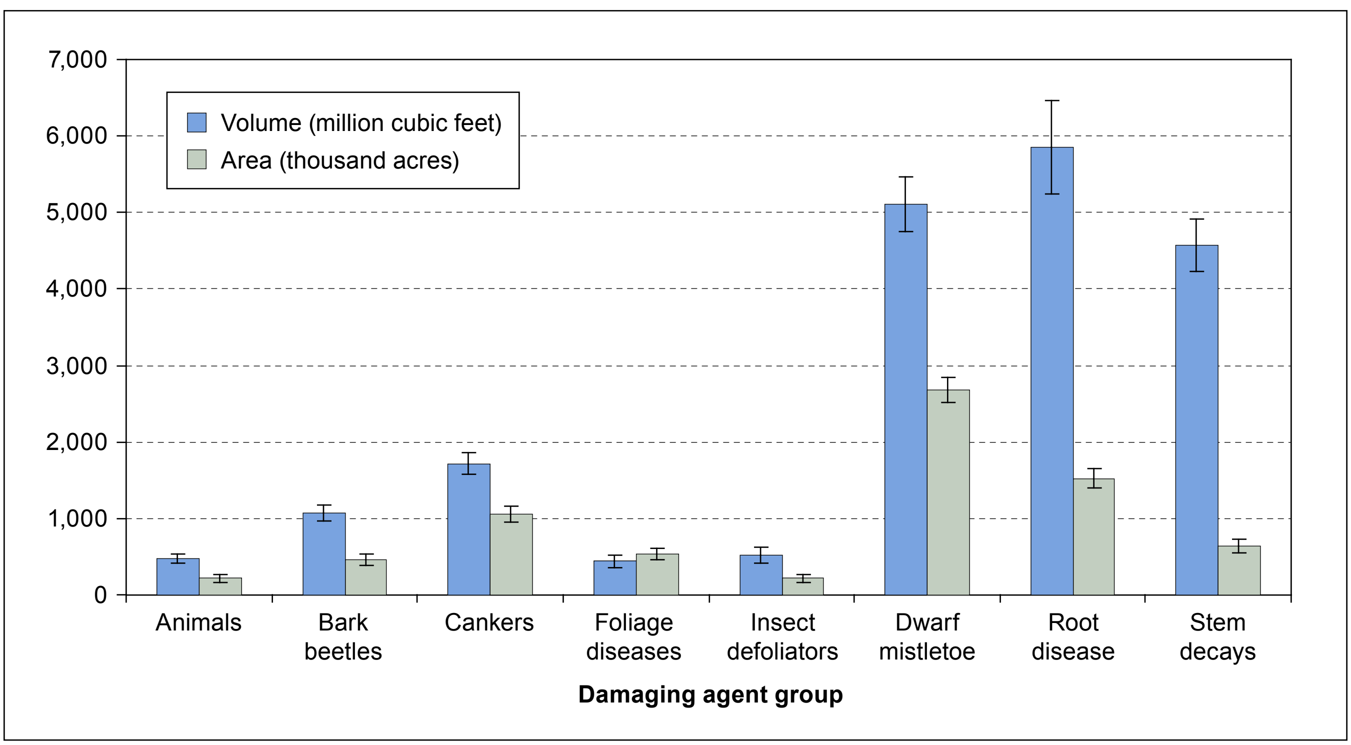


Figure 64—Area and volume of live trees affected by one or more biotic agents on forest land in Oregon, 2001–2005; acres are those with >25 percent of basal area with damage; volume is gross volume of live trees >5 inches diameter at breast height.

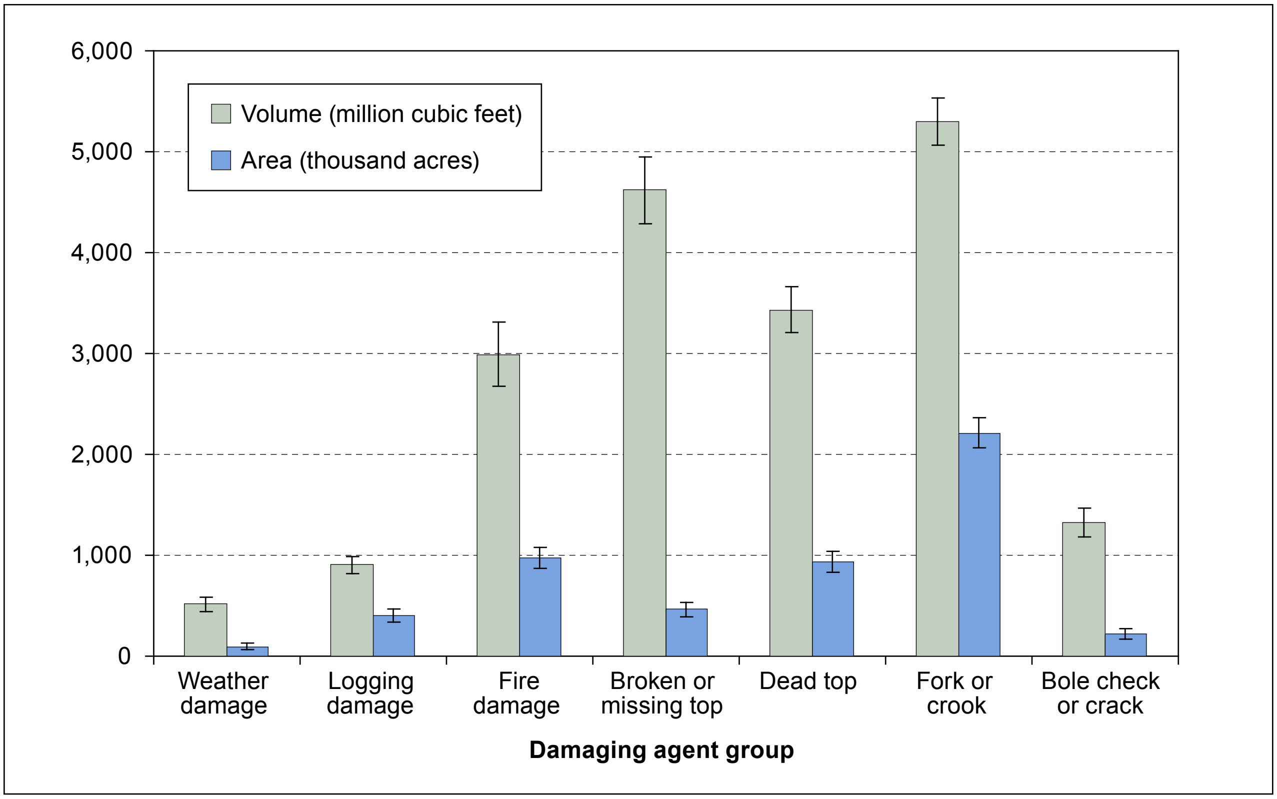


Figure 65—Area and volume of live trees affected by one or more abiotic agents on forest land in Oregon, 2001–2005; acres are those with ≥25 percent of basal area with damage; volume is gross volume of live trees ≥5 inches diameter at breast height.

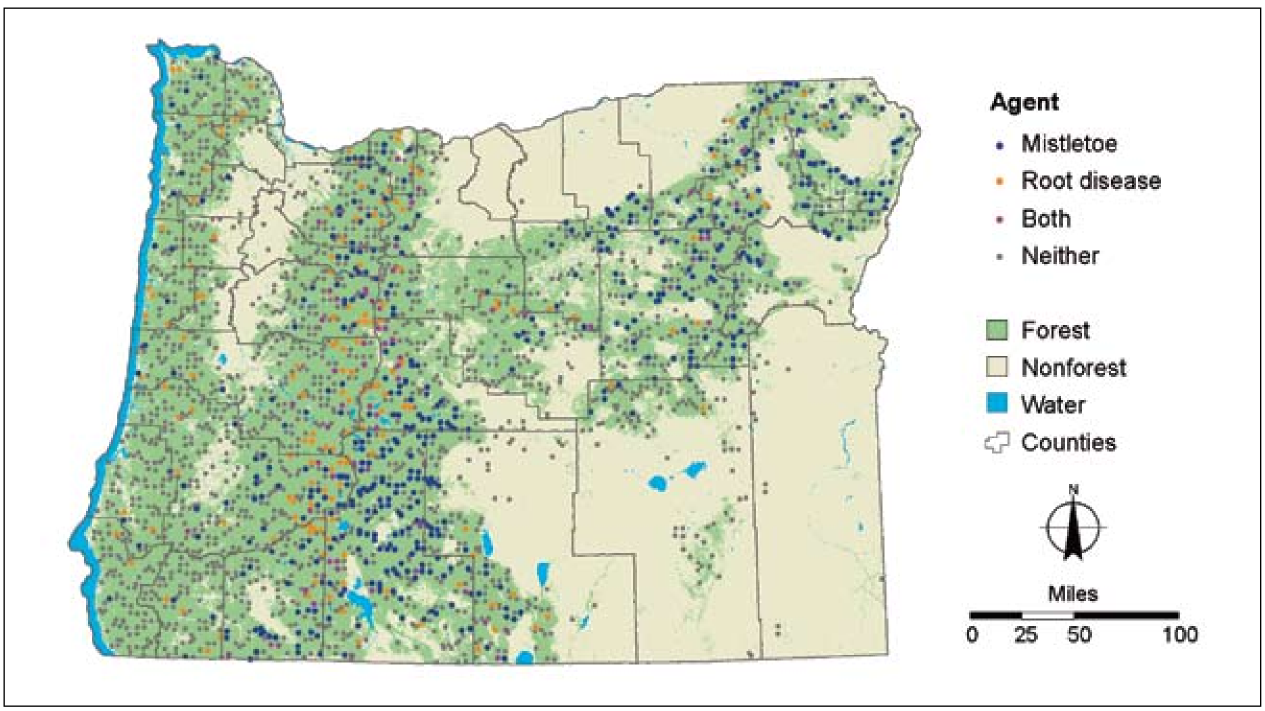


Figure 66—Root disease and dwarf mistletoe incidence on visited Forest Inventory and Analysis plots, Oregon, 2001–2005 (forest/nonforest geographic information system (GIS) layer: Blackard et al. 2008; urban/water GIS layer: Homer et al. 2004).

Compared to the previous periodic inventories (1994–2003), our findings show a smaller percentage of trees, acres, and volume affected by damaging agents:

	Periodic inventory 1994–2003[a]	**Annual inventory 2001–2005**
Percentage of trees >5 inches d.b.h. affected	43	29
Percentage of area with >25 percent basal area affected	64	52
Percentage of volume of trees >5 inches d.b.h. affected	49	33

[a] Dunham, P. 2007. [N.d.]. Incidence of insects, diseases, and other damaging agents on Oregon forests. Manuscript in preparation. On file with: Sally Campbell, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, 620 SW Main, Suite 400, Portland, OR 97205.

Interpretation

Some of the most common biotic (living) agents of forest disturbance, such as dwarf mistletoes and stem decays, are more prevalent in unmanaged or older stands. If the current trajectory of management on federal forests continues, we would expect to see increases in these agents on national forests and other federal lands in the future; conversely, we would expect decreases or continued lower levels on private and nonfederal forests, where stands are younger and more intensively managed. Root disease, often widespread in older stands, may become more damaging in young stands that are established in infested areas. The incidence and impact of many insects and diseases are closely tied to past forest management practices that have influenced forest structure and composition (Campbell and Liegel 1996).

In the near future, the greatest insect or disease threats to Oregon's forests are likely to come from introduced organisms, and also from native species whose populations and impacts are increased by drought, high stand densities, and climate changes (Pimentel et al. 2005). Recent bark beetle epidemics in southern California and British Columbia, are attributed to a number of these factors (British Columbia Ministry of Forests 2006, Pedersen 2003, Walker et al. 2006). Although FIA underrecords bark beetles, insect defoliators, and foliage diseases owing to a number of factors,[2] results of widespread bark beetle epidemics should be observable in future FIA data on tree mortality. Annual aerial surveys can also provide excellent, timely information on insect- and disease-caused defoliation. Tracking the incidence and impact of insects, diseases, and other damaging agents over time will become particularly important as changes in climate and in human activities affect the structure and composition of Oregon's forests.

Insects, Diseases, and Other Damaging Agents Tables in Appendix 2

Table 44—Estimated number of live trees with damage on forest land, by species and type of damage, Oregon, 2001–2005

Table 45—Estimated area of forest land with more than 25 percent of the tree basal area damaged, by forest type and type of damage, Oregon, 2001–2005

Table 46—Estimated gross volume of live trees with damage on forest land, by species and type of damage, Oregon, 2001–2005

Table 47—Estimated number of live trees with damage, acres of forest land with greater than 25 percent of the basal area damaged, and gross volume of live trees with damage, by geographic region and ownership group, Oregon, 2001–2005

[2] These agents are likely underrecorded due to FIA's difficulty in detecting (1) symptoms of bark beetle attack on live trees prior to mortality, (2) defoliation events that are not evenly distributed geographically or temporally and thus are less likely to coincide with FIA plot visits, and (3) damage occurring on upper portions of trees in dense stands.

Invasive Plants[3]

Background

Invasions of nonnative plants into new areas are having a large impact on the composition and function of natural and managed ecosystems. Invasive plants can have a large economic impact, both by changing or degrading land use and through the costs of eradication efforts, now estimated at over $35 billion per year (Pimentel et al. 2005).

Nonnative plant invasions competitively exclude desired species, alter disturbance regimes, and are a primary cause of extinction of native species (D'Antonio and Vitousek 1992, Mooney and Hobbs 2000, Vitousek et al. 1996). Despite their importance, there is little comprehensive information about the extent and impact of invasive species. Most of the emphasis given invasive plants is in the context of local eradication efforts. Comprehensive numbers are not available to describe the magnitude of the problem, which plants are having the most impact, and where these plants are found.

[3] Author: Andrew Gray.

The FIA phase 3 vegetation inventory (Gray and Azuma 2005, Schulz 2003), conducted on a trial basis for several years now, provides a useful source of information on plant composition. In 2000 and 2001, 110 plots were sampled in Oregon with this protocol. Botanists visited plots during mid-summer and recorded all species found or collected samples for later identification. Because the definition of "invasive" can be quite subjective, all species that were listed as nonnative to the United States (USDA Natural Resources Conservation Service 2000) were selected for analysis. Vegetation data collected on the phase 2 (standard inventory) plots were also analyzed by selecting records of nonnative species that were readily identifiable by most crews (i.e., common shrubs or common and distinctive herbs).

Findings

Sixty-nine percent of the plots across Oregon's forest land had at least one nonnative species growing on them. The percentage was highest in some of the eastern Oregon ecosections (e.g., 100 percent of plots in the Blue Mountain foothills) and lowest in the Coast Range (about 47 percent of plots) (fig. 67). Invasive plants were pervasive on forest land

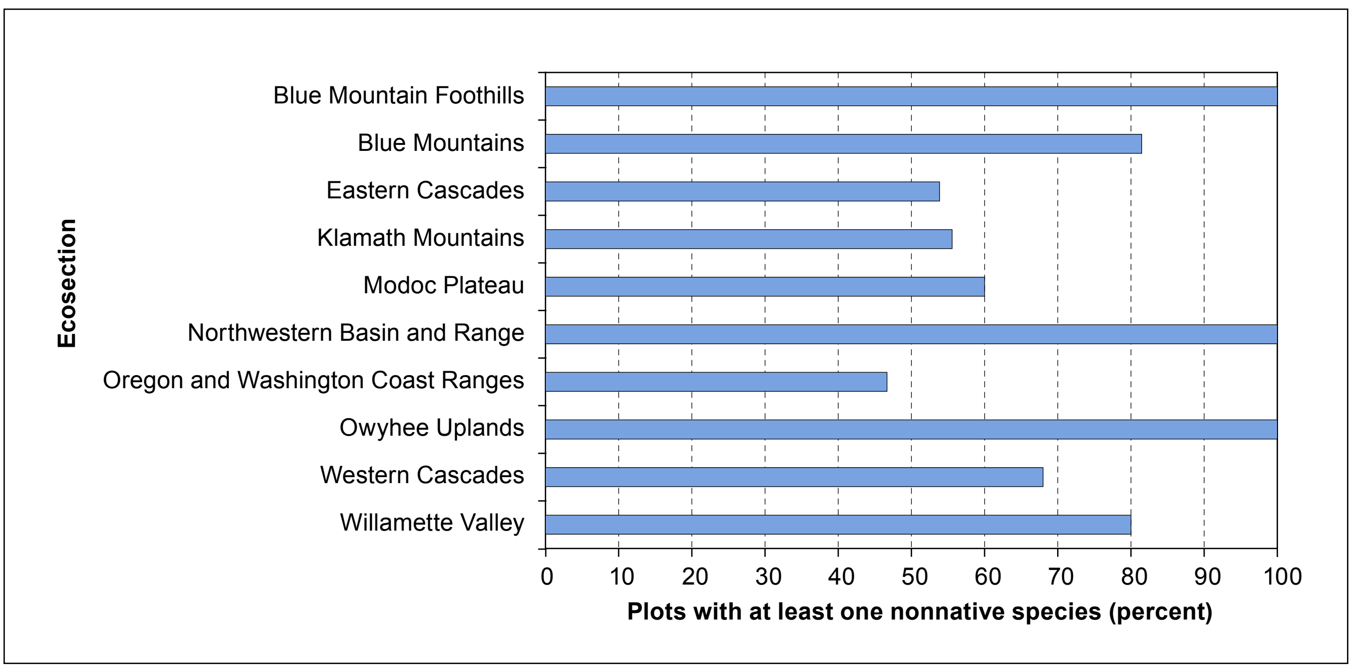


Figure 67—Percentage of plots with at least one nonnative species present by ecosection on forest land in Oregon, 2001–2005.

in the Willamette Valley ecosection, with a surprisingly high mean of 11 nonnative species covering 42 percent of the plot area. The percentage of nonnative species decreased with increasing stand size class (fig. 68). The basic metric proposed by the Heinz Center (2002) for national reporting of the impact of nonnative plants simply sums the cover of nonnative plants and divides by the cover of all plants. For Oregon, this calculation indicates that 6.2 percent of all plant cover on forest land consists of nonnative plants (standard error = 1.2 percent).

The most common invasive plant found on phase 3 plots in western Oregon was Himalaya blackberry (fig. 69), and the most common in eastern Oregon was cheatgrass (see "Scientific and Common Plant Names"). These and some other nonnative species are readily identifiable through long field seasons, so the vegetation records on phase 2 plots provide an estimate of overall abundance on forest land. The area covered by each species on each plot was extrapolated to all forest land with standard inventory statistics. These data suggest that Himalaya blackberry covered 149,000 acres and cheatgrass covered 196,000 acres of forest land in Oregon.

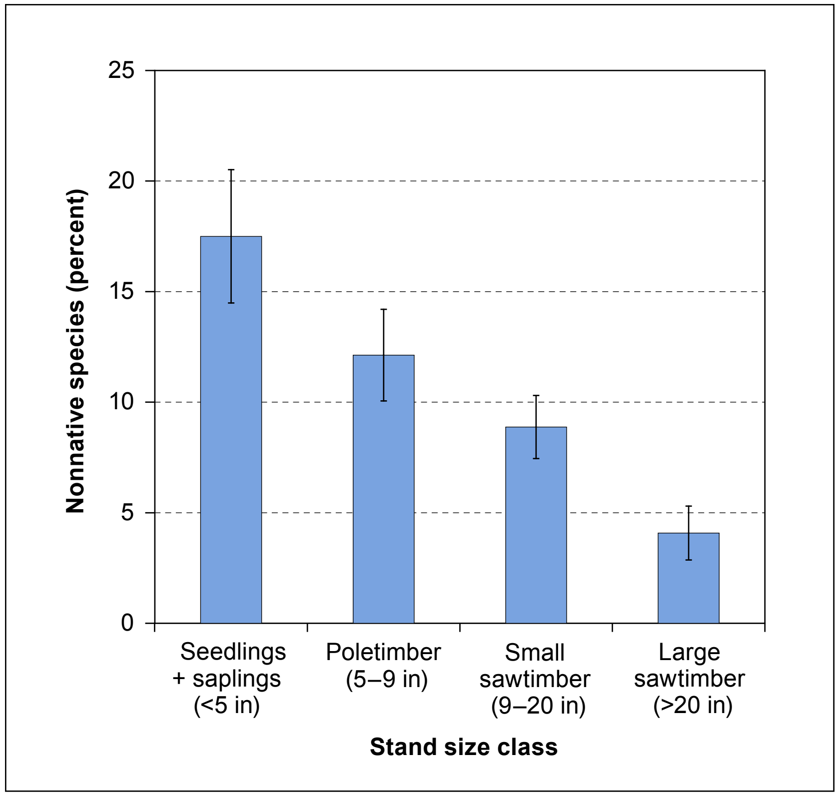


Figure 68—Mean percentage of species on a plot that were nonnative by stand size class on forest land in Oregon, 2001–2005.

Andrew Gray

Figure 69—Himalaya blackberry, the most common invasive plant in forests of western Oregon.

Interpretation

Nonnative invasive plant species already are well established in Oregon's forested lands, making up a significant proportion of the species and plant cover present. Current trends suggest that their importance will increase. For example, species like English holly and false brome (see "Scientific and Common Plant Names") have been rapidly increasing in abundance in western Oregon. Most species tend to be associated with young, recently disturbed stands (Gray 2005), although the two species mentioned above are good examples of those well suited to shady, undisturbed forests. Although FIA's Phase 3 vegetation inventory provides sufficient comprehensive information on species composition to inform national indicators, the plot density is too low to assess distribution of individual species. The FIA phase 2 sample does provide that information for species that are readily identifiable, and potentially for others of specific interest if crews are given dedicated identification training.

Invasive Plants Tables in Appendix 2

Table 24—Index of vascular plant species richness on forest land, by ecological section, Oregon, 2005

Table 48—Estimated area of forest land covered by selected nonnative vascular plant species and number of sample plots, by life form and species, Oregon, 2001–2005

Air Quality[4]

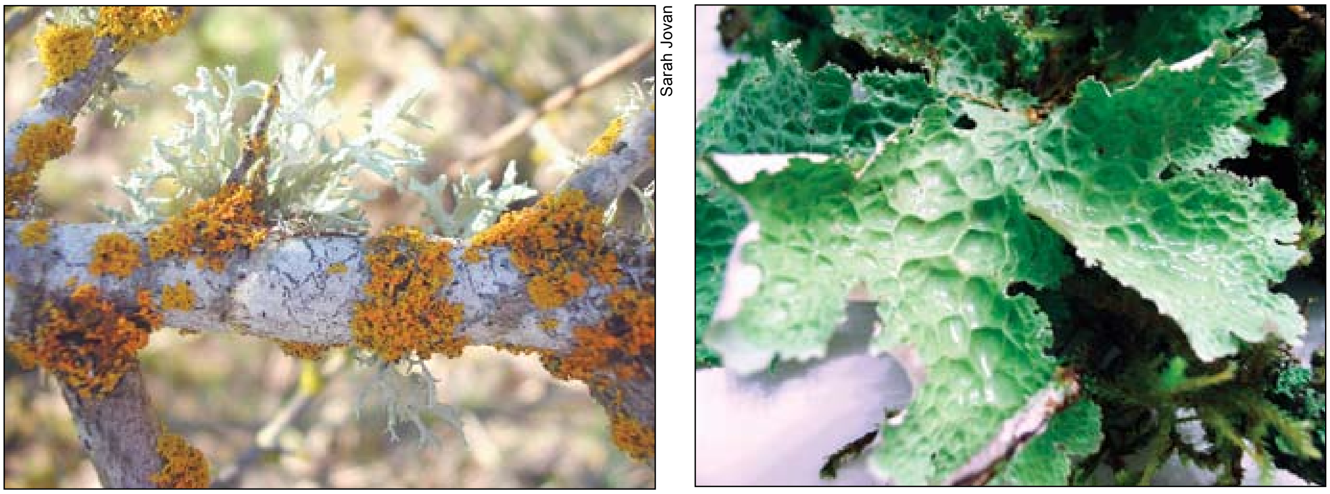
Air quality in many of Oregon's forests is fair to excellent, better than in many other parts of the country. Still, evidence of degraded air quality has been detected in some forests of the Columbia Gorge National Scenic Area (Fenn et al. 2007) and the Willamette Valley, and in those near major urban areas such as Portland and Medford (Eilers et al. 1994, Geiser and Neitlich 2007). Air quality effects on vegetation depend on many factors; among the most important are plant life stage, species, pollutants, site conditions, and degree of exposure. Effects commonly culminate in declines in stand productivity and shifts in community composition when sensitive individuals are damaged or killed. Changes can cascade through the ecosystem, especially if the affected species provide sustenance or habitat for wildlife or other important ecosystem services.

The FIA Program monitors two phase 3 indicators for air quality: (1) injury to ozone (O_3)-sensitive plants (fig. 70), and (2) the composition of epiphytic (i.e., tree-dwelling) lichen communities (fig. 71). Instruments that directly measure air pollutants are sparsely distributed in Oregon's forests (DEQ 2005). Thus, air quality monitoring with indicator species is indispensable, allowing for a spatially comprehensive assessment of risks to forest health across the landscape.

[4] Authors: Sarah Jovan and Sally Campbell.

Sally Campbell

Figure 70—Ozone injury (chlorotic mottle) on Jeffrey pine needles, Columbia Gorge biosite.



Sarah Jovan

Eric Straley

Figure 71—Lichens are well known for their high sensitivity to air quality. Bright orange *Xanthoria polycarpa* (left) is a common indicator of nitrogen pollution in Oregon. *Lobaria oregana* (right) is a typical indicator of clean air.

Ozone Injury Background

Tropospheric (ground-level) O_3 is highly toxic to plants and is considered an important ecological threat to Oregon's forest resources (Eilers et al. 1994). For the FIA O_3 indicator, three or more plant species known for their O_3 susceptibility (bioindicators) are scored for foliar injury at each O_3 plot (biosite). Injury data are combined into a biosite index that is used to predict local potential for O_3 damage (Coulston et al. 2003). Using geospatial interpolation of biosite indices averaged over a number of years, we can predict relative risk to susceptible forest vegetation across a broader geographic area and identify areas where O_3 is more likely to cause injury (Coulston et al. 2003). The FIA biosite network is the only statewide O_3 detection program that uses bioindicators to monitor O_3 impacts to forest vegetation.

Ozone Injury Findings

In contrast to widespread O_3 injury detected on California biosites, no O_3 injury was found on Oregon biosites visited between 2000 and 2005 (fig. 72). This finding is consistent with low measurements from ambient O_3 sampling networks (fig. 73) (DEQ 2005, Eilers et al. 1994). However, at one Washington biosite in the Columbia Gorge about 100 miles east of Portland, planted Jeffrey pine has shown injury 5 of the last 6 years, indicating that phytotoxic O_3 levels are present (Campbell et al. 2007). An assessment of risk using the geospatial interpolation method mentioned above shows very low or no risk to Oregon's forests from O_3.

Ozone Injury Interpretation

All of Oregon's air basins currently meet the national standards for O_3, although projected population increases are expected to result in higher pollutant emissions (DEQ 2005). It is hoped that continued efforts and innovations to abate vehicular and industrial emissions will sustain low O_3 levels. Because the entire biosite network is fully resampled each year, the FIA O_3 indicator will allow us to easily track temporal and geographic fluctuations in O_3 injury.

Lichen Community Background

For the lichen community indicator, surveyors determine the abundance and diversity of epiphytic lichens on phase 3 plots. The FIA Program uses these data for monitoring air quality as well as forest biodiversity (see "Lichen and Plant Biodiversity" section in "Forest Structure and Function" chapter) and climate change (Jovan 2008). With the help of multivariate models, FIA lichen data are used to score air quality at each plot. Two models are used to monitor Oregon's forests: one each for the west and east

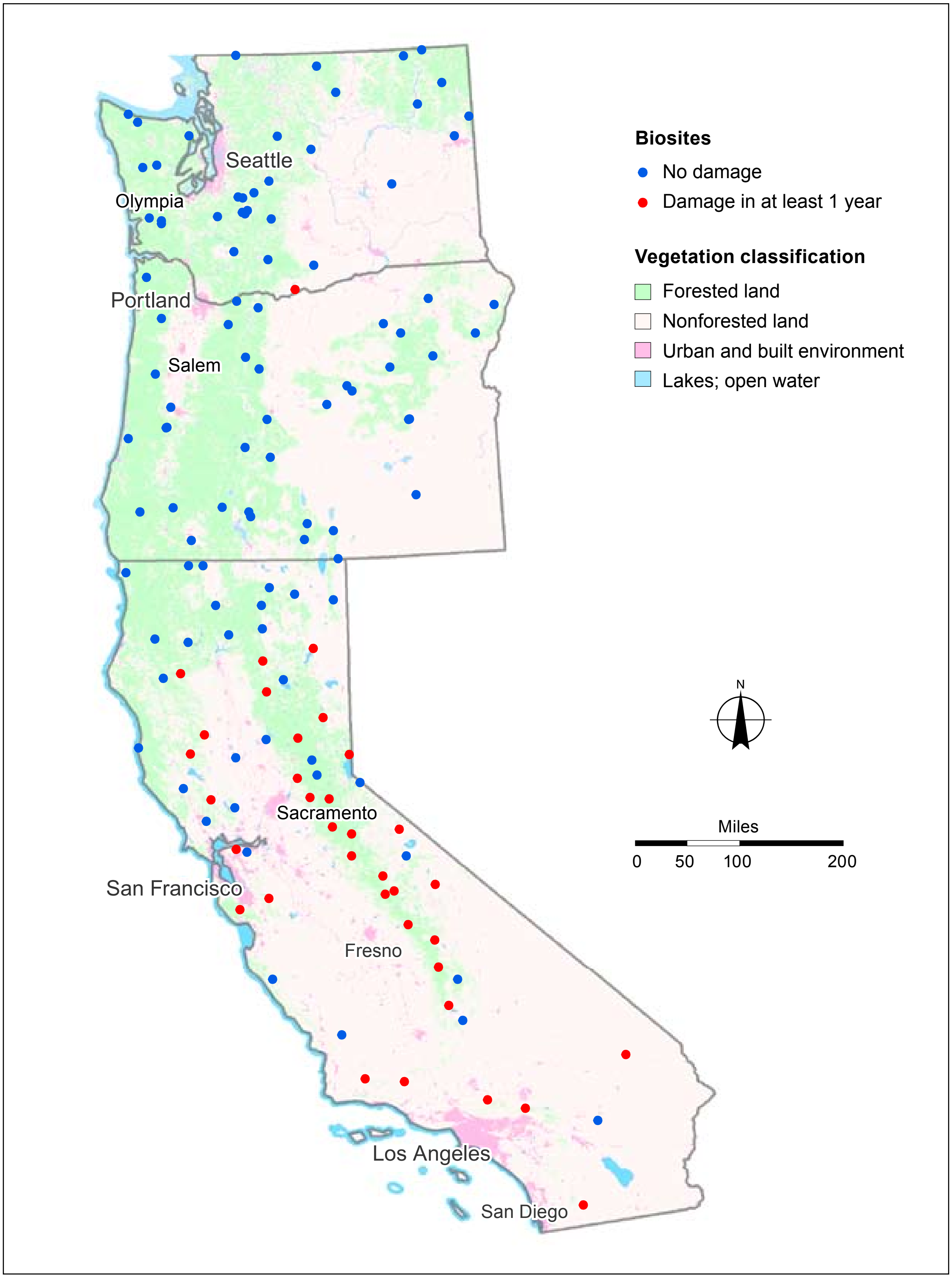


Figure 72—Forest Inventory and Analysis ozone biosites and injury status for forests in Washington, Oregon, and California, 2000–2005 (forest/nonforest geographic information system (GIS) layer: Blackard et al. 2008; urban/water GIS layer: Homer et al. 2004).

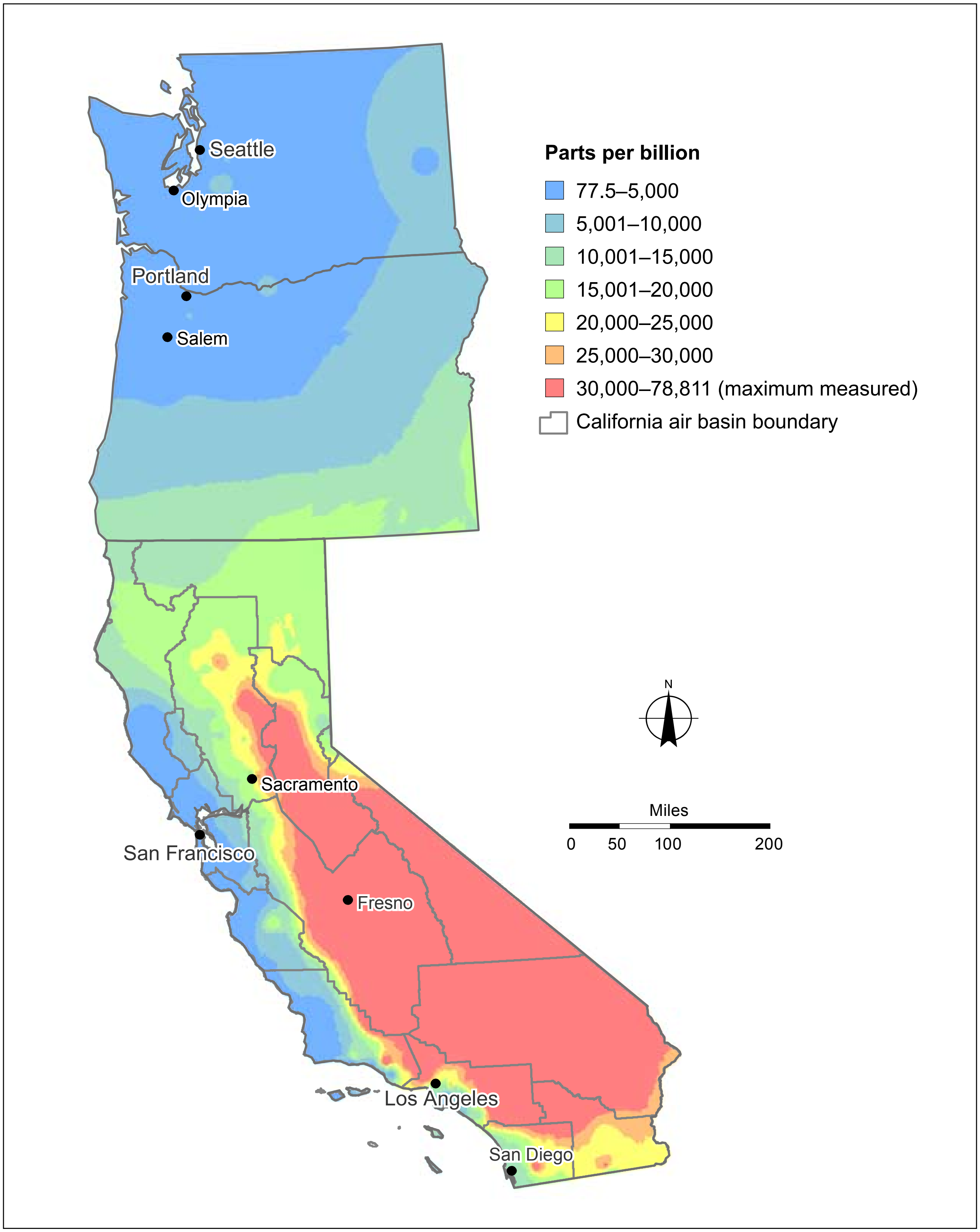


Figure 73—Average ozone exposure in Washington, Oregon, and California, based on cumulative hourly ozone concentrations exceeding 60 parts per billion (SUM60) June 1 to August 31, 8am to 8pm, 2001 to 2005 average (SUM60 ozone data: U.S. Environmental Protection Agency 2006).

sides of the Cascades. The west-side model, as reported here, was developed by Geiser and Neitlich (2007) in collaboration with FIA and the Forest Service's PNW Region, Air Resource Program.

Low air pollution scores suggest lower levels of pollutants and vice-versa. Geiser and Neitlich (2007) made their assessment by (1) examining the distribution of lichen indicator species across plots, (2) laboratory analysis of nitrogen (N) and sulfur (S) accumulation in collected lichens, (3) correlations of scores to pollutant measurements collected at a subset of plots, and (4) land use patterns. Air quality scores are used to delineate six air quality zones, best, good, fair, degraded, poor, and worst.

Lichen Community Findings

Results from 5 years of surveys (1998–2001 and 2003) provide strong evidence that N pollution is having a heavy impact on some west-side forests. Diverse assemblages of pollution-sensitive lichens characterized low-scoring plots, and species that indicate high N levels, known as nitrophytes (fig. 71), were relatively abundant at high-scoring plots (fig. 74). The presence of these lichen communities suggests that the Willamette Valley, much of which is in agricultural or urban land use, is part of a major N hotspot that extends into foothill forests of the Coast and Cascade ranges.

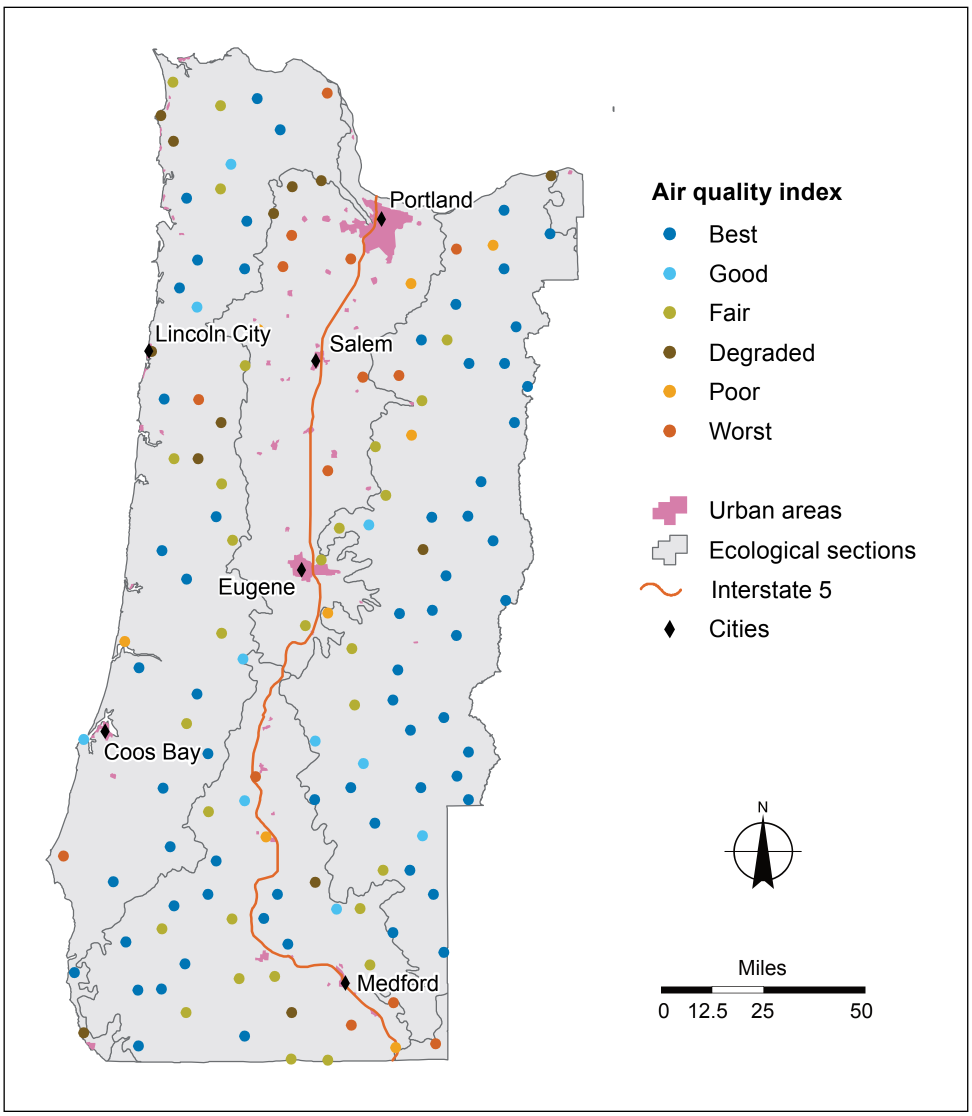


Figure 74—Air quality scores (Geiser and Neitlich 2007) on forest land plots in western Oregon, 1998–2001, 2003 (ecosection geographic information system (GIS) layer: Cleland et al. 2005, urban GIS layer: U.S. Geological Survey 2001).

A deterioration in air quality owing to N was also detected on both the Oregon and Washington sides of the Columbia River Gorge, a phenomenon well-documented by Fenn et al. (2007). Poor-scoring sites south of the Willamette Valley tend to lie near the Interstate-5 corridor. Otherwise, air quality at most sites in the Western Cascades, Klamath Mountains, and Coast Range is rated as "fair," "good," or "best."

Lichen Community Interpretation

Beyond degrading air quality, the ecological and economic impacts of excessive N pose an increasing concern for terrestrial and aquatic ecosystems in the Pacific Northwest. In addition to promoting a nitrophytic lichen flora, N pollution can cause accelerated accumulation of fuels, soil acidification, shifts in plant communities, and a decline in mycorrhizal fungi (Fenn et al. 2003). Remeasurement of lichen communities beginning in 2009 will allow FIA to track changes in N as well as the proliferation of other ecologically harmful pollutants. More elaborate discussion of lichens and Oregon's air quality may be found in Geiser and Neitlich (2007) and Jovan (2008), and at the Forest Service PNW Region lichen-air quality Web page: http://www.fs.fed.us/r6/aq/lichen/.

Air Quality Tables in Appendix 2

Table 49—Summary of Forest Inventory and Analysis plots sampled for lichen community, air quality index information, western Pacific Northwest and western Oregon, 1998–2001, 2003

Table 50—Summary of Forest Inventory and Analysis plots sampled for lichen community, climate index information, western Pacific Northwest and western Oregon, 1998–2001, 2003

Table 51—Ozone injury summary information from ozone biomonitoring plots, by year, Oregon, 2000–2005

Crown Fire Hazard[5]

Background

Reduction of wildfire hazard has emerged as a priority issue in Oregon, where fuel treatments are proposed on an unprecedented scale. Characterization of fire hazard typically focuses on crown fire potential—the tendency of a forest stand to experience crown rather than surface fire—because crown fires are typically stand-replacing events and often are regarded as highly destructive (fig. 75). Before an effective fuel treatment program can be developed, it is essential to know initial hazard levels and identify where hazard reduction is most technically, economically, and socially feasible (see, for example, Barbour et al. 2008; Vogt et al. 2005). The FIA inventory provides an unprecedented opportunity to assess the extent of crown fire hazard across all land ownerships, ecosection groups[6] and forest types. Examining these statistics on a proportional basis, by forest type and geographic distribution, provides key insights into factors associated with high crown fire hazard.

All plots with forest[7] were simulated with the Forest Vegetation Simulator (FVS) and its Fire and Fuels Extension (FFE) (Reinhardt and Crookston 2003) to calculate indices of crown fire potential and fire type under severe fire weather. Each inventory plot was assigned to the appropriate FVS variant by geographic information system (GIS) overlay with the FVS variant map (USDA Forest Service 2007a). Other than the tree height, canopy bulk density, and canopy base height crown fuel parameters, which were

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[5] Authors: Jeremy Fried and Glenn Christensen.

[6] Ecosection groupings (see fig. 5 in "Introduction"): Coast/West Cascades—Oregon Coast Range and Western Cascades; Southwest/Eastern Cascades—Southern Cascades, Eastern Cascades, and Klamath Mountains; Eastern Oregon—Palouse Prairie, Norwestern Basin and Range, Owyhee Uplands, Snake River Basalts and Basins, Blue Mountain Foothills, Columbia Basin, and Blue Mountains.

[7] FVS-FFE was applied to all conditions classified as forested on the ground. Though classified as forested, sometimes by field crews considering areas of the condition outside of the plot footprint, some conditions contained few or no trees on the plot, such that stand attributes the model uses to estimate crown fire potential (for example, canopy bulk density, height to canopy base) cannot be calculated reliably. FFE assumes that sparsely forested conditions have a surface fire regime, which may or may not be true depending on stand structure in the remainder of the condition (outside the plot footprint).

Figure 75—Stands within the Biscuit Fire in southwest Oregon experienced a variety of fire regimes, including mixed-severity with both surface and crown fire (top) and severe crown fire with 100-percent tree mortality (bottom).

derived from the tree-level data collected by FIA, fuel (e.g., surface fuel model) and weather (e.g., windspeed 20 feet above the ground) parameters were assigned default values.[8] Fire type was modeled using FFE as one of four classes (see tabulation below), and results were analyzed and mapped.[9]

Fire type	Fire characteristics
Surface	Only surface fuels on the forest floor burn.
Conditional	Existing crown fire will continue as a crown surface fire, but if canopy gaps interrupt its spread, it will convert to a surface fire and not reinitiate as a crown fire.
Passive	Some crowns will burn as individual trees, or groups of trees "torch," with fire climbing from the surface via ladders of dead branches and lesser vegetation.
Active	Fire moves through the tree crowns and reinitiates as a crown fire if canopy gaps interrupt its progress.

Findings

Patterns for the crown fire potential indices and fire type were similar, so for simplicity, only the fire type results are reported here. Under the modeled weather conditions, fire would likely occur as a surface fire on 59 percent of the forest statewide. Passive crown fire would likely occur on 31 percent of the forest, and active crown fire would be expected on only 9 percent. However, there is substantial regional variation—for example, active crown fires would be expected on about 5 percent of forests in the Southwest/Eastern Cascades ecosection group, and on about 15 percent of those in the Coast/West Cascades ecosection group (fig. 76). It is difficult to predict how these differences in potential hazard translate to events on the ground, because incidence of severe fire weather also differs among these regions.

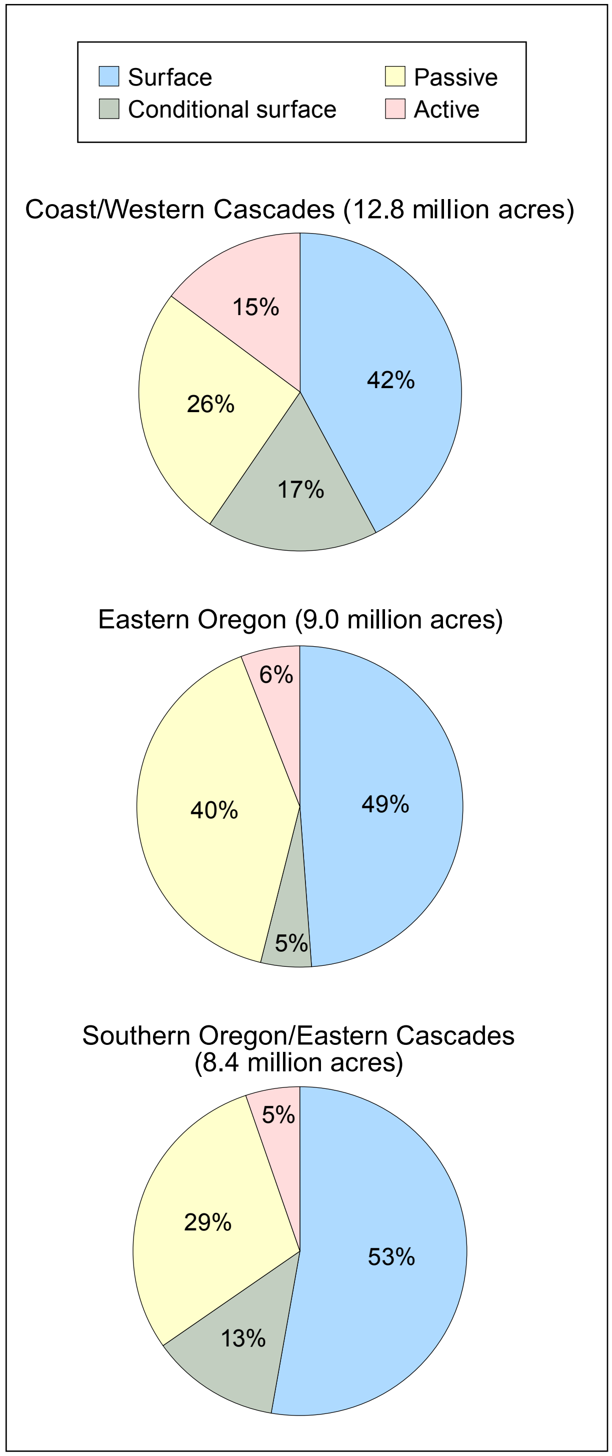

Figure 76—Percentage of forest land in each modeled fire type category by ecosection group in Oregon, 2001–2005.

[8] Surface fuels were determined via lookup tables based on forest type. For the fire weather scenario, FFE default parameters were used such that 20-foot windspeed was set at 20 miles per hour, temperature at 70 degrees F; 1, 10, 100, and 1000 hour fuel moisture at 4, 4, 5, and 10 percent, respectively; duff fuel moisture at 15 percent, and live fuel moisture at 70 percent.

[9] To better visualize the geographic distribution of fire regimes, local kriging interpolation was performed on the ordinal variable, fire type, as if it were a ratio (continuous) variable. This produces a surface of crown fire potential from the plot data, with values ranging from 1 (surface fire) to 4 (active crown fire).

Moreover, incidence of crown fire appears to differ by forest type. Among the four most prevalent coniferous forest type groups, Douglas-fir and fir/spruce/hemlock have the highest incidence of active crown fire, and ponderosa pine and lodgepole pine the lowest (fig. 77). This is probably because Douglas-fir and fir/spruce/hemlock forests have denser canopies and are more likely to contain ladder fuels. However, passive crown fire is more common than active crown fire in all four forest type groups, and does not appear to differ much among forest types. Fire regime also appears to differ by ownership (fig. 78), with state-owned lands predicted to have the highest percentage of forests in which surface fire would be expected (76 percent in surface or conditional surface) and other federal lands having the lowest (49 percent). Such differences could be due to differences in management, but may also be traced to differences in age class structure, forest type, and stand history.

The geographic distribution of likely fire type consistently indicates a concentration of elevated crown fire potential in forests of the Western Cascades. Other patterns are difficult to decipher, although the substantial area of likely surface fire regimes in southwest Oregon could reflect the sizeable component of evergreen hardwoods there (which moderate crown fire potential as represented in the models) (fig. 79). Research into these patterns, their significance, and the lessons that can be learned from them is underway.

Interpretation

These data paint a different picture of fire hazard and fuel treatment opportunity than do certain commonly used maps of fire regime condition class (Hardy et al. 1999; Schmidt et al. 2002). These maps depict most of the area in at least some ecosection groups (notably Southwest/East Cascades)

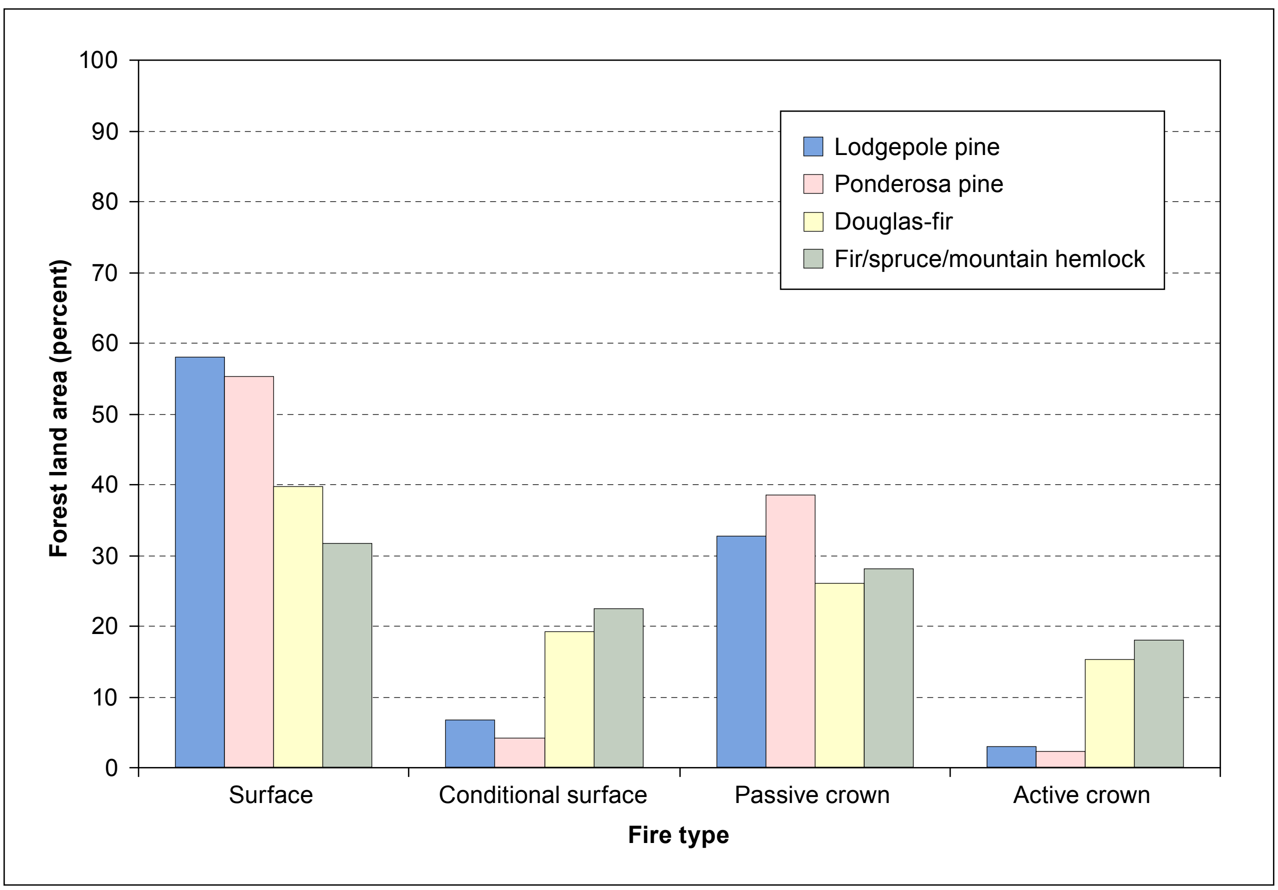

Figure 77—Percentage of forest land in each of the four most prevalent coniferous forest type groups in each modeled fire type class in Oregon, 2001–2005.

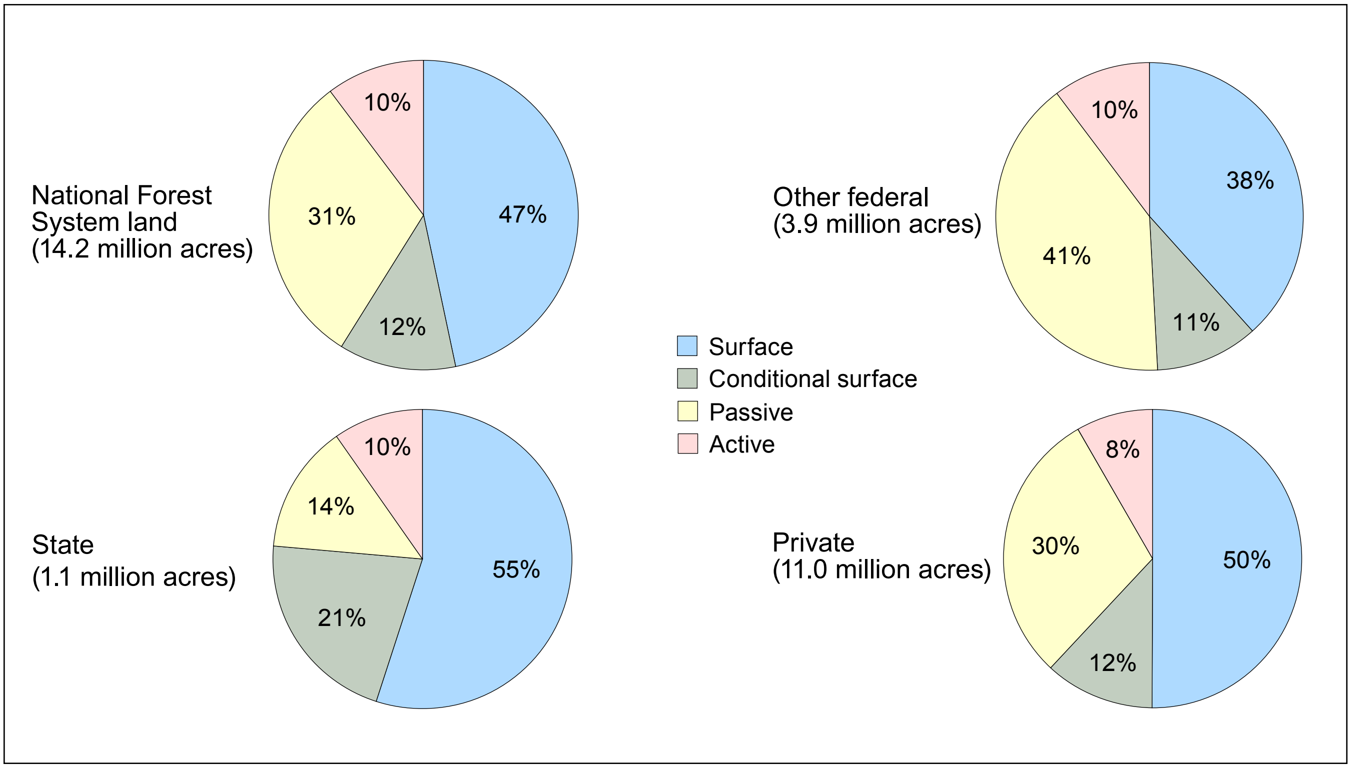

Figure 78—Percentage of forest land in each modeled fire type category by ownership group in Oregon, 2001–2005.

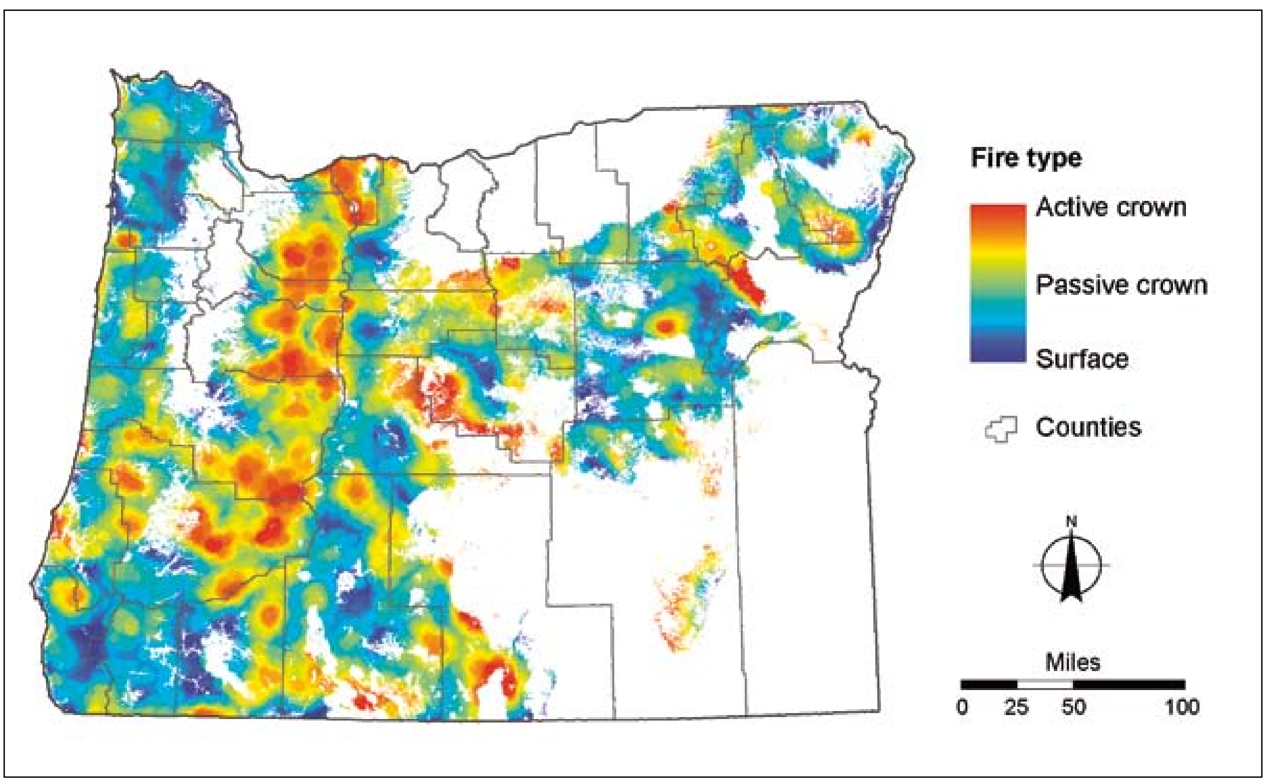

Figure 79—Predicted likely fire type in forested areas using kriging as a modeling method.

as having significantly departed from historical fire regimes and, by implication, as being in urgent need of intervention to reduce fire hazard. Under the fire weather assumed for this analysis, less than half the forested lands are predicted to develop crown fires, and an even smaller fraction, 5 to 15 percent, can be expected to develop active crown fire. Although crown-fire potential models such as FFE have yet to be rigorously validated against behavior of actual fires, many fire managers regard them as suitable for "ballpark" predictions of what is likely to occur.

These results have implications both for the scope of fuel treatment programs and for the challenges that firefighters will face. In the context of firefighting, building a fire line that disrupts the continuity of surface fuels can be effective in stopping fire spread in areas prone to surface fires. In areas where crown fire, if it occurs, is likely to be passive, trees will torch individually, and most trees may die. On those more limited areas where active crown fire is likely to occur, a far more labor- and time-intensive job of linebuilding to remove standing trees would be required for fire containment efforts to be successful.

From the standpoint of implementing fuel treatments, these results suggest that only a fraction of the forested landscape is likely to benefit from fuel treatment if the objective is to reduce crown fire hazard. Given that spatial analyses of fuel treatments has demonstrated that treating a small percentage of the landscape can reduce landscape-scale fire hazard significantly and sometimes cost-effectively (Finney 2001), these results suggest that the fuels management challenge may be more tractable than has been assumed.

Fire Incidence[10]

Background

All forest types in Oregon have the potential to experience crown or surface fire, although fire incidence differs considerably by region and forest type. State and federal agencies estimate the size of all wildland fires and some prescribed fires, map the perimeters of larger fires, and calculate statistics on fire incidence for the lands for which they have protection responsibility. Agencies' fire incidence reports seldom specify the vegetation type that was burned, and in addition, different agencies use different reporting thresholds. Therefore, reliable and consistent estimates of annual burned area across all ownership classes are lacking. The FIA field crews record evidence of surface and crown fire that occurred since the previous plot visit (usually 5 to 10 years) (fig. 80), making it possible to estimate both the average forest area burned per year and the average percentage of forest burned per year.

Findings

We estimate that over the decade 1995–2004, more than 155,000 acres of forest burned statewide per year (range 49,000 to 575,000). No clear trends in area burned were observed. This average represents 0.51 percent of total forest land in Oregon, but year-to-year variability was considerable (fig. 81), ranging from 1.90 percent of forest area burned in 2002 to zero percent in 2004. Regional variability also was high; the average annual percentage of burned forest ranged from 0.11 percent in the Coast/West Cascades ecosection group to 0.95 percent in the Southwest/East Cascades ecosection group[11] (fig. 6).

The following tabulation shows the mean and standard error for the percentage of Oregon forest land area burned, by region from 1995 to 2004:

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[10] Authors: Jeremy Fried and Glenn Christensen.

[11] Ecosection groupings (see Ecosection level map in "Introduction"): Coast/West Cascades—Oregon Coast Range and Western Cascades; Southwest/Eastern Cascades—Southern Cascades, Eastern Cascades, and Klamath Mountains; Eastern Oregon—Palouse Prairie, Northwestern Basin and Range, Owyhee Uplands, Snake River Basalts and Basins, Blue Mountain Foothills, Columbia Basin, and Blue Mountains.

Figure 80—Evidence of fire recorded by field crews can be the result of prescribed burns, as shown here, or naturally caused fires.

Region	Percent	Standard error
Coast/West Cascades	0.11	0.04
Southwest/Eastern Cascades	.95	.14
Eastern Oregon	.68	.10
All areas	.51	.05

The estimate of 155,000 acres per year of burned forest compares favorably with data derived from databases of fire incidents for all agencies maintained by the Bureau of Land Management. Calculations from these data put the 10-year average burned area in Oregon for this period at just under 274,000.[12] These and other interagency fire databases are concerned with causes of the fire and the ownership of the acres burned, not the vegetation within the fires, and thus much of the area accounted for by these statistics is covered in flammable vegetation not classified as forest. Because FIA does not collect a complete ground-based sample of nonforest lands, it is not possible to estimate directly from FIA plot data the area burned in nonforest vegetation types.

Caveats

Because fire is a relatively rare event, the number of plots where recent fire is observed is small, and therefore, standard errors on estimates of area burned are large. Generating estimates for subsets of the forest land base (e.g., ownership classes, particular forest types) is impractical

[12] Fitzpatrick, M. 2007. Personal communication. Predictive Services Support Staff, NW Coordination Center, Bureau of Land Management, 333 Southwest First Ave., Portland, OR 97204.

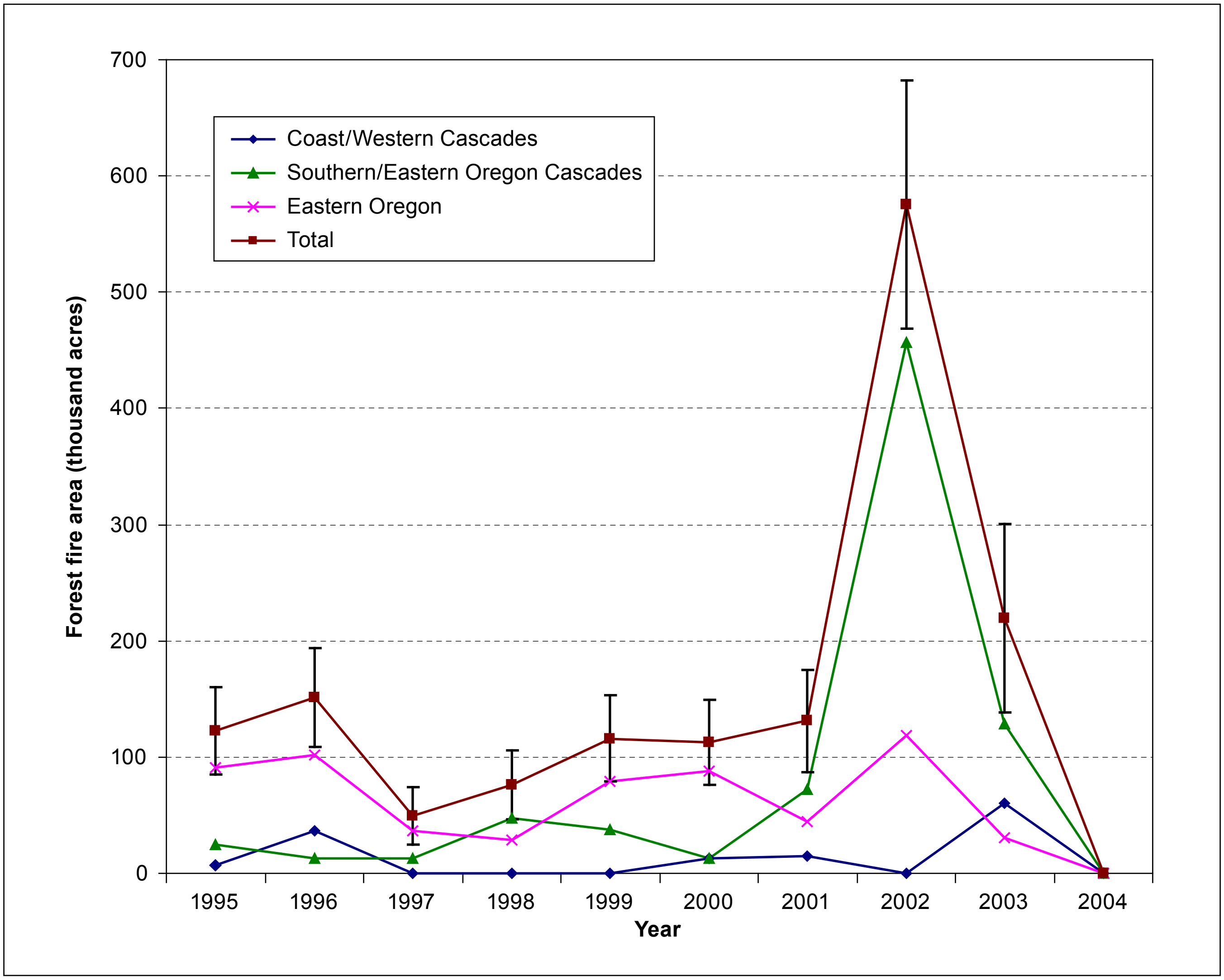


Figure 81—Area of forest fire by ecosection group on forest land in Oregon, 1995–2003.

because of the small sample, inconsistent differentiation of fire type (e.g., surface vs. crown) and origin (e.g., prescribed vs. wildfire), and because field crews did not usually have the training to assess a severity level. For those reasons, all acres observed to have been burned were pooled for this analysis.

However, we have no reason to believe that these estimates are any less accurate than those based on available agency databases. Most fire incident databases have numerous fire reports that do not have information on the area burned, some have large discrepancies between reported sizes and the geographic information system (GIS)-calculated area, and they differ in the size thresholds of fires included. They also generally do not track acres by vegetation type, making it impossible to analyze burned area by forest type. These common problems suggest that users who rely on such databases may unknowingly under- or overestimate actual area burned.

Interpretation

The high year-to-year variability in wildfire incidence and extent makes it impossible to assess whether there is an increasing trend in forest area burned over the past 10 years. Even so, increased media attention to wildfires and a perception among land managers of the need for managing wildland fuels more actively may be generating the impression that the area burned is increasing.

We lack landscape-scale historical or paleoecological data to compare with today's average annual rate of 0.51 percent of forest land burned. Thus we cannot determine whether this rate represents a departure from historical rates. It is also likely that the distribution of acres burned among severity classes and forest types is changing with climatic fluctuations, but our inventory is not designed to detect such changes efficiently.

Fire Incidence Tables in Appendix 2

Table 52—Total acres of forest land with a forest fire incident, by year and ecosection group, Oregon, 1995–2004

The Biscuit Fire[13]

The 2002 Oregon fire season was one of the worst in recorded history. Total fire perimeters encompassed over 900,000 acres, including almost 500,000 in the Biscuit Fire alone (fig. 82). Statewide suppression costs exceeded $150 million. In the aftermath of the Biscuit Fire, a debate continues about salvage logging, artificial regeneration, and riparian issues in the Biscuit area. Divergent conclusions offered by Sessions et al. (2003 and 2004) and Donato et al. (2006) highlight the arguments for and against salvage logging and artificial regeneration.

[13] Author: David Azuma.

David Azuma

Figure 82—Burned-over stand, Biscuit Fire 2002.

Additional work by Reeves et al. (2006) discussed the impacts of postfire logging in riparian areas.

To assess forest type areas and wood volumes associated with different burn severities within the Biscuit Fire, Azuma et al. (2004a) overlaid FIA data from the late 1990s onto a burn-severity map developed by the multiagency postfire Burn Area Emergency Rehabilitation (BAER) program (Parsons and Orlemann 2002). We looked particularly at the relationships among burn severity, site productivity, forest type, and size class over the sample area, which consisted of both wilderness and nonreserved land.

In general, we found that most of the sampled area (63 percent) had experienced burns of low or very low severity, that less-productive areas had experienced the most severe burns, and that stands of big trees (both hardwood and softwood types) had burned less severely than stands of smaller trees.

Nearly 70 percent of the sampled area was classified as softwood forest types. These areas were dominated by Douglas-fir, which occurred on more than 44 percent of the area and accounted for 71 percent of the prefire board feet volume across all forest types. Douglas-fir forest types burned less severely than most other softwood forest types, with less than 35 percent of the area classified as high or moderate burn severity.

More than three-quarters (76 percent) of the area of very large trees (>20 inches d.b.h.) of both hardwood and softwood forest types burned at low or very low severity. Fifty-five percent of the softwood area and 82 percent of the hardwood area burned at low or very low severity. More than 94 percent of the tanoak area burned at low or very low severity.

Sites that mostly experienced highly or moderately severe fire tended to be of lower site productivity and had lower stand volumes, more brush, and less large-diameter woody debris before the fire compared to areas of higher productivity. Almost 45 percent of the sampled area was classified as low productivity, suggesting that artificial regeneration in these areas would be expensive and achieve limited success.

To validate the Azuma et al. (2004a) work, FIA conducted a postfire remeasurement of 180 plots within the Biscuit Fire perimeter. Initial results confirm the prior FIA overlay and severity ratings from the BAER map. When completed, this study will link pre- and postfire stand conditions, fire weather, fire severity, recovery, and fire impacts.

The PNW-FIA Program has also implemented the pre- and postfire assessment protocol for other large fires in connection with the 2003 McNally and 2006 Day Fires in California and the 2003 B&B Fire in central Oregon. This effort is building a unique research database covering a wide range of forest types, prefire stand structures, and fire severities that will prove useful in addressing the links among prefire stand conditions, severity, and postfire impacts.

FIA BioSum[14]

Background

Land managers who are contemplating the implementation of legislation like the Healthy Forests Restoration Act of 2002 understand that mechanical fuel treatments have the potential to produce large quantities of wood that is unmerchantable as sawtimber. Conventional wisdom suggests that effective treatments require the removal of large numbers of small stems at considerable cost, and that this harvested material has little or no value.

One widely considered approach to this perceived problem is to develop forest bioenergy production facilities that simultaneously generate renewable energy and increase employment opportunities in rural areas. Scientists at PNW-FIA developed an analytical system, FIA BioSum (Forest Inventory and Analysis Biomass Summarization), to guide investors seeking to exploit such opportunities and land managers seeking to attract such investment. This system can evaluate a multitude of fuel treatment prescriptions and assess their economic feasibility in terms of modeled harvest yields and costs, haul costs, and product values, and it also can model the achieved reduction in fire hazard.

The FIA BioSum system integrates data and simulation programs, using linked spatial and relational databases, into a geographically explicit analytical framework for summarizing potential biomass production from fuel treatments (Daugherty and Fried 2007; Fried 2003; Fried et al. 2003, 2005; Fried and Christensen 2004). The system relies on publicly available data (for example, inventory plots and GIS layers representing roads, existing wood-processing facilities, and land ownership) and off-the-shelf computer simulators. The simulators apply stand prescriptions, assess fire hazard, and evaluate fuel treatment costs via joint optimization of treatments and processing facility siting. The system requires many assumptions about acres eligible for treatment, logging and haul costs, product prices, and fuel-treatment prescription options. Some of these inputs must be developed in consultation with local experts in fire, fuels, silviculture, and logging.

Findings

The FIA BioSum system was applied to a 28-million-acre, mostly forested landscape spanning four ecosections in central and southern Oregon and northern California (fig. 83). As shown below, when the model is set to maximize net revenue, FIA BioSum suggests this area can produce \$5.9 to \$8.9 billion in net revenue through the treatment of 2.8 to 8.1 million acres, depending on how the problem is constrained. About 61 million to 124 million green tons of woody biomass would be recovered for power generation, sufficient to operate a network of bioenergy plants with a combined capacity of 496 to 1009 megawatts over a 10-year period. In these scenarios, estimated production potential for merchantable wood products ranges from 8.3 to 12.4 billion cubic feet, almost all from the harvest of trees larger than 12 inches d.b.h. (the threshold size determined by modeling for effectiveness in reducing crown fire hazard). Results of the modeling depend on the level of treatment effectiveness required and on whether all eligible acres are treated (which would entail subsidy on some acres) or only those that contribute profit to the enterprise. See the tabulation on page 82.

We evaluated a range of power-generating capacities and conversion efficiencies to assess the tradeoffs of building lower versus higher capacity plants; these included increased hauling costs for transporting wood chips longer distances to reach a higher capacity plant. Results suggest that unless small-capacity (<15 mW) facilities achieve efficiencies near to those of large capacity facilities (at least 90 percent of the efficiency of big plants), they do not represent a viable alternative

[14] Authors: Jeremy Fried and Glenn Christensen.

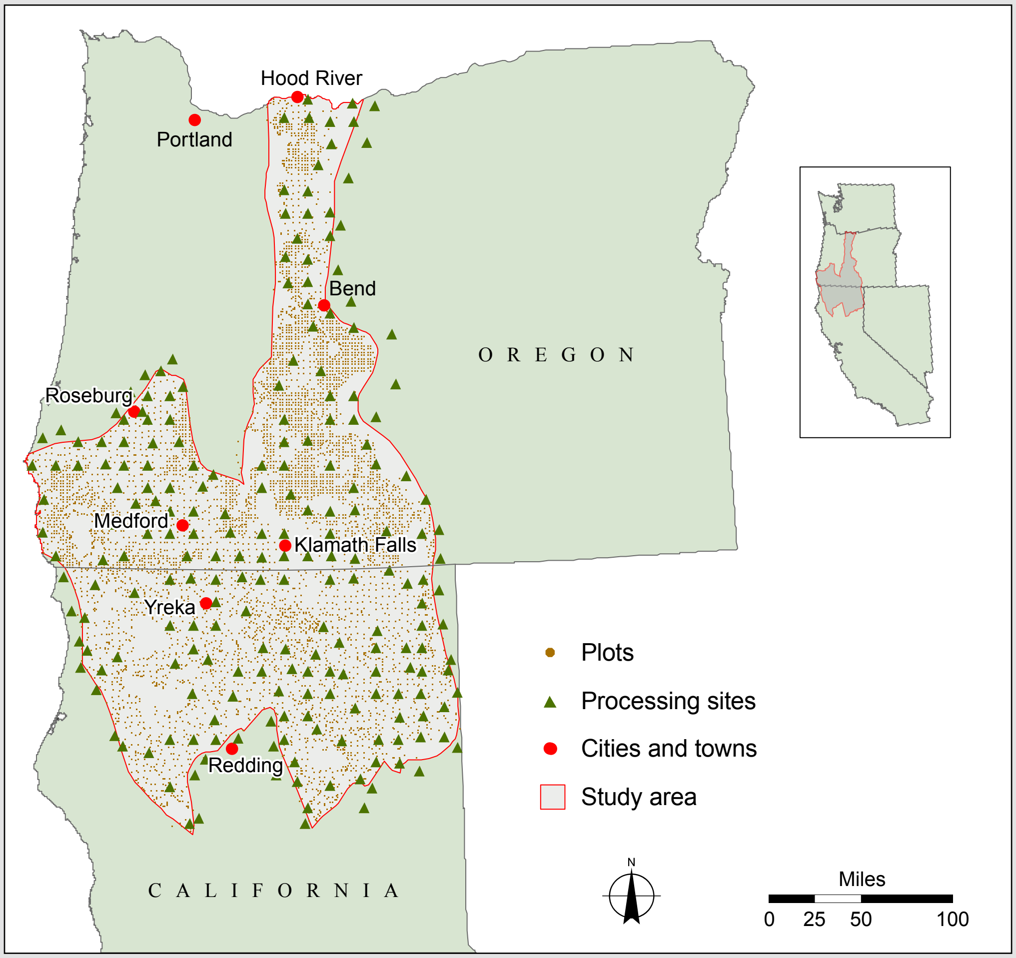


Figure 83—Oregon/California BioSum study area showing locations of inventory plots, sites evaluated as potential power-generating facilities, and major cities.

	Scenario			
	1	2	3	4
Constraint on acres treated [a]	Any	All	Any	All
Constraint on effectiveness [b]	Moderate/high	Moderate/high	High	High
Net revenue (billion dollars)	8.94	6.65	7.15	5.88
Merchantable net revenue (billion dollars) [c]	7.71	4.74	6.24	4.61
Biomass net revenue (billion dollars) [c]	1.23	1.92	0.91	1.27
Merchantable volume (billion ft^3)	10.93	12.41	8.35	9.22
Delivered biomass (million green tons)	81.21	123.87	60.92	84.40
Area treated (million acres)	4.49	8.12	2.84	4.05
Highly effective area treated (million acres)	2.53	3.21	2.84	4.05
Number of facilities	31	47	23	30
Bioenergy capacity (megawatts)	661	1009	496	688

[a] "Any" allows the model to select optimal number of acres to treat; "all" requires treatment of all acres that meet effectiveness constraint.
[b] Effectiveness refers to the set of effectiveness criteria applied. Moderate effectiveness requires a modeled improvement in resistance to active crown fire; high effectiveness requires modeled improvement in resistance to both active and passive crown fire. These criteria limit the number of acres considered in analysis; under the high constraint, only high-effectiveness acres are eligible for treatment.
[c] On-site treatment costs are only deducted from merchantable gross revenue. Biomass net revenue equals delivered value net of haul costs.

given the large amount of biomass removed. The locations selected by the optimization model as the best places to build bioenergy facilities were comparatively insensitive to capacity constraints. Locations that were selected when minimum electrical generation capacity was set high were a subset of those selected when the minimum capacity constraint was set low, lending support to the idea that some places in the forested landscape are inherently well-suited for bioenergy facilities under a variety of potential wood supply and energy pricing scenarios by virtue of their location on the transportation network relative to where fuel treatments would occur.

The FIA BioSum framework provides a statistically representative foundation for assessing the opportunities to use "waste" from fuel treatments to expand capacity for generating bioenergy (fig. 84). However, results of these optimizations should not be the only basis for a decision to develop a fuel-treatment program. Decisionmakers will also need to factor in the nonmarket benefits and costs of fuel reduction, the various resource goals among landowners and management agencies that are unrelated to fuel, and the reluctance of investors to commit capital without a reasonable expectation of sufficient fuel supply. Nevertheless, FIA BioSum does provide a starting point and a tool for further analysis.

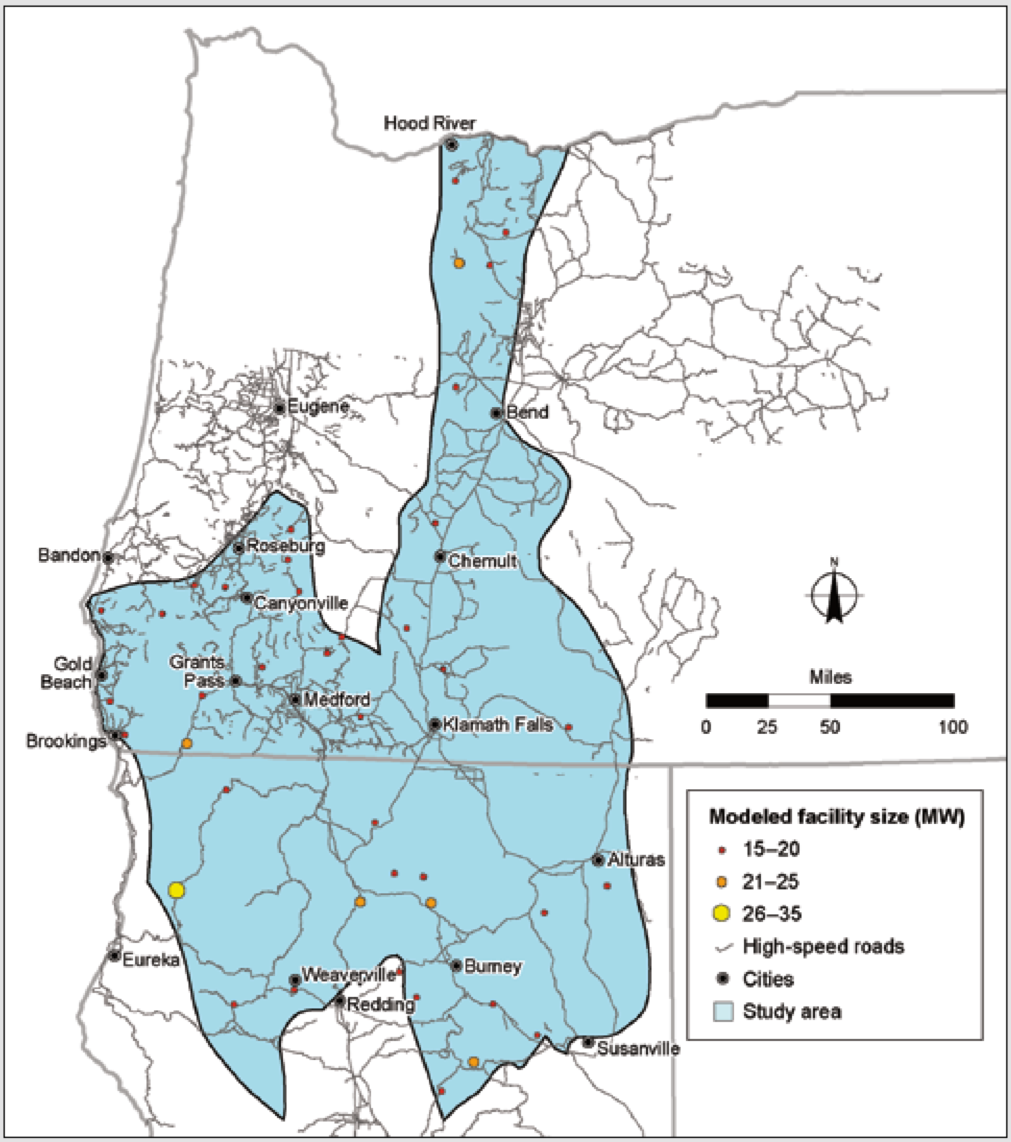
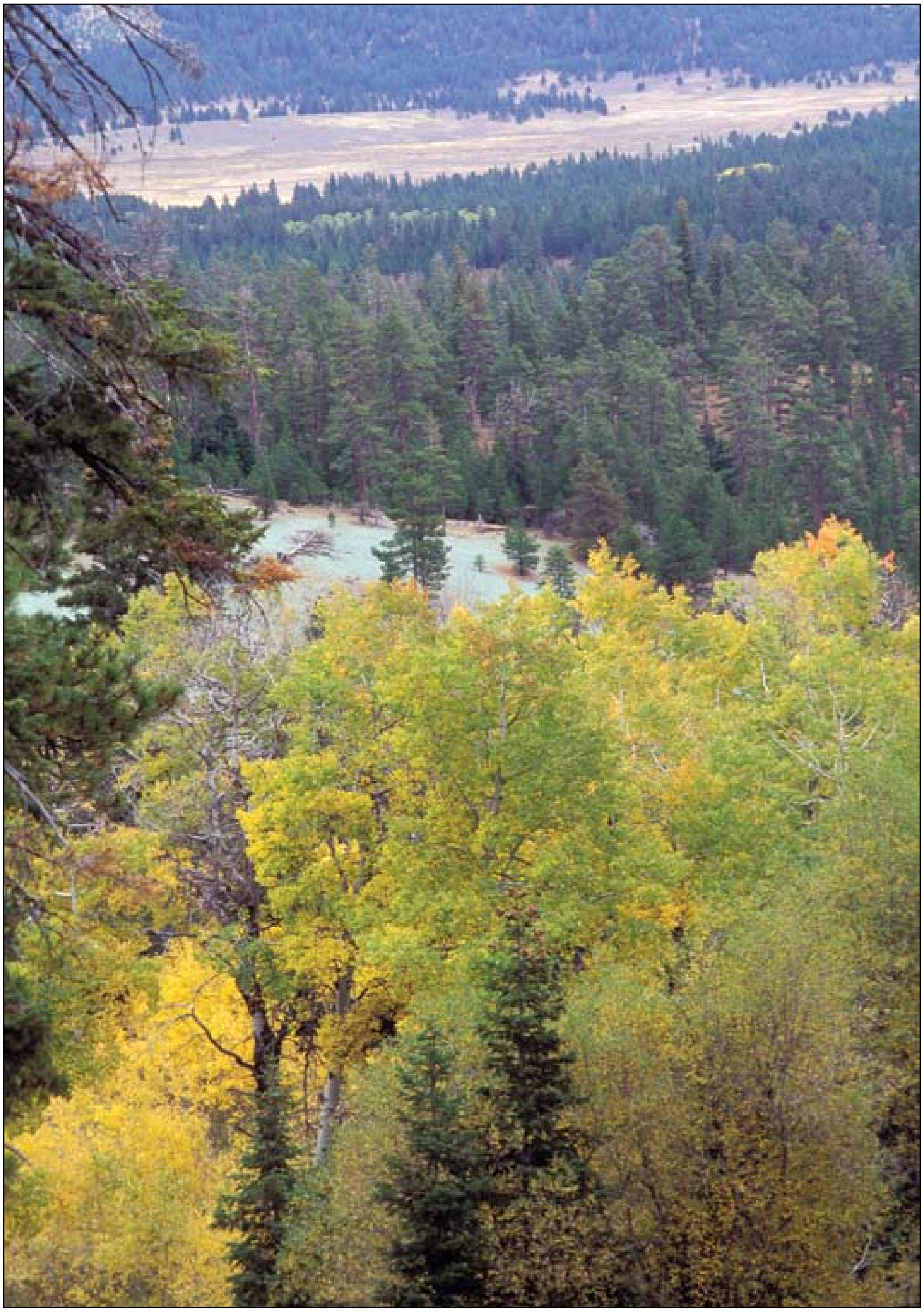


Figure 84—Model-recommended locations for forest bioenergy production facilities, with minimum 5-megawatt (MW) capacity, and high-speed road network.



Warner Mountains, Fremont National Forest.

Chapter 6: Products

Oregon's forests are an essential source of raw material for timber and nontimber forest products, and they provide many other amenities and services to the people of Oregon. The forest products industry has historically been a mainstay of Oregon's economy and culture. Its contributions continue today in the form of wood products, employment and income, tax revenue, and maintenance of forest lands across the landscape. This chapter examines the productive capacity of Oregon's forests and its contribution to the state's economy and environment.

Data in this chapter address Montréal Process criterion 2 and indicators pertaining to maintenance of productive capacity of forest ecosystems and criterion 6 and indicators pertaining to maintenance and enhancement of long-term multiple socioeconomic benefits to meet the needs of societies.

Data in this chapter also address Oregon indicator B pertaining to social and economic outputs and benefits and indicator C pertaining to maintenance and enhancement of productive capacity of Oregon's forests.

Oregon's Primary Forest Products Industry[1]

Background

Oregon's forest products industry uses timber harvested from Oregon as well as other states in the Western United States and Canada. The industry provides ecological, social, and economic benefits by supplying society with wood products such as lumber and plywood (fig. 85) and by providing employment and income associated with forest management, timber harvesting, and wood products manufacturing. Future availability of forests for harvesting and remaining capacity and capability of the primary forest products industry to use timber are important issues facing Oregon's forest products industry.

In cooperation with Pacific Northwest Forest Inventory and Analysis (PNW-FIA) Program, the Bureau of Business and Economic Research at the University of Montana conducts a periodic census of Oregon's primary forest

[1] Authors: Jason Brandt and Todd Morgan.


Gary Lettman

Figure 85—Plywood is one of the many timber products that Oregon mills produce.

products industry (that is, timber processors and users of mill residue). The latest census is the source of information presented below and provides detail on timber harvest and flow and comprehensive information about the state's timber processing sectors, product volumes, sales values, and mill residue (Brandt et al. 2006).

Findings

During 2003, a total of 249 primary forest products facilities operated in 32 of Oregon's 36 counties (fig. 86). Oregon remains the leading softwood lumber-producing state in the United States. Total Oregon lumber production during 2003 was 6,574 million board feet (MMBF) lumber tally with a sales value of just under $2.3 billion. Production capacity for Oregon sawmills was 7,764 MMBF lumber tally, with 79 percent of lumber-producing capacity aggregated among 33 sawmills with annual production capacity greater than 100 MMBF. These largest sawmills also accounted for 79 percent (5,196 MMBF) of lumber production. Sawmills received approximately 3,211 MMBF Scribner, or 75 percent, of the timber delivered to Oregon processors in 2003. The volume-weighted statewide average recovery in 2003 was 2.07 board feet of lumber per board foot Scribner of timber input.

Shown below are 2003 sales from Oregon's primary forest products sectors:

Sector	2003 product sales value
	Thousands of U.S. dollars
Sawmills	2,284,985
Pulp and board facilities	2,271,143
Plywood and veneer plants	1,773,487
Other sectors[a]	345,688
Chipping facilities	23,627
Log homes plants	13,153
Posts, pole, pilings, and utility pole plants	11,403

[a] Other sectors include manufacturers of bark products, cedar products, biomass energy, engineered wood products, log exports, log furniture, fuel pellets, and firelogs.

Oregon's primary forest products sectors had product sales of more than $6.7 billion in 2003. The largest share of sales from the pulp and board sector and sawmills were to Washington and California, whereas the largest portion of plywood, veneer, and other primary products sales were within Oregon. During 2003, Oregon's plywood and veneer sector produced 4,106 millon square feet (MMSF) (⅜-inch basis) of plywood[2] and 2,094 MMSF (⅜-inch basis) of veneer, making Oregon the leading producer of plywood in the United States.

The pulp and board sector is the major consumer of mill residue in the state, processing over 70 percent of the residue generated from sawmills and plywood and veneer facilities in the state. Oregon's pulp and paper sector produced more than 4.4 million dry tons of pulp and paper, and board facilities produced a total of 1,676 MMSF of products, including particleboard, medium-density fiberboard, and hardboard. Mill residue-utilizing facilities other than pulp and board, consisted of one biomass energy-generating operation, three firelog and wood pellet manufacturers, and five bark product facilities. Sawmills produced 78 percent (5.9 million dry tons) of all mill residue generated in Oregon during 2003. Other facilities produced about 1.7 million dry tons of residue for a total of about 7.6 million dry tons, nearly all of which (99.8 percent) was used.

Almost 65,700 workers, earning a total of $3.3 billion annually, were directly employed in the primary and secondary wood and paper products industry in Oregon during 2003. About 70 percent of these workers were employed in the harvesting and processing of timber or in private-sector land management, earning nearly $2.3 billion in labor income. The secondary industry employed 22,400 workers, with earnings of approximately $1 billion. The secondary industry includes firms (e.g., window frame and door manufacturers, truss and remanufacturing facilities, as well as furniture and packaging makers) that further process output from the primary industry.

[2] Plywood volume reported here is substantially higher than that published by the Engineered Wood Association because we include softwood and hardwood plywood production as well as specialty veneer panel products, whereas the Engineered Wood Association's estimate includes just softwood plywood.

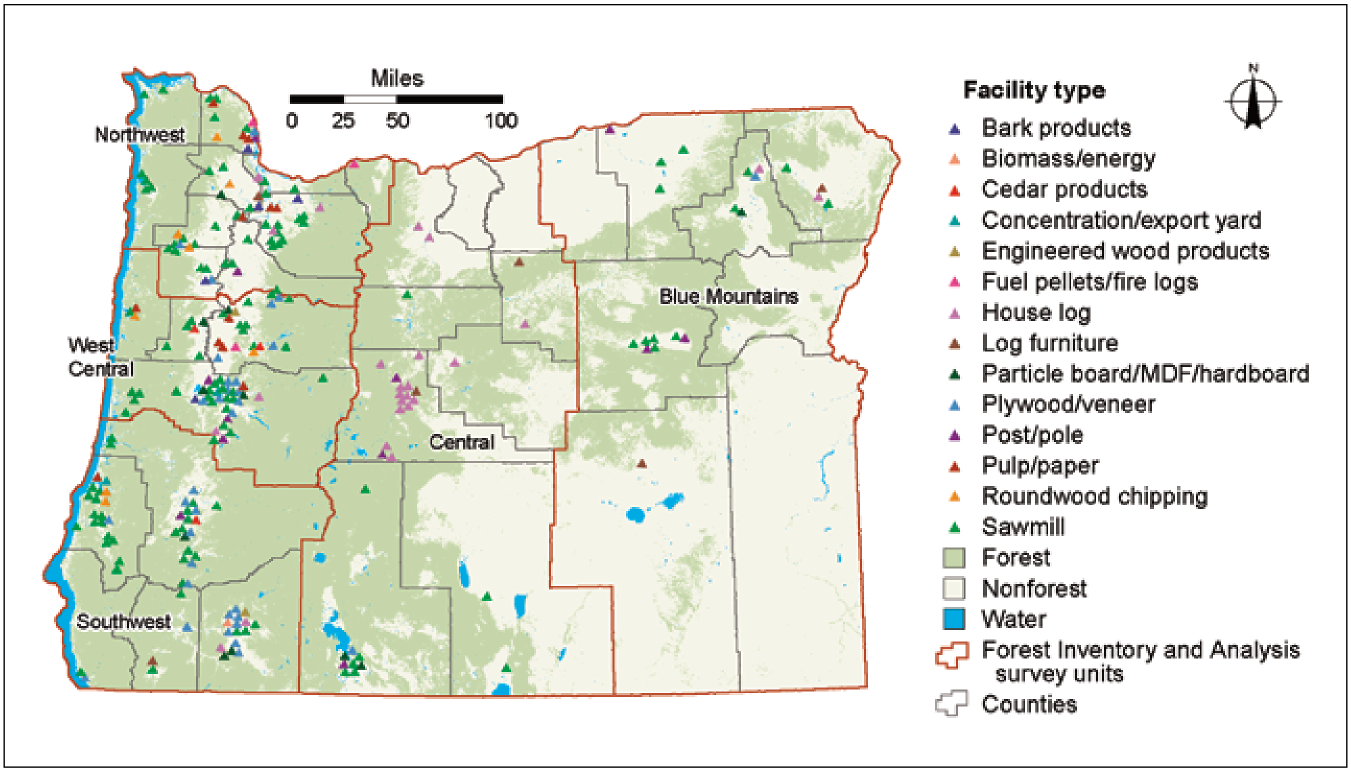


Figure 86—Active Oregon primary forest products facilities by county and resource area, 2003 (forest/nonforest geographic information system (GIS) layer: Blackard et al. 2008; urban/water GIS layer: Homer et al. 2004).

Oregon's forest products industry has consistently been responsible for a higher portion of labor income than employment, indicating the industry provides above-average wages and benefits. During 2003, Oregon's average worker, across all industries earned $32,400, while for the forest products industry the figure was almost 55 percent higher, at nearly $50,200. In addition to primary and secondary employment, the forest products industry also provides indirect employment such as log hauling and machinery sales and service.

Interpretation

After declining in response to reductions in federal timber harvest levels during the 1990s, Oregon's forest products industry is experiencing a resurgence. Oregon's total timber harvest has increased about 8 percent since 2003. Lumber production has also increased, with 2005 lumber production almost 14 percent higher than 2003 and 2006 production about 8 percent higher than 2003. Improved milling technology has increased product recovery (e.g., overrun) while allowing increased use of smaller-diameter trees. Oregon is expected to remain the leader in U.S. softwood lumber and plywood production.

Growth, Removals, and Mortality[3]

Background

Increases or decreases in timber volume can be explained by examining growth, removals, and mortality of trees. Comparing removals and mortality to growth addresses one aspect of forest sustainability; when removals and mortality exceed growth, total tree volume will decline. In localized areas, removing trees to reduce risk from fire or insect outbreaks can cause removals to exceed growth, but may benefit the health of the stand. Alternatively, widespread mortality from some agent of disturbance such as bark beetles may also offset growth gains and thus slow stand development (fig. 87).

Because the current FIA inventory differed from past inventories in how the different parts of the forest land base were measured (i.e., forest land, timberland, and inclusion or exclusion of reserved land), and because the inventories used different definitions of forest attributes (e.g., growing stock), it is not possible to simply compare prior published results with current results to estimate change in the net volume of trees. To minimize the definition-based effects, we estimated net change based on revisited plots and assessed them under our current algorithms and definitions.[4] We estimated current annual gross growth from increment cores taken from a subset of softwood trees on the revisited plots. The difference between net change and current annual gross growth is our estimate for removal and mortality.

Findings

Growth of softwood trees on Oregon's timberland significantly exceeds removals and mortality. The ratio of growth to removals and mortality is similar in eastern (2.02) and western Oregon (1.95). Across the state, the net change was positive for all owner groups (national forest, state and local government, corporate, and noncorporate private owners).

[3] Author: Olaf Kuegler.

[4] In western Oregon we established new plots on BLM land and previous plots were not revisited. As a result, we did not estimate growth, removals, and mortality on BLM land.

Tom Iraci

Figure 87—Growth of trees is offset by harvesting and mortality. Mortality in the Santiam Pass area of Oregon, shown here, was caused by western spruce budworm (*Choristoneura occidentalis* Freeman).

The tabulation below shows the net growth of softwood trees on timberland in Oregon:

	Annualized net change					
	Oregon		Western Oregon		Eastern Oregon	
	Total	SE	Total	SE	Total	SE
	Thousand cubic feet					
National forest	712,758	147,497	494,111	140,241	218,647	47,450
State and local	140,236	96,084	132,904	95,568	7,332	9,943
Corporate private	117,540	102,852	127,420	97,904	-9,880	31,515
Noncorporate private	110,941	79,701	73,107	73,198	37,834	31,533
All owners	1,081,475	218,663	827,542	208,901	253,933	65,862

In eastern Oregon, between 1987 and 1999, the ratio of growth to removals and mortality was less than 1 for national forest, other public, and private forest land (Campbell et al. 2004). Currently, growth significantly exceeds removal and mortality on east-side national forest land. Standard errors for our limited sample were too high for us to definitively estimate trends on land owned by state and local government, corporate, and noncorporate private owners.

In western Oregon, growth significantly exceeded removals and mortality on national forest timberland. The positive trends for state and local, corporate, and noncorporate private timberland were not statistically significant.

Across Oregon, state and local timberlands produce the largest amount of softwood timber (211 cubic feet per acre per year), followed by corporate lands (150 cubic feet), noncorporate private lands (122 cubic feet), and national forest timberlands (86 cubic feet). Softwood timberlands are far more productive in western Oregon (178 cubic feet per acre per year) than in eastern Oregon (50 cubic feet).

Western white pine (see "Scientific and Common Plant Names") is the only species group with a significant estimated decline in volume. Potential volume declines in other species groups were not statistically significant.

Caveats

The design and definitions used in past inventories are significantly different from those used in our current inventory (see app. 2). The design has changed from a variable-radiux plot to a fixed-radius design and from five to four subplots with only the center of one subplot being the same. As a result, only a small fraction of trees were remeasured in the current annual inventory. Although it is still valid to estimate overall net change based on these different designs, there are some inherent problems. For this chapter we have tried to minimize procedural differences between inventories by comparing only subplots from the two inventories that have the same center location and by applying the same definitions and algorithms to both data sets (i.e., for growing stock, timberland, reserved land, forest type, tree volume). However, a small bias introduced by measurement or model error that may exist in one inventory and not in the other will exaggerate the estimate of net change.[5]

We estimated gross growth by taking tree cores from a subset of trees in our current inventory. Although the field crew was instructed to core one live tree for each condition, representing each species and crown class, that was not always possible. This introduces a small bias with an unknown direction into our gross growth estimate.[6] Furthermore, increment cores were not cross-dated, and standardized ring-width indices were not developed.

Removals and mortality are estimated as the difference between gross growth and net change. Even if these estimates are unbiased, they are still subject to sampling

[5] Since overall softwood trees on timberland grow about 3 percent per year, a total volume bias of only 1 percent per year amounts to about 30 percent of gross growth.

[6] The estimated bias for total volume for Oregon, based on trees selected for gross growth estimate, is 5.1 percent with a standard error of 1.5 percent. In contrast, the estimated bias for total volume based on the first tree per species, crown class, and condition is 1.2 percent with a standard error of 1.5 percent.

error. Thus, the estimate for removals and mortality can be negative. Although such an estimate is still unbiased, it is of course logically untenable. Furthermore, any bias in the gross growth or the net change estimates is also present in removals and mortality estimates.

Past inventories were conducted between 1993 and 1999, while the current inventory covers 2001 through 2005. As a result, the remeasurement period ranges between 2 and 12 years, with an average of 8.6 years.

Finally, the sampling errors for most of our estimates are very large compared to the estimates. Sampling error should be taken into account when basing conclusions on the estimates.

In 2005, PNW-FIA began collecting information that can be used for growth, mortality, and harvest. The data include remeasurement of previous trees in two of the five periodic subplots and recording natural mortality and harvest on all five prior subplots. These new data will allow better estimates of change for the next report.

Growth, Removals, and Mortality Tables in Appendix 2

Table 53—Estimated gross growth of softwood growing stock volume on timberland, by location and owner, Oregon, 2001–2005

Table 54—Estimated ratio of growth to removal and mortality of softwood growing stock species on timberland, by owner group and location, Oregon, 2001–2005

Table 55—Estimated gross growth, net change, removals, and mortality of softwood growing stock on timberland, by owner and location, Oregon, 2001–2005

Table 56—Estimated gross growth, net change, removals and mortality of softwood growing stock on timberland, by species group and owner, Oregon, 2001–2005

Removals for Timber Products[7]

Background

Volume removed from forest inventory during the harvesting of timber is known as removals (fig. 88). Removals are an important indicator of the sustainability of timber harvest. Removals that exceed growth could indicate overharvesting and decreasing forest inventory, whereas growth greatly exceeding removals could signal a need for increased vegetation management to decrease risks of insect outbreaks or wildfire.

Removals can come from two sources: the growing stock portion of live trees (live trees of commercial species meeting specified standards of quality or vigor), or dead trees and other nongrowing stock sources. The two general types of removals are (1) timber products harvested for processing by mills and (2) logging residue (i.e., wood cut or killed but not used). Removals, as reported here, are based on a 2003 census of Oregon's primary forest products industry (Brandt et al. 2006).

Findings

Oregon's 2003 timber harvest for wood products was 4.055 billion board feet Scribner, and dead trees accounted for 25.7 MMBF (less than 1 percent). The 2003 harvest was roughly 99 percent of the average annual harvest for the previous 10 years, but only 57 percent of the 40-year average (fig. 89).

Removals for timber products totaled 1,055.1 million cubic feet (MMCF) during 2003. Growing stock accounted for 979.0 MMCF (93 percent) of removals for products, with the remainder coming from other sources including dead trees. Saw logs were the leading product harvested, accounting for 67 percent of removals for products. Veneer logs accounted for 19 percent, and pulpwood and fuelwood, including industrial fuel and residential firewood, accounted for 7 and 6 percent, respectively. Poles, posts, and other miscellaneous products accounted for the remaining 1 percent of removals for products. Softwoods accounted for approximately 94 percent of removals for timber products.

[7] Authors: Todd Morgan and Jason Brandt.

Figure 88—Harvest of red alder, Redland, Oregon.

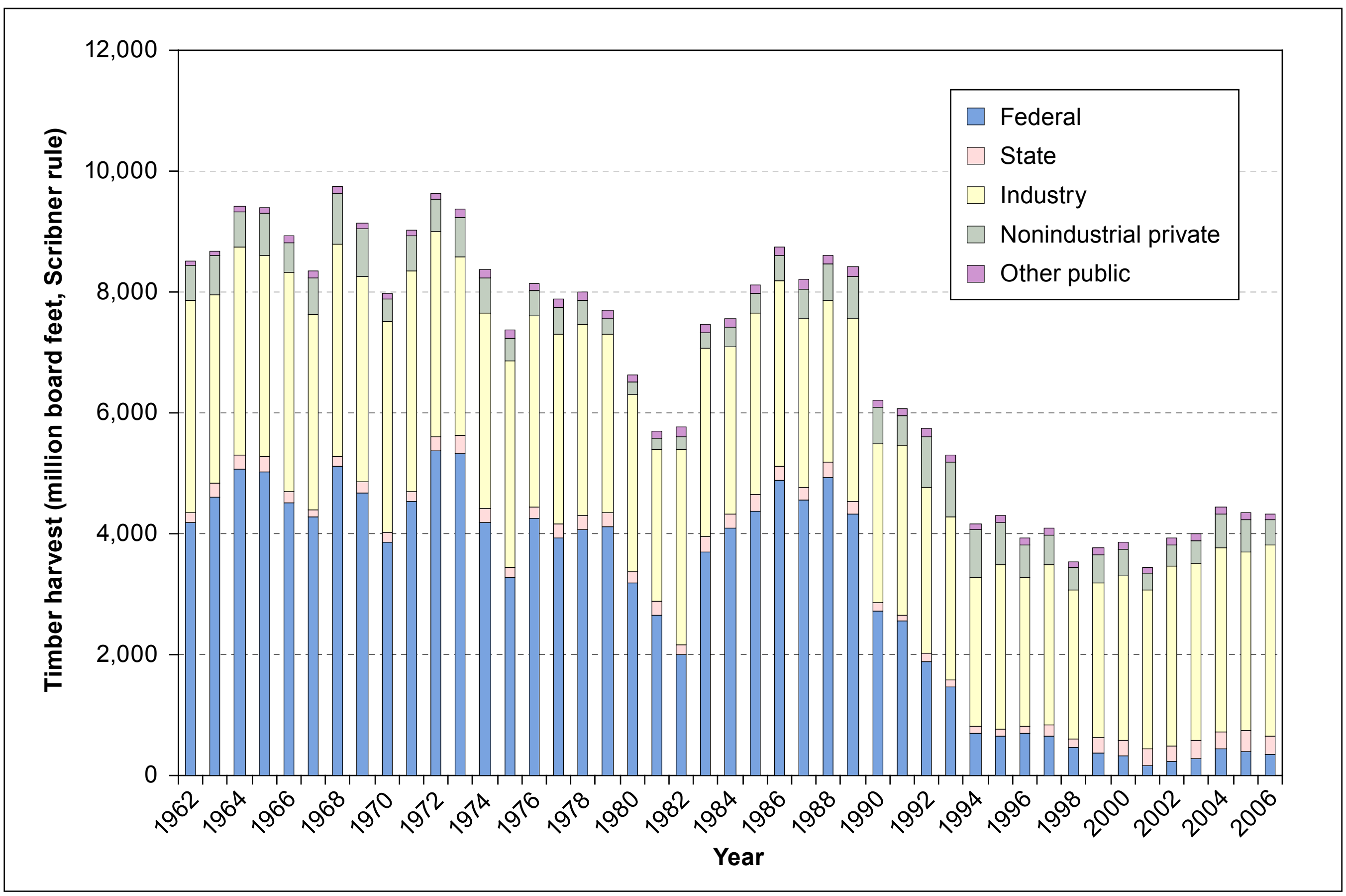


Figure 89—Timber harvest by ownership in Oregon, 1962–2004 (harvest data: Andrews and Kutara 2005).

The largest volumes of hardwoods were used for saw logs and pulpwood.

Total removals from Oregon's timberlands during 2003 were 1,356.8 MMCF. This included 1,055.1 MMCF used for timber products and 301.7 MMCF of logging residue left in the forest as slash. Growing-stock removals were 1,039.9 MMCF. Slightly over 94 percent (979.0 MMCF) of growing-stock removals was used to produce wood products, and just under 6 percent (60.8 MMCF) was not used. Saw logs were the largest component (67 percent) of growing-stock removals, followed by veneer logs (19 percent), and pulpwood (7 percent).

Corporate timberlands provided almost 74 percent (764.5 MMCF) of growing-stock removals, whereas other private and tribal lands supplied 11 percent (118.1 MMCF). National forests supplied slightly less than 5 percent of the volume removed from growing stock. Other public landowners, including the Bureau of Land Management and the state of Oregon, provided slightly more than 10 percent.

Douglas-fir was the leading species harvested, accounting for 65 percent (679.8 MMCF) of growing-stock removals (fig. 90). True firs and hemlock each represented about 9 percent. Ponderosa pine, cedars, spruces, lodgepole pine, larch, sugar pine, and other softwoods together accounted for 11 percent. Hardwoods including red alder accounted for 6 percent of growing-stock removals. Douglas-fir was the leading species harvested for most products; 69 percent of saw logs and 63 percent of veneer logs were of Douglas-fir. Red alder was the leading species harvested for fuelwood; most of the cedar and larch harvested were used for other products.

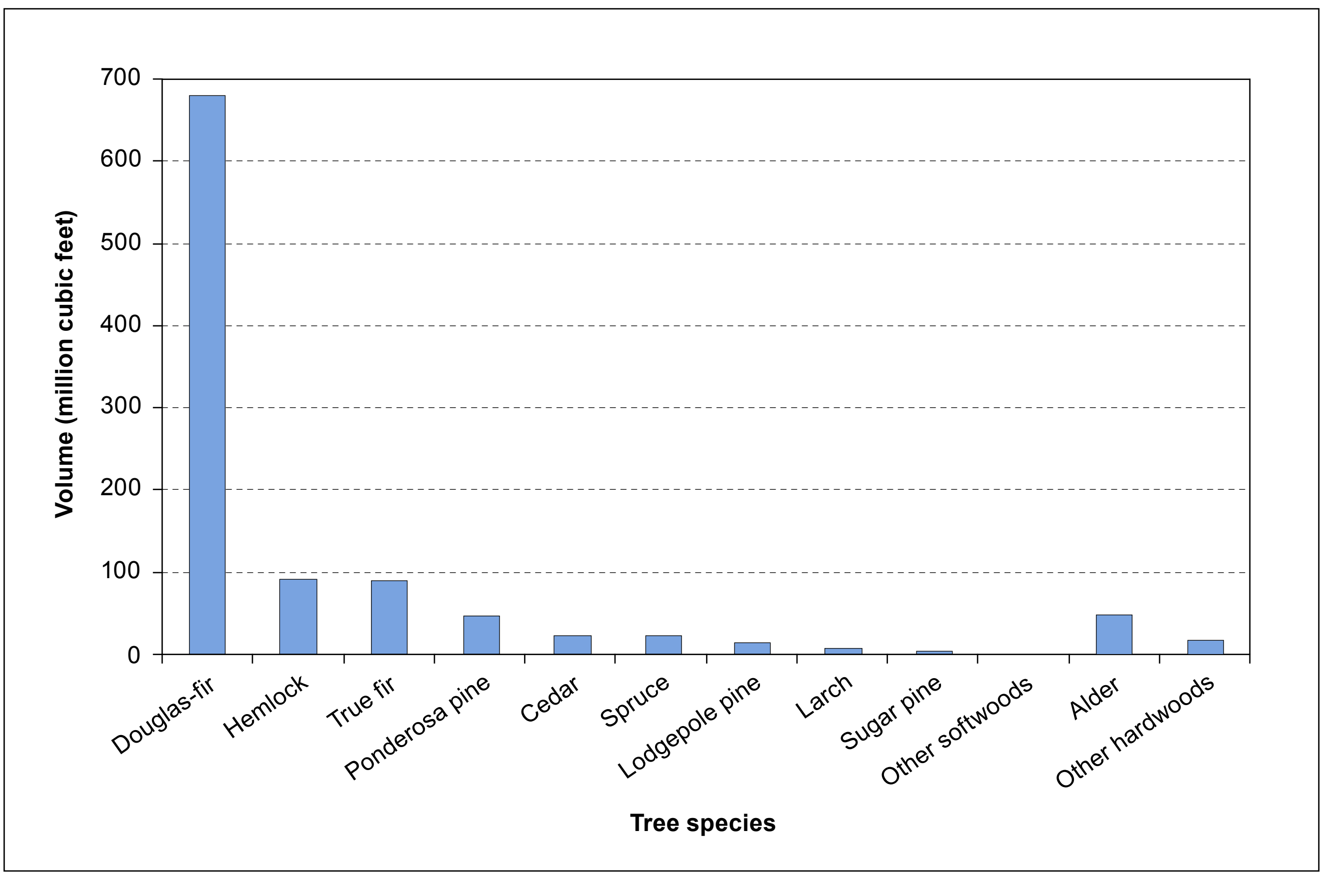


Figure 90—Volume of growing stock removals by tree species in Oregon, 2003 (removals data: Brandt et al. 2006).

Interpretation

Sustainability of Oregon's forests depends on sustainable harvest levels and a forest products industry capable of using material removed from inventory. Statewide, growth exceeded removals, but reductions in national forest harvests since the late 1980s led to a decline in Oregon's overall timber harvest and caused a distinct shift in the proportion of timber harvested from public versus private lands. From 1993 to 2005, timber harvests from national forests in Oregon averaged less than 10 percent of the state's total annual harvest, whereas between 1962 and 1992, national forest timber harvests averaged 38 percent of the state's total annual harvest. Recently there has been a slight increase in Oregon's timber harvest volume, and Oregon's forest products industry has begun a resurgence. Throughout this upswing, careful consideration to growth and removals among the different ownership classes is needed to ensure that sustainable harvest levels are achieved and maintained.

Removals for Timber Products Tables in Appendix 2

Table 57—Total roundwood output by product, species group, and source of material, Oregon, 2003

Table 58—Volume of timber removals by type of removal, source of material, and species group, Oregon, 2003

Nontimber Forest Products[8]

Background

Nontimber forest products (NTFP) are species harvested from forests for reasons other than production of timber commodities. Vascular plants, lichens, and fungi are the primary organisms included in NTFPs (Jones 1999) and are collected for subsistence, recreational, educational, or commercial purposes (Vance et al. 2001). The NTFPs are fundamental to many botanical, floral, and woodcraft industries and are important to medicinal and natural food industries as well.

Although harvest of NTFPs is prevalent in Pacific coast forests, relatively little is known about their overall abundance or how they are affected by different land management practices. It is also not clear whether current levels of harvesting are sustainable or whether they are negatively affecting the resources (Everett 1997). Because PNW-FIA crews record the cover of the most abundant and readily identifiable vascular plant species found on each phase 2 plot, the inventory can provide useful baseline information on the status and trends of many NTFP species (Vance et al. 2002). Crews also collect samples of epiphytic lichens found on phase 3 plots, allowing assessment of selected lichen NTFPs.

Lists of vascular plant NTFPs were compiled from the literature (Everett 1997, Jones 1999, Vance et al. 2001) and compared with species recorded on FIA plots. Species that were readily identifiable by most crews (i.e., common shrubs or common and distinctive herbs) were included in the analyses, as well as seedlings and saplings of selected tree species (under the assumption that most boughs are harvested from small trees). Mean cover of each species across all sampled subplots was calculated, and the area covered on each plot extrapolated to all forest land with standard inventory statistics.

[8] Authors: Andrew Gray and Sarah Jovan.

Findings

The NTFP plant species with the greatest cover was swordfern (fig. 91), which covered 1.5 million acres. Brackenfern was the next most widespread herb, covering 260,000 acres. The shrubs covering the most acreage were vine maple (935,000 acres), salal (890,000 acres), and dwarf Oregon grape (546,000 acres). In comparison, the cover of NTFP tree seedlings and saplings was quite low except for Douglas-fir, which covered 200,000 acres. Plant NTFPs were most prevalent in moist ecosections; the Coast Range had the most cover (fig. 92). Lichen NTFPs were common, with wolf lichen and beard lichens recorded on 57 percent of the forested plots.

Andrew Gray

Figure 91—Swordfern is the nontimber forest product that covers the greatest area of Oregon forest lands.

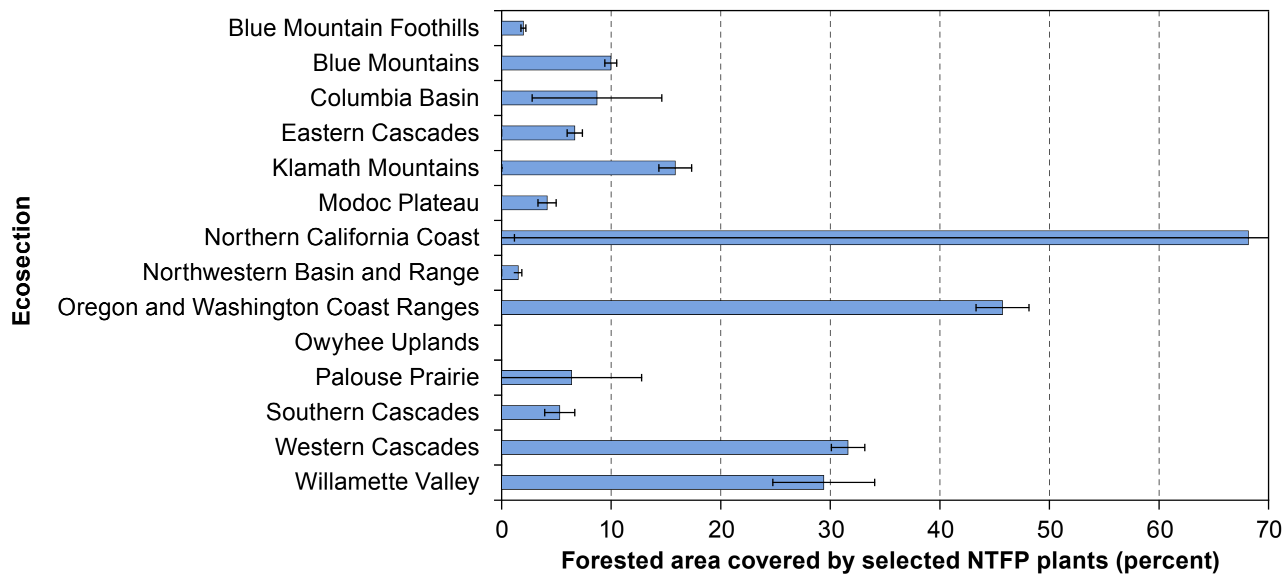


Figure 92—Forested area covered by selected vascular plant nontimber forest products (NTFPs) by ecosection on forest land in Oregon, 2001–2005.

Interpretation

Oregon's forests appear to have abundant resources of vascular plant species used as NTFPs, including those used for floral, medicinal, and woodcraft businesses and those important for subsistence and recreation (e.g., swordfern, St. John's wort, greenleaf manzanita, Oregon grape, and thinleaf huckleberry). The proportion of plants of a species that produce the desired quality of greens or fruits is unknown, so the actual resource may be somewhat less than that reported here. These figures will provide an important baseline for changes over time and could be used for more detailed analyses by ownership or geography.

Nontimber Forest Products Tables in Appendix 2

Table 59—Estimated area of forest land covered by vascular plant nontimber forest products, by plant group and species, Oregon, 2001–2005

Table 60—Percentage of forested plots with selected lichen nontimber forest products present, by species, Oregon, 2001–2005

Tom Iraci

Chapter 7: Conclusions

We hope this report has provided a better understanding of Oregon's forest resources, highlighting information that is new as well as confirming things you may already know from personal experience or from other data and publications. Because this report is an overview, touching briefly on many relevant topics, we expect some readers will be eager to see more indepth research and analysis on selected topics to fully understand current status, change, and relationships in Oregon forests. Some possible areas of future work may include more-comprehensive analysis and reporting of forest fuels, and indepth work on forest health issues, carbon dynamics, and forest productivity.

We expect that our own Pacific Northwest Forest Inventory and Analysis (PNW-FIA) research staff as well as researchers and analysts from other programs and institutes will investigate many of the questions that can be addressed with the annual inventory data, especially once a full cycle of data has been collected.

The annual FIA inventory, as currently designed, will continue into the future, provided funding and support for it are maintained. As directed by the 1998 Farm Bill (Section 253(c) of the Agricultural Research, Extension, and Education Reform Act of 1998), findings from the inventory will be published every 5 years. For Oregon, the next report will be written in about 2012, after all FIA plots have been visited and the first full cycle of data collection is completed.

Glossary

abiotic—Pertaining to nonliving factors such as temperature, moisture, and wind (Goheen and Willhite 2006).

aerial photography—Imagery acquired from an aerial platform (typically aircraft or helicopter) by means of a specialized large-format camera with well-defined optical characteristics. The geometry of the aircraft orientation at the time of image acquisition is also recorded. The resultant photograph will be of known scale, positional accuracy, and precision. Aerial photography for natural resource use is usually either natural color or color-infrared, and is film based or acquired using digital electronic sensors.

air quality index—Value or set of values derived from a multivariate model that examines the composition of lichen communities at each plot to provide a relative estimate of air quality.

anthropogenic—Of human origin or influence (Helms 1998).

aspect—Compass direction that a slope faces.

basal area—The cross-sectional area of a tree's trunk.

biodiversity—Variety and variability among living organisms and the ecological complexes in which they occur. Diversity can be defined as the number of different items and their relative frequencies. http://www.epa.gov/OCEPAterms/bterms.html. (21 March 2008).

bioenergy—Renewable energy made available from materials derived from biological sources. http://en.wikipedia.org/wiki/Bioenergy. (21 March 2008).

biomass—The aboveground weight of wood and bark in live trees 1.0 inch diameter at breast height (d.b.h.) and larger from the ground to the tip of the tree, excluding all foliage. The weight of wood and bark in lateral limbs, secondary limbs, and twigs under 0.5 inch in diameter at the point of occurrence on sapling-size trees is included in the measure, but on poletimber- and sawtimber-sized trees this material is excluded. Biomass is typically expressed as green or oven-dry weight in tons (USDA Forest Service 2006).

biosite index, ozone—A value calculated from the amount and severity of ozone injury at a site (biosite) that reflects local air quality and plant response and therefore potential risk of ozone impact in the area represented by that biosite (Campbell et al. 2007).

biotic—Pertaining to living organisms and their ecological and physiological relations (Helms 1998).

board foot—A volume measure of lumber 1 foot wide, 1 foot long, and 1 inch thick (12 in × 12 in x 1 in = 144 cubic inches). http://www.ccffa-oswa.org/B.html. (21 March 2008).

bole—Trunk or main stem of a tree (USDA Forest Service 2006).

bulk density—Mass of soil per unit volume. A measure of the ratio of pore space to solid materials in a given soil, expressed in units of grams per cubic centimeter of ovendry soil (USDA Forest Service 2006).

carbon mass—The estimated weight of carbon stored within wood tissues. On average, carbon mass values are about half of biomass values for trees, and are summarized as thousand tons or mean tons per acre.

carbon sequestration—Incorporation of carbon dioxide into permanent plant tissues (Helms 1998).

chapparal—A shrubland or heathland plant community found primarily in California, USA, that is shaped by a Mediterranean climate (mild, wet winters and hot dry summers) and wildfire. A typical chaparral plant community consists of densely-growing evergreen scrub oaks and other drought-resistant shrubs. It often grows so densely that it is all but impenetrable to large animals and humans. http://en.wikipedia.org/wiki/Chaparral. (21 March 2008).

climate index—A value or set of values derived from a multivariate model that examines the composition of lichen communities at each plot that provides a relative estimate of air quality.

coarse woody material—Down dead tree and shrub boles, large limbs, and other woody pieces that are severed from their original source of growth. Corase woody material also includes dead trees that are supported by roots, severed from roots, or uprooted, and leaning >45 degrees from vertical (USDA Forest Service 2006).

cogeneration facilities—One or more parallel generation units producing both electrical energy and steam or another form of useful energy for industrial, commercial, heating, or cooling purposes. http://www.srpnet.com/about/econ/terms.aspx. (21 March 2008).

compaction (soil)—Process by which soil grains are rearranged so as to come into closer contact with one another, resulting in a decrease in void space and an increase in soil bulk density (Helms 1998).

corporate forest land—An ownership class of private forest lands owned by a company, corporation, legal partnership, investment firm, bank, timberland investment management organization (TIMO), or real-estate investment trust (REIT).

crook—Abrupt bend in a tree or log (Helms 1998).

crown—The part of a tree or woody plant bearing live branches or foliage (Helms 1998).

crown density—The amount of crown stem, branches, twigs, shoots, buds, foliage, and reproductive structures that block light penetration through the visible crown. Dead branches and dead tops are part of the crown. Live and dead branches below the live crown base are excluded. Broken or missing tops are visually reconstructed when forming this crown outline by comparing outlines of adjacent healthy trees of the same species and d.b.h. or diameter at root collar (d.r.c.) (USDA Forest Service 2006).

crown dieback—Recent mortality of branches with fine twigs, which begins at the terminal portion of a branch and proceeds toward the trunk. Dieback is only considered when it occurs in the upper and outer portions of the tree (USDA Forest Service 2006).

crown fire—Fire that spreads across the tops of trees or shrubs more or less independently of a surface fire. Crown fires are sometimes classed as running (independent or active) or dependent (passive) to distinguish the degree of independence from the surface fire (Helms 1998).

current gross annual growth—The total growth of a given stand of trees, within a defined area, over the period of 1 year.

cyanolichens—Lichen species containing cyanobacteria, which fixes atmospheric nitrogen into a form that plants can use.

damage—Damage to trees caused by biotic agents such as insects, diseases, and animals or abiotic agents such as weather, fire, or mechanical equipment.

defoliation—Premature removal of foliage (Goheen and Willhite 2006).

diameter at breast height—The diameter of a tree stem, located at 4.5 feet above the ground (breast height) on the uphill side of a tree. The point of diameter measurement may vary on abnormally formed trees (USDA Forest Service 2006).

diameter at root collar—The diameter of a tree (usually a woodland species), measured outside of the bark at the ground line or stem root collar (USDA Forest Service 2006).

dieback—Progressive dying from the extremity of any part of the plant. Dieback may or may not result in death of the entire plant (Helms 1998).

disturbance—Any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment (Helms 1998).

down woody material (DWM)—Dead material on the ground in various stages of decay, including coarse and fine woody material. Previously named down woody debris (DWD). The DWM indicator for Forest Inventory and Analysis includes measurements of depth of duff layer, litter layer, and overall fuelbed; fuel loading on the microplot; and residue piles (USDA Forest Service 2006).

ecological region—A top-level scale in a hierarchical classification of ecological units subdivided on the basis of global, continental, and regional climatic regimes and broad physiography. Ecological regions (ecoregions) are further subdivided into domains, divisions, and provinces. The next level down in the hierarchy, subregion, is divided into ecological sections (ecosections) and subsections (Cleland et al. 1997).

ecosection—A level in a hierarchical classification of ecological units for a geographic area delineated on the basis of similar climate, geomorphic processes, stratigraphy, geologic origin, topography, and drainage systems (Cleland et al. 1997).

ecosystem—A spatially explicit, relatively homogeneous unit of the Earth that includes all interacting organisms and components of the abiotic environment within its boundaries. An ecosystem can be of any size: a log, a pond, a field, a forest, or the Earth's biosphere (Helms 1998).

elevation—Height above a fixed reference point, often the mean sea level. http://en.wikipedia.org/wiki/Elevation. (21 March 2008).

endemic—(1) Indigenous to or characteristic of a particular restricted geographical area. Antonym: exotic. (2) Referring to a disease constantly infecting a few plants throughout an area. (3) A population of potentially injurious plants, animals, or viruses that are at low levels (see epidemic) (Helms 1998).

epidemic—(1) Entomology: pertaining to populations of plants, animals, and viruses that build up, often rapidly, to unusually and generally injuriously high levels. Synonym: outbreak. Many insect and other animal populations cycle periodically or irregularly between endemic and epidemic levels. (2) Pathology: a disease sporadically infecting a large number of hosts in an area and causing considerable loss (Helms 1998).

epiphyte—Plant growing on but not nourished by another plant (Helms 1998).

erosion—The wearing away of the land surface by running water, wind, ice, or other geological agents (USDA Forest Service 2006).

exchangeable cations—Positively charged ions, often nutrients that are available for exchange and uptake by plants.

federal forest land—An ownership class of public lands owned by the U.S. government (USDA Forest Service 2006).

fine woody material (FWM)—Down dead branches, twigs, and small tree or shrub boles <3 inches in diameter not attached to a living or standing dead source (USDA Forest Service 2006).

fire regime—The characteristic frequency, extent, intensity, severity, and seasonality of fires within an ecosystem (Helms 1998).

fixed-radius plot—A circular sampled area with a specified radius in which all trees of a given size, shrubs, and other items are tallied (USDA Forest Service 2006).

foliage transparency—The amount of skylight visible through micro-holes in the live portion of the crown, i.e. where you see foliage, normal or damaged, or remnants of its recent presence (USDA Forest Service 2006).

forb—A broad-leaved herbaceous plant, as distinguished from grasses, shrubs, and trees (USDA Forest Service 2006).

forest industry land—An ownership class of private lands owned by a company or an individual(s) operating a primary wood-processing plant (USDA Forest Service 2006).

forest land—Land that is at least 10 percent stocked by forest trees of any size, or land formerly having such tree cover, and not currently developed for a nonforest use. The minimum area for classification as forest land is 1 acre. Roadside, streamside, and shelterbelt strips of timber must be at least 120 feet wide to qualify as forest land (USDA Forest Service 2006).

forest type—A classification of forest land based on and named for the tree species that forms the plurality of live-tree stocking (USDA Forest Service 2006).

forest type group—A combination of forest types that share closely associated species or site requirements (USDA Forest Service 2006).

fork—The place on a tree where the stem separates into two pieces; usually considered a defect.

fuel treatment—Any manipulation or removal of wildland fuels to reduce the likelihood or ignition or to lessen potential fire damage and resistance to control; e.g., lopping, chipping, crushing, piling, and burning. Synonym: fuel modification, hazard reduction (Helms 1998).

fuelwood—Wood salvaged from mill waste, cull logs, branches, etc., and used to fuel fires in a boiler or furnace. http://nfdp.ccfm.org/compendium/products/terminology_e.php. (21 March 2008).

fungus—Member of a group of saprophytic and parasitic organisms that lack chlorophyll, have cell walls made of chitin, and reproduce by spores; includes molds, rusts, mildews, smuts, and mushrooms. Fungi absorb nutrients from the organic matter in which they live. Not classified as plants; instead fungi are placed in the Kingdom: Fungi (Goheen and Willhite 2006).

geospatial—The combination of spatial software and analytical methods with terrestrial or geographic data sets. Often used in conjunction with geographic information systems and geomatics. http://en.wikipedia.org/wiki/Geospatial. (21 March 2008).

geothermal energy—The word "geothermal" is derived from words literally meaning "Earth" plus "heat." To produce electric power from geothermal resources, underground reservoirs of steam or hot water are tapped by wells and the steam rotates turbines that generate electricity. http://www.ngdc.noaa.gov/seg/hazard/stratoguide/glossary.html. (21 March 2008).

graminoid—Grasses (family Gramineae or Poaceae) and grasslike plants such as sedges (family Cyperaceae) and rushes (family Juncaceae). http://www.biology-online.org/dictionary/Graminoid. (21 March 2008).

grassland—Land on which the vegetation is dominated by grasses, grasslike plants, or forbs (Helms 1998).

greenhouse gas—A gas, such as carbon dioxide or methane, that contributes to potential climate change. http://www.epa.gov/OCEPAterms/gterms.html. (21 March 2008).

growing stock—All live trees 5 inches d.b.h or larger that are considered merchantable in terms of saw-log length, and grade; excludes rough and rotten cull trees (USDA Forest Service 2006).

hardwood—Tree species belonging to the botanical subdivision Angiospermae, class Dicotyledonous, usually broad-leaved and deciduous (USDA Forest Service 2006).

herbivory—The consumption of herbaceous vegetation by organisms ranging from insects to large mammals such as deer, elk, or cattle. http://www.biology-online.org/dictionary/Herbivory. (21 March 2008).

increment borer—An auger-like instrument with a hollow bit and an extractor, used to extract thin radial cylinders of wood (increment cores) from trees having annual growth rings, to determine increment or age (Helms 1998).

interpolation—A method of reallocating attribute data from one spatial representation to another. Kriging is a more complex example that allocates data from sample points to a surface. http://hds.essex.ac.uk/g2gp/gis/sect101.asp. (21 March 2008).

invasive plant—Plants that are not native to the ecosystem under consideration and that cause or are likely to cause economic or environmental harm or harm to human, animal, or plant health. http://www.invasivespeciesinfo.gov/docs/council/isacdef.pdf. (21 March 2008).

ladder fuel—Combustible material that provides vertical continuity between vegetation strata and allows fire to climb into the crowns of trees or shrubs with relative ease. Ladder fuels help initiate and ensure the continuation of a crown fire (Helms 1998).

late-successional reserves (LSRs)—Federally managed forests held in reserve for wildlife habitat and thus set aside from most commercial logging. The LSRs may contain old clearcuts as well as old-growth forests. Logging may be allowed in an LSR if it will accelerate development of old-growth characteristics. http://www.umpqua-watersheds.org/glossary/gloss_l.html. (21 March 2008).

lichen—An organism consisting of a fungus and an alga or cyanobacterium living in symbiotic association. Lichens look like masses of small, leafy, tufted or crustlike plants (USDA Forest Service 2006).

live trees—All living trees, including all size classes, all tree classes, and both commercial and noncommercial species for tree species listed in the FIA field manual (USDA Forest Service 2006).

mean annual increment (MAI) at culmination—A measure of the productivity of forest land expressed as the average increase in cubic feet of wood volume per acre per year. For a given species and site index, the mean is based on the age at which the MAI culminates for fully stocked natural stands. The MAI is based on the site index of the plot (Azuma et al. 2004b).

mensuration—Determination of dimensions, form, weight, growth, volume, and age of trees, individually, or collectively, and of the dimensions of their products (Helms 1998).

mesic—Describes sites or habitats characterized by intermediate moisture conditions; i.e., neither decidedly wet nor dry (Helms 1998).

microclimate—The climate of a small area, such as that under a plant or other cover, differing in extremes of temperature and moisture from the larger climate outside (Helms 1998).

mineral soil—A soil consisting predominantly of products derived from the weathering of rocks (e.g., sands, silts, and clays) (USDA Forest Service 2006).

MMBF—A million board feet of wood in logs or lumber (Helms 1998).

model—(1) An abstract representation of objects and events from the real world for the purpose of simulating a process, predicting an outcome, or characterizing a phenomenon. (2) Geographic information system (GIS) data representative of reality (e.g., spatial data models), including the arc-node, georelational model, rasters or grids, polygon, and triangular irregular networks (Helms 1998).

Montréal Process—In September 1993, the Conference on Security and Cooperation in Europe (CSCE) sponsored an international seminar in Montréal, Canada, on the sustainable development of boreal and temperate forests, with a focus on developing criteria and indicators for the assessment of these forests. After the seminar, Canada drew together countries from North and South America, Asia, and the Pacific Rim to develop criteria and indicators for nontropical forests and, in June 1994, the initiative now known as the Montréal Process began. The European countries elected to work as a region in the Pan-European Forest Process in the followup to the Ministerial Conferences on the Protection of Forests in Europe. http://www.mpci.org/rep-pub/1999/broch_e.html#2. (21 March 2008).

mortality—The death of trees from natural causes, or subsequent to incidents such as storms, wildfire, or insect and disease epidemics (Helms 1998).

multivariate analysis—Branch of statistics concerned with analyzing multiple measurements that have been made on one or several individuals (Helms 1998).

municipal land—Land owned by municipalities or land leased by them for more than 50 years (USDA Forest Service 2006).

mycelium—Vegetative part of a fungus, composed of hyphae and forming a thallus (Helms 1998).

mycorrhiza—The usually symbiotic association between higher plant roots (host) and the mycelia of specific fungi. Mycorrhizae often aid plants in the uptake of water and certain nutrients and may offer protection against other soil-borne organisms (Helms 1998).

national forest lands—Federal lands that have been designated by Executive order or statute as national forest or purchase units and other lands under the administration of the U.S. Department of Agriculture, Forest Service, including experimental areas and Bankhead-Jones Title III lands (Azuma et al. 2004b).

Native American lands—Tribal lands, and allotted lands held in trust by the federal government. Native American lands are grouped with farmer-owned and miscellaneous private lands as other private lands (Azuma et al. 2004b).

native species—Plant species that were native to an American region prior to Euro-American settlement. For vascular plants, they are the species that are not present on the USDA Natural Resources Conservation Service (NRCS) (2000) list of nonnative species (see nonnative species) (USDA NRCS 2000).

net primary production (NPP)—NPP represents the amount of chemical energy that is availbable to consumers in an ecosystem. It is the remaining energy from gross primary productivity discounting the loss of energy required by primary producers for respiration (adapted from Campbell 1990).

net volume—Gross volume less deductions for sound and rotten defects. Growing-stock net volume is gross volume (in cubic feet) less deductions for rot and missing bole sections on poletimber and sawtimber growing-stock trees. Sawtimber net volume is gross volume (in board feet) less deductions for rot, sweep, crook, missing bole sections, and other defects that affect the use of sawtimber trees for lumber (Azuma et al. 2004b).

nitrogen oxides (NO_x)—Gases consisting of one molecule of nitrogen and varying numbers of oxygen molecules, produced in the emissions of vehicle exhausts and from power stations. Atmospheric NO_x contributes to formation of photochemical ozone (smog), which can impair visibility and harm human health. http://www.climatechange.ca.gov/glossary/letter_n.html. (21 March 2008).

nitrophyte—One of a group of lichen species that grow in nitrogen-rich habitats.

noncorporate forest land—Private forest land owned by nongovernmental conservation or natural resource organizations; unincorporated partnerships, associations, or clubs; individuals or families; or Native Americans.

nonforest inclusion—An area that is not forested and is less than 1.0 acre and does not qualify as its own condition class (USDA Forest Service 2006).

nonnative species—Plant species that were introduced to America subsequent to Euro-American settlement. Nonnative vascular plants are present on the USDA NRCS (2000) list of nonnative species.

nonstocked areas—Timberland that is less than 10 percent stocked with live trees. Recent clearcuts scheduled for planting are classified as nonstocked area (Azuma et al. 2004b).

nontimber forest products (NTFP)—Species harvested from forests for reasons other than production of timber commodities. Vascular plants, lichens, and fungi are the primary organisms included in NTFPs.

old-growth forest—Old-growth forest is differentiated from younger forest by its structure and composition, and often by its function. Old-growth stands are typified by the presence of large older trees; variety in tree species, sizes, and spacing; multiple canopy layers; high amounts of standing and down dead wood; and broken, deformed, or rotting tops, trunks, and roots (Franklin et al. 1986).

other private forest lands—Lands in private ownership and not reported separately. These may include coal companies, land trusts, and other corporate private landowners (USDA Forest Service 2006).

overrun—Difference between the log scale of a shipment of timber and the actual volume of lumber obtained from it. http://forestry.about.com/library/glossary/blforglo.htm. (21 March 2008).

overstory—That portion of the trees, in a forest of more than one story, forming the uppermost canopy layer (Helms 1998).

owner class—A variable that classifies land into categories of ownership. Current ownership classes are listed in the FIA field manual (USDA Forest Service 2006).

owner group—A variable that combines owner classes into the following groups: Forest Service, other federal agency, state and local government, and private. Differing categories of owner group on a plot require different conditions (USDA Forest Service 2006).

ownership—A legal entity having an ownership interest in land, regardless of the number of people involved. An ownership may be an individual; a combination of persons; a legal entity such as corporation, partnership, club, or trust; or a public agency. An ownership has control of a parcel or group of parcels of land (USDA Forest Service 2006).

ozone (O_3), tropospheric—A regional, gaseous air pollutant produced primarily through sunlight-driven chemical reactions of nitrogen oxide (NO_2) and hydrocarbons in the troposphere (the lowest layer of the atmosphere). Ozone plays a significant role in greenhouse warming and urban smog and causes foliar injury to deciduous trees, conifers, shrubs, and herbaceous species (Air and Waste Management Association 1998).

paleoecology—Study of the relationships of past organisms and the environment in which they lived (Helms 1998).

pathogen—Parasitic organism directly capable of causing disease (Helms 1998).

photointerpretation (aerial photography)—A process where points, or areas of interest on an aerial photograph are studied to determine information about land cover. The FIA Pprogram uses photointerpretation to determine whether field plots are forested or not, the possible forest type and size class, and in analysis for land cover and land use changes.

phytotoxic—Poisonous to plants (Helms 1998).

prescribed burn—Deliberate burning of wildland fuels in either their natural or their modified state and under specified environmental conditions, usually to make the site less susceptible to severe wildfire. Synonym: controlled burn, prescribed fire (adapted from Helms 1998).

productive forest land—Forest land that is producing or capable of producing in excess of 20 cubic feet per acre per year of wood at culmination of mean annual increment (MAI) without regard to reserved status (USDA Forest Service 2006).

public land—An ownership group that includes all federal, state, county, and municipal lands (USDA Forest Service 2006).

pulpwood—Whole trees, tree chips, or wood residues used to produce wood pulp for the manufacture of paper products. Pulpwood is usually wood that is too small, of inferior quality, or the wrong species for the manufacture of lumber or plywood (adapted from Helms 1998; also http://nfdp.ccfm.org/compendium/products/terminology_e.php. (21 March 2008).)

quadrat—The basic 3.28 square feet sampling unit for the Phase 3 Vegetation Indicator (USDA Forest Service 2006).

rangeland—Expansive, mostly unimproved lands on which a significant proportion of the natural vegetation is native grasses, grass-like plants, forbs, and shrubs. Rangelands include natural grasslands, savannas, shrublands, many deserts, tundra, alpine communities, coastal marshes, and wet meadows. http://en.wikipedia.org/wiki/Rangeland (21 March 2008).

regeneration (artificial and natural)—The established progeny from a parent plant, seedlings or saplings existing in a stand, or the act of renewing tree cover by establishing young trees naturally or artificially. May be artificial (direct seeding or planting) or natural (natural seeding, coppice, or root suckers) (adapted from Helms 1998).

remote sensing—Capture of information about the Earth from a distant vantage point. The term is often associated with satellite imagery but also applies to aerial photography, airborne digital sensors, ground-based detectors, and other devices. http://www.nsc.org/ehc/glossar2.htm. (21 March 2008).

reserved forest land—Land permanently reserved from wood products utilization through statute or administrative designation. Examples include national forest wilderness areas and national parks and monuments (USDA Forest Service 2006).

richness—The number of different species in a given area, often referred to at the plot scale as alpha diversity and at the region scale as gamma diversity (USDA NRCS 2000).

riparian—Related to, living in, or associated with a wetland, such as the bank of a river or stream or the edge of a lake or tidewater. The riparian biotic community significantly influences and is influenced by the neighboring body of water (Helms 1998).

salvage cutting—Removal of dead trees, or trees damaged or dying because of injurious agents other than competition, to recover economic value that would otherwise be lost. Synonym: salvage felling, salvage logging (Helms 1998).

sampling error—Difference between a population value and a sample estimate that is attributable to the sample, as distinct from errors due to bias in estimation, errors in observation, etc. Sampling error is measured as the standard error of the sample estimate (Helms 1998).

sapling—A live tree 1.0 to 4.9 inhes in diameter (USDA Forest Service 2006).

saw log—A log meeting minimum standards of diameter, length, and defect for manufacture into lumber or plywood. The definition includes logs with a minimum diameter outside bark for softwoods of 7 inches (9 inches for hardwoods) (Azuma et al. 2004b).

sawtimber trees—Live softwood trees of commercial species at least 9.0 inches in d.b.h. and live hardwood trees of commercial species at least 11.0 inches in d.b.h. At least 25 percent of the board foot volume in a sawtimber tree must be free from defect. Softwood trees must contain at least one 12-foot saw log with a top diameter of not less than 7 inches outside bark; hardwood trees must contain at least one 8-foot saw log with a top diameter of not less than 9 inches outside bark (Azuma et al. 2004b).

seedlings—Live trees <1.0 inch d.b.h. and at least 6 inches in height (softwoods) or 12 inches in height (hardwoods) (USDA Forest Service 2006).

shrub—Perennial, multistemmed woody plant, usually less than 13 to16 feet in height, although under certain environmental conditions shrubs may be single-stemmed or taller than 16 feet. Includes succulents (e.g., cacti) (USDA Forest Service 2007b).

shrubland—A shrub-dominated vegetation type that does not qualify as forest.

slope—Measure of change in surface value over distance, expressed in degrees or as a percentage (Helms 1998).

snag—Standing dead tree ≥5 inches d.b.h. and ≥4.5 feet in length, with a lean of <45 degrees. Dead trees leaning more than 45 degrees are considered to be DWM. Standing dead material shorter than 4.5 feet are considered stumps (USDA Forest Service 2007b).

species group—A collection of species used for reporting purposes (USDA Forest Service 2006).

species turnover—A measure of difference in species composition among plots within an area (e.g., ecological section). Also known as beta diversity. Species turnover is calculated by dividing the total number of species in an area by the mean number of species per plot (USDA NRCS 2000).

specific gravity constants—Ratio of the density (weight per unit volume) of an object (such as wood) to the density of water at 4 degrees C (39.2 degrees F) (Helms 1998).

stand age—Average age of the live dominant and codominant trees in the predominant stand size class (USDA Forest Service 2006).

state land—An ownership class of public lands owned by states or lands leased by states for more than 50 years (USDA Forest Service 2006).

stocked/nonstocked—In the FIA Program, a minimum stocking value of 10 percent live trees is required for accessible forest land (USDA Forest Service 2007b).

stocking—(1) At the tree level, the density value assigned to a sampled tree (usually in terms of numbers of trees or basal area per acre), expressed as a percentage of the total tree density required to fully use the growth potential of the land. (2) At the stand level, the sum of the stocking values of all trees sampled (Bechtold and Patterson 2005).

stratification—A statistical tool used to reduce the variance of the attributes of interest by partitioning the population into homogenous strata (Bechtold and Patterson 2005).

succession—The gradual supplanting of one community of plants by another (Helms 1998).

surface fire—A fire that burns only surface fuels, such as litter, loose debris, and small vegetation (Helms 1998).

sustainability—The capacity of forests, ranging from stands to ecoregions, to maintain their health, productivity, diversity, and overall integrity in the long run, in the context of human activity and use (Helms 1998).

terrestrial—Of or relating to the earth or its inhabitants; of or relating to land as distinct from air or water. http://www.merriam-webster.com/dictionary/terrestrial. (21 March 2008).

timberland—Forest land that is producing or capable of producing >20 cubic feet per acre per year of wood at culmination of mean annual increment (MAI). Timberland excludes reserved forest lands (USDA Forest Service 2006).

transect—A narrow sample strip or a measured line laid out through vegetation chosen for study (Helms 1998).

tree—A woody perennial plant, typically large, with a single well-defined stem carrying a more or less definite crown; sometimes defined as attaining a minimum diameter of 3 inches and a minimum height of 15 feet at maturity. For FIA, any plant on the tree list in the current field manual is measured as a tree (USDA Forest Service 2006).

understory—All forest vegetation growing under an overstory (Helms 1998).

unproductive forest land—Forest land that is not capable of producing in excess of 20 cubic feet per acre per year of wood at culmination of MAI without regard to reserved status (USDA Forest Service 2006).

unreserved forest land—Forest land that is not withdrawn from harvest by statute or administrative regulation. Includes forest lands that are not capable of producing in excess of 20 cubic feet per acre per year of industrial wood in natural stands (Smith et al. 2004).

upland—Any area that does not qualify as a wetland because the associated hydrologic regime is not sufficiently wet to produce vegetation, soils, or hydrologic characteristics associated with wetlands. In flood plains, such areas are more appropriately termed nonwetlands. http://www.biology-online.org/dictionary/Upland. (21 March 2008).

vascular plant—A plant possessing a well-developed system of conducting tissue to transport water, mineral salts, and sugars. http://www.biology-online.org/dictionary/Vascular_plant. (21 March 2008).

veneer log—A high-quality log of a desirable species suitable for conversion to veneer. Veneer logs must be large, straight, of minimum taper, and free of defects. http://www.agnr.umd.edu/MCE/Publications/Publication.cfm?ID=78. (21 July 2007).

wilderness—(1) According to the Wilderness Act of 1964, “a wilderness, in contrast with those areas where man and his works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain.” (2) A roadless land legally classified as a component area of the National Wilderness Preservation System and managed to protect its qualities of naturalness, solitude, and opportunity for primitive recreation. Wilderness areas are usually of sufficient size to make maintenance in such a state feasible (Helms 1998).

wildfire—Any uncontained fire, other than prescribed fire, occurring on wildland. Synonym: wildland fire (adapted from Helms 1998).

wildland—Land other than that dedicated for uses such as agriculture, urban, mining, or parks (Helms 1998).

wildland forest—A large continuous tract of forest with few or no developed structures on it. Delineated on aerial imagery for the purpose of detecting land use change. The PNW-FIA Program and the Oregon Department of Forestry jointly use a minimum of 640 acres with fewer than five developed structures to designate wildland forest.

wildland-urban interface (WUI)—A term used to describe an area where various structures (most notably private homes) and other human developments meet or are intermingled with forest and other vegetative fuel types. http://www.borealforest.org/nwgloss13.htm. (21 March 2008).

xeric—Pertaining to sites or habitats characterized by decidedly dry conditions (Helms 1998).

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Scientific and Common Plant Names

Scientific name	Common name
Trees:	
Abies spp.	True fir species
Abies amabilis (Dougl. ex Loud.) Dougl. ex Forbes	Pacific silver fir
Abies concolor (Gord. & Glend.) Lindl. ex Hildebr.	White fir
Abies grandis (Dougl. ex D. Don) Lindl.	Grand fir
Abies lasiocarpa (Hook.) Nutt.	Subalpine fir
Abies magnifica A. Murr.	California red fir
Abies magnifica A. Murr. var. *shastensis* Lemmon	Shasta red fir
Abies procera Rehd.	Noble fir
Acer spp.	Maple
Acer glabrum Torr.	Rocky Mountain maple
Acer macrophyllum Pursh	Bigleaf maple
Alnus spp.	Alder
Alnus rhombifolia Nutt.	White alder
Alnus rubra Bong.	Red alder
Arbutus menziesii Pursh	Pacific madrone
Betula spp.	Birch
Calocedrus decurrens (Torr.) Florin	Incense-cedar
Cercocarpus ledifolius Nutt.	Curl-leaf mountain mahogany
Chamaecyparis lawsoniana (A. Murr.) Parl.	Port-Orford-cedar
Chamaecyparis nootkatensis (D. Don) Spach	Alaska yellow-cedar
Chrysolepis chrysophylla (Dougl. ex Hook.) Hjelmqvist	Giant chinquapin, golden chinquapin
Cornus nuttallii Audubon ex Torr. & Gray	Pacific dogwood
Crataegus spp.	Hawthorn
Fraxinus spp.	Ash
Fraxinus latifolia Benth.	Oregon ash
Juniperus spp.	Redcedar, juniper
Juniperus occidentalis Hook.	Western juniper
Larix spp.	Larch
Larix occidentalis Nutt.	Western larch
Lithocarpus densiflorus (Hook. & Arn.) Rehd.	Tanoak
Malus spp.	Apple
Malus fusca (Raf.) Schneid.	Oregon crabapple
Picea spp.	Spruce
Picea engelmannii Parry ex Engelm.	Engelmann spruce
Picea sitchensis (Bong.) Carr.	Sitka spruce
Pinus spp.	Pine, Pinyon
Pinus albicaulis Engelm.	Whitebark pine
Pinus aristata Engelm.	Bristlecone pine
Pinus attenuata Lemmon	Knobcone pine
Pinus contorta Dougl. ex Loud.	Lodgepole pine
Pinus coulteri D. Don	Coulter pine
Pinus discolor D.K. Bailey & Hawksw.	Border pinyon
Pinus edulis Engelm.	Twoneedle pinyon, Colorado pinyon
Pinus flexilis James	Limber pine
Pinus jeffreyi Grev. & Balf.	Jeffrey pine
Pinus lambertiana Dougl.	Sugar pine
Pinus longaeva D.K. Bailey	Great Basin bristlecone pine
Pinus monophylla Torr. & Frém.	Singleleaf pinyon

Scientific name	Common name
Pinus monticola Dougl. ex D. Don	Western white pine
Pinus ponderosa P.& C. Lawson	Ponderosa pine
Populus spp.	Cottonwood
Populus balsamifera L. ssp. *trichocarpa* (Torr. & A. Gray ex Hook.) Brayshaw	Black cottonwood
Populus tremuloides Michx.	Quaking aspen
Prunus spp.	Cherry and plum spp.
Prunus emarginata (Dougl. ex Hook.) D. Dietr.	Bitter cherry
Prunus virginiana L.	Chokecherry
Pseudotsuga menziesii (Mirbel) Franco	Douglas-fir
Quercus spp.	Oak
Quercus chrysolepis Liebm.	Canyon live oak
Quercus garryana Dougl. ex Hook.	Oregon white oak
Quercus kelloggii Newberry	California black oak
Quercus lobata Née	California white oak
Sequoia sempervirens (Lamb. ex D. Don) Endl.	Redwood
Taxus brevifolia Nutt.	Pacific yew
Thuja spp.	Cedar
Thuja plicata Donn ex D. Don	Western redcedar
Tsuga spp.	Hemlock
Tsuga heterophylla (Raf.) Sarg.	Western hemlock
Tsuga mertensiana (Bong.) Carr.	Mountain hemlock
Ulmus spp.	Elm
Umbellularia californica (Hook. & Arn.) Nutt.	California-laurel
Shrubs:	
Acer circinatum Pursh	Vine maple
Arceuthobium spp.	Dwarf mistletoe
Arctostaphylos spp.	Manzanita
Arctostaphylos columbiana Piper	Hairy manzanita
Arctostaphylos nevadensis Gray	Pinemat manzanita
Arctostaphylos patula Greene	Greanleaf manzanita
Arctostaphylos uva-ursi (L.) Spreng.	Kinnikinnick
Arctostaphylos viscida Parry	Sticky whiteleaf manzanita
Ceanothus velutinus Dougl. ex Hook.	Snowbrush ceanothus
Chimaphila umbellata (L.) W. Bart.	Pipsissewa
Cytisus scoparius (L.) Link	Scotch broom
Eriodictyon californicum (Hook. & Arn.) Torr.	California yerba santa
Frangula purshiana (DC.) Cooper	Pursh's buckthorn
Gaultheria shallon Pursh	Salal
Ilex aquifolium L.	English holly
Ilex opaca Aiton	American holly
Mahonia aquifolium (Pursh) Nutt.	Oregon grape
Mahonia nervosa (Pursh) Nutt.	Dwarf Oregon grape
Mahonia repens (Lindl.) G. Don	Creeping barberry
Oplopanax horridus Miq.	Devilsclub
Paxistima myrsinites (Pursh) Raf.	Oregon boxleaf
Ribes spp.	Currant
Rosa spp.	Rose
Rubus discolor Weihe & Nees	Himalayan blackberry
Rubus laciniatus Willd.	Cutleaf blackberry
Rubus ursinus Cham. & Schlecht.	Trailing blackberry
Salix spp.	Willow

Scientific name	Common name
Salix scouleriana Barratt ex Hook.	Scouler's willow
Sambucus nigra L.	European black elderberry
Sambucus nigra L. ssp. *cerulea* (Raf.) R. Bolli	Blue elderberry
Sambucus racemosa L.	Red elderberry
Symphoricarpos spp.	Snowberry
Vaccinium membranaceum Dougl. ex Torr.	Thinleaf huckleberry
Vaccinium ovatum Pursh	California huckleberry
Forbs:	
Achillea millefolium L.	Common yarrow
Anaphalis margaritacea (L.) Benth.	Western pearly everlasting
Arnica cordifolia Hook.	Heartleaf arnica
Asarum caudatum Lindl.	British Columbia wildginger
Centaurea solstitialis L.	Yellow star-thistle
Cirsium spp.	Thistle
Cirsium arvense (L.) Scop.	Canada thistle
Cirsium vulgare (Savi) Ten.	Bull thistle
Digitalis purpurea L.	Purple foxglove
Equisetum spp.	Horsetail
Hypericum perforatum L.	St. John's wort
Hypochaeris radicata L.	Hairy cat's ear
Leucanthemum vulgare Lam.	Oxeye daisy
Polystichum munitum (Kaulfuss) K. Presl	Swordfern
Pteridium aquilinum (L.) Kuhn	Brackenfern
Trillium ovatum Pursh	Pacific trillium
Urtica dioica L.	Stinging nettle
Xerophyllum tenax (Pursh) Nutt.	Common beargrass
Graminoids:	
Aira caryophyllea L.	Silver hairgrass
Avena fatua L.	Wild oat
Brachypodium sylvaticum (Huds.) Beauv.	False brome
Bromus diandrus Roth	Ripgut brome
Bromus tectorum L.	Cheatgrass
Cynosurus echinatus L.	Bristly dogstail grass
Dactylis glomerata L.	Orchardgrass
Elymus elymoides (Raf.) Swezey	Bottlebrush squirreltail
Holcus lanatus L.	Common velvetgrass
Taeniatherum caput-medusae (L.) Nevski	Medusahead
Lichens:	
Alectoria sarmentosa (Ach.) Ach.	Witch's hair lichen
Bryoria fremontii (Tuck.) Brodo & D. Hawksw.	Old man's beard
Letharia vulpina (L.) Hue	Wolf lichen
Lobaria spp.	Lungwort lichens
Lobaria oregana (Tuck.) Mull. Arg.	Oregon lung lichen
Lobaria pulmonaria (L.) Hoffm.	Lungwort lichen
Parmelia saxatilis (L.) Ach.	Crottle
Pseudocyphellaria spp.	Pseudocyphellaria lichen
Usnea spp.	Beard lichens
Usnea hirta (L.) F.H. Wigg.	Beard lichen
Vulpicida canadensis (Rasanen) J. E. Mattsson & M.J. Lai	Brown-eyed sunshine lichen
Xanthoria polycarpa (Hoffm.) Rieber	Orange wall lichen

Metric Equivalents

When you know:	Multiply by:	To find:
Inches	2.54	Centimeters
Feet	0.3048	Meters
Miles	1.609	Kilometers
Acres	0.405	Hectares
Board feet	0.0024	Cubic meters
Cubic feet	0.0283	Cubic meters
Cubic feet per acre	0.06997	Cubic meters per hectare
Square feet	0.0929	Square meters
Square feet per acre	0.229	Square meters per hectare
Ounce	28349.5	Milligrams
Pounds	0.453	Kilograms
Pounds per cubic foot	16.018	Kilograms per cubic meter
Tons per acre	2.24	Megagrams per hectare
Degrees Farenheit	17.22	Degrees Celcius
Kilowatt hours	3,409	B.t.u. (mean)

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Appendix 1: Methods and Design

Field Design and Sampling Method

The Pacific Northwest Research Station's Forest Inventory and Analysis (PNW-FIA) Program implemented the new annual inventory across all ownerships in Oregon in 2001. The overall sampling design is a significant change from that of previous periodic inventories; the differences will be discussed more fully below.

In the annual inventory system for the Pacific Northwest (Alaska, Washington, Oregon, and California), the objective is to measure approximately 10 percent of the annual plots across an entire state each year. This annual subsample is referred to as a panel. The plots measured in a single panel are selected to ensure systematic coverage within each county, spanning both public and privately owned forests, and including lands reserved from industrial wood production such as national parks, wilderness areas, and natural areas. Estimates of forest attributes can be derived from measurements of a single panel for areas as small as a survey unit or ecosection; however, such estimates are often imprecise because one panel represents only 10 percent of the full inventory sample. More-precise statistics are obtained by combining data from multiple panels. After at least 60 percent of plots have been sampled, change can be estimated through a comparison of different sets of panels, using a moving average. Estimates from sampled plots in the five panels measured from 2001 to 2005 were combined to produce the statistics in this report. Once all panels have been measured (2010), we will remeasure each one approximately every 10 years.

The FIA Program collects information in three phases. In phase 1, a sample of points is interpreted from remotely sensed imagery, either aerial photos or satellite data, and the landscape is stratified into meaningful groupings, such as forested and nonforested areas, ecologically similar regions, and forest types. In phase 2, field plots are measured for a variety of indicators that describe forest composition, structure, and the physical geography of the landscape. Phase 2 plots are spaced at approximate 3-mile intervals on a hexagonal grid throughout the forest. In phase 3, a 1/16 sample of phase 2 plots is measured to assess forest health indicators.

Phase 1

The goal of phase 1 is to reduce the variance associated with estimates of forest land area and volume. Digital imagery collected by remote-sensing satellites is classed into a few similar strata (such as forest or nonforest) by means of standard techniques for image classification, and the total area of each of these strata is used to assign a representative acreage to each sample plot. Source data were derived from Landsat Thematic Mapper (98.4 feet resolution) imagery collected between 1990 and 1992. An image-filtering technique is used to classify individual plots by a summary of the 5- by 5-pixel region that surrounds the pixel containing a sample plot. The resulting 26 classes, or strata (ranging from entirely forested to entirely nonforested, for example), are combined with other geographic attributes likely to improve stratification effectiveness, such as owner class. The resulting strata are evaluated for each estimation unit (county, or combination of small counties), and collapsed as necessary to ensure that at least four plots are in each stratum. Stratified estimation is applied by assigning each plot to one of these collapsed strata and by calculating the area of each collapsed stratum in each estimation unit. The estimates from stratified data are usually more precise than those from unstratified estimates.

Phase 2

The plot installed at each forested phase 2 location is a cluster of four subplots spaced 120 feet apart (fig. 93). Subplot 1 is in the center, with subplots 2 through 4 uniformly distributed radially around it. Each point serves as the center of a 1/24-acre circular subplot used to sample all trees at least 5.0 inches in diameter at breast height (d.b.h.). A 1/300-acre microplot, with its center located just east of each subplot center, is used to sample trees 1.0 to 4.9 inches d.b.h., as well as seedlings (trees less than 1.0 inch d.b.h.). On national forests in Oregon, a hectare plot (a 185.1-foot fixed-radius plot centered on subplot 1) is also established to tally trees larger than 32 inches d.b.h. in eastern Oregon and 48 inches d.b.h. in western Oregon.

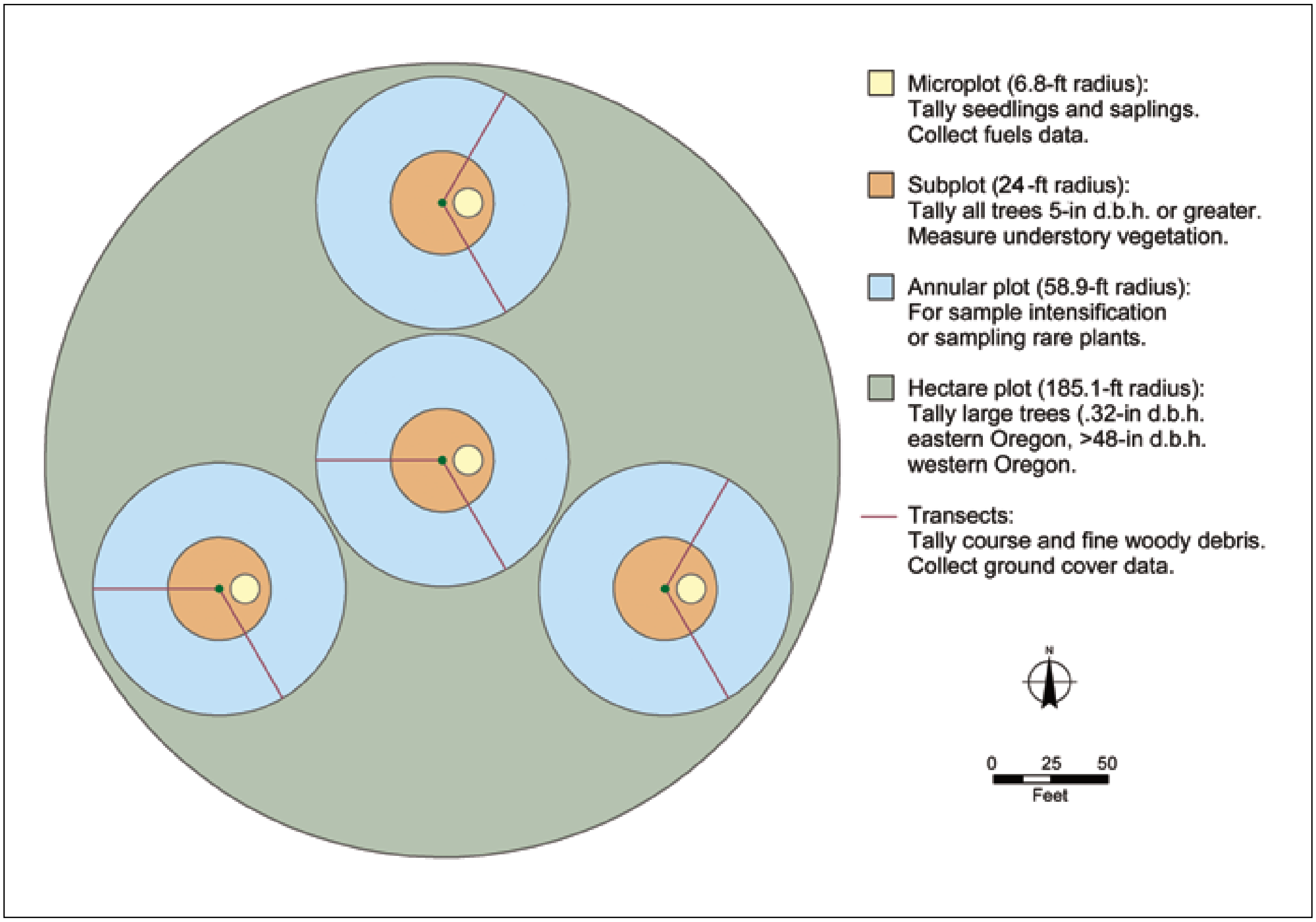

Figure 93—The Forest Inventory and Analysis plot design used in the Oregon annual inventory, 2001–2005.

All phase 2 plots classified through aerial photography as possibly being forested are established in the field without regard to land use or land cover. Field crews delineate areas that are comparatively less heterogeneous than the plot as a whole with regard to reserved status, owner group, forest type, stand size class, regeneration status, and tree density; these areas are described as condition classes. The process of delineating these condition classes on a fixed-radius plot is called mapping. All measured trees are assigned to the mapped condition class in which they are located.

On phase 2 plots, crews assess physical characteristics such as slope, aspect, and elevation; stand characteristics such as age, size class, forest type, disturbance, site productivity, and regeneration status; and tree characteristics such as tree species, diameter, height, damages, decay, and vertical crown dimensions. They also collect general descriptive information such as soil depth, proximity to water and roads, and the geographic position of the plot in the larger landscape. In Oregon, crews also assess height and cover of understory species, the structure of live and dead fuels, and the structure and composition of downed wood as regional variables (see "Core, Core-Optional, and Regional Variables" section below).

The PNW-FIA Program sampled 2,619 forested phase 2 plots in Oregon between 2001 and 2005. Estimates of timber volume and other forest attributes were derived from tree measurements and classifications made at each plot. Volumes for individual tally trees were computed with equations for each of the major species in Oregon. Estimates of growth, removals, and mortality were determined from the remeasurement of 1,437 permanent sample plots established in the previous inventory in conjunction with increment cores taken during the annual inventory.

Phase 3

More-extensive forest health measurements are collected in a 16-week period during the growing season (when most plants are in full leaf and many are flowering) on a subset (1/16) of phase 2 sample locations. At the phase 3 plots, measurements are taken on tree crowns, soils, lichens, down woody material, and understory vegetation, in addition to the phase 2 variables. One forest health measurement, ozone injury, is conducted on a separate grid with all 35 ozone plots measured annually.

The PNW-FIA Program sampled 333 forested phase 3 plots in Oregon between 2001 and 2005. The relatively small number of phase 3 samples is intended to serve as a broad-scale detection monitoring system for forest health problems.

Core, Core-Optional, and Regional Variables

The majority of FIA variables collected in Oregon are identical to those collected by FIA elsewhere in the United States—these are national "core" or "core optional" variables (as the name suggests, collection of core optional variables is optional but, if collected, they must be collected in the same way everywhere). A number of other variables are unique to PNW-FIA—these are "regional" variables and include such items as down woody material and understory vegetation on phase 2 plots (not to be confused with down woody and understory vegetation on phase 3 plots, which are measured using a slightly different protocol), as well as insect and disease damage, a record of previous disturbance on the plot, and measurements for special studies (such as nesting habitat assessment for the marbled murrelet (*Brachyramphus marmoratus*)).

Data Processing

The data used for this report are stored in the FIA National Information Management System (NIMS). NIMS provides a means to input, edit, process, manage, and distribute FIA data. NIMS includes a process for data loading, a national set of edit checks to ensure data consistency, an error-correction process, approved equations and algorithms, code to compile and calculate attributes, a table report generator, and routines to populate the presentation database. NIMS applies numerous algorithms and equations to calculate, for example, stocking, forest type, stand size, volume, and biomass. NIMS generates estimates and associated statistics based on county areas and stratum weights developed outside of NIMS. Additional FIA statistical design and estimation techniques are further reviewed in Bechtold and Patterson (2005).

Statistical Estimates

Throughout this report we have published standard errors (SE) for most of our estimates. These standard errors account for the fact that we measured only a small sample of the forest (thereby producing a sample-based estimate) and not the entire forest (which is the population parameter of interest). Because of small sample sizes or high variability within the population, some estimates can be very imprecise. The reader is encouraged to take the standard error into account when drawing any inference. One way to consider this type of uncertainty is to construct confidence intervals. Customarily, 66 percent or 95-percent confidence intervals are used. A 95-percent confidence interval means that one can be 95-percent confident that the interval contains the true population parameter of interest. For more details about confidence intervals, please consult Moore and McCabe (1989) or other statistical literature.

It is relatively easy to construct approximate 66-percent or 95-percent confidence intervals by multiplying the standard error by 1.0 (for 66-percent confidence intervals) or 1.96 (for 95-percent confidence intervals) and subtracting from and adding this to the estimate itself. For example, in table 2 of appendix 2 we estimated the total timberland in Oregon to be 24,735 thousand acres with a SE of 256. A 95 percent confidence interval for the total timberland area ranges from 24,233 to 25,237 thousand acres.

The reader may want to assess whether or not two estimates are significantly different from each other. The statistically correct way to address this is to estimate the SE of the difference of two estimates, and either construct a confidence interval or use the equivalent z-test. However, this requires the original inventory data. It is often reasonable to assume that two estimates are nearly uncorrelated. For example, plots usually belong to one and only one owner. The correlation between estimates for different owners will be very small. If both estimates can be assumed to be nearly uncorrelated, the SE of the difference can be estimated by

$$SE_{Difference} = \sqrt{SE^2_{\text{Estimate 1}} + SE^2_{\text{Estimate 2}}}$$

Using the SE of the difference, a confidence interval for the difference can be constructed with this method.

If two estimates are based on data that occur on the same plot at the same time, the above equation should not be used. For example, table 17 in appendix 2 contains estimates of tree volume by diameter class. If the reader wants to compare the volume of trees in the diameter class 9.0 to 10.9 d.b.h. (21.6 billion board feet) with that of trees in the diameter class 21.0 to 22.9 d.b.h. (33.15 billion board feet), the covariance between the estimates is not zero and this equation should not be used.

There are two other approaches the reader could possibly consider, but we do not recommend them. The first is to construct a confidence interval for one estimate and evaluate whether the other estimates fall within the interval. The problem is that unless both estimates are **highly positively** correlated, this approach will lead to a too-small confidence interval. The second approach is to construct confidence intervals for both estimates and determine whether or not they overlap. The problem here is that unless **both** estimates are highly negatively correlated, this approach will be very conservative. For more complex and indepth analysis, the reader may contact the PNW-FIA Program.

All estimates—means, totals and their associated SE—are based on the poststratification methods described by Bechtold and Patterson (2005).

Access Denied, Hazardous, or Inaccessible Plots

Although every effort was made to visit all field plots that were entirely or partially forested, some were not sampled for a variety of reasons. Field crews may have been unable to obtain permission from the landowner to access the plot ("denied access"), and there were some plots that were impossible for crews to safely reach or access ("hazardous/inaccessible"). Some private landowners deny access to their land. Although permission to visit public lands is almost always granted, some public land lies in higher elevation areas that can be very difficult or impossible to reach.

This kind of missing data can introduce bias into the estimates if the nonsampled plots tend to be different from the entire population. Plots that are obviously nonforested (based on aerial photos) are rarely visited, and therefore the proportion of denied-access, hazardous, or inaccessible plots is significantly smaller than it is for forested plots.

The poststratification approach outlined in Bechtold and Patterson (2005) removes nonsampled plots from the sample. Estimates are adjusted for plots that are partially nonsampled by increasing the estimates by the nonsampled proportion within each stratum. To reduce the possible bias introduced by nonsampled plots, we delineated five broad strata groups: census water, forested public land, nonforested public land, forested private land, and nonforested private land. Some of these five broad strata groups were further divided into smaller strata to reduce the variance.

Percentage of denied-access and hazardous/inaccessible plots for each of the five broad strata groups for Oregon, 2001–2005 are as follows:

Strata group	Total plots	Denied access	Hazardous/ inaccessible
		- - - - *Percent* - - - -	
Census water	147	0.68	0.17
Private forest	1,189	10.04	0.42
Private nonforest	1,133	3.00	0.03
Public forest	1,701	0.57	0.90
Public nonforest	1,111	0.29	0.40
Total	5,281	3.17	0.48

Timber Products Output Survey

The timber products information presented in this report was based on a census of Oregon's timber processors and out-of-state processors that use Oregon timber. The census was conducted by the University of Montana's

Bureau of Business and Economic Research in cooperation with PNW-FIA (Brandt et al. 2006). Through a written questionnaire or a phone interview, forest products manufacturers provided the following information for each of their facilities: plant production capacity and employment; volume of raw material received by county and ownership; species of timber received; finished product volumes, types, sales value, and market locations; and utilization and marketing of manufacturing residue. This survey is designed to determine the size and composition of Oregon's timber harvest and forest products industry, the industry's use of forest resources, and the generation and disposition of wood residues.

National Woodland Owner Survey

This survey of private forest owners is conducted annually by the FIA Program to increase our understanding of private woodland owners. Questionnaires are mailed to individuals and private groups who own woodlands in which FIA has established forest inventory plots. Nationally, 20 percent of these owners (about 50,000) are contacted each year, with more-detailed questionnaires sent to coincide with national census, inventory, and assessment programs. For Oregon, 161 private noncorporate woodland owners were sent questionnaires, and the 92 that were returned provide the data that were summarized and presented in this report.

Periodic Versus Annual Inventories

The PNW-FIA Program began fieldwork for the fifth inventory of Oregon in 2001. This was the first inventory that used the annual inventory system, in which 1/10 of all forested plots (referred to as one panel) were visited each year. The first statewide panel of field plots was completed in 2001, and half of all field plots in the state were measured by 2006, prompting production of this congressionally mandated 5-year analysis of Oregon's forest resources.

Data from new inventories are often compared with those from earlier inventories to determine trends in forest resources. However, for the comparisons to be valid, the procedures used in the two inventories must be similar. Previous inventories of Oregon's forest resources were completed in 1964, 1976, 1985, 1992, and 1998. These were periodic inventories in which all forested plots outside of national forests in the state were visited within a 2- or 3-year window.

As a result of our ongoing efforts to improve the efficiency and reliability of the inventory, several changes in procedures and definitions have been made since the last Oregon inventory in 1998. These changes include an increase in plot density of about 18 percent, a new plot footprint (changing from a five-subplot configuration in which about 2.5 acres were sampled, to a four-subplot configuration in which about 1 acre is sampled) (figs. 93 and 94), a new set of nationally consistent measurement protocols, and a plot visitation schedule that calls for sampling of 10 percent of all forested plots in the state each year. Although these changes will have little impact on statewide estimates of forest area, timber volume, and tree biomass, they may significantly affect plot classification variables such as forest type and stand size class (especially county-level estimates).

Estimates of growth, removals, and mortality (GRM) are particularly dependent on comparisons between inventories, and thus are most likely to be valid when based on remeasurements of the same plots and trees. Only half of the field plots (5 out of 10 panels) have been visited under the annual system to date, and the increase in plot density means about 18 percent of the plots are new and were not visited during a previous inventory. Unlike the five-subplot, variable-radius design used in the 1998 periodic inventory, the annual inventory uses fixed-radius sampling on four subplots, with only one subplot center coinciding with that of a periodic subplot (fig. 94). Thus, relatively few of the trees sampled at the periodic inventory were or will be remeasured in the annual inventory. Estimates of GRM will improve as the annual inventory becomes fully implemented and several panels of plots are remeasured.

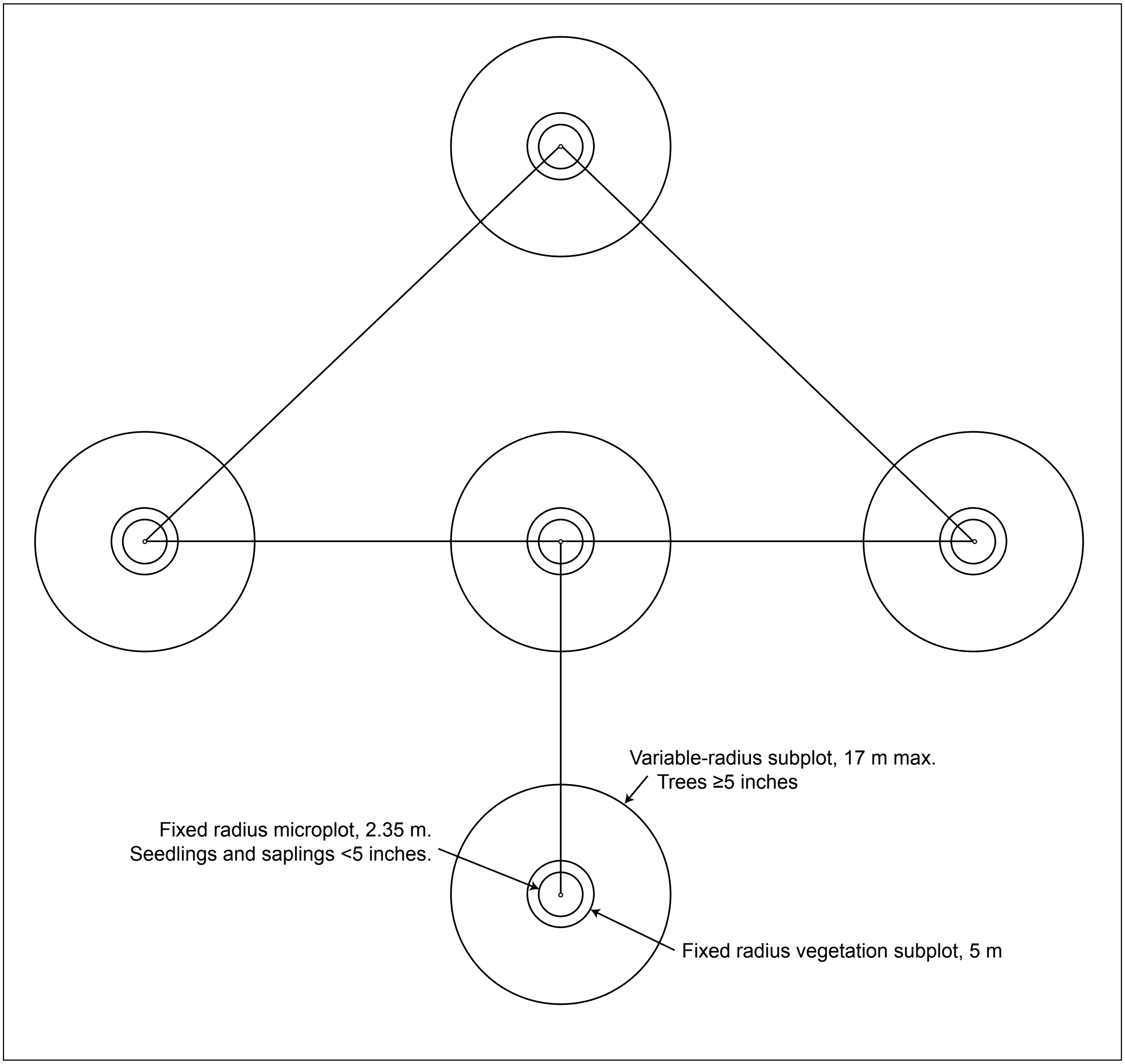

Figure 94—Typical plot design used in Oregon periodic inventories.

Appendix 2: Summary Data Tables

The following tables contain basic information about the forest resources of Oregon as they relate to the discussions of current forest issues and basic resource information presented in this report. These tables aggregate data to a variety of levels, including county (fig. 5), ecosection (fig. 6), owner group (fig. 7), survey unit (fig. 8), and forest type, allowing FIA inventory results to be applied at various scales and used for various analyses. Many other tables could be generated from the Oregon annual data, but space limits us to a few (60+) key ones. Data are also available for download in nonsummarized form at http://www.fia.fs.fed.us.

The national FIA Web site (http://www.fia.fs.fed.us/tools-data/data/) contains a tool for querying the Oregon annual data and generating custom tables or maps. Some of the tables below contain summaries of regional variables; data for regional variables currently are not included in the national FIA database (FIADB). Additional information on regional variables can be requested from our office by e-mailing Karen Waddell (kwaddell@fs.fed.us).

Please note that information in tables presented here and in those generated from the FIADB may differ. As new data are added each year to FIADB, any tables generated from it will be based on the current full set of data in FIADB (e.g., 2001–2006, 2001–2007, etc.), whereas tables in this publication contain data from only 2001–2005. The user can take a snapshot of data from FIADB by selecting the desired years and generating tables that are similar, but probably not identical, to those presented here.

List of Tables

Table 1—Number of Forest Inventory and Analysis plots measured from 2001 to 2005, by land class, sample status, ownership group, Oregon

Table 2—Estimated area of forest land, by owner class and forest land status, Oregon, 2001–2005

Table 3—Estimated area of forest land, by forest type group and productivity class, Oregon, 2001–2005

Table 4—Estimated area of forest land, by forest type group, ownership, and land status, Oregon, 2001–2005

Table 5—Estimated area of forest land, by forest type group and stand size class, Oregon, 2001–2005

Table 6—Estimated area of forest land, by forest type group and stand age class, Oregon, 2001–2005

Table 7—Estimated area of timberland, by forest type group and stand size class, Oregon, 2001–2005

Table 8—Estimated number of live trees on forest land, by species group and diameter class, Oregon, 2001–2005

Table 9—Estimated number of growing-stock trees on timberland, by species group and diameter class, Oregon, 2001–2005

Table 10—Estimated net volume of all live trees on forest land, by owner class and forest land status, Oregon, 2001–2005

Table 11—Estimated net volume of all live trees on forest land, by forest type group and stand size class, Oregon, 2001–2005

Table 12—Estimated net volume of all live trees on forest land, by species group and ownership, Oregon, 2001–2005

Table 13—Estimated net volume of all live trees on forest land, by species group and diameter class, Oregon, 2001–2005

Table 14—Estimated net volume of growing-stock trees on timberland, by species group and diameter class, Oregon, 2001–2005

Table 15—Estimated net volume of growing-stock trees on timberland, by species group and ownership, Oregon, 2001–2005

Table 16—Estimated net volume (International ¼-inch rule) of sawtimber trees on timberland, by species group and diameter class, Oregon, 2001–2005

Table 17—Estimated net volume (Scribner rule) of sawtimber trees on timberland, by species group and diameter class, Oregon, 2001–2005

Table 18—Estimated net volume (cubic feet) of sawtimber trees on timberland, by species group and ownership, Oregon, 2001–2005

Table 19—Estimated aboveground biomass of all live trees on forest land, by owner class and forest land status, Oregon, 2001–2005

Table 20—Estimated aboveground biomass of all live trees on forest land, by species group and diameter class, Oregon, 2001–2005

Table 21—Estimated mass of carbon of all live trees on forest land, by owner class and forest land status, Oregon, 2001–2005

Table 22—Estimated biomass and carbon mass of live trees, snags, and down wood on forest land, by forest type group, Oregon, 2001–2005

Table 23—Average biomass and carbon mass of live trees, snags, and down wood on forest land, by forest type group, Oregon, 2001–2005

Table 24—Index of vascular plant species richness on forest land, by ecological section, Oregon, 2005

Table 25—Index of lichen richness on forest land, by ecological section, Oregon, 1998–2001, 2003

Table 26—Summary of lichen community indicator species richness on forest land, Pacific Northwest and Oregon, 1998–2001, 2003

Table 27—Estimated average biomass, volume, and density of down wood on forest land, by forest type group and diameter class, Oregon, 2001–2005

Table 28—Estimated biomass and carbon mass of down wood on forest land, by forest type group and owner, Oregon, 2001–2005.

Table 29—Estimated average biomass, volume, and density of snags on forest land, by forest type group and diameter class, Oregon, 2001–2005

Table 30—Estimated biomass and carbon mass of snags on forest land, by forest type group and owner, Oregon, 2001–2005.

Table 31—Estimated area and net volume of live trees on riparian forest land by location, Oregon, 2001–2005

Table 32—Estimated area of riparian forest land by forest type group, owner, and location, Oregon, 2001–2005

Table 33—Estimated net volume of live trees on riparian forest land by species group, owner and location, Oregon, 2001–2005

Table 34—Estimated mean crown density and other statistics for live trees on forest land, by species group, Oregon, 2001–2005

Table 35—Mean foliage transparency and other statistics for live trees on forest land, by species group, Oregon, 2001–2005

Table 36—Mean crown dieback and other statistics for live trees on forest land, by species group, Oregon, 2001–2005

Table 37—Properties of the forest floor layer on forest land, by forest type, Oregon, 2001, 2003–2005

Table 38—Properties of the mineral soil layer on forest land, by depth of layer and forest type, Oregon, 2001, 2003–2005

Table 39—Chemical properties of mineral soil layers on forest land, by depth of layer and forest type, Oregon, 2001, 2003–2005

Table 40—Chemical properties (trace elements) of mineral soils on forest land, by forest type, Oregon, 2001, 2003–2005

Table 41—Compaction, bare soil, and slope properties of forest land, by forest type, Oregon, 2001, 2003–2005

Table 42—Mean cover of understory vegetation on forest land, by forest type group and life form, Oregon 2001–2005

Table 43—Mean cover of understory vegetation on forest land, by forest type class, age class, and life form, Oregon, 2001–2005

Table 44—Estimated number of live trees with damage on forest land, by species and type of damage, Oregon, 2001–2005

Table 45—Estimated area of forest land with more than 25 percent of the tree basal area damaged, by forest type and type of damage, Oregon, 2001–2005

Table 46—Estimated gross volume of live trees with damage on forest land, by species and type of damage, Oregon, 2001–2005

Table 47— Estimated number of live trees with damage, acres of forest land with greater than 25 percent of the basal area damaged, and gross volume of live trees with damage, by geographic region and ownership group, Oregon, 2001–2005

Table 48—Estimated area of forest land covered by selected nonnative vascular plant species and number of sample plots, by life form and species, Oregon, 2001–2005

Table 49—Summary of Forest Inventory and Analysis plots sampled for lichen community, air quality index information, western Pacific Northwest (PNW) and western Oregon, 1998–2001, 2003

Table 50—Summary of Forest Inventory and Analysis plots sampled for lichen community, climate index information, western Pacific Northwest (PNW) and western Oregon, 1998–2001, 2003

Table 51—Ozone injury summary information from ozone biomonitoring plots, by year, Oregon, 2000–2005

Table 52—Total acres of forest land with a forest fire incident, by year and ecosection group, Oregon, 1995–2004

Table 53—Estimated gross growth of softwood growing stock volume on timberland, by location and owner, Oregon, 2001–2005

Table 54—Estimated ratio of growth to removal and mortality of softwood growing stock species on timberland, by owner group and location, Oregon, 2001–2005

Table 55—Estimated gross growth, net change, and removals and mortality of softwood growing stock on timberland, by owner and location, Oregon, 2001–2005

Table 56—Estimated gross growth, net change, and removals and mortality of softwood growing stock on timberland, by species group and owner, Oregon, 2001–2005

Table 57—Total roundwood output by product, species group, and source of material, Oregon, 2003

1Table 58—Volume of timber removals by type of removal, source of material, and species group, Oregon, 2003

Table 59—Estimated area of forest land covered by vascular plant nontimber forest products, by plant group and species, Oregon, 2001–2005

Table 60—Percentage of forested plots with selected lichen nontimber forest products present, by species, Oregon, 2001–2005

Table 1—Number of Forest Inventory and Analysis plots measured from 2001 to 2005, by land class, sample status, ownership group, Oregon

Land class and sample status	National forest	Other public	Private	Total
Forest land plots:				
Softwood types	1,202	386	762	2,350
Hardwood types	83	66	207	356
Nonstocked	46	8	33	87
Total	1,331	460	1,002	2,793
Nonforest land plots:	330	1,239	1,435	3,004
Unsampled plots:				
Denied access	10	8	169	187
Hazardous	33	11	16	60
Total	43	19	185	247
Total all plots	1,704	1,718	2,622	6,044

Table 2—Estimated area of forest land, by owner class and forest land status, Oregon, 2001–2005

	Unreserved forests						Reserved forests							
	Timberland[a]		Other forest[b]		Total		Productive[a]		Other forest[b]		Total		All forest land	
Owner class	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
							Thousand acres							
USDA Forest Service:														
National forest	11,756	187	378	66	12,133	183	2,058	144	81	32	2,139	146	14,272	125
National grassland	—	—	11	12	11	12	—	—	—	—	—	—	11	12
Total	11,756	187	389	67	12,145	183	2,058	144	81	32	2,139	146	14,283	125
Other federal government:														
National Park Service	—	—	—	—	—	—	147	31	12	12	159	34	159	34
Bureau of Land Management	2,238	108	1,393	116	3,632	145	58	26	71	30	129	39	3,760	144
U.S. Fish and Wildlife Service	—	—	—	—	—	—	16	14	—	—	16	14	16	14
Departments of Defense and Energy	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other federal	27	17	—	—	27	17	—	—	—	—	—	—	27	17
Total	2,266	110	1,393	116	3,659	146	221	43	83	32	304	53	3,963	144
State and local government:														
State	871	90	46	24	917	93	23	15	—	—	23	15	940	94
Local	135	40	—	—	135	40	12	12	—	—	12	12	146	42
Other public	10	10	—	—	10	10	—	—	—	—	—	—	10	10
Total	1,015	99	46	24	1,061	101	34	19	—	—	34	19	1,096	103
Corporate private	5,844	196	156	42	6,000	199	—	—	—	—	—	—	6,000	199
Noncorporate private:														
Nongovernmental conservation or natural resource organizations	233	52	—	—	233	52	—	—	—	—	—	—	233	52
Unincorporated partnerships, associations, or clubs	74	30	33	19	106	36	—	—	—	—	—	—	106	36
Native American	358	60	105	35	463	67	—	—	—	—	—	—	463	67
Individual	3,190	169	1,139	108	4,329	193	—	—	—	—	—	—	4,329	193
Total	3,855	180	1,277	113	5,131	204	—	—	—	—	—	—	5,131	204
All owners	24,735	256	3,261	180	27,996	274	2,313	151	164	45	2,477	157	30,473	233

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 500 acres were estimated.

[a] Forest land that is capable of producing in excess of 20 cubic feet/acre/year of wood at culmination of mean annual increment.

[b] Forest land that is not capable of producing in excess of 20 cubic feet/acre/year of wood at culmination of mean annual increment

Table 3—Estimated area of forest land, by forest type group and productivity class, Oregon, 2001–2005

	Site productivity class[a] (cubic feet/acre/year)														All productivity classes	
	0–19		20–49		50–84		85–119		120–164		165–224		225+			
Forest type group	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Thousand acres															
Softwoods:																
Douglas-fir	23	17	857	98	1,440	123	1,990	144	3,948	190	2,060	145	62	28	10,380	245
Fir/spruce/mountain hemlock	133	40	990	106	1,411	125	855	98	454	73	116	36	—	—	3,960	193
Hemlock/Sitka spruce	—	—	35	20	68	28	141	40	367	63	218	50	227	51	1,055	105
Lodgepole pine	68	29	1,346	120	445	72	40	21	139	42	—	—	—	—	2,039	143
Other western softwoods	24	18	15	13	16	13	4	3	—	—	—	—	—	—	59	25
Pinyon/juniper	3	3	—	—	—	—	—	—	—	—	—	—	—	—	3	3
Ponderosa pine	30	18	2,138	147	2,359	155	516	77	211	49	—	—	—	—	5,254	204
Western juniper	2,645	161	325	60	129	37	25	17	33	21	12	12	—	—	3,170	174
Western larch	—	—	52	24	97	33	54	25	14	12	—	—	—	—	218	49
Western white pine	12	12	23	17	—	—	17	15	—	—	—	—	—	—	52	26
Total	2,938	171	5,782	221	5,965	229	3,642	194	5,167	216	2,406	155	290	58	26,191	275
Hardwoods:																
Alder/maple	—	—	19	14	10	8	130	37	650	82	455	68	76	29	1,340	111
Aspen/birch	30	18	22	17	15	11	—	—	1	2	—	—	—	—	69	27
Elm/ash/cottonwood	12	8	13	11	1	1	32	18	23	16	13	12	—	—	93	30
Other hardwoods	33	20	59	26	164	43	46	24	121	38	10	6	—	—	432	69
Tanoak/laurel	25	18	56	26	70	28	162	42	249	54	34	19	—	—	597	79
Western oak	257	55	169	44	231	51	77	28	42	21	17	12	—	—	793	92
Woodland hardwoods	78	30	72	29	46	22	12	12	5	5	—	—	—	—	213	49
Total	435	71	410	68	538	76	458	70	1,091	107	529	73	76	29	3,538	176
Nonstocked	52	24	164	43	210	49	104	32	144	38	60	24	11	11	745	88
All forest types	3,425	184	6,356	231	6,712	242	4,205	207	6,403	233	2,995	172	377	66	30,473	233

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 500 acres were estimated.

[a] Site productivity class refers to the potential productivity of forest land expressed as the mean annual increment (in cubic feet/acre/year) at culmination in fully stocked stands.

Table 4—Estimated area of forest land, by forest type group, ownership, and land status, Oregon, 2001–2005

Forest type group	USDA Forest Service				Other federal				State and local government				Corporate private				Noncorporate private				All owners	
	Timberland[a]		Other forest land		Timberland[a]		Other forest land		Timberland[a]		Other forest land		Timberland[a]		Other forest land		Timberland[a]		Other forest land			
	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Thousand acres																					
Softwoods:																						
Douglas-fir	3,416	148	562	77	1,474	99	29	19	644	80	12	12	2,842	151	—	—	1,390	118	11	12	10,380	245
Fir/spruce/mountain hemlock	2,181	147	892	99	50	25	119	34	30	19	—	—	447	73	—	—	197	48	43	23	3,960	193
Hemlock/Sitka spruce	326	57	94	34	74	28	—	—	62	27	12	12	376	63	—	—	111	35	—	—	1,055	105
Lodgepole pine	1,245	112	247	54	72	29	58	26	—	—	—	—	317	61	—	—	99	32	—	—	2,039	143
Other western softwoods	21	14	24	18	—	—	12	12	—	—	—	—	—	—	—	—	2	2	—	—	59	25
Pinyon/juniper	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	3	3	3
Ponderosa pine	3,283	162	178	45	192	44	—	—	62	27	—	—	807	92	12	11	709	82	11	12	5,254	204
Western juniper	246	51	188	46	60	25	1,347	114			34	21	51	24	115	37	156	43	973	99	3,170	174
Western larch	120	35	54	25	—	—	—	—	—	—	—	—	21	16	—	—	23	17	—	—	218	49
Western white pine	29	19	23	17	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	52	26
Total	10,869	194	2,262	151	1,923	110	1,565	121	798	88	58	27	4,861	189	127	38	2,686	155	1,042	103	26,191	275
Hardwoods:																						
Alder/maple	164	40	—	—	48	22	—	—	139	39	—	—	493	71	—	—	496	71	—	—	1,340	111
Aspen/birch	32	19	—	—	1	2	29	18	—	—	—	—	—	—	—	—	6	6	1	1	69	27
Elm/ash/cottonwood	1	1	—	—	—	—	—	—	—	—	8	8	12	8	8	7	60	27	4	3	93	30
Other hardwoods	50	23	20	15	70	27	—	—	22	16	2	3	95	34	—	—	141	40	33	20	432	69
Tanoak/laurel	151	39	128	39	67	27	—	—	—	—	—	—	164	42	—	—	88	32	—	—	597	79
Western oak	83	30	37	20	133	39	43	22	29	18	—	—	80	31	17	15	198	44	173	44	793	92
Woodland hardwoods	63	24	36	21	12	12	47	24	—	—	—	—	—	—	4	3	51	25	—	—	213	49
Total	543	72	220	50	332	60	119	37	190	46	11	9	844	93	29	17	1,039	101	211	49	3,538	176
Nonstocked	343	60	46	22	11	7	13	11	27	17	12	12	140	38	—	—	129	36	24	17	745	88
All forest types	11,756	187	2,528	159	2,266	110	1,697	126	1,015	99	81	31	5,844	196	156	42	3,855	180	1,277	113	30,473	233

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 500 acres were estimated.
[a] Unreserved forest land that is capable of producing in excess of 20 cubic feet/acre/year of wood at culmination of mean annual increment.

Table 5—Estimated area of forest land, by forest type group and stand size class, Oregon, 2001–2005

Forest type group	Large-diameter stands[a] Total	Large-diameter stands[a] SE	Medium-diameter stands[b] Total	Medium-diameter stands[b] SE	Small-diameter stands[c] Total	Small-diameter stands[c] SE	All size classes Total	All size classes SE
	Thousand acres							
Softwoods:								
Douglas-fir	7,906	231	867	97	1,607	126	10,380	245
Fir/spruce/mountain hemlock	3,330	178	221	52	409	69	3,960	193
Hemlock/Sitka spruce	892	97	50	23	114	34	1,055	105
Lodgepole pine	645	84	474	72	920	100	2,039	143
Other western softwoods	28	18	5	3	26	18	59	25
Pinyon / juniper	3	3	—	—	—	—	3	3
Ponderosa pine	4,405	192	295	57	554	78	5,254	204
Western juniper	2,045	145	362	62	762	94	3,170	174
Western larch	112	35	15	12	90	32	218	49
Western white pine	32	19	—	—	20	15	52	26
Total	19,399	293	2,288	155	4,503	212	26,191	275
Hardwoods:								
Alder/maple	697	82	420	65	224	50	1,340	111
Aspen/birch	6	6	19	13	45	23	69	27
Elm/ash/cottonwood	54	24	—	—	39	19	93	30
Other hardwoods	153	41	107	35	172	45	432	69
Tanoak/laurel	185	44	172	44	240	52	597	79
Western oak	325	59	307	58	161	42	793	92
Woodland hardwoods	144	39	—	—	69	28	213	49
Total	1,563	122	1,025	103	950	102	3,538	176
Nonstocked	—	—	—	—	—	—	745	88
All forest types	20,963	294	3,313	182	5,453	230	30,473	233

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 500 acres were estimated.
[a] Stands with a majority of trees at least 11.0 inches diameter at breast height for hardwoods and 9.0 inches diameter at breast height for softwoods.
[b] Stands with a majority of trees at least 5.0 inches diameter at breast height but not as large as large-diameter trees.
[c] Stands with a majority of trees less than 5.0 inches diameter at breast height.

Table 6—Estimated area of forest land, by forest type group and stand age class, Oregon, 2001–2005

	Stand age class (years)																									
	1–20		21–40		41–60		61–80		81–100		101–120		121–140		141–160		161–180		181–200		201+		Unknown		All forest land	
Forest type group	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Thousand acres																									
Softwoods:																										
Douglas-fir	2,027	140	2,271	151	1,513	123	940	100	1,107	109	484	74	392	66	280	55	142	41	254	53	937	98	32	20	10,380	245
Fir/spruce/mountain hemlock	148	40	202	47	403	70	528	77	788	94	361	64	228	52	276	57	229	53	332	63	465	73	—	—	3,960	193
Hemlock/Sitka spruce	155	40	223	50	233	52	102	34	34	19	67	25	17	14	48	24	—	—	52	25	125	36	—	—	1,055	105
Lodgepole pine	386	64	375	65	320	60	401	67	362	64	101	35	45	24	14	12	11	12	22	17	—	—	1	1	2,039	143
Other western softwoods	2	2	—	—	18	14	—	—	13	12	15	13	12	12	—	—	—	—	—	—	—	—	—	—	59	25
Pinyon / juniper	—	—	—	—	—	—	3	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	3
Ponderosa pine	322	60	319	61	1,007	103	1,273	118	1,220	115	279	57	163	44	212	50	124	37	154	43	181	46	—	—	5,254	204
Western juniper	132	38	260	56	552	80	916	101	609	84	160	42	64	28	59	26	73	30	137	41	191	47	16	13	3,170	174
Western larch	48	23	35	19	12	12	0	0	47	22	42	22	—	—	22	16	—	—	—	—	11	12	—	—	218	49
Western white pine	—	—	—	—	—	—	11	12	—	—	12	12	—	—	—	—	12	12	—	—	17	15	—	—	52	26
Total	3,219	176	3,687	192	4,057	200	4,176	204	4,179	202	1,521	128	921	102	911	101	592	84	952	105	1,927	140	49	23	26,191	275
Hardwoods:																										
Alder/maple	402	66	447	67	288	55	85	29	20	11	18	15	20	11	7	6	17	15	4	4	13	13	20	15	1,340	111
Aspen/birch	13	12	12	12	12	12	11	12	20	12	—	—	—	—	—	—	—	—	1	2	—	—	—	—	69	27
Elm/ash/cottonwood	20	11	31	20	5	4	24	17	13	11	—	—	—	—	—	—	—	—	—	—	—	—	—	—	93	30
Other hardwoods	72	29	90	32	112	36	79	30	65	27	—	—	—	—	—	—	14	13	—	—	—	—	—	—	432	69
Tanoak/laurel	164	43	138	40	132	39	39	22	54	23	11	11	—	—	—	—	13	13	—	—	34	18	12	12	597	79
Western oak	24	17	51	25	225	51	233	50	150	41	53	25	57	26	1	1	—	—	—	—	—	—	—	—	793	92
Woodland hardwoods	14	12	33	19	29	16	27	18	77	30	—	—	9	9	—	—	—	—	—	—	—	—	24	17	213	49
Total	709	87	802	91	802	92	498	74	399	64	82	31	85	30	7	6	44	24	5	4	48	22	56	26	3,538	176
Nonstocked	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	745	88
All forest types	4,095	194	4,533	206	4,933	217	4,738	217	4,667	213	1,603	132	1,007	106	930	102	636	87	976	106	1,985	141	105	35	30,473	233

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 500 acres were estimated.

Table 7—Estimated area of timberland, by forest type group and stand size class, Oregon, 2001–2005

	Large-diameter stands[a]		Medium-diameter stands[b]		Small-diameter stands[c]		All size classes	
Forest type group	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
				Thousand acres				
Softwoods:								
Douglas-fir	7,354	228	866	97	1,547	123	9,767	242
Fir/spruce/mountain hemlock	2,376	156	196	49	334	62	2,906	172
Hemlock/Sitka spruce	785	91	50	23	114	34	949	99
Lodgepole pine	551	77	363	63	820	95	1,734	133
Other western softwoods	2	3	5	3	15	13	23	14
Ponderosa pine	4,219	190	295	57	539	78	5,053	202
Western juniper	360	63	42	20	110	34	513	75
Western larch	79	29	4	3	80	30	163	42
Western white pine	20	15	—	—	9	9	29	19
Total	15,748	287	1,821	139	3,568	188	21,137	281
Hardwoods:								
Alder/maple	697	82	420	65	224	50	1,340	111
Aspen/birch	6	6	13	12	20	15	39	20
Elm/ash/cottonwood	42	22	—	—	31	17	73	28
Other hardwoods	151	41	107	35	119	37	377	65
Tanoak/laurel	154	41	147	40	169	43	470	71
Western oak	270	54	177	44	76	29	523	75
Woodland hardwoods	74	27	—	—	52	25	126	37
Total	1,393	115	864	95	692	87	2,948	161
Nonstocked	—	—	—	—	—	—	650	82
All forest types	17,141	291	2,684	165	4,260	202	24,735	256

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 500 acres were estimated. About 12 percent of timberland in Oregon is considered limited-use timberland. This land is not reserved by Congressional act or law, but may be limited in use for wood production. Examples include riparian corridors, late-successional reserves, administratively withdrawn areas, and adaptive management areas.

[a] Stands in which the majority of trees are at least 11.0 inches diameter at breast height for hardwoods and 9.0 inches diameter at breast height for softwoods.

[b] Stands in which the majority of trees are at least 5.0 inches diameter at breast height but not as large as large-diameter trees.

[c] Stands in which the majority of trees are less than 5.0 inches diameter at breast height.

Table 8—Estimated number of live trees on forest land, by species group and diameter class, Oregon, 2001–2005

Species group	1.0–2.9 Total	1.0–2.9 SE	3.0–4.9 Total	3.0–4.9 SE	5.0–6.9 Total	5.0–6.9 SE	7.0–8.9 Total	7.0–8.9 SE	9.0–10.9 Total	9.0–10.9 SE	11.0–12.9 Total	11.0–12.9 SE	13.0–14.9 Total	13.0–14.9 SE	15.0–16.9 Total	15.0–16.9 SE
	Thousand trees															
Softwoods:																
Douglas-fir	778,704	57,410	350,040	26,726	288,074	13,559	245,687	11,760	200,325	9,164	153,076	7,297	103,608	4,955	78,946	3,893
Engelmann and other spruces	29,709	9,143	5,994	3,167	5,310	985	3,768	772	3,486	700	3,104	681	1,804	477	1,652	458
Incense-cedar	67,235	12,342	31,082	7,510	11,845	1,752	7,641	1,272	4,831	1,049	2,937	644	3,513	734	1,240	396
Lodgepole pine	752,029	95,387	256,811	30,125	142,237	11,709	86,936	6,905	52,250	4,193	24,024	2,280	11,193	1,352	4,424	664
Other western softwoods	169,187	26,472	82,315	13,736	41,307	4,991	24,684	2,922	18,985	2,332	15,073	1,962	10,529	1,446	8,669	1,332
Ponderosa and Jeffrey pines	376,059	36,713	204,704	21,728	121,311	8,316	91,628	5,176	72,570	4,180	50,770	3,044	38,873	2,615	23,941	1,793
Redwood	20,967	22,380	8,387	8,952	471	503	67	72	—	—	67	72	—	—	—	—
Sitka spruce	6,117	2,409	6,316	3,530	3,893	828	2,739	801	3,210	1,076	2,603	885	2,201	673	1,660	655
Sugar pine	10,105	3,667	839	895	994	391	1,124	433	347	162	420	248	284	147	359	194
True fir	712,923	58,934	300,074	26,266	171,535	10,041	110,945	6,428	73,620	4,239	52,197	3,269	33,373	2,262	22,090	1,696
Western hemlock	331,548	51,829	122,562	16,282	68,648	5,582	50,117	4,049	34,633	2,762	28,975	2,610	20,845	2,059	15,299	1,619
Western juniper	64,707	9,792	44,906	8,281	40,481	3,299	30,638	2,551	20,605	2,034	13,183	1,250	7,795	861	6,048	814
Western larch	24,958	9,357	16,505	5,042	5,598	1,495	5,224	1,152	4,348	862	3,525	675	2,245	525	2,040	410
Western redcedar	68,134	13,791	22,959	6,145	11,025	1,636	6,560	1,025	4,866	853	4,008	775	2,885	592	2,183	480
Western white pine	20,365	7,011	12,455	4,749	3,860	967	2,410	657	1,822	438	917	282	1,163	400	352	163
Total	3,432,747	152,211	1,465,951	61,036	916,589	23,323	670,171	16,390	495,899	12,142	354,881	9,234	240,311	6,626	168,901	5,199
Hardwoods:																
Cottonwood and aspen	12,273	7,144	4,253	3,229	1,741	931	1,112	828	784	339	996	446	457	259	323	194
Oak	91,459	19,828	81,038	17,185	47,011	6,099	22,493	3,007	11,478	1,728	5,592	892	3,780	654	3,227	605
Other western hardwoods	484,831	61,476	198,020	23,538	126,279	8,657	77,607	5,916	44,416	3,749	23,626	2,326	12,137	1,255	8,157	1,031
Red alder	113,497	18,870	59,768	10,745	54,522	5,688	41,564	4,398	29,025	2,926	20,035	2,206	12,848	1,521	8,298	1,105
Western woodland hardwoods	120,961	48,305	23,738	8,909	10,853	1,855	9,833	1,725	4,716	1,143	2,942	731	1,668	503	962	320
Total	823,022	82,927	366,818	33,103	240,406	12,302	152,610	8,116	90,419	5,134	53,191	3,426	30,891	2,156	20,967	1,674
All species groups	4,255,770	174,546	1,832,768	69,552	1,156,996	26,778	822,780	18,172	586,318	12,945	408,072	9,742	271,202	6,928	189,868	5,417

Diameter class (inches)

Table 8—Estimated number of live trees on forest land, by species group and diameter class, Oregon, 2001–2005 (continued)

	Diameter class (inches)														All classes	
	17.0–18.9		19.0–20.9		21.0–24.9		25.0–28.9		29.0–32.9		33.0–36.9		37+			
Species group	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Thousand trees															
Softwoods:																
Douglas-fir	55,795	3,006	41,110	2,373	52,406	2,986	31,367	2,422	16,481	1,156	11,141	702	22,501	1,395	2,429,262	86,200
Engelmann and other spruces	1,418	353	697	249	1,806	536	256	70	196	77	144	63	67	37	59,411	12,378
Incense-cedar	1,353	362	1,169	360	1,441	384	781	258	416	124	274	67	707	137	136,465	19,829
Lodgepole pine	2,530	515	1,148	340	585	229	87	40	11	12	14	13	34	20	1,334,313	126,641
Other western softwoods	5,603	915	5,144	953	6,478	997	2,504	522	968	242	545	133	485	202	392,476	45,575
Ponderosa and Jeffrey pines	16,806	1,463	11,502	1,082	14,359	1,151	8,765	727	4,671	383	2,349	214	1,551	182	1,039,861	61,745
Redwood	—	—	—	—	—	—	—	—	—	—	—	—	—	—	29,960	31,978
Sitka spruce	1,600	513	765	322	1,464	543	1,047	559	294	110	178	71	361	146	34,449	7,113
Sugar pine	302	151	439	181	588	207	452	211	324	147	271	69	716	148	17,563	4,162
True fir	19,328	1,617	11,780	1,158	16,933	1,563	9,715	1,307	4,558	529	2,116	277	2,010	296	1,543,200	91,995
Western hemlock	9,950	1,204	6,985	899	10,052	1,097	5,136	739	2,171	361	894	178	1,008	172	708,823	66,512
Western juniper	4,410	650	2,056	447	2,887	498	1,043	155	445	92	247	63	130	40	239,580	19,595
Western larch	1,592	397	1,265	337	1,090	299	380	87	232	72	91	47	34	20	69,127	13,127
Western redcedar	1,973	438	1,569	450	2,617	548	2,627	622	1,037	218	791	151	1,312	216	134,546	19,491
Western white pine	641	241	275	144	576	203	215	109	294	120	68	34	177	93	45,590	11,402
Total	123,300	4,208	85,904	3,249	113,283	3,964	64,374	3,222	32,100	1,443	19,121	854	31,091	1,557	8,214,623	211,639
Hardwoods:																
Cottonwood and aspen	370	168	68	72	—	—	61	69	35	27	54	33	100	66	22,628	10,951
Oak	1,390	343	1,187	316	822	273	709	280	137	79	24	17	60	28	270,406	34,389
Other western hardwoods	4,666	713	1,898	434	3,071	541	1,439	339	468	143	231	61	176	47	987,022	83,428
Red alder	3,615	646	3,317	624	1,928	526	951	286	148	83	33	20	24	17	349,573	30,323
Western woodland hardwoods	281	146	203	124	286	146	—	—	—	—	—	—	—	—	176,445	52,025
Total	10,322	1,052	6,673	828	6,106	816	3,161	525	789	197	341	80	361	86	1,806,075	109,478
All species groups	133,622	4,328	92,576	3,389	119,389	4,084	67,535	3,263	32,888	1,457	19,463	861	31,451	1,565	10,020,699	238,064

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 500 trees were estimated.

Table 9—Estimated number of growing-stock trees[a] on timberland, by species group and diameter class, Oregon, 2001–2005

	Diameter class (inches)															
	1.0–2.9		3.0–4.9		5.0–6.9		7.0–8.9		9.0–10.9		11.0–12.9		13.0–14.9		15.0–16.9	
Species group	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Thousand trees															
Softwoods:																
Douglas–fir	754,899	56,756	341,189	26,588	277,989	13,235	236,487	11,609	190,696	8,983	145,355	7,127	96,459	4,856	72,730	3,767
Engelmann and other spruces	19,129	6,986	3,251	2,750	3,637	776	2,720	600	2,980	636	2,447	567	1,673	468	1,392	404
Incense–cedar	60,492	11,441	24,694	6,373	10,456	1,563	6,329	1,045	3,916	861	2,012	416	3,304	724	1,036	363
Lodgepole pine	649,800	89,395	202,892	25,083	113,144	10,134	67,194	5,704	39,980	3,626	16,798	1,702	8,476	1,181	3,389	603
Other western softwoods	87,478	18,712	35,925	8,628	20,254	3,581	10,890	1,861	7,765	1,414	6,832	1,323	3,558	707	2,913	653
Ponderosa and Jeffrey pines	366,005	36,266	199,413	21,620	117,166	8,246	88,541	5,094	70,369	4,097	48,219	2,986	37,461	2,578	23,042	1,777
Redwood	20,967	22,380	8,387	8,952	471	503	67	72	—	—	67	72	—	—	—	—
Sitka spruce	6,117	2,409	6,316	3,530	3,615	803	2,229	612	2,918	1,034	1,930	654	1,819	600	1,497	646
Sugar pine	10,105	3,667	839	895	907	383	1,124	433	347	162	420	248	284	147	359	194
True fir	529,937	53,169	226,070	22,773	129,930	8,989	84,892	5,734	54,678	3,677	39,037	2,790	25,257	1,966	17,525	1,546
Western hemlock	313,523	51,265	111,428	15,682	60,581	5,234	45,201	3,869	32,055	2,672	26,439	2,495	18,981	1,951	14,089	1,576
Western juniper	30,482	7,046	12,463	3,852	11,899	1,791	8,448	1,432	4,634	805	3,323	649	1,593	372	1,441	427
Western larch	24,958	9,357	15,692	4,972	3,966	858	3,910	764	3,676	790	2,938	610	1,788	476	1,704	368
Western redcedar	67,334	13,769	22,959	6,145	9,686	1,541	5,786	939	3,992	736	3,684	754	2,506	553	1,837	456
Western white pine	10,914	3,438	8,229	3,068	2,284	573	1,321	385	1,148	381	699	251	711	293	135	101
Total	2,952,140	146,048	1,219,748	56,012	765,984	22,014	565,138	15,733	419,154	11,647	300,198	8,880	203,872	6,431	143,088	4,974
Hardwoods:																
Cottonwood and aspen	6,035	3,258	1,579	1,733	865	466	1,112	828	711	331	859	434	384	249	249	180
Oak	74,204	17,786	43,707	9,233	29,994	4,237	15,652	2,363	8,583	1,526	4,449	796	3,055	586	2,082	459
Other western hardwoods	464,329	60,408	183,572	22,735	114,127	7,864	68,883	5,308	39,948	3,465	21,813	2,277	11,310	1,228	7,730	1,003
Red alder	113,497	18,870	59,768	10,745	53,712	5,558	41,173	4,374	28,854	2,914	19,973	2,205	12,714	1,517	8,163	1,102
Total	658,066	65,792	288,626	27,364	198,697	10,735	126,820	7,315	78,096	4,762	47,094	3,303	27,463	2,060	18,224	1,582
All species groups	3,610,206	162,314	1,508,374	62,952	964,681	25,312	691,959	17,441	497,250	12,447	347,291	9,422	231,335	6,748	161,312	5,202

Table 9—Estimated number of growing–stock trees[a] on timberland, by species group and diameter class, Oregon, 2001–2005 (continued)

	Diameter class (inches)															
	17.0–18.9		19.0–20.9		21.0–24.9		25.0–28.9		29.0–32.9		33.0–36.9		37.0+		All classes	
Species group	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Thousand trees															
Softwoods:																
Douglas-fir	51,066	2,886	37,162	2,264	46,425	2,826	28,172	2,353	14,521	1,099	9,887	676	19,950	1,338	2,322,985	85,470
Engelmann and other spruces	1,191	329	498	194	1,236	421	189	58	154	72	111	60	56	35	40,664	9,188
Incense-cedar	1,219	348	897	281	1,305	372	713	248	382	122	240	59	571	114	117,568	16,798
Lodgepole pine	1,444	384	881	294	501	214	87	40	11	12	—	—	22	17	1,104,619	115,047
Other western softwoods	1,532	380	2,016	534	3,512	771	1,439	452	418	149	215	70	345	187	185,091	29,148
Ponderosa and Jeffrey pines	16,320	1,453	10,743	1,045	13,397	1,126	8,126	678	4,362	374	2,146	206	1,361	167	1,006,669	61,311
Redwood	—	—	—	—	—	—	—	—	—	—	—	—	—	—	29,960	31,978
Sitka spruce	1,258	444	456	219	1,016	357	435	253	224	94	123	57	258	130	30,213	6,539
Sugar pine	302	151	439	181	577	207	452	211	300	147	234	64	620	136	17,310	4,161
True fir	15,655	1,489	8,996	1,040	12,635	1,394	7,505	1,261	3,148	463	1,402	202	1,185	210	1,157,851	82,660
Western hemlock	8,999	1,170	6,169	868	9,064	1,052	4,751	719	1,877	327	810	169	818	144	654,784	65,446
Western juniper	673	225	348	162	499	198	116	42	33	20	23	17	23	17	75,997	11,638
Western larch	1,387	379	936	282	909	260	278	69	198	69	12	12	23	17	62,375	12,827
Western redcedar	1,779	411	1,311	417	2,423	527	2,377	560	898	204	652	135	1,045	187	128,269	19,422
Western white pine	217	128	141	103	152	104	163	105	201	115	68	34	177	93	26,558	6,277
Total	103,041	3,980	70,994	2,977	93,650	3,752	54,802	3,112	26,728	1,363	15,922	806	26,454	1,475	6,960,913	203,364
Hardwoods:																
Cottonwood and aspen	232	134	68	72	—	—	61	69	10	11	42	31	39	22	12,246	4,705
Oak	1,131	291	958	269	368	166	557	259	120	78	24	17	48	25	184,931	26,463
Other western hardwoods	4,594	702	1,738	403	2,909	531	1,367	332	447	142	219	60	176	47	923,161	81,420
Red alder	3,382	633	3,145	605	1,858	521	815	268	148	83	23	17	24	17	347,251	30,225
Total	9,339	1,009	5,908	776	5,134	758	2,801	501	725	194	307	77	287	60	1,467,589	91,519
All species groups	112,381	4,103	76,902	3,124	98,784	3,862	57,604	3,156	27,453	1,379	16,229	813	26,742	1,482	8,428,502	225,501

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 500 trees were estimated.

[a] Growing-stock trees are live trees of commercial species that meet certain merchantability standards; excludes trees that are entirely cull (rough or rotten tree classes).

Table 10—Estimated net volume of all live trees on forest land, by owner class and forest land status, Oregon, 2001–2005

	Unreserved forests						Reserved forests							
	Timberland[a]		Other forest[b]		Total		Productive[a]		Other forest[b]		Total		All forest land	
Owner class	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
							Million cubic feet							
USDA Forest Service:														
National forest	45,928	1,586	361	110	46,289	1,580	10,101	930	180	123	10,281	936	56,570	1,498
National grassland	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	45,928	1,586	361	110	46,289	1,580	10,101	930	180	123	10,281	936	56,570	1,498
Other federal government:														
National Park Service	—	—	—	—	—	—	707	163	18	18	724	164	724	164
Bureau of Land Management	11,603	825	344	52	11,947	822	306	142	18	9	324	142	12,271	810
U.S. Fish and Wildlife Service	—	—	—	—	—	—	9	8	—	—	9	8	9	8
Departments of Defense and Energy	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Other federal	113	83	—	—	113	83	—	—	—	—	—	—	113	83
Total	11,716	830	344	52	12,059	826	1,021	216	36	20	1,057	217	13,116	809
State and local government:														
State	5,173	639	4	3	5,177	639	124	89	—	—	124	89	5,300	645
Local	359	128	—	—	359	128	153	159	—	—	153	159	512	203
Other public	1	1	—	—	1	1	—	—	—	—	—	—	1	1
Total	5,533	651	4	3	5,537	651	277	182	—	—	277	182	5,813	675
Corporate private	15,029	880	38	16	15,066	880	—	—	—	—	—	—	15,066	880
Noncorporate private														
Nongovernmental conservation or natural resource organizations	637	181	—	—	637	181	—	—	—	—	—	—	637	181
Unincorporated partnerships, associations, or clubs	273	147	7	5	280	147	—	—	—	—	—	—	280	147
Native American	1,368	311	110	69	1,478	315	—	—	—	—	—	—	1,478	315
Individual	7,953	645	327	70	8,280	646	—	—	—	—	—	—	8,280	646
Total	10,231	734	444	98	10,675	736	—	—	—	—	—	—	10,675	736
All owners	88,436	2,047	1,190	157	89,626	2,038	11,398	972	216	125	11,614	978	101,240	1,967

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 500,000 cubic feet were estimated.

[a] Forest land that is capable of producing in excess of 20 cubic feet/acre/year of wood at culmination of mean annual increment.

[b] Forest land that is not capable of producing in excess of 20 cubic feet/acre/year of wood at culmination of mean annual increment.

Table 11—Estimated net volume of all live trees on forest land, by forest type group and stand size class, Oregon, 2001–2005

	Large-diameter stands[a]		Medium-diameter stands[b]		Small-diameter stands[c]		All size classes	
Forest type group	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	Million cubic feet							
Softwoods:								
Douglas-fir	53,964	1,949	1,304	177	373	70	55,640	1,935
Fir/spruce/mountain hemlock	15,482	1,057	222	59	180	40	15,885	1,057
Hemlock/Sitka spruce	7,243	904	112	50	19	10	7,374	907
Lodgepole pine	1,513	235	648	120	345	52	2,506	261
Ponderosa pine	9,858	582	193	41	189	42	10,241	580
Western juniper	776	79	54	14	44	10	874	80
Western larch	373	132	30	29	33	16	436	136
Western white pine	74	54	—	—	6	5	80	55
Other western softwoods	51	39	10	7	5	5	66	40
Total	89,335	2,031	2,573	232	1,194	105	93,102	1,996
Hardwoods:								
Alder/maple	3,106	406	857	154	40	14	4,003	427
Aspen/birch	27	27	21	17	16	11	64	34
Elm/ash/cottonwood	145	74	—	—	7	5	152	75
Tanoak/laurel	999	264	560	156	44	19	1,602	304
Western oak	856	188	311	72	53	20	1,220	200
Woodland hardwoods	100	31	—	—	26	15	126	34
Other hardwoods	457	136	374	143	50	18	881	195
Total	5,689	528	2,124	268	236	41	8,048	573
Nonstocked	—	—	—	—	—	—	90	28
All forest types	95,024	2,030	4,696	349	1,430	112	101,240	1,967

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 500,000 cubic feet were estimated.

[a] Stands in which the majority of trees are at least 11.0 inches diameter at breast height for hardwoods and 9.0 inches diameter at breast height for softwoods.

[b] Stands in which the majority of trees are at least 5.0 inches diameter at breast height but not as large as large-diameter trees.

[c] Stands in which the majority of trees are less than 5.0 inches diameter at breast height.

Table 12—Estimated net volume of all live trees on forest land, by species group and ownership, Oregon, 2001–2005

	USDA Forest Service		Other federal		State and local government		Corporate private		Noncorporate private		All owners	
Species group	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
						Million cubic feet						
Softwoods:												
Douglas-fir	25,481	1,190	8,319	666	3,682	515	8,605	649	5,070	547	51,157	1,591
Engelmann and other spruces	636	114	—	—	—	—	14	10	84	58	733	129
Incense-cedar	432	85	167	47	15	13	147	37	75	25	837	107
Lodgepole pine	2,157	176	231	83	20	17	224	53	130	65	2,762	213
Other western softwoods	2,715	374	277	78			74	41	179	100	3,245	397
Ponderosa and Jeffrey pines	6,725	346	561	120	179	75	695	87	1,195	147	9,354	403
Sitka spruce	442	264	—	—	141	80	357	159	107	56	1,047	326
Sugar pine	512	107	199	61	2	2	46	24	11	6	771	125
True fir	9,748	666	959	258	128	64	595	92	667	120	12,097	732
Western hemlock	4,036	408	871	166	692	196	1,883	331	433	107	7,915	589
Western juniper	122	20	300	38	4	3	22	8	216	27	664	51
Western larch	670	94	—	—	3	2	47	14	40	18	759	97
Western redcedar	1,152	193	154	59	59	37	191	56	259	80	1,815	228
Western white pine	362	81	89	57	—	—	—	—	2	2	454	99
Total	55,189	1,489	12,127	784	4,925	601	12,901	799	8,469	660	93,612	1,915
Hardwoods:												
Cottonwood and aspen	29	22	11	5	34	34	7	5	89	35	169	54
Oak	125	37	174	35	66	50	108	39	460	92	933	121
Other western hardwoods	746	95	645	100	118	38	1,030	141	957	132	3,495	234
Red alder	433	95	131	43	670	138	1,020	150	680	120	2,934	249
Western woodland hardwoods	48	9	27	17	1	1	—	—	20	12	97	23
Total	1,381	145	988	117	888	162	2,165	226	2,206	214	7,629	369
All species groups	56,570	1,498	13,116	809	5,813	675	15,066	880	10,675	736	101,240	1,967

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 500,000 cubic feet were estimated.

Table 13—Estimated net volume of all live trees on forest land, by species group and diameter class, Oregon, 2001–2005

	Diameter class (inches)													
	5.0–6.9		7.0–8.9		9.0–10.9		11.0–12.9		13.0–14.9		15.0–16.9		17.0–18.9	
Species group	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million cubic feet													
Softwoods:														
Douglas–fir	721	36	1,697	83	2,637	125	3,369	173	3,356	169	3,702	194	3,365	189
Engelmann and other spruces	12	2	21	4	43	9	62	14	52	14	76	21	92	24
Incense–cedar	27	4	33	6	38	9	31	7	62	13	32	11	42	12
Lodgepole pine	331	31	552	48	638	56	481	49	323	41	167	26	127	27
Other western softwoods	61	8	105	13	175	23	253	35	271	40	335	55	282	48
Ponderosa and Jeffrey pines	173	12	357	21	572	34	680	44	830	57	737	57	743	67
Redwood	1	1	—	—	—	—	1	1	—	—	—	—	—	—
Sitka spruce	10	2	15	5	38	13	56	20	67	23	79	33	97	33
Sugar pine	2	1	5	2	3	1	5	3	7	4	10	6	14	7
True fir	362	22	628	39	828	52	978	65	989	71	911	73	1,053	94
Western hemlock	165	15	360	32	490	42	711	70	784	82	807	90	696	90
Western juniper	43	4	75	6	92	10	88	9	75	9	71	10	66	11
Western larch	14	4	36	8	56	11	73	14	73	17	88	18	92	23
Western redcedar	25	4	39	6	52	9	73	15	75	16	80	18	98	22
Western white pine	8	2	12	3	19	5	19	6	31	11	17	8	33	14
Total	1,954	57	3,935	110	5,678	156	6,879	208	6,995	216	7,112	246	6,799	256
Hardwoods:														
Cottonwood and aspen	4	2	6	4	11	5	21	10	16	10	17	10	20	10
Oak	110	14	120	18	112	18	87	15	98	17	104	22	68	17
Other western hardwoods	363	25	498	40	497	42	449	45	333	36	308	40	236	36
Red alder	155	16	320	34	424	45	460	54	428	51	382	53	203	37
Western woodland hardwoods	10	2	19	4	15	4	15	4	13	4	9	3	4	2
Total	642	34	962	56	1,059	63	1,032	72	888	66	820	71	532	57
All species groups	2,596	68	4,897	124	6,737	167	7,912	220	7,884	225	7,932	255	7,331	262

	Diameter class (inches)													
	19.0–20.9		21.0–24.9		25.0–28.9		29.0–32.9		33.0–36.9		37.0+		All classes	
Species group	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million cubic feet													
Softwoods:														
Douglas–fir	3,284	203	5,772	356	5,046	431	3,652	263	3,219	220	11,337	784	51,157	1,591
Engelmann and other spruces	48	17	174	52	40	11	40	17	46	20	28	17	733	129
Incense–cedar	53	17	86	24	76	27	54	16	49	12	255	54	837	107
Lodgepole pine	67	21	44	17	8	4	2	2	2	2	20	15	2,762	213
Other western softwoods	338	67	604	97	324	70	174	44	130	35	194	83	3,245	397
Ponderosa and Jeffrey pines	687	66	1,215	98	1,224	104	903	76	611	58	621	77	9,354	403
Redwood	—	—	—	—	—	—	—	—	—	—	—	—	1	1
Sitka spruce	60	25	152	62	170	111	64	26	49	21	190	79	1,047	326
Sugar pine	22	10	60	21	64	31	59	23	83	21	436	92	771	125
True fir	864	89	1,706	175	1,514	220	937	114	558	71	768	127	12,097	732
Western hemlock	609	84	1,211	140	887	135	515	85	280	53	399	70	7,915	589
Western juniper	30	8	60	11	29	4	16	4	10	3	8	3	664	51
Western larch	89	23	102	28	55	13	46	15	22	11	15	9	759	97
Western redcedar	103	29	215	47	275	65	171	38	159	33	452	87	1,815	228
Western white pine	20	11	63	23	31	16	60	26	22	11	119	65	454	99
Total	6,274	259	11,465	451	9,745	561	6,692	319	5,240	257	14,843	850	93,612	1,915
Hardwoods:														
Cottonwood and aspen	5	5	—	—	10	11	7	6	16	10	38	25	169	54
Oak	58	16	46	17	77	37	24	18	5	5	24	13	933	121
Other western hardwoods	111	26	293	56	179	46	91	29	61	16	75	22	3,495	234
Red alder	230	47	191	55	112	36	19	8	5	3	6	4	2,934	249
Western woodland hardwoods	4	2	8	5	—	—	—	—	—	—	—	—	97	23
Total	408	56	538	81	377	70	141	36	87	22	143	36	7,629	369
All species groups	6,682	269	12,003	461	10,122	565	6,833	321	5,327	258	14,986	853	101,240	1,967

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 500,000 cubic feet were estimated.

Table 14—Estimated net volume of growing-stock trees[a] on timberland, by species group and diameter class, Oregon, 2001–2005

	Diameter class (inches)																					
	5.0–6.9		7.0–8.9		9.0–10.9		11.0–12.9		13.0–14.9		15.0–16.9		17.0–18.9		19.0–20.9		21.0–28.9		29.0+		All classes	
Species group	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million cubic feet																					
Softwoods:																						
Douglas-fir	698	35	1,639	82	2,516	122	3,217	170	3,144	167	3,436	189	3,118	184	2,989	195	9,769	662	16,672	1,024	47,199	1,591
Engelmann and other spruces	8	2	15	3	36	8	49	12	49	14	64	19	79	22	36	14	147	46	95	49	577	113
Incense-cedar	24	4	27	5	31	7	22	5	59	13	28	10	39	11	40	13	147	35	322	62	738	97
Lodgepole pine	261	26	423	39	487	48	330	35	237	35	131	24	67	18	47	16	45	18	16	14	2,043	174
Other western softwoods	32	6	48	9	71	15	113	23	83	18	115	28	76	20	137	39	540	129	277	108	1,492	278
Ponderosa and Jeffrey pines	166	12	344	20	553	33	649	43	801	56	712	57	723	66	639	63	2,278	161	1,968	157	8,833	398
Redwood	1	1	0	0	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	1	1
Sitka spruce	9	2	11	3	35	13	40	15	52	19	71	33	72	28	33	16	139	46	210	87	671	191
Sugar pine	2	1	5	2	3	1	5	3	7	4	10	6	14	7	22	10	122	39	506	101	698	122
True fir	278	20	481	34	623	45	730	54	752	61	723	67	862	87	664	81	2,489	343	1,545	205	9,148	680
Western hemlock	150	14	329	31	457	41	651	67	727	80	744	87	630	88	547	82	1,928	219	1,057	153	7,219	578
Western juniper	14	2	23	4	24	4	27	5	19	4	19	6	13	4	7	4	17	6	4	2	167	23
Western larch	10	2	27	5	47	10	61	13	57	15	74	17	79	22	63	19	124	28	52	17	594	84
Western redcedar	23	4	35	6	43	8	67	15	66	15	70	17	86	20	84	27	445	89	668	113	1,587	203
Western white pine	5	1	7	2	12	4	14	5	18	7	7	5	13	8	8	7	42	20	187	79	314	90
Total	1,681	53	3,415	105	4,939	151	5,976	202	6,071	210	6,204	237	5,870	246	5,317	241	18,234	850	23,578	1,150	81,283	1,987
Hardwoods:																						
Cottonwood and aspen	2	1	6	4	10	5	19	10	15	10	14	10	17	10	5	5	10	11	29	14	127	42
Oak	75	10	88	15	89	16	74	14	81	16	73	17	58	15	47	14	96	42	54	26	735	104
Other western hardwoods	335	24	453	37	453	40	420	44	316	36	303	40	236	36	106	25	461	80	228	49	3,312	229
Red alder	155	16	320	34	424	45	459	54	423	51	377	53	198	37	229	47	289	71	29	10	2,904	248
Total	568	31	866	53	977	61	972	72	836	66	766	69	510	56	387	55	856	116	340	59	7,078	360
All species groups	2,248	64	4,281	119	5,915	162	6,948	214	6,907	220	6,970	247	6,380	253	5,704	253	19,090	862	23,917	1,157	88,361	2,047

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 500,000 cubic feet were estimated.

[a] Growing-stock trees are trees of commercial species that meet certain merchantability standards; excludes trees that are entirely cull (rough or rotten tree classes).

Table 15—Estimated net volume of growing-stock trees[a] on timberland, by species group and ownership, Oregon, 2001–2005

	USDA Forest Service		Other federal		State and local government		Corporate private		Noncorporate private		All owners	
Species group	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
							Million cubic feet					
Softwoods:												
Douglas-fir	21,744	1,187	8,169	672	3,617	510	8,600	649	5,070	547	47,199	1,591
Engelmann and other spruces	480	96	—	—	—	—	14	10	84	58	577	113
Incense-cedar	335	72	166	47	15	13	147	37	75	25	738	97
Lodgepole pine	1,636	150	38	16	20	17	224	53	125	65	2,043	174
Other western softwoods	1,264	259	26	12			74	41	127	92	1,492	278
Ponderosa and Jeffrey pines	6,269	340	519	118	179	75	686	87	1,180	147	8,833	398
Redwood	—	—	—	—	—	—	1	1	—	—	1	1
Sitka spruce	140	73	—	—	67	28	357	159	107	56	671	191
Sugar pine	458	103	180	60	2	2	46	24	11	6	698	122
True fir	7,213	615	596	243	128	64	587	92	625	117	9,148	680
Western hemlock	3,367	393	871	166	666	195	1,882	330	433	107	7,219	578
Western juniper	95	17	13	6			14	7	45	12	167	23
Western larch	504	81	—	—	3	2	47	14	40	18	594	84
Western redcedar	957	166	154	59	28	17	191	56	258	80	1,587	203
Western white pine	247	73	64	53	—	—	0	0	2	2	314	90
Total	44,709	1,569	10,796	802	4,725	583	12,869	799	8,183	658	81,283	1,987
Hardwoods:												
Cottonwood and aspen	29	22	3	2	—	—	6	5	89	35	127	42
Oak	99	34	154	33	66	50	101	39	315	70	735	104
Other western hardwoods	621	88	626	99	88	28	1,030	141	946	131	3,312	229
Red alder	421	95	131	43	653	137	1,020	150	679	120	2,904	248
Total	1,170	141	914	115	807	152	2,158	226	2,029	206	7,078	360
All species groups	45,880	1,586	11,710	830	5,532	651	15,027	880	10,212	734	88,361	2,047

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 500,000 cubic feet were estimated.
[a] Growing-stock trees are trees of commercial species that meet certain merchantability standards; excludes trees that are entirely cull (rough or rotten tree classes).

Table 16—Estimated net volume (International ¼-inch rule) of sawtimber trees[a] on timberland, by species group and diameter class, Oregon, 2001–2005

	Diameter class (inches)											
	9.0–10.9		11.0–12.9		13.0–14.9		15.0–16.9		17.0–18.9		19.0–20.9	
Species group	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million board feet (International ¼-inch rule)											
Softwoods:												
Douglas-fir	11,282	558	16,936	914	17,840	960	20,585	1,148	19,160	1,141	18,908	1,252
Engelmann and other spruces	160	34	250	63	269	78	380	112	490	140	219	88
Incense-cedar	121	28	95	21	283	63	144	53	209	60	222	70
Lodgepole pine	2,141	217	1,696	186	1,307	193	754	140	400	107	279	98
Other western softwoods	291	62	554	113	436	96	665	163	446	119	843	243
Ponderosa and Jeffrey pines	2,143	129	2,997	203	4,095	291	3,862	314	4,140	384	3,783	376
Redwood	—	—	2	3	—	—	—	—	—	—	—	—
Sitka spruce	151	56	209	79	290	108	424	201	436	171	203	100
Sugar pine	10	5	25	14	39	21	55	30	81	43	133	57
True fir	2,693	202	3,690	277	4,190	347	4,221	394	5,204	536	4,134	510
Western hemlock	2,088	193	3,516	371	4,271	476	4,561	542	3,981	562	3,536	533
Western juniper	89	17	112	24	85	20	88	26	60	21	35	18
Western larch	209	47	313	67	322	84	436	98	478	130	388	116
Western redcedar	181	35	338	75	359	84	398	97	506	118	508	160
Western white pine	52	17	76	28	100	38	39	30	77	46	49	42
Total	21,611	683	30,810	1,079	33,886	1,204	36,612	1,437	35,667	1,527	33,242	1,539
Hardwoods:												
Cottonwood and aspen	—	—	88	47	89	57	86	60	105	63	27	29
Oak	—	—	77	15	88	18	77	19	71	19	63	19
Other western hardwoods	—	—	939	114	768	102	666	96	518	90	248	70
Red alder	—	—	2,165	258	2,332	285	2,210	313	1,199	225	1,413	295
Total	—	—	3,269	288	3,276	309	3,039	332	1,892	253	1,752	304
All species groups	21,611	683	34,079	1,113	37,162	1,249	39,652	1,479	37,560	1,556	34,994	1,602

	Diameter class (inches)											
	21.0–22.9		23.0–24.9		25.0–26.9		27.0–28.9		29.0+		All classes	
Species group	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million board feet (International ¼-inch rule)											
Softwoods:												
Douglas-fir	17,229	1,269	16,406	1,462	17,064	1,604	13,790	1,662	116,516	7,262	285,716	10,690
Engelmann and other spruces	444	170	291	146	124	39	81	41	660	342	3,369	701
Incense-cedar	241	79	211	97	158	80	255	136	2,139	422	4,078	589
Lodgepole pine	127	62	97	57	41	21	10	10	94	81	6,947	718
Other western softwoods	1,208	311	1,002	310	847	307	414	181	1,892	744	8,600	1,727
Ponderosa and Jeffrey pines	3,625	415	3,359	358	3,195	289	4,228	501	13,372	1,081	48,799	2,379
Redwood	—	—	—	—	—	—	—	—	—	—	2	3
Sitka spruce	539	223	88	69	141	94	105	76	1,438	605	4,025	1,201
Sugar pine	44	45	328	128	258	129	156	108	3,625	729	4,754	849
True fir	4,288	568	4,040	695	4,541	857	3,457	723	10,694	1,433	51,151	4,263
Western hemlock	3,540	566	3,776	639	2,654	498	2,985	600	7,406	1,079	42,313	3,628
Western juniper	46	22	17	9	10	5	12	7	20	9	575	86
Western larch	258	101	264	105	158	45	109	38	350	113	3,287	493
Western redcedar	591	154	598	186	1,022	296	575	206	4,468	756	9,543	1,269
Western white pine	126	93	10	10	127	94	18	14	1,349	573	2,023	636
Total	32,306	1,653	30,488	1,862	30,341	2,040	26,196	2,095	164,023	8,142	475,182	13,184
Hardwoods:												
Cottonwood and aspen	—	—	—	—	—	—	62	70	197	93	653	221
Oak	25	13	—	—	81	42	22	21	84	40	589	109
Other western hardwoods	306	77	334	120	117	46	234	90	472	115	4,602	478
Red alder	514	171	636	240	316	142	357	161	172	59	11,313	1,193
Total	845	188	970	268	515	155	675	197	924	172	17,157	1,336
All species groups	33,151	1,665	31,458	1,889	30,856	2,053	26,871	2,105	164,947	8,159	492,339	13,372

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 500,000 board feet were estimated.

[a] Sawtimber trees have merchantability limits that differ for softwood and hardwood species as follows: ≥9 inches diameter at breast height for softwoods and ≥11 inches diameter at breast height for hardwoods.

Table 17—Estimated net volume (Scribner rule)[a] of sawtimber trees[b] on timberland, by species group and diameter class, Oregon, 2001-2005

	Diameter class (inches)											
	9.0–10.9		11.0–12.9		13.0–14.9		15.0–16.9		17.0–18.9		19.0–20.9	
Species group	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million board feet (Scribner rule)											
Softwoods:												
Douglas-fir	6,595	328	10,742	586	11,900	643	14,346	810	13,666	818	13,934	934
Engelmann and other spruces	119	26	198	50	219	64	321	95	417	118	185	74
Incense-cedar	54	12	51	12	146	32	78	29	124	37	129	40
Lodgepole pine	1,553	157	1,309	142	1,058	157	622	116	332	89	238	84
Other western softwoods	233	40	432	78	343	64	532	119	373	91	650	182
Ponderosa and Jeffrey pines	1,560	95	2,293	157	3,256	232	3,118	252	3,410	320	3,144	315
Redwood	—	—	1	1	—	—	—	—	—	—	—	—
Sitka spruce	81	31	126	49	181	70	288	140	297	121	142	71
Sugar pine	6	3	16	10	25	13	42	23	55	29	92	40
True fir	1,794	135	2,598	197	3,107	262	3,253	310	4,068	418	3,336	416
Western hemlock	1,217	117	2,245	244	2,903	331	3,217	389	2,886	417	2,627	402
Western larch	157	36	248	53	265	69	366	83	409	112	336	101
Western redcedar	94	19	195	45	215	51	248	61	325	77	336	105
Western white pine	34	11	55	21	64	25	30	24	58	35	33	31
Total	13,499	421	20,509	712	23,681	836	26,460	1,041	26,419	1,133	25,182	1,171
Hardwoods:												
Cottonwood and aspen	—	—	66	36	65	42	74	52	88	55	18	19
Oak	—	—	59	12	68	14	60	15	55	15	49	14
Other western hardwoods	—	—	722	88	606	81	533	77	418	74	203	58
Red alder	—	—	1,717	206	1,924	236	1,864	265	1,027	194	1,232	259
Total	—	—	2,564	228	2,663	254	2,530	280	1,589	216	1,502	266
All species groups	13,499	421	23,072	746	26,344	879	28,990	1,082	28,008	1,161	26,685	1,230

	Diameter class (inches)											
	21.0–22.9		23.0–24.9		25.0–26.9		27.0–28.9		29.0+		All classes	
Species group	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million board feet (Scribner rule)											
Softwoods:												
Douglas-fir	12,842	954	12,444	1,125	13,157	1,251	10,712	1,309	94,335	6,008	214,674	8,472
Engelmann and other spruces	389	149	258	130	112	36	73	38	611	319	2,902	620
Incense-cedar	130	43	133	62	100	51	161	88	1,618	329	2,723	418
Lodgepole pine	108	53	86	51	36	18	9	9	61	49	5,413	565
Other western softwoods	947	235	792	240	666	234	340	142	1,635	664	6,943	1,405
Ponderosa and Jeffrey pines	3,080	355	2,884	307	2,795	248	3,649	404	12,059	973	41,247	2,024
Redwood	—	—	—	—	—	—	—	—	—	—	1	1
Sitka spruce	387	165	62	50	87	59	68	49	1,123	483	2,843	884
Sugar pine	31	31	240	93	197	97	111	77	3,057	618	3,872	698
True fir	3,481	476	3,249	544	3,684	669	2,853	577	9,160	1,220	40,583	3,420
Western hemlock	2,669	435	2,906	498	2,063	393	2,371	481	5,998	880	31,101	2,753
Western larch	219	86	235	93	142	40	98	34	318	103	2,793	423
Western redcedar	383	102	416	130	704	206	395	145	3,321	565	6,632	895
Western white pine	98	72	9	9	93	70	16	13	1,146	491	1,636	534
Total	24,763	1,277	23,713	1,445	23,835	1,595	20,855	1,658	134,445	6,757	363,362	10,508
Hardwoods:												
Cottonwood and aspen	—	—	—	—	—	—	55	62	176	85	541	188
Oak	19	10	—	—	63	33	17	16	66	32	459	86
Other western hardwoods	247	63	280	103	92	36	192	76	396	97	3,689	391
Red alder	452	152	561	211	281	127	317	143	147	51	9,521	1,019
Total	719	164	841	235	437	136	582	173	785	149	14,211	1,133
All species groups	25,482	1,288	24,554	1,471	24,271	1,606	21,437	1,668	135,230	6,771	377,573	10,672

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 500,000 board feet were estimated.

[a] Volume is based on Scribner board foot rule.

[b] Sawtimber trees have merchantability limits that differ for softwood and hardwood species as follows: ≥9 inches diameter at breast height for softwoods and ≥11 inches diameter at breast height for hardwoods.

Table 18—Estimated net volume (cubic feet) of sawtimber trees[a] on timberland, by species group and ownership, Oregon, 2001–2005

	USDA Forest Service		Other federal		State and local government		Corporate private		Noncorporate private		All owners	
Species group	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
						Million cubic feet						
Softwoods:												
Douglas-fir	20,816	1,174	7,571	658	3,402	494	7,450	611	4,612	524	43,852	1,563
Engelmann and other spruces	450	93	—	—	—	—	10	8	80	57	541	109
Incense-cedar	315	69	157	45	15	13	129	35	60	23	675	93
Lodgepole pine	987	104	25	11	18	15	138	41	77	49	1,246	125
Other western softwoods	1,174	249	23	11			64	35	120	90	1,380	268
Ponderosa and Jeffrey pines	5,838	328	497	116	171	73	569	79	1,037	134	8,112	381
Sitka spruce	136	71	—	—	65	27	333	155	102	55	637	185
Sugar pine	450	102	178	60	2	2	45	24	10	6	685	121
True fir	6,474	590	566	236	110	55	463	77	549	106	8,162	650
Western hemlock	3,122	381	784	156	604	184	1,665	307	383	95	6,558	549
Western juniper	74	15	9	4			11	6	29	9	123	18
Western larch	467	77	—	—	1	1	39	13	33	18	540	80
Western redcedar	915	162	147	58	28	17	171	54	244	78	1,505	198
Western white pine	232	72	63	52	—	—	—	—	1	1	296	89
Total	41,450	1,542	10,020	782	4,416	560	11,089	749	7,339	623	74,313	1,945
Hardwoods:												
Cottonwood and aspen	22	18	2	2	—	—	6	5	69	28	99	33
Oak	13	5	26	8	15	12	24	10	56	15	134	23
Other western hardwoods	208	47	142	26	17	6	278	55	231	38	877	86
Red alder	297	82	81	29	461	107	526	98	430	91	1,795	188
Total	541	98	252	39	493	109	834	120	786	111	2,905	215
All species groups	41,990	1,550	10,272	792	4,909	606	11,923	781	8,125	655	77,219	1,976

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 500,000 cubic feet were estimated.

[a] Sawtimber trees have merchantability limits that differ for softwood and hardwood species as follows: ≥9 inches diameter at breast height for softwoods and ≥11 inches diameter at breast height for hardwoods.

Table 19—Estimated aboveground biomass of all live trees on forest land, by owner class and forest land status, Oregon, 2001–2005

	Unreserved forests						Reserved forests							
	Timberland[a]		Other forest[b]		Total		Productive[a]		Other forest[b]		Total		All forest land	
Owner class	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million bone-dry tons													
USDA Forest Service:														
National forest	922.3	31.1	9.0	2.6	931.3	30.9	199.0	17.9	3.4	2.2	202.4	18.0	1,133.6	29.0
Other federal government:														
National Park Service	—	—	—	—	—	—	13.9	3.2	0.3	0.3	14.2	3.3	14.2	3.3
Bureau of Land Management	232.6	16.0	11.5	1.8	244.1	15.9	6.5	3.0	0.7	0.4	7.3	3.0	251.3	15.7
U.S. Fish and Wildlife Service	—	—	—	—	—	—	0.5	0.5	—	—	0.5	0.5	0.5	0.5
Other federal	2.3	1.6	—	—	2.3	1.6	—	—	—	—	—	—	2.3	1.6
Total	234.9	16.1	11.5	1.7	246.3	16.0	21.0	4.4	1.0	0.5	22.0	4.5	268.3	15.7
State and local government:														
State	98.4	12.1	0.2	0.1	98.5	12.1	2.2	1.5	—	—	2.2	1.5	100.7	12.2
Local	7.4	2.5	—	—	7.4	2.5	2.8	2.9	—	—	2.8	2.9	10.1	3.8
Other public	0.0	0.0	—	—	0	0	—	—	—	—	—	—	0	0
Total	105.8	12.3	0.2	0.1	105.9	12.3	4.9	3.2	—	—	4.9	3.2	110.8	12.7
Corporate private	305.8	16.9	1.1	0.5	306.9	16.9	—	—	—	—	—	—	306.9	16.9
Noncorporate private:														
Nongovernmental conservation or natural resource organizations	13.8	3.9	—	—	13.8	3.9	—	—	—	—	—	—	13.8	3.9
Unincorporated partnerships, associations, or clubs	5.3	2.8	0.2	0.2	5.5	2.8	—	—	—	—	—	—	5.5	2.8
Native American	25.8	5.7	2.3	1.3	28.1	5.8	—	—	—	—	—	—	28.1	5.8
Individual	163.1	12.4	9.7	1.9	172.8	12.5	—	—	—	—	—	—	172.8	12.5
Total	208.0	14.1	12.2	2.3	220.2	14.1	—	—	—	—	—	—	220.2	14.1
All owners	1,776.7	39.5	33.9	3.9	1,810.6	39.3	224.9	18.7	4.4	2.3	229.3	18.8	2,039.9	37.6

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 50,000 bone-dry tons were estimated; includes all live trees ≥1 inch diameter at breast height.

[a] Forest land that is capable of producing in excess of 20 cubic feet/acre/year of wood at culmination of mean annual increment.

[b] Forest land that is not capable of producing in excess of 20 cubic feet/acre/year of wood at culmination of mean annual increment.

Table 20—Estimated aboveground biomass of all live trees on forest land, by species group and diameter class, Oregon, 2001–2005

	Diameter class (inches)															
	1.0–2.9		3.0–4.9		5.0–6.9		7.0–8.9		9.0–10.9		11.0–12.9		13.0–14.9		15.0–16.9	
Species group	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million bone-dry tons															
Softwoods:																
Douglas-fir	4.7	0.4	7.4	0.6	19.4	0.9	35.6	1.7	51.4	2.4	63.7	3.2	62.8	3.1	68.9	3.6
Engelmann and other spruces	0.7	0.2	0.2	0.1	0.3	0.1	0.4	0.1	0.7	0.1	0.9	0.2	0.7	0.2	1.0	0.3
Incense-cedar	0.3	0.1	0.4	0.1	0.4	0.1	0.6	0.1	0.6	0.1	0.5	0.1	1.0	0.2	0.5	0.2
Lodgepole pine	10.5	1.3	6.5	0.8	8.3	0.7	10.0	0.9	10.4	0.9	7.5	0.8	5.0	0.6	2.6	0.4
Other western softwoods	1.3	0.2	1.3	0.2	1.8	0.2	2.3	0.3	3.5	0.5	4.9	0.7	5.1	0.8	6.3	1.0
Ponderosa and Jeffrey pines	1.3	0.1	3.0	0.3	5.1	0.4	8.1	0.5	11.6	0.7	13.1	0.8	15.3	1.1	13.2	1.0
Redwood	0.3	0.3	0.7	0.7	0.1	0.1	0.0	0.0	—	—	0.0	0.0	—	—	—	—
Sitka spruce	0.1	0.0	0.1	0.1	0.3	0.1	0.3	0.1	0.7	0.2	0.9	0.3	1.1	0.4	1.3	0.5
Sugar pine	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2	0.1
True fir	9.2	0.9	7.3	0.7	9.9	0.6	12.7	0.8	15.1	0.9	17.2	1.1	16.9	1.2	15.7	1.3
Western hemlock	0.9	0.2	2.1	0.3	4.3	0.4	7.5	0.7	9.6	0.8	13.6	1.3	15.1	1.6	15.5	1.7
Western juniper	0.3	0.1	0.7	0.1	1.7	0.1	2.4	0.2	2.7	0.3	2.6	0.3	2.1	0.2	2.2	0.3
Western larch	0.7	0.3	0.7	0.2	0.5	0.1	0.9	0.2	1.2	0.2	1.4	0.3	1.4	0.3	1.7	0.4
Western redcedar	0.4	0.1	0.5	0.1	0.5	0.1	0.7	0.1	0.8	0.2	1.1	0.2	1.2	0.3	1.3	0.3
Western white pine	0.3	0.1	0.3	0.1	0.2	0.1	0.2	0.1	0.3	0.1	0.3	0.1	0.5	0.2	0.3	0.1
Total	31.0	1.8	31.1	1.6	52.8	1.5	81.8	2.2	108.6	2.9	127.7	3.8	128.3	3.9	130.4	4.5
Hardwoods:																
Cottonwood and aspen	0.1	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.2	0.1	0.3	0.2	0.3	0.2	0.3	0.2
Oak	0.5	0.1	2.2	0.5	3.5	0.4	3.7	0.5	3.3	0.5	2.5	0.4	2.7	0.5	3.0	0.6
Other western hardwoods	2.0	0.2	5.5	0.7	10.2	0.7	13.1	1.1	12.7	1.1	10.7	1.1	7.5	0.8	6.8	0.9
Red alder	0.4	0.1	1.4	0.2	3.7	0.4	6.1	0.6	7.7	0.8	8.2	1.0	7.7	0.9	6.9	1.0
Western woodland hardwoods	0.2	0.1	0.1	0.1	0.2	0.0	0.3	0.1	0.3	0.1	0.3	0.1	0.2	0.1	0.2	0.1
Total	3.2	0.3	9.3	0.9	17.7	1.0	23.3	1.4	24.2	1.5	22.1	1.5	18.4	1.3	17.2	1.4
All species groups	34.2	1.8	40.4	1.8	70.5	1.8	105.1	2.6	132.8	3.2	149.8	4.1	146.7	4.2	147.7	4.7

Table 20—Estimated aboveground biomass of all live trees on forest land, by species group and diameter class, Oregon, 2001–2005 (continued)

	Diameter class (inches)															
	17.0–18.9		19.0–20.9		21.0–24.9		25.0–28.9		29.0–32.9		33.0–36.9		37.0+		All classes	
Species group	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million bone-dry tons															
Softwoods:																
Douglas-fir	62.9	3.5	61.3	3.7	108.4	6.6	96.3	8.0	69.3	4.9	63.0	4.2	235.0	16.2	1,010.1	30.5
Engelmann and other spruces	1.2	0.3	0.7	0.2	2.4	0.7	0.6	0.2	0.6	0.2	0.6	0.3	0.4	0.2	11.4	1.9
Incense-cedar	0.8	0.2	0.9	0.3	1.5	0.4	1.4	0.5	1.0	0.3	0.9	0.2	5.1	1.1	15.9	2.0
Lodgepole pine	2.0	0.4	1.1	0.3	0.7	0.3	0.1	0.1	0.0	0.0	0.0	0.0	0.3	0.2	65.0	4.5
Other western softwoods	5.2	0.9	6.4	1.3	11.5	1.9	6.2	1.3	3.3	0.8	2.6	0.7	4.4	2.0	66.1	7.9
Ponderosa and Jeffrey pines	13.0	1.2	11.8	1.1	20.4	1.7	20.3	1.8	14.7	1.2	9.8	0.9	9.9	1.2	170.6	7.1
Redwood	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.1	1.2
Sitka spruce	1.6	0.5	1.0	0.4	2.4	1.0	2.8	1.8	1.1	0.4	0.8	0.4	3.1	1.3	17.4	5.3
Sugar pine	0.2	0.1	0.4	0.2	1.0	0.3	1.1	0.5	1.1	0.5	1.5	0.4	8.9	1.9	14.7	2.4
True fir	18.4	1.6	15.0	1.5	30.4	3.1	27.0	3.9	17.7	2.1	11.0	1.5	17.3	2.7	240.6	13.9
Western hemlock	13.4	1.7	12.1	1.6	24.3	2.8	18.8	2.8	10.8	1.8	6.0	1.2	9.2	1.6	163.2	11.8
Western juniper	2.0	0.3	1.1	0.2	2.1	0.4	1.0	0.1	0.5	0.1	0.4	0.1	0.3	0.1	21.8	1.6
Western larch	1.7	0.4	1.7	0.5	2.0	0.5	1.1	0.2	0.9	0.3	0.4	0.2	0.3	0.2	16.5	1.9
Western redcedar	1.6	0.4	1.6	0.5	3.7	0.8	5.2	1.2	3.1	0.7	3.2	0.6	9.6	1.8	34.5	4.1
Western white pine	0.5	0.2	0.3	0.2	0.9	0.3	0.5	0.2	1.0	0.4	0.3	0.2	1.8	1.0	7.5	1.5
Total	124.5	4.7	115.2	4.7	211.6	8.2	182.1	10.2	125.0	6.0	100.5	5.0	305.7	17.6	1,856.3	36.5
Hardwoods:																
Cottonwood and aspen	0.3	0.2	0.1	0.1	—	—	0.2	0.2	0.1	0.1	0.3	0.2	0.7	0.5	3.0	0.9
Oak	1.8	0.4	1.7	0.5	1.4	0.5	2.4	1.0	0.6	0.4	0.1	0.1	0.6	0.3	30.1	3.4
Other western hardwoods	5.1	0.8	2.6	0.6	6.0	1.1	3.9	0.9	1.8	0.5	1.2	0.3	1.4	0.4	90.6	5.9
Red alder	3.9	0.7	4.6	0.9	3.7	1.1	2.5	0.8	0.5	0.2	0.2	0.1	0.5	0.4	57.8	4.7
Western woodland hardwoods	0.1	0.0	0.1	0.0	0.2	0.1	—	—	—	—	—	—	—	—	2.1	0.4
Total	11.2	1.2	9.0	1.2	11.3	1.6	9.0	1.6	3.0	0.7	1.8	0.4	3.2	0.7	183.6	8.3
All species groups	135.7	4.8	124.2	4.9	222.8	8.4	191.0	10.4	128.0	6.1	102.2	5.0	308.8	17.6	2,039.9	37.6

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 50,000 bone-dry tons were estimated; includes all live trees ≥1 inch diameter at breast height.

Table 21—Estimated mass of carbon of all live trees on forest land, by owner class and forest land status, Oregon, 2001–2005

	Unreserved forests						Reserved forests							
	Timberland[a]		Other forest[b]		Total		Productive[a]		Other forest[b]		Total		All forest land	
Owner class	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Million bone-dry tons													
USDA Forest Service:														
National forest	479.6	16.2	4.6	1.3	484.2	16.1	103.5	9.3	1.8	1.2	105.3	9.4	589.5	15.1
Other federal government:														
National Park Service	—	—	—	—	—	—	7.2	1.7	0.2	0.2	7.4	1.7	7.4	1.7
Bureau of Land Management	120.5	8.3	6.0	0.9	126.4	8.3	3.4	1.6	0.4	0.2	3.7	1.6	130.2	8.1
U.S. Fish and Wildlife Service	—	—	—	—	—	—	0.3	0.3	—	—	0.3	0.3	0.3	0.3
Other federal	1.2	0.8	—	—	1.2	0.8	—	—	—	—	—	—	1.2	0.8
Total	121.6	8.3	6.0	0.9	127.6	8.3	10.9	2.3	0.5	0.2	11.4	2.3	139.0	8.1
State and local government:														
State	50.8	6.2	0.1	0.1	50.9	6.2	1.1	0.8	—	—	1.1	0.8	52.0	6.3
Local	3.8	1.3	—	—	3.8	1.3	1.4	1.5	—	—	1.4	1.5	5.2	2.0
Total	54.6	7.6	0.1	0.1	54.7	7.6	2.5	2.3	—	—	2.5	2.3	57.2	8.3
Corporate private	157.8	8.7	0.6	0.2	158.4	8.7	—	—	—	—	—	—	158.4	8.7
Noncorporate private:														
Nongovernmental conservation or natural resource organizations	7.0	2.0	—	—	7.0	2.0	—	—	—	—	—	—	7.0	2.0
Unincorporated partnerships, associations, or clubs	2.8	1.4	0.1	0.1	2.9	1.4	—	—	—	—	—	—	2.9	1.4
Native American	13.4	3.0	1.2	0.7	14.6	3.0	—	—	—	—	—	—	14.6	3.0
Individual	83.8	6.4	4.9	0.9	88.7	6.4	—	—	—	—	—	—	88.7	6.4
Total	106.9	7.3	6.2	1.2	113.1	7.3	—	—	—	—	—	—	113.1	7.3
All owners	920.6	20.5	17.5	2.0	938.1	20.4	117.0	9.7	2.3	1.2	119.2	9.8	1,057.3	19.5

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 50,000 bone-dry tons were estimated; includes all live trees ≥1 inch diameter at breast height.

[a] Forest land that is capable of producing in excess of 20 cubic feet/acre/year of wood at culmination of mean annual increment.

[b] Forest land that is not capable of producing in excess of 20 cubic feet/acre/year of wood at culmination of mean annual increment.

Table 22—Estimated biomass and carbon mass of live trees, snags, and down wood on forest land, by forest type group, Oregon, 2001–2005

	Biomass							Carbon						
	Live trees (≥1 in d.b.h.)		Snags (≥5 in d.b.h.)		Down wood[a] (≥3 in l.e.d.)			Live trees (≥1 in d.b.h.)		Snags (≥5 in d.b.h.)		Down wood[a] (≥3 in l.e.d.)		
Forest type group	Total	SE	Total	SE	Total	SE	Biomass total	Total	SE	Total	SE	Total	SE	Carbon total
	Million bone-dry tons													
Softwoods:														
Douglas-fir	1,102.4	37.6	74.1	5.1	176.6	7.5	1,353.1	572.6	19.6	38.5	2.6	91.8	3.9	702.9
Fir/spruce/mountain hemlock	315.1	20.3	46.1	3.6	62.3	4.2	423.5	164.1	10.6	24	1.9	32.4	2.2	220.5
Lodgepole pine	61.3	5.7	6.9	1.2	19.3	2.1	87.5	31.9	3	3.6	0.6	10.0	1.1	45.5
Other western softwoods	26.7	2.2	1.5	0.3	3.1	0.6	31.3	13.9	1.2	0.8	0.1	1.7	0.3	16.4
Ponderosa pine	196.8	11	13.3	1.6	29.3	1.8	239.4	102.4	5.7	6.9	0.8	15.2	1	124.5
Western hemlock/Sitka spruce	142.3	17.2	11.8	1.9	31.2	4.1	185.3	73.9	8.9	6.2	1	16.3	2.1	96.4
Western larch	9.5	2.7	2.3	1.1	2.6	0.8	14.4	4.9	1.4	1.2	0.6	1.3	0.4	7.4
Western white pine[b]	1.5	1	0.8	0.6	0.9	0.7	3.2	0.8	0.5	0.4	0.3	0.5	0.4	1.7
Total	1,855.5	38.3	156.8	6.2	325.3	8.8	2,337.6	964.6	19.9	81.5	3.2	169.2	4.6	1,215.3
Hardwoods:														
Alder/maple	78	8.1	7.1	1.3	19.8	2.8	104.9	39.2	4.1	3.7	0.7	10.3	1.5	53.2
Aspen/birch	1.3	0.6	0.1	0.1	0.3	0.2	1.7	0.7	0.3	0.1	0	0.2	0.1	1.0
Elm/ash/cottonwood	3	1.4	0.1	0.1	0.2	0.1	3.3	1.5	0.7	0.1	0.1	0.1	0.1	1.7
Other hardwoods	22.1	4.8	1.8	0.9	3.5	1	27.4	11.1	2.4	0.9	0.5	1.8	0.5	13.8
Tanoak/laurel	42.2	7.7	5.5	1.2	8.4	1.8	56.1	21.2	3.9	2.8	0.6	4.4	0.9	28.4
Western oak	33.2	5.1	3.2	0.7	2.5	0.5	38.9	16.6	2.6	1.6	0.4	1.3	0.3	19.5
Woodland hardwoods	2.8	0.7	0.3	0.1	0.9	0.4	4.0	1.4	0.4	0.1	0.1	0.5	0.2	2.0
Total	182.6	12.6	18.1	2.1	35.7	3.5	236.4	91.7	6.4	9.3	1.1	18.5	1.8	119.5
Nonstocked	1.8	0.5	8.3	3	5.9	1.2	16.0	0.9	0.3	4.3	1.5	3.1	0.6	8.3
All forest types	2,039.9	37.6	183.3	7.0	366.9	9	2,590.1	1,057.3	19.5	95.1	3.6	190.8	4.7	1,343.2

Note: Totals may be off because of rounding; data subject to sampling error; SE = standard error; — = less than 500,000 bone-dry tons were estimated; d.b.h. = diameter at breast height; l.e.d. = large-end diameter of the log.

[a] Down wood in this table includes coarse woody material only; an additional 127 million tons of biomass and 65 million tons of carbon were estimated for fine woody material.

[b] This forest type group is represented by less than five plots.

Table 23—Average biomass and carbon mass of live trees, snags, and down wood on forest land, by forest type group, Oregon, 2001–2005

	Biomass							Carbon						
	Live trees (≥1 in d.b.h.)		Snags (≥5 in d.b.h.)		Down wood[a] (≥3 in l.e.d.)			Live trees (≥1 in d.b.h.)		Snags (≥5 in d.b.h.)		Down wood[a] (≥3 in l.e.d.)		
Forest type group	Total	SE	Total	SE	Total	SE	Mean of total	Total	SE	Total	SE	Total	SE	Mean of total
	Bone-dry tons per acre													
Softwoods:														
Douglas-fir	106.2	2.9	7.1	0.5	17.0	0.6	130.3	55.2	1.5	3.7	0.2	8.8	0.3	67.7
Fir/spruce/mountain hemlock	79.6	3.4	11.6	0.7	15.7	0.7	106.9	41.4	1.8	6.1	0.4	8.2	0.4	55.7
Lodgepole pine	30.1	1.8	3.4	0.6	9.5	0.7	43.0	15.7	0.9	1.8	0.3	4.9	0.4	22.4
Other western softwoods	8.3	0.5	0.5	0.1	1.0	0.2	9.8	4.3	0.3	0.2	0.2	0.5	0.1	5.0
Ponderosa pine	37.5	1.5	2.5	0.3	5.6	0.3	45.6	19.5	0.8	1.3	0.1	2.9	0.1	23.7
Western hemlock/Sitka spruce	134.8	9.1	11.2	1.4	29.6	2.4	175.6	70.1	4.7	5.8	0.8	15.4	1.2	91.3
Western larch	43.6	7.4	10.3	4.4	12.0	2.4	65.9	22.7	3.9	5.4	2.3	6.2	1.2	34.3
Western white pine[b]	28.9	11.5	14.7	8.7	16.6	10.7	60.2	15.0	6.0	7.7	4.6	8.7	5.6	31.4
Total	70.8	1.4	6.0	0.2	12.4	0.3	89.2	36.8	0.7	3.1	0.1	6.5	0.2	46.4
Hardwoods:														
Alder/maple	58.2	3.8	5.3	0.9	14.8	1.7	78.3	29.3	1.9	2.7	0.4	7.6	0.9	39.6
Aspen/birch	18.9	6.9	1.8	1.0	4.3	1.6	25.0	9.4	3.4	0.9	0.5	2.2	0.8	12.5
Elm/ash/cottonwood	32.4	10.0	1.6	0.9	1.7	0.5	35.7	16.1	4.9	0.8	0.4	0.9	0.3	17.8
Other hardwoods	51.1	7.6	4.2	2.0	8.2	1.8	63.5	25.7	3.8	2.2	1.0	4.2	0.9	32.1
Tanoak/laurel	70.6	9.1	9.2	1.6	14.1	2.4	93.9	35.5	4.6	4.7	0.8	7.3	1.2	47.5
Western oak	41.8	4.4	4.0	0.8	3.2	0.5	49.0	20.9	2.2	2.0	0.4	1.6	0.3	24.5
Woodland hardwoods	13.2	1.8	1.2	0.6	4.4	1.4	18.8	6.7	0.9	0.6	0.3	2.3	0.7	9.6
Total	51.6	2.6	5.1	0.5	10.1	0.8	66.8	25.9	1.3	2.6	0.3	5.2	0.4	33.7
Nonstocked	2.4	0.7	11.2	3.7	7.9	1.4	21.5	1.2	0.3	5.8	1.9	4.1	0.7	11.1
All forest types	66.9	1.2	6.0	0.2	12.1	0.3	85.0	34.7	0.6	3.1	0.1	6.3	0.2	44.1

Note: Means are calculated using a ratio of means formula across plots within forest type groups; data subject to sampling error; SE = standard error; d.b.h. = diameter at breast height; l.e.d. = large-end diameter of the log.

[a] Down wood in this table includes coarse woody material only.

[b] This forest type group is represented by less than five plots.

Table 24—Index of vascular plant species richness on forest land, by ecological section, Oregon, 2005

Ecological section	Number of plots	Species richness/plot Mean	Species richness/plot SE	Total richness	Species turnover	Native richness/plot Mean	Native richness/plot SE	Nonnative richness/plot Mean	Nonnative richness/plot SE	Native species cover (sum) Mean	Native species cover (sum) SE	Nonnative cover (sum) Mean	Nonnative cover (sum) SE
Blue Mountain Foothills	5	44.6	7.6	156	3.5	25.2	5.7	5.4	2.0	40.2	9.2	10.4	4.7
Blue Mountains	27	47.4	3.3	504	10.6	31.6	2.3	3.6	0.8	59.0	9.8	4.0	1.7
Eastern Cascades	13	27.3	3.1	194	7.1	19.8	2.1	1.1	0.4	22.4	5.9	1.4	1.2
Klamath Mountains	9	37.8	5.0	173	4.6	27.4	4.0	1.3	0.4	49.6	15.8	0.3	0.2
Modoc Plateau	5	26.8	5.1	108	4.0	13.0	3.1	1.0	0.4	14.4	7.7	4.1	4.0
Northwestern Basin and Range	5	30.8	5.2	98	3.2	21.2	4.2	1.2	0.2	37.3	12.1	0.7	0.4
Oregon and Washington Coast Ranges	15	42.1	5.0	231	5.5	31.3	3.3	4.1	1.6	64.8	14.8	2.2	1.3
Owyhee Uplands	1	30.0	—	30	1.0	19.0	—	2.0	—	56.0	—	10.3	—
Western Cascades	25	45.8	4.2	381	8.3	34.6	3.3	2.8	0.7	65.2	9.8	3.0	1.5
Willamette Valley	5	55.8	12.8	188	3.4	26.4	5.6	11.4	4.3	85.8	23.1	41.9	21.4

Note: Data subject to sampling error; SE = standard error; — = value can't be estimated (N = 1). Native and nonnative species values only include vegetation records identified to the species level. Species' cover at the plot level were summed with no overlap assumptions (id est, total cover could exceed 100 percent).

Table 25—Index of lichen richness on forest land, by ecological section, Oregon, 1998–2001, 2003

Ecosection	Number of plots	Minimum richness	Maximum richness	Mean richness	SD[a]
Blue Mountain Foothills	24	1	17	8.3	4.1
Blue Mountains	59	4	31	15.1	6.6
Eastern Cascades	34	3	26	9.1	5.2
Klamath Mountains	31	4	45	20.9	8.6
Modoc Plateau	15	7	15	10.3	2.8
Northwestern Basin and Range	7	1	8	5.4	2.4
Oregon and Washington Coast Ranges	44	0	27	12.8	8.1
Owyhee Uplands	1	5	5	5	—
Southern Cascades	4	19	22	20.8	1.3
Western Cascades	61	0	36	19.6	7.8
Willamette Valley	12	13	43	24.7	9.7

Note: Data subject to sampling error; SE = standard error; — = value can not be estimated (N = 1).
[a] SD = standard deviation.

Table 26—Summary of lichen community indicator species richness on forest land, Pacific Northwest and Oregon, 1998–2001, 2003

Parameter	Pacific Northwest	Oregon	Western Oregon	Eastern Oregon
Number of plots[a]	491	292	144	148
Number of plots by lichen species richness category:				
0 to 6 species	60	44	15	29
7–15 species	186	118	35	83
16–25 species	188	94	63	31
>25 species	57	36	31	5
Median	15	14	19	10
Range of species richness per plot (low–high)	0–45	0–45	0–45	1–31
Average lichen species richness per plot (alpha diversity)	15.85	15	18.47	11.64
Standard deviation of lichen species richness per plot	7.99	8.45	9	6.29
Species turnover rate (beta diversity)[b]	13.12	12.13	9.2	7.73
Total number of species per area (gamma diversity)	208	182	170	90

[a] Plot totals do not include quality assurance surveys.
[b] Beta diversity is calculated as gamma diversity divided by alpha diversity.

Table 27—Estimated average biomass, volume, and density of down wood on forest land, by forest type group and diameter class, Oregon, 2001–2005

	Biomass								Volume								Density[b]					
	Diameter class (inches)[a]								Diameter class (inches)[a]								Diameter class (inches)[a]					
	FWM		CWM						FWM		CWM						CWM					
	< 3 in		3 to 19 in		≥20 in		Total		< 3 in		3 to 19 in		≥20 in		Total		3 to 19 in		≥20 in		Total	
Forest type group	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
	Bone-dry tons per acre								*Cubic feet per acre*								*Logs per acre*					
Softwoods:																						
Douglas-fir	5.4	0.2	7.0	0.2	10.1	0.5	22.5	0.8	390.3	13.5	812.7	22.4	1,201.5	59.8	2,404.5	96.1	245.2	6.6	17.0	0.9	262.2	6.8
Fir/spruce/mountain hemlock	4.5	0.2	9.4	0.4	6.4	0.5	20.3	0.9	376.6	13.6	1,149.8	47.5	835.7	68.1	2,362.1	95.4	300.0	10.7	11.4	0.9	311.4	10.7
Lodgepole pine	4.2	0.2	8.4	0.6	1.1	0.2	13.7	0.9	350.6	19.5	995.8	79.2	155.6	30.8	1,502.0	111.5	339.1	20.1	3.0	0.6	342.1	20.1
Other western softwoods	1.5	0.4	0.6	0.1	0.4	0.1	2.5	1.0	96.6	28.0	61.2	9.6	44.0	13.6	201.8	136.9	28.1	3.9	1.0	0.3	29.1	4.0
Ponderosa pine	2.9	0.1	3.6	0.2	1.9	0.2	8.4	0.8	235.2	8.6	435.6	19.9	271.9	25.1	942.7	72.4	210.1	8.6	4.6	0.5	214.7	8.7
Western hemlock/Sitka spruce	5.8	0.7	9.5	0.6	20.0	2.2	35.3	2.9	454.8	52.1	1,211.8	71.6	2,628.0	290.4	4,294.6	377.6	342.2	27.3	33.2	3.5	375.4	27.4
Western larch	3.3	0.6	10.4	2.1	1.6	0.7	15.3	5.3	247.7	41.0	1,212.6	245.8	243.6	108.1	1,703.9	551.1	409.6	49.4	4.6	2.5	414.2	50.3
Western white pine	1.9	0.5	3.4	1.7	13.3	9.0	18.6	10.7	168.8	44.7	407.0	191.6	1,494.2	1,012.8	2,070.0	1,197.5	112.7	21.9	11.8	7.4	124.5	23.5
Total	4.2	0.1	6.1	0.1	6.3	0.3	16.6	0.5	318.8	7.6	736.5	15.8	784.1	30.4	1,839.4	52.7	232.0	4.5	11.1	0.4	243.1	4.6
Hardwoods:																						
Alder/maple	4.8	0.3	4.5	0.3	10.2	1.6	19.5	2.3	371.1	27.4	601.7	47.7	1,281.9	186.2	2,254.7	251.1	197.5	12.4	17.2	2.5	214.7	12.9
Aspen/birch	1.5	0.4	3.6	1.2	0.7	0.4	5.8	1.7	139.0	35.5	440.5	172.3	120.0	71.9	699.5	255.5	191.1	50.2	4.2	3.0	195.3	51.7
Elm/ash/cottonwood	1.6	0.5	1.7	0.5	—	—	3.3	0.7	145.1	52.2	190.8	41.5	—	—	335.9	73.5	91.7	12.3	—	—	91.7	12.3
Other hardwoods	4.3	0.6	4.1	0.7	4.0	1.4	12.4	2.5	275.2	42.5	429.3	68.9	474.1	181.5	1,178.6	381.5	185.1	36.0	5.8	2.0	190.9	37.1
Tanoak/laurel	5.6	1.1	5.7	0.8	8.4	2.1	19.7	4.4	375.9	70.7	608.3	69.6	946.6	213.1	1,930.8	450.5	242.5	31.6	11.9	2.9	254.4	32.6
Western oak	2.6	0.3	2.3	0.4	0.9	0.3	5.8	0.7	153.2	15.4	238.6	36.6	109.9	37.4	501.7	66.9	101.4	12.8	2.6	1.0	104.0	12.9
Woodland hardwoods	5.0	2.1	2.5	1.0	1.9	0.9	9.4	2.7	343.7	158.5	307.2	140.4	225.9	102.0	876.8	260.1	135.1	41.2	2.6	1.3	137.7	41.1
Total	4.2	0.3	4.0	0.2	6.1	0.8	14.3	1.3	299.2	20.0	468.7	27.8	743.9	86.9	1,511.8	141.3	175.4	9.8	10.0	1.2	185.4	10.1
Nonstocked	4.4	0.6	4.9	0.7	3.0	0.8	12.3	1.8	333.0	46.9	478.8	62.2	340.2	88.6	1,152.0	157.1	220.0	29.0	9.5	3.1	229.5	30.9
All forest types	4.2	0.1	5.8	0.1	6.3	0.2	16.3	0.4	316.8	7.0	692.0	14.1	769.9	27.9	1,778.7	48.2	225.1	4.1	10.9	0.4	236.0	4.2

Note: Means are calculated using a ratio of means formula across plots within forest type groups; data subject to sampling error; SE = standard error; — = less than 0.05 bone-dry tons per acre, 0.05 cubic feet per acre, and 0.05 logs per acre were estimated; CWM = coarse woody material; FWM = fine woody material.

[a] The diameter of the large end is used to classify CWM with decay classes of 1–4; diameter at the point of intersection with the transect is used for heavily decomposed CWM (decay class 5) and for all FWM.

[b] An estimate of pieces per acre is not possible for fine woody material.

Table 28—Estimated biomass and carbon mass of down wood[a] on forest land, by forest type group and owner, Oregon, 2001–2005

Forest type group	USDA Forest Service		Other federal		State and local goverments		Corporate private		Other private		All owners	
	Biomass	Carbon	Biomass	Carbon	Biomass	Carbon	Biomass	Carbon	Biomass	Carbon	Biomass	Carbon
	Million bone-dry tons											
Softwoods:												
Douglas-fir	76.2	39.6	28.8	15.0	15.8	8.2	43.4	22.6	12.3	6.4	176.6	91.8
Fir/spruce/mountain hemlock	50.6	26.3	2.3	1.2	0.5	0.3	5.6	2.9	3.3	1.7	62.3	32.4
Lodgepole pine	15.4	8.0	0.6	0.3	—	—	2.4	1.2	0.9	0.5	19.3	10.0
Other western softwoods	1.5	0.8	0.9	0.5	—	—	0.1	0.1	0.6	0.3	3.1	1.7
Ponderosa pine	20.7	10.8	0.9	0.4	0.3	0.2	4.3	2.2	3.1	1.6	29.3	15.2
Western hemlock/Sitka spruce	13.5	7.0	3.0	1.6	2.5	1.3	9.8	5.1	2.4	1.3	31.2	16.3
Western larch	2.1	1.1	—	—	—	—	0.5	0.2	0.1	—	2.6	1.3
Western white pine	0.9	0.5	—	—	—	—	—	—	—	—	0.9	0.5
Total	180.9	94.1	36.5	19.0	19.1	10.0	66.1	34.3	22.7	11.8	325.3	169.2
Hardwoods:												
Alder/maple	4.8	2.5	1.1	0.6	2.4	1.3	7.3	3.7	4.2	2.2	19.8	10.3
Aspen/birch	0.1	0.1	0.2	0.1	—	—	—	—	—	—	0.3	0.2
Other hardwoods	0.4	0.2	0.6	0.3	0.1	0.1	1.9	1.0	0.7	0.3	3.7	1.8
Tanoak/laurel	3.4	1.7	1.7	0.9	—	—	2.4	1.2	0.9	0.5	8.5	4.4
Western oak	0.5	0.2	0.7	0.4	—	—	0.6	0.3	0.8	0.4	2.5	1.3
Woodland hardwoods	0.6	0.3	—	—	—	—	—	—	0.3	0.1	0.9	0.5
Total	9.8	5.0	4.3	2.3	2.5	1.4	12.2	6.2	6.9	3.5	35.7	18.5
Nonstocked	2.1	1.1	0.1	—	0.6	0.3	2.8	1.5	0.4	0.2	5.9	3.1
All forest types	192.8	100.2	40.9	21.3	22.2	11.7	81.1	42.0	30.0	15.5	366.9	190.8

Note: Totals may be off because of rounding; data subject to sampling error; — = less than 50,000 bone-dry tons were estimated. Standard errors available upon request.

[a] In this table, down wood includes logs ≥ 3 inches in diameter at the large end (coarse woody material); an additional 127 million tons of biomass and 65 million tons of carbon were estimated for fine woody material in the state.

Table 29—Estimated average biomass, volume, and density of snags on forest land, by forest type group and diameter class, Oregon, 2001–2005

	Biomass								Volume								Density							
	Diameter class (inches)								Diameter class (inches)								Diameter class (inches)							
	5 to 19		20 to 39		≥40		Total		5 to 19		20 to 39		≥40		Total		5 to 19		20 to 39		≥40		Total	
Forest type group	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
	Bone-dry tons per acre								*Cubic feet per acre*								*Trees per acre*							
Softwoods:																								
Douglas-fir	2.6	0.2	3.0	0.3	1.5	0.2	7.1	0.5	119.4	0.5	129.4	7.7	52.0	13.6	300.7	22.5	16.6	0.8	2.2	0.2	0.4	0.4	19.2	0.9
Fir/spruce/mountain hemlock	5.7	0.4	4.7	0.4	1.3	0.3	11.7	0.7	304.8	0.7	239.3	22.1	52.5	23.2	596.6	36.4	31.1	2.2	3.7	0.3	0.2	0.2	35.0	2.2
Lodgepole pine	2.8	0.5	0.5	0.2	—	—	3.3	0.6	153.5	0.6	30.8	25.8	2.7	9.1	187.0	30.9	24.0	3.7	0.4	0.1	—	—	24.4	3.8
Other western softwoods	0.3	0.1	0.2	0.1	—	—	0.5	0.1	11.5	0.1	9.8	2.5	1.2	4.0	22.5	5.0	2.7	0.4	0.2	0.1	—	—	2.9	0.5
Ponderosa pine	1.4	0.2	0.9	0.1	0.2	0.1	2.5	0.3	71.1	0.3	52.1	9.0	11.8	7.8	135.0	15.5	9.3	1.0	0.6	0.1	—	—	10.0	1.0
Western hemlock/Sitka spruce	3.0	0.4	3.8	0.9	4.4	0.8	11.2	1.4	145.4	1.4	166.8	19.5	146.2	44.9	458.5	68.4	20.3	2.2	2.9	0.6	1.1	0.2	24.3	2.2
Western larch	5.7	1.7	4.6	3.3	—	—	10.3	4.4	303.2	4.4	278.0	96.9	—	—	581.2	260.1	33.9	8.0	2.5	1.4	—	—	36.4	8.6
Western white pine	1.3	0.5	4.6	2.9	8.9	6.3	14.7	8.7	65.2	8.7	318.0	23.0	617.0	201.7	1,000.2	617.5	15.8	10.1	1.2	0.6	1.0	0.7	18.0	9.4
Total	2.6	0.1	2.3	0.1	1.0	0.1	6.0	0.2	129.5	0.2	111.2	5.5	38.4	7.1	279.1	11.9	16.5	0.6	1.8	0.1	0.2	0.2	18.5	0.6
Hardwoods:																								
Alder/maple	1.6	0.2	1.3	0.4	2.5	0.6	5.3	0.9	72.6	0.9	47.9	10.0	75.3	17.2	195.8	38.3	12.4	1.4	1.2	0.2	0.7	0.1	14.3	1.4
Aspen/birch	1.7	1.0	0.1	0.1	—	—	1.8	1.0	89.4	1.0	3.8	55.5	—	3.7	93.2	54.7	16.5	7.1	0.2	0.2	—	—	16.7	7.0
Elm/ash/cottonwood	0.4	0.2	1.2	1.0	—	—	1.6	0.9	24.4	0.9	45.2	13.5	—	36.5	69.6	34.0	2.1	1.0	1.0	0.8	—	—	3.1	1.0
Other hardwoods	2.0	0.4	2.0	1.8	0.3	0.2	4.2	2.0	76.0	2.0	129.3	16.0	6.2	120.5	211.6	128.7	16.1	3.4	0.9	0.7	0.2	0.1	17.2	3.6
Tanoak/laurel	4.1	1.0	2.7	0.7	2.4	0.8	9.2	1.6	172.4	1.6	112.6	41.1	99.7	34.1	384.7	75.0	30.8	7.5	2.0	0.5	0.5	0.1	33.2	7.6
Western oak	2.5	0.4	1.2	0.4	0.3	0.2	4.0	0.8	107.5	0.8	63.0	21.9	12.1	21.8	182.6	39.7	15.7	2.2	1.1	0.3	—	—	16.7	2.3
Woodland hardwoods	0.5	0.2	0.7	0.4	—	—	1.2	0.6	28.0	0.6	40.0	15.7	—	—	68.0	33.1	8.0	2.2	0.9	0.6	—	—	8.9	2.1
Total	2.1	0.2	1.5	0.3	1.5	0.3	5.1	0.5	94.1	0.5	70.7	9.9	48.8	17.9	213.6	26.7	16.2	1.6	1.2	0.2	0.4	0.1	17.8	1.6
Nonstocked	6.8	2.2	3.8	1.5	0.6	0.3	11.2	3.7	355.7	3.7	200.3	118.0	14.8	80.7	570.8	191.9	26.0	7.6	2.3	0.8	0.2	0.1	28.4	8.0
All forest types	2.6	0.1	2.3	0.1	1.1	0.1	6.0	0.2	131.0	0.2	108.7	5.7	39.0	6.7	278.7	11.6	16.7	0.6	1.7	0.1	0.3	0.3	18.6	0.6

Note: Means are calculated using a ratio of means formula across plots within forest type groups; data subject to sampling error; SE = standard error; — = less than 0.05 bone-dry tons per acre, 0.05 cubic feet per acre, and 0.05 trees per acre were estimated; includes snags ≥5 inches diameter at breast height.

Table 30—Estimated biomass and carbon mass of snags on forest land, by forest type group and owner, Oregon, 2001–2005

Forest type group	USDA Forest Service		Other federal		State and local goverments		Corporate		Other private		All owners	
	Biomass	Carbon	Biomass	Carbon	Biomass	Carbon	Biomass	Carbon	Biomass	Carbon	Biomass	Carbon
	Million bone-dry tons											
Softwoods:												
Douglas-fir	48.6	24.3	11.1	5.6	4.8	2.4	6.9	3.5	2.8	1.4	74.2	38.5
Fir/spruce/mountain hemlock	41.2	20.6	2.2	1.1	0.2	0.1	1.0	0.5	1.5	0.8	46.1	24.0
Hemlock/Sitka spruce	7.3	3.7	1.4	0.7	0.4	0.2	2.2	1.1	0.5	0.2	11.8	6.2
Lodgepole pine	6.5	3.2	0.2	0.1	—	—	0.1	0	0.1	0.1	6.9	3.6
Other western softwoods	0.5	0.2	0.8	0.4	—	—	0	0	0.2	0.1	1.5	0.8
Ponderosa pine	10.7	5.4	0.5	0.2	0.1	0.1	0.8	0.4	1.2	0.6	13.3	6.9
Western larch	2.2	1.1	—	—	—	—	0	0	—	—	2.3	1.2
Western white pine	0.8	0.4	—	—	—	—	—	—	—	—	0.8	0.4
Total	117.8	58.9	16.2	8.1	5.5	2.8	11.0	5.5	6.3	3.1	156.8	81.5
Hardwoods:												
Alder/maple	2.6	1.3	0	0	1.1	0.6	2.3	1.1	1.1	0.5	7.2	3.7
Aspen/birch	0	0	—	—	—	—	—	—	0.1	0.0	0.1	0.1
Elm/ash/cottonwood	—	—	—	—	—	—	—	—	0.1	0.1	0.1	0.1
Other hardwoods	0.9	0.4	0.2	0.1	0.1	0	0.3	0.1	0.4	0.2	1.8	0.9
Tanoak/laurel	3.8	1.9	0.4	0.2	—	—	1.0	0.5	0.2	0.1	5.5	2.8
Western oak	1.1	0.6	0.8	0.4	—	—	0.3	0.2	0.9	0.5	3.2	1.6
Woodland hardwoods	0.2	0.1	0	0	—	—	0	0	0.1	0.0	0.3	0.1
Total	8.7	4.3	1.4	0.7	1.2	0.6	3.9	1.9	3.0	1.5	18.1	9.3
Nonstocked	8.0	4.0	—	—	0.1	0.0	0.2	0.1	0.1	0.0	8.3	4.3
All forest types	134.4	67.2	17.7	8.8	6.8	3.4	15.1	7.5	9.3	4.7	183.3	95.1

Note: Totals may be off because of rounding; data subject to sampling error; — = less than 50,000 bone-dry tons were estimated; includes snags ≥ 5 inches in diameter at breast height. Standard errors available upon request.

Table 31—Estimated area and net volume of live trees on riparian forest land by location, Oregon, 2001–2005

	Forest land area				Net volume of live trees			
	Riparian[a]		Proportion of forest land		Riparian[a]		Proportion of forest land	
Location	Total	SE	Percent[b]	SE	Total	SE	Percent[b]	SE
	Thousand acres		*Percent*		*Million cubic feet*		*Percent*	
Western Oregon:								
North	477	59	12.56	1.52	2,236	361	11.44	1.78
Central	507	59	11.42	1.29	3,501	580	13.40	2.08
South	603	61	8.65	0.87	2,994	480	8.86	1.36
Total	1,588	103	10.43	0.67	8,730	834	10.99	1.00
Eastern Oregon:								
Central	195	39	2.24	0.45	498	151	3.21	0.96
Blue Mountains	374	53	5.71	0.81	1,067	209	10.05	1.85
Total	569	66	3.73	0.43	1,566	258	5.99	0.96
Total Oregon	2,157	122	7.08	0.40	10,296	872	9.75	0.79

Note: Data subject to sampling error; SE = standard error.
[a] Riparian forest land is defined as forest land within 100 feet of a permanent water body.
[b] Riparian as a percentage of all forest land within each category.

Table 32—Estimated area of riparian forest land by forest type group, owner, and location, Oregon, 2001–2005

	Western Oregon				Eastern Oregon				All Oregon			
	Riparian[a]		Proportion of forest land		Riparian[a]		Proportion of forest land		Riparian[a]		Proportion of forest land	
Location	Total	SE	Percent[b]	SE	Total	SE	Percent[b]	SE	Total	SE	Percent[b]	SE
	Thousand acres		*Percent*		*Thousand acres*		*Percent*		*Thousand acres*		*Percent*	
Softwoods:												
Public	679	69	9.21	0.92	415	56	4.09	0.56	1,094	89	6.25	0.50
Private	409	55	9.05	1.17	104	27	2.50	0.65	513	61	5.90	0.69
Total	1,088	88	9.15	0.72	519	63	3.63	0.44	1,607	108	6.13	0.41
Hardwoods:												
Public	125	27	11.05	2.25	31	18	10.79	5.61	157	32	11.00	2.13
Private	343	46	17.89	2.17	7	8	3.44	3.97	350	46	16.53	2.02
Total	468	53	15.35	1.61	38	19	7.80	3.75	506	56	14.30	1.48
Nonstocked	32	13	11.52	4.53	12	10	2.67	2.13	44	16	6.06	2.19
All public	829	75	9.63	0.86	458	60	4.25	0.55	1,287	96	6.64	0.49
All private	759	72	11.48	1.06	111	28	2.48	0.63	870	77	7.85	0.69
Total Oregon	1,588	103	10.43	0.67	569	66	3.73	0.43	2,157	122	7.08	0.40

Note: Data subject to sampling error; SE = standard error.
[a] Riparian forest land is defined as forest land within 100 feet of a permanent water body.
[b] Riparian as a percentage of all forest land area within each category.

Table 33—Estimated net volume of live trees on riparian forest land by species group, owner, and location, Oregon, 2001–2005

	Western Oregon				Eastern Oregon				All Oregon			
	Riparian[a]		Proportion of forest land		Riparian[a]		Proportion of forest land		Riparian[a]		Proportion of forest land	
Location	Total	SE	Percent[b]	SE	Total	SE	Percent[b]	SE	Total	SE	Percent[b]	SE
	Million cubic feet		*Percent*		*Million cubic feet*		*Percent*		*Million cubic feet*		*Percent*	
Softwoods:												
Public	5,107	690	9.32	1.22	1,183	221	5.52	1.01	6,290	724	8.25	0.92
Private	2,032	354	11.84	1.88	358	131	7.99	2.74	2,389	377	11.04	1.60
Total	7,139	773	9.92	1.03	1,541	257	5.94	0.96	8,680	815	8.87	0.80
Hardwoods:												
Public	510	114	15.95	3.11	16	16	12.99	11.57	526	115	15.84	3.02
Private	1,081	152	25.00	2.83	9	7	9.45	6.91	1,090	152	24.67	2.78
Total	1,591	188	21.15	2.10	25	17	11.47	7.33	1,616	189	20.88	2.05
All public	5,617	721	9.69	1.20	1,199	221	5.56	1.00	6,817	754	8.57	0.92
All private	3,113	426	14.49	1.78	366	132	8.02	2.69	3,479	445	13.35	1.54
Total Oregon	8,730	834	10.99	1.00	1,566	258	5.99	0.96	10,296	872	9.75	0.79

Note: Data subject to sampling error; SE = standard error.

[a] Riparian forest land is defined as forest land within 100 feet of a permanent water body.

[b] Net volume in riparian forests as a percentage of net volume in forest land within each category.

Table 34—Estimated mean crown density and other statistics[a] for live trees on forest land, by species group, Oregon, 2001–2005

Species group	Plots	Trees	Crown density Mean	SE	Minimum	Median	Maximum
	- - *Number* - -		- - - - - - - - *Percent* - - - - - - - -				
Softwoods:							
Douglas-fir	169	2,020	46.4	1.4	5	45	95
Engelmann and other spruces	10	49	49.1	1.2	15	50	80
Incense-cedar	18	55	49.7	3.4	15	50	95
Lodgepole pine	50	540	43.3	3.3	5	40	85
Other western softwoods	76	597	45.2	1.4	5	45	99
Ponderosa and Jeffrey pines	86	747	37.7	1.7	5	35	95
Sitka spruce	8	83	46.3	11.6	10	50	85
Sugar pine	9	31	42.6	3.6	15	40	95
True fir	81	861	43.9	1.7	0	45	99
Western hemlock	51	364	45.0	2.6	5	45	90
Western larch	13	30	42.5	4.6	5	40	75
Western redcedar	17	54	37.0	3.0	15	35	65
Western white pine	11	23	39.1	4.4	10	40	85
Total	303	5,454	44.2	0.9	0	40	99
Hardwoods:							
Oak	24	144	37.6	2.5	0	40	80
Other western hardwoods	58	399	39.3	1.8	0	40	80
Red alder	38	313	40.8	3.5	0	40	85
Western woodland hardwoods	9	34	30.7	6.9	5	25	75
Total	98	903	39.2	1.7	0	40	85
All species	307	6,357	43.5	0.8	0	40	99

Note: Data subject to sampling error; SE = standard error; includes live trees > 4.9 inches in diameter at breast height.

[a] The mean, standard error (SE), and median calculations consider the clustering of trees on plots.

Table 35—Mean foliage transparency and other statistics[a] for live trees on forest land, by species group, Oregon, 2001–2005

Species group	Plots	Trees	Foliage transparency				
			Mean	SE	Minimum	Median	Maximum
	- - Number - -		*- - - - - - - - - - - - - - - - - Percent - - - - - - - - - - - - - - -*				
Softwoods:							
Douglas-fir	169	2,020	19.2	0.5	0	15	90
Engelmann and other spruces	10	49	12.7	0.6	5	15	20
Incense-cedar	18	55	16.9	2.8	5	15	80
Lodgepole pine	50	540	17.0	1.0	5	15	35
Other western softwoods	76	597	20.6	3.4	5	15	80
Ponderosa and Jeffery pines	86	747	23.0	2.5	0	20	90
Sitka spruce	8	83	16.9	3.4	10	15	45
Sugar pine	9	31	19.4	1.4	5	20	35
True fir	81	861	17.3	0.9	5	15	99
Western hemlock	51	364	19.6	1.3	0	15	90
Western larch	13	30	18.8	1.0	15	20	35
Western redcedar	17	54	23.0	1.3	15	20	50
Western white pine	11	23	18.5	2.2	10	15	45
Total	303	5,454	19.3	0.7	0	15	99
Hardwoods:							
Oak	24	144	23.3	2.6	10	20	99
Other western hardwoods	58	399	26.3	1.5	10	25	99
Red alder	38	313	34.0	4.8	0	30	99
Western woodland hardwoods	9	34	34.7	3.2	10	35	75
Total	98	903	28.7	2.0	0	25	99
All species	307	6,357	20.6	0.7	0	20	99

Note: Data subject to sampling error; SE = standard error; includes live trees > 4.9 inches in diameter at breast height.

[a] The mean, standard error (SE), and median calculations consider the clustering of trees on plots.

Table 36—Mean crown dieback and other statistics[a] for live trees on forest land, by species group, Oregon, 2001–2005

Species group	Plots	Trees	Crown dieback Mean	SE	Minimum	Median	Maximum
	- - *Number* - -		- - - - - - - - *Percent* - - - - - - - -				
Softwoods:							
Douglas-fir	170	2,039	1.3	0.2	0	0	95
Engelmann and other spruces	10	49	1.9	1.4	0	0	30
Incense-cedar	18	55	0.9	0.5	0	0	20
Lodgepole pine	50	558	3.2	0.7	0	0	90
Other western softwoods	76	602	4.7	1.8	0	0	90
Ponderosa and Jeffrey pines	86	753	1.1	0.2	0	0	95
Sitka spruce	8	83	1.2	0.5	0	0	20
Sugar pine	9	31	1.8	1.3	0	0	20
True fir	81	862	2.3	0.6	0	0	95
Western hemlock	51	364	1.2	0.4	0	0	95
Western larch	13	30	5.2	3.1	0	0	95
Western redcedar	17	54	0.1	0.1	0	0	5
Western white pine	11	23	2.6	1.4	0	0	30
Total	303	5,503	2	0.3	0	0	95
Hardwoods:							
Oak	24	145	2.8	1.0	0	0	60
Other western hardwoods	59	416	2.3	0.7	0	0	99
Red alder	38	313	2.9	1.2	0	0	99
Western woodland hardwoods	9	34	12.2	2.9	0	5	95
Total	99	921	2.9	0.6	0	0	99
All species	307	6,424	2.1	0.3	0	0	99

Note: Data subject to sampling error; SE = standard error; includes live trees > 4.9 inches in diameter at breast height.

[a] The mean, standard error (SE), and median calculations consider the clustering of trees on plots.

Table 37—Properties of the forest floor layer on forest land, by forest type, Oregon, 2001, 2003–2005

Forest type	Samples	Moisture content (oven-dry basis)	Organic carbon	Total nitrogen
	Number	*Percent*	- - - - - - *Percent* - - - - - -	
Aspen	2	51.27	37.13	1.36
Bigleaf maple	2	138.42	28.56	1.07
California black oak	1	19.22	38.34	0.88
California laurel	1	61.05	18.89	0.47
Canyon live oak	1	14.50	36.20	0.63
Douglas-fir	85	79.43	34.54	0.91
Engelmann spruce	2	14.14	35.24	1.00
Giant chinquapin	1	98.61	30.50	1.05
Grand fir	7	18.10	35.44	1.03
Lodgepole pine	19	19.07	39.15	0.82
Mountain brush woodland	2	7.12	28.78	1.07
Mountain hemlock	6	56.91	41.04	0.98
Noble fir	3	39.86	38.32	1.01
Oregon white oak	4	10.86	29.01	0.96
Pacific madrone	3	30.90	29.85	0.67
Ponderosa pine	39	23.14	35.72	0.86
Red alder	12	137.52	34.99	1.32
Sitka spruce	2	100.24	44.82	1.44
Subalpine fir	5	172.09	38.39	1.21
Sugar pine	1	7.82	31.57	0.48
Tanoak	6	58.08	39.99	0.87
Western hemlock	6	177.66	39.23	1.14
Western juniper	34	13.53	27.70	0.74
Western larch	1	65.90	43.24	1.36
Western white pine	1	21.10	43.46	0.65
White fir	10	38.99	32.57	0.74
Other hardwoods	2	39.82	36.48	1.29
Nonstocked	9	89.06	35.69	0.96

Note: Data subject to sampling error.

Table 38—Properties of the mineral soil layer on forest land, by depth of layer and forest type, Oregon, 2001, 2003–2005

Depth of layer and forest type	Samples	Soil properties: Texture	Moisture content (oven-dry basis)	Coarse fragments	Bulk density
	Number	*Most common*	*Percent*	*Percent*	*g/cm³*
Mineral layer 1 (0–10 cm):					
Aspen	1	Clayey	21.08	17.48	—
Bigleaf maple	2	Loamy	28.28	38.47	0.87
California black oak	1	Clayey	9.83	42.30	1.19
Canyon live oak	1	Coarse sand	6.95	57.52	0.94
Douglas-fir	75	Loamy	30.24	34.45	0.75
Engelmann spruce	1	Loamy	8.08	13.85	0.38
Giant chinquapin	1	Organic	77.90	31.94	0.28
Grand fir	7	Loamy	19.14	17.69	0.82
Lodgepole pine	17	Sandy	13.92	12.67	0.71
Mountain brush woodland	2	Loamy	4.16	19.60	1.42
Mountain hemlock	3	Coarse sand	33.60	26.70	0.65
Noble fir	3	Loamy	12.42	31.99	0.76
Nonstocked	5	Clayey	13.18	12.34	0.86
Oregon white oak	5	Clayey	19.32	26.07	1.09
Other hardwoods	2	Loamy	25.52	26.15	0.69
Pacific madrone	2	Sandy	8.83	36.51	1.33
Ponderosa pine	36	Loamy	9.78	23.00	0.88
Red alder	10	Loamy	53.69	21.40	0.58
Sitka spruce	2	Clayey	40.34	2.62	1.18
Subalpine fir	4	Loamy	23.73	19.52	0.76
Sugar pine	1	Clayey	21.04	11.93	0.70
Tanoak	5	Clayey	21.25	37.57	0.98
Western hemlock	5	Loamy	41.05	44.45	0.56
Western juniper	23	Sandy	7.52	16.54	0.96
Western larch	1	Loamy	16.91	27.55	0.25
Western white pine	1	Sandy	22.77	9.77	0.33
White fir	10	Loamy	16.74	23.84	0.79
Mineral layer 2 (10–20 cm):					
Aspen	1	Clayey	24.39	27.66	—
Bigleaf maple	2	Loamy	19.72	20.68	0.90
California black oak	1	Clayey	10.09	49.20	1.43
Canyon live oak	1	Coarse sand	8.19	5.48	1.10
Douglas-fir	75	Clayey	28.38	36.42	0.94
Engelmann spruce	1	Loamy	8.91	1.47	0.87
Giant chinkapin	1	Loamy	23.66	45.78	0.74
Grand fir	7	Clayey	15.10	17.95	0.79
Lodgepole pine	16	Sandy	15.02	11.58	0.85
Mountain brush woodland	2	Loamy	7.20	22.63	0.97
Mountain hemlock	3	Coarse sand	28.09	27.88	0.86
Noble fir	3	Loamy	15.34	30.51	0.84
Nonstocked	5	Clayey	16.11	13.11	0.98
Oregon white oak	4	Clayey	21.36	37.82	1.04
Other hardwoods	2	Loamy	29.62	26.48	0.69
Pacific madrone	2	Sandy	7.29	40.19	1.44
Ponderosa pine	33	Loamy	10.29	28.07	0.96
Red alder	10	Clayey	45.73	27.28	0.85
Sitka spruce	1	Clayey	29.32	14.08	0.96
Subalpine fir	3	Loamy	13.07	32.65	0.93
Sugar pine	1	Clayey	31.45	9.98	0.84
Tanoak	4	Clayey	21.97	38.47	0.94
Western hemlock	5	Clayey	41.86	43.64	0.81
Western juniper	18	Loamy	8.83	22.83	1.21
Western larch	1	Clayey	11.47	38.09	0.60
Western white pine	1	Sandy	31.31	3.71	0.70
White fir	10	Loamy	11.36	25.48	0.95

Note: Data subject to sampling error; — = No data available for this sample.

Table 39—Chemical properties of mineral soil layers on forest land, by depth of layer and forest type, Oregon, 2001, 2003–2005

Depth of layer and forest type	Samples	pH H_2O	pH $CaCl_2$	Organic carbon	Inorganic carbon	Total nitrogen	Extractable phosphorus	Exchangeable cations Na	K	Mg	Ca	Al	ECEC[a]	Extractable sulfur
	Number			- - - - - - - *Percent* - - - - - - -			- - - - -	- - - - -	- - - - - *mg/kg*	- - - - -	- - - - -	- - - - -	*cmolc/kg*	*mg/kg*
Mineral layer 1 (0–10 cm):														
Aspen	1	5.92	5.20	8.94	0.35	0.81	127.00	0	676.65	219.50	2,896.0	9.63	18.09	1.85
Bigleaf maple	2	5.8	5.20	5.17	0.20	0.26	21.97	0.78	352.54	226.25	1,714.5	37.17	11.73	2.33
California black oak	1	5.64	4.88	3.31	0.18	0.11	5.90	3.32	105.81	350.40	1,421.0	5.16	10.31	0.18
Canyon live oak	1	6.3	5.77	5.59	0.38	0.18	43.75	7.63	465.20	303.30	2,990.0	2.70	18.67	1.57
Douglas-fir	74	5.59	4.90	5.85	0.24	0.26	37.22	17.25	330.54	317.27	1,979.2	115.81	14.69	6.89
Engelmann spruce	1	6.16	5.42	3.79	0.17	0.20	32.90	7.77	297.80	255.50	2,215.0	0	13.95	2.66
Giant chinquapin	1	5.58	4.88	21.30	0.31	0.62	25.33	15.10	335.50	200.10	3,631.0	14.54	20.85	14.55
Grand fir	7	6.5	5.86	3.78	0.21	0.20	51.87	16.40	834.06	231.43	2,445.9	6.62	16.39	13.75
Lodgepole pine	17	5.89	5.11	3.89	0.16	0.15	67.77	11.19	318.80	115.32	1,072.4	22.21	7.41	3.87
Mountain brush woodland	2	6.48	5.81	3.61	0.24	0.15	58.46	13.54	415.00	710.40	3,356.5	0.98	23.72	1.27
Mountain hemlock	3	5.14	4.58	2.57	0.15	0.06	38.62	7.86	38.74	8.59	125.3	48.93	1.37	9.55
Noble fir	3	5.94	5.20	4.06	0.24	0.14	10.00	3.61	252.29	33.86	750.8	15.34	4.86	7.52
Nonstocked	5	6.52	5.91	2.81	0.13	0.22	19.97	37.57	619.13	401.92	2,429.4	1.25	17.19	4.09
Oregon white oak	3	6.44	5.82	2.54	0.25	0.16	26.62	10.36	270.22	379.23	3,493.1	1.73	21.30	2.70
Other hardwoods	2	5.15	4.54	8.60	0.32	0.52	23.14	11.99	522.27	256.18	2,417.9	434.90	20.40	4.80
Pacific madrone	2	6.12	5.52	2.53	0.26	0.14	30.91	6.02	176.31	283.95	2,398.0	1.49	14.79	1.04
Ponderosa pine	35	6.21	5.50	2.91	0.18	0.13	50.65	16.20	432.92	311.55	1,900.8	9.14	13.33	3.01
Red alder	10	4.71	4.14	8.01	0.30	0.50	11.60	33.29	239.18	336.81	1,329.4	361.48	14.18	10.69
Sitka spruce	2	4.44	3.70	11.79	0.38	0.71	4.07	107.36	94.69	183.95	165.0	626.80	10.01	18.45
Subalpine fir	4	6.16	5.51	6.56	0.27	0.38	33.51	3.98	497.37	204.46	2,748.0	82.55	17.60	7.75
Sugar pine	1	5.09	4.23	3.88	0.10	0.15	0.51	8.76	122.10	83.52	244.3	484.90	7.65	12.13
Tanoak	4	4.94	4.17	6.32	0.20	0.24	6.93	17.00	125.50	76.37	278.8	303.90	5.79	10.92
Western hemlock	5	5.07	4.36	15.23	0.36	0.55	9.28	29.20	217.07	372.73	1,510.2	255.10	14.12	15.29
Western juniper	23	6.55	5.92	2.78	0.19	0.24	27.86	26.48	458.82	518.41	2,288.5	6.42	17.04	4.84
Western larch	1	5.63	4.80	7.27	0.21	0.34	20.00	11.49	453.40	179.8	1,340.0	32.16	9.73	11.30
Western white pine	1	5.05	4.24	9.84	0.09	0.20	23.55	2.71	147.90	20.15	220.2	51.99	2.23	13.24
White fir	10	6.10	5.30	3.72	0.22	0.15	75.05	9.55	380.25	126.99	1,341.1	12.45	8.89	3.24

Table 39—Chemical properties of mineral soil layers on forest land, by depth of layer and forest type, Oregon, 2001, 2003–2005 (continued)

Depth of layer and forest type	Samples	pH		Organic carbon	Inorganic carbon	Total nitrogen	Extractable phosphorus	Exchangeable cations						Extractable sulfur
		H_2O	$CaCl_2$					Na	K	Mg	Ca	Al	ECEC[a]	
	Number			*- - - - - - - Percent - - - - - - -*			*mg/kg*	*- - - - - - - - - - - - - - - mg/kg - - - - - - - - - - - - - - -*					*cmolc/kg*	*mg/kg*
Mineral layer 2 (10–20 cm):														
Aspen	1	6.12	5.47	5.26	0.27	0.54	76.60	17.75	1164.18	208.10	2,448.0	4.60	17.03	6.90
Bigleaf maple	2	5.33	4.72	5.81	0.22	0.37	16.36	0	232.26	76.89	667.4	215.58	6.95	5.28
California black oak	1	6.15	5.21	1.22	0.15	0.06	1.52	5.42	44.04	481.20	1,068.0	4.42	9.47	2.99
Canyon live oak	1	5.83	5.23	1.84	0.32	0.11	52.06	0	503.60	202.30	1,374.0	6.58	9.88	0
Douglas-fir	74	5.60	4.93	4.02	0.21	0.19	23.89	8.19	269.42	257.38	1,636.4	131.37	12.47	7.37
Engelmann spruce	1	5.75	5.17	1.12	0.16	0.07	21.12	22.27	177.60	230.00	1,599.0	0	10.42	5.67
Giant chinquapin	1	5.81	5.07	7.67	0.22	0.29	110.92	38.68	154.60	122.10	1,524.0	465.10	14.34	146.50
Grand fir	7	6.32	5.62	1.44	0.17	0.10	40.33	12.94	466.47	180.21	1,889.0	3.19	12.19	3.46
Lodgepole pine	16	6.10	5.30	1.87	0.16	0.09	40.63	18.39	315.35	204.54	1,576.0	7.63	10.52	33.73
Mountain brush woodland	2	6.40	5.66	3.55	0.24	0.15	21.75	14.15	271.66	783.95	4,220.0	1.19	28.27	4.58
Mountain hemlock	3	5.44	5.02	2.00	0.15	0.06	12.72	3.15	37.93	6.71	43.9	9.71	0.49	23.09
Noble fir	3	5.86	5.15	2.18	0.21	0.09	7.64	0	209.65	39.21	501.6	40.68	3.81	12.82
Nonstocked	5	6.24	5.61	2.25	0.11	0.17	15.19	15.46	564.92	277.01	1,763.2	2.60	12.62	5.71
Oregon white oak	2	6.15	5.38	1.36	0.17	0.10	43.26	12.20	210.05	622.45	5,825.0	1.30	34.79	2.08
Other hardwoods	2	5.57	4.98	5.60	0.36	0.35	13.16	0.44	540.50	205.06	2,460.9	205.15	17.63	7.45
Pacific madrone	2	6.10	5.37	2.86	0.28	0.15	10.78	5.32	140.45	232.00	2,535.5	1.21	14.96	1.35
Ponderosa pine	33	6.31	5.54	1.90	0.18	0.10	26.63	8.23	356.99	285.53	1,844.9	5.67	12.57	4.26
Red alder	10	4.98	4.35	4.63	0.26	0.30	8.23	2.58	131.62	298.24	1,243.1	308.88	12.44	17.05
Sitka spruce	1	5.18	4.36	5.84	0.37	0.33	1.71	76.05	34.89	177.80	281.5	294.80	6.56	9.30
Subalpine fir	3	6.15	5.57	5.19	0.25	0.23	43.06	4.84	315.59	563.55	2,024.4	3.66	15.60	9.30
Sugar pine	1	5.10	4.10	0.97	0.13	0.07	0.17	16.28	80.50	80.07	174.2	1277.73	16.01	0
Tanoak	3	5.10	4.34	4.13	0.21	0.18	2.62	2.12	85.21	41.47	156.9	253.78	4.17	14.26
Western hemlock	5	4.93	4.26	6.70	0.31	0.33	6.03	11.70	236.47	129.95	452.9	628.14	10.97	21.16
Western juniper	17	6.82	6.12	1.63	0.21	0.14	18.32	33.17	656.32	647.51	2,629.6	3.71	20.31	4.02
Western larch	1	6.51	4.80	4.59	0.20	0.24	19.32	10.57	328.60	65.61	486.0	0	3.85	3.31
Western white pine	1	5.43	4.58	3.05	0.14	0.08	61.08	27.93	94.69	28.93	19.3	51.37	1.27	0.92
White fir	10	6.04	5.26	1.98	0.17	0.09	54.56	4.31	315.37	108.18	939.3	12.94	6.55	3.77

Note: Data subject to sampling error.

[a] ECEC = effective cation exchange capacity, H_2O = water, $CaCl_2$ = calcium chloride, Na = sodium, K = potassium, Mg = magnesium, Ca = calcium, and Al = aluminum.

Table 40—Chemical properties (trace elements) of mineral soils on forest land, by forest type, Oregon, 2001, 2003–2005

		Extractable						
Depth of layer and forest type	Samples	Manganese	Iron	Nickel	Copper	Zinc	Cadmium	Lead
	Number	*mg/kg*						
Mineral layer 1 (0–10 cm):								
Aspen	1	14.25	0.19	0.52	—	0.34	0.07	—
Bigleaf maple	2	23.34	0.33	0.01	—	0.08	0.03	0.04
California black oak	1	22.04	—	—	—	—	0.01	—
Canyon live oak	1	18.06	—	—	—	0.01	0.12	—
Douglas-fir	74	42.68	3.36	0.14	—	1.03	0.04	0.06
Engelmann spruce	1	30.25	—	—	—	0.45	0.03	—
Giant chinquapin	1	120.80	—	0.32	—	2.23	0.11	0.93
Grand fir	7	25.48	0.30	0.05	—	0.18	0.03	—
Lodgepole pine	17	25.85	0.23	0.03	—	0.45	0.04	0.13
Mountain brush woodland	2	8.09	—	0.27	—	0.03	0.02	0.03
Mountain hemlock	3	15.04	1.80	0.08	—	0.30	—	—
Noble fir	3	31.51	0.13	—	—	0.13	0.03	0.01
Nonstocked	5	15.90	0.18	0.10	—	0.03	0.05	0.10
Oregon white oak	3	8.40	—	0.18	—	—	0.06	0.12
Other hardwoods	2	12.91	50.95	0.28	—	0.61	0.09	0.58
Pacific madrone	2	7.50	—	—	—	0.02	0.06	—
Ponderosa pine	35	29.15	0.67	0.04	—	0.26	0.05	0.08
Red alder	10	33.29	8.59	0.03	—	1.54	0.05	0.08
Sitka spruce	2	1.58	68.39	0.38	—	0.59	0.09	—
Subalpine fir	4	9.23	0.82	0.05	—	0.08	0.04	0.17
Sugar pine	1	284.60	—	0.14	—	0.67	0.10	—
Tanoak	4	44.84	2.29	0.50	—	1.14	0.03	0.08
Western hemlock	5	75.29	7.28	0.16	—	3.99	0.04	0.32
Western juniper	23	7.81	0.73	0.17	—	0.04	0.05	0.06
Western larch	1	48.53	—	—	—	0.78	0.04	—
Western white pine	1	33.94	—	—	—	1.47	0.06	0.34
White fir	10	22.04	0.11	0.02	—	0.48	0.08	0.04
Mineral layer 2 (10–20 cm):								
Aspen	1	8.65	—	—	—	—	0.04	—
Bigleaf maple	2	32.88	0.92	0.06	—	0.58	0.02	0.19
California black oak	1	12.30	—	—	—	—	—	—
Canyon live oak	1	23.89	—	—	—	—	—	0.41
Douglas-fir	74	29.15	1.33	0.07	0.04	0.53	0.02	0.19
Engelmann spruce	1	14.39	—	—	—	—	—	0.63
Giant chinquapin	1	45.86	—	0.18	—	2.44	0.03	0.17
Grand fir	7	14.30	—	0.07	0.23	0.09	0.03	0.15
Lodgepole pine	16	12.17	0.24	0.05	—	0.20	0.01	0.33
Mountain brush woodland	2	4.15	—	—	—	—	—	0.01
Mountain hemlock	3	4.96	0.94	0.01	—	0.12	—	0.04
Noble fir	3	23.68	0.14	—	—	0.14	—	0.16
Nonstocked	5	11.02	—	0.10	0.06	0.16	0.04	0.29
Oregon white oak	2	18.03	—	—	—	1.37	0.02	—
Other hardwoods	2	7.67	5.11	0.08	—	—	—	0.08
Pacific madrone	2	8.66	—	—	—	—	—	0.33
Ponderosa pine	33	17.01	0.14	0.01	0.01	0.04	0.02	0.12
Red alder	10	24.79	0.18	0.01	—	2.12	0.01	0.33
Sitka spruce	1	1.28	5.69	—	—	—	—	0.85
Subalpine fir	3	6.95	—	0.11	—	0.05	0.01	0.15
Sugar pine	1	93.30	—	0.34	0.09	0.52	—	0.09
Tanoak	3	10.46	1.88	0.01	—	0.06	—	—
Western hemlock	5	44.39	11.33	0.13	—	1.99	—	0.14
Western juniper	17	6.00	0.16	0.08	0.06	0.02	0.03	0.16
Western larch	1	19.35	—	0.13	—	0.05	0.04	0.43
Western white pine	1	4.07	2.25	—	—	0.72	—	1.41
White fir	10	13.35	0.01	0.02	0.04	0.20	0.02	0.02

Note: Data subject to sampling error; — = less than 0.005 mg/kg were estimated.

Table 41—Compaction, bare soil, and slope properties of forest land, by forest type, Oregon, 2001, 2003–2005

Forest type	Plots sampled	Plots reporting compaction	Compacted area per plot	Bare soil cover	Slope
	Number	- - - - - -	- - - - - -	*Percent* - - - - - -	- - - - - -
Aspen	1	0	0	17.50	26.00
Bigleaf maple	2	1	18.75	3.00	30.50
California black oak	1	0	0	1.00	42.00
Canyon live oak	1	0	0	5.00	65.00
Douglas-fir	69	27	7.58	5.21	33.37
Engelmann spruce	2	2	17.08	5.29	28.00
Giant chinquapin	1	0	0	10.00	33.00
Grand fir	7	3	5.29	4.10	25.43
Lodgepole pine	18	7	4.93	17.44	9.31
Mountain brush woodland	2	1	2.63	9.50	40.50
Mountain hemlock	4	1	10.00	13.25	9.50
Noble fir	2	1	14.38	10.75	23.00
Oregon white oak	4	1	18.75	4.94	31.25
Pacific madrone	2	0	0	2.50	48.00
Ponderosa pine	36	10	1.62	6.78	17.94
Red alder	9	3	12.59	17.89	35.11
Sitka spruce	1	0	0	1.00	0
Subalpine fir	4	1	0.31	6.71	48.75
Sugar pine	1	0	0	4.00	2.00
Tanoak	5	3	6.25	15.77	54.00
Western hemlock	5	3	27.33	11.68	50.20
Western juniper	34	11	1.68	26.65	16.52
Western larch	1	0	0	0.50	0
Western white pine	1	0	0	2.33	19.00
White fir	10	3	6	13.44	16.44
Other hardwoods	1	0	0	5.00	35.00
Nonstocked	10	2	0.63	26.15	14.50

Note: Data subject to sampling error.

Table 42—Mean cover of understory vegetation on forest land, by forest type group and life form, Oregon, 2001–2005

Forest type class[a] and age class	Seedlings and saplings		Shrubs		Forbs		Graminoids		All understory plants		Bare soil	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
	Percent											
Douglas-fir	4.4	0.2	36.9	0.8	18.9	0.6	4.8	0.3	58.6	0.8	2.5	0.2
Fir/spruce/mountain hemlock	7.2	0.4	20.9	1.0	14.3	0.9	7.8	0.6	44.8	1.3	4.3	0.4
Hemlock/Sitka spruce	4.2	0.6	29.6	1.9	21.9	1.7	0.7	0.2	50.3	2.3	1.1	0.2
Lodgepole pine	8.5	0.7	15.6	1.2	5.0	0.6	9.2	0.8	35.3	1.6	11.4	1.0
Other western softwoods	1.4	0.1	11.2	0.7	4.7	0.4	20.1	1.1	35.3	1.3	18.1	1.1
Pinyon/juniper	1.0	1.0	9.0	9.0	1.0	1.0	1.0	1.0	12.0	12.0	15.0	15.0
Ponderosa pine	2.9	0.2	13.5	0.6	8.3	0.5	18.3	0.7	40.1	1.0	6.5	0.4
Western larch	7.7	1.5	26.0	3.9	15.0	2.8	19.1	3.2	61.5	4.6	5.4	2.1
Western white pine	3.7	2.1	27.9	13.1	14.3	4.1	20.8	14.3	65.6	13.5	13.5	7.6
Total	4.5	0.1	24.6	0.5	13.3	0.3	10.2	0.3	47.8	0.5	6.2	0.2
Hardwoods:												
Alder/maple	2.5	0.3	43.1	2.0	33.8	1.9	6.6	0.9	73.2	1.8	1.9	0.3
Aspen/birch	11.0	3.1	23.9	7.0	28.2	8.6	16.9	4.4	63.6	9.5	2.2	0.9
Elm/ash/cottonwood	1.9	0.6	52.0	7.2	9.6	2.8	25.5	8.7	81.5	4.3	3.0	1.5
Other western hardwoods	5.7	0.7	27.4	2.9	9.3	1.4	12.0	1.8	50.6	3.4	3.4	0.7
Tanoak/laurel	11.3	1.9	26.8	3.1	13.5	2.5	1.5	0.9	49.5	3.7	5.6	1.4
Western oak	5.8	0.9	23.0	2.3	8.3	1.1	26.6	2.8	57.7	2.9	4.5	1.1
Total	5.5	0.5	32.8	1.3	19.4	1.1	11.9	1.0	61.6	1.4	3.4	0.4
Nonstocked	1.2	0.2	16.6	2.5	12.5	1.7	19.3	2.5	46.9	3.3	13.4	1.7
All forest type groups	4.5	0.1	25.3	0.4	14.0	0.3	10.6	0.3	49.4	0.5	6.0	0.2

Note: Data subject to sampling error; SE = standard error.

Table 43—Mean cover of understory vegetation on forest land, by forest type class, age class, and life form, Oregon, 2001–2005

Forest type class[a] and age class	Seedlings and saplings Mean	Seedlings and saplings SE	Shrubs Mean	Shrubs SE	Forbs Mean	Forbs SE	Graminoids Mean	Graminoids SE	All understory plants Mean	All understory plants SE	Bare soil Mean	Bare soil SE
							Percent					
Dry conifer:												
0–19	9.8	1.7	14.9	1.9	9.0	1.4	18.1	2.1	46.9	3.0	12.7	1.9
20–39	6.3	1.0	25.0	2.6	7.1	1.4	12.6	1.9	45.5	3.2	10.3	1.6
40–79	3.9	0.3	14.2	0.9	5.7	0.4	14.0	0.9	35.4	1.3	8.1	0.7
80–159	3.9	0.3	12.7	0.8	9.2	0.7	17.1	0.9	39.9	1.4	6.0	0.5
160+	3.9	0.5	15.1	2.3	7.3	1.2	19.9	2.6	44.0	3.0	8.9	1.6
All ages	4.6	0.3	14.5	0.6	7.6	0.4	15.9	0.6	39.6	0.9	7.9	0.4
Wet conifer:												
0–19	4.7	0.4	33.1	1.5	18.4	1.0	9.4	1.0	59.2	1.7	6.0	0.7
20–39	3.3	0.4	36.2	1.4	17.6	1.0	4.0	0.6	55.4	1.5	3.1	0.5
40–79	3.1	0.2	25.5	1.0	15.6	0.8	10.2	0.7	50.0	1.2	7.0	0.6
80–159	4.6	0.3	24.7	1.0	15.0	0.7	10.4	0.6	48.7	1.1	5.6	0.5
160+	6.3	0.4	28.3	1.4	12.2	0.9	4.0	0.5	46.2	1.5	6.1	0.8
All ages	4.3	0.1	28.2	0.6	15.5	0.4	8.3	0.3	51.0	0.6	5.8	0.3
Dry hardwood:												
0–19	12.2	2.6	28.9	5.9	7.0	1.7	3.5	2.1	48.1	6.4	12.2	3.9
20–39	10.8	3.6	36.2	4.6	17.4	3.9	6.8	2.7	64.1	5.2	2.1	0.6
40–79	6.6	0.9	26.1	2.4	9.6	1.4	15.5	2.1	53.7	2.8	2.5	0.5
80–159	5.0	0.9	18.7	2.4	9.8	1.7	22.0	3.1	50.3	3.6	4.4	0.9
160+	7.6	1.8	26.5	7.1	6.6	2.1	11.3	7.5	49.5	10.0	7.0	2.7
All ages	7.4	0.7	25.5	1.6	10.1	0.9	14.6	1.5	53.1	1.9	4.5	0.6
Wet hardwood:												
0–19	5.9	1.1	46.7	3.8	22.9	3.1	12.5	2.5	76.4	2.8	1.7	0.5
20–39	1.9	0.4	37.2	3.1	36.2	3.1	6.5	1.5	69.9	3.0	1.7	0.4
40–79	1.8	0.6	46.5	3.4	36.9	3.4	5.5	1.5	76.5	2.8	1.5	0.4
80–159	3.1	0.9	42.1	7.6	29.2	7.2	17.1	5.6	72.8	5.7	3.3	1.3
160+	0.7	0.5	36.9	12.4	18.7	5.9	1.4	1.0	56.9	14.1	7.1	5.7
All ages	2.8	0.4	42.8	1.9	32.1	1.8	8.2	1.1	73.3	1.7	2.0	0.3
All forest type classes:												
0–19	6.2	0.5	31.1	1.3	16.5	0.8	10.7	0.8	58.1	1.4	7.1	0.6
20–39	4.0	0.4	34.7	1.2	18.3	0.9	5.8	0.6	56.2	1.2	4.0	0.4
40–79	3.6	0.2	23.3	0.7	13.3	0.6	11.5	0.5	47.4	0.9	6.6	0.4
80–159	4.4	0.2	20.6	0.7	13.0	0.5	13.3	0.5	46.2	0.9	5.7	0.3
160+	5.9	0.4	26.4	1.2	11.4	0.8	6.6	0.7	46.1	1.3	6.6	0.7
All ages	4.5	0.1	25.3	0.4	14.0	0.3	10.6	0.3	49.4	0.5	6.0	0.2

Note: Data subject to sampling error; SE = standard error.

[a] Dry conifer includes the pinyon/juniper; ponderosa, western white, and lodgepole pines; and western larch forest type groups. Wet conifer includes the Douglas-fir, fir/spruce/mountain hemlock, hemlock/Sitka spruce, other softwoods, and nonstocked forest type groups. Dry hardwood includes the western oak, tanoak/laurel, and other hardwoods forest type groups. Wet hardwood includes the elm/ash/cottonwood, aspen/birch, and alder/maple forest type groups.

Table 44—Estimated number of live trees with damage on forest land, by species and type of damage, Oregon, 2001–2005

Species	Total number of live trees[a]		Number of live trees with damage[b]		Type of damage											
	Total	SE	Total	SE	Animal	Bark beetles	Cankers	Defoliators	Dwarf mistletoe	Leafy mistletoe	Foliage diseases	Stem decay	Other insects	Physical damage or defect	Root disease	Weather
	Thousand trees															
Softwoods:																
Alaska yellow-cedar	1,800	1,734	782	855	—	—	—	—	—	—	—	10	—	772	—	—
California red fir	6,800	4,211	1,718	1,079	—	—	764	—	34	—	—	34	—	379	1,193	—
Douglas-fir	2,429,262	86,200	362,948	19,066	8,800	5,955	28,331	10,106	36,622	—	15,705	11,289	1,828	219,337	60,112	4,942
Engelmann spruce	59,411	12,378	19,063	4,723	—	403	1,135	140	889	—	196	32	2,024	12,165	2,860	263
Grand fir	510,780	48,328	158,870	22,841	2,993	6,174	6,215	20,747	4,327	—	6,016	1,732	4,075	93,932	36,519	3,863
Incense-cedar	136,465	19,829	11,667	2,829	—	—	156	78	—	22	—	865	—	10,663	277	1,366
Jeffrey pine	11,384	6,172	183	114	—	—	—	—	—	—	—	—	—	183	—	—
Knobcone pine	1,066	640	920	631	—	—	457	—	291	—	—	—	—	920	—	—
Lodgepole pine	1,334,313	126,641	812,234	82,882	6,874	26,828	276,888	2,192	364,304	—	1,377	1,372	4,076	324,146	41,634	19,864
Mountain hemlock	295,997	41,385	108,617	20,689	274	145	1,024	1,091	26,970	—	124	1,175	124	32,409	55,028	11,650
Noble fir	42,396	10,078	7,627	2,295	74	—	1,000	575	862	—	—	66	—	3,999	1,485	—
Pacific silver fir	301,023	45,475	106,476	20,973	64	405	6,565	1,670	16,004	—	927	1,388	739	43,347	38,257	10,661
Pacific yew	29,684	8,229	5,636	2,035	—	—	73	—	—	—	—	582	—	5,111	—	—
Ponderosa pine	1,028,476	61,472	333,004	28,754	15,498	21,930	34,887	11,521	89,676	—	3,489	715	676	193,238	18,605	894
Port-Orford-cedar	30,680	11,898	7,207	4,742	480	—	73	—	—	—	—	169	—	6,142	4,310	—
Redwood	29,960	31,978	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Shasta red fir	80,533	21,992	17,275	4,714	—	617	952	—	24	—	1,264	337	—	7,731	5,885	3,440
Sitka spruce	34,449	7,113	5,496	1,484	168	—	310	219	—	—	70	84	446	3,820	827	—
Subalpine fir	157,149	28,965	78,422	18,058	261	275	3,479	1,208	2,778	—	570	647	1,972	60,410	16,043	5,421
Sugar pine	17,563	4,162	1,518	326	—	192	262	—	—	—	15	245	—	1,022	13	—
Western hemlock	708,823	66,512	147,143	16,358	5,132	745	3,166	213	50,837	—	10	3,255	107	72,112	33,096	4,541
Western juniper	239,580	19,595	57,365	9,162	2,094	—	231	319	—	1,000	34,281	5,009	—	20,207	—	528
Western larch	69,127	13,127	21,305	4,643	885	377	87	309	6,408	—	—	109	74	14,727	1,461	300
Western redcedar	134,546	19,491	28,914	6,673	278	—	11	—	11	—	—	2,361	68	22,835	4,514	221
Western white pine	45,590	11,402	16,575	5,473	67	151	7,441	—	—	—	—	278	—	8,642	4,127	915
White fir	444,518	53,944	116,673	15,336	141	2,383	8,387	5,623	12,123	—	67	2,305	129	55,230	38,687	10,290
Whitebark pine	33,249	11,424	18,681	7,397	1,261	83	312	—	—	—	67	166	—	10,601	14	8,969

Table 44—Estimated number of live trees with damage on forest land, by species and type of damage, Oregon, 2001–2005 (continued)

Species	Total number of live trees[a]		Number of live trees with damage[b]		Type of damage											
	Total	SE	Total	SE	Animal	Bark beetles	Cankers	Defoliators	Dwarf mistletoe	Leafy mistletoe	Foliage diseases	Stem decay	Other insects	Physical damage or defect	Root disease	Weather
	Thousand trees															
Hardwoods:																
Bigleaf maple	183,883	36,787	17,217	3,588	18	—	73	—	—	—	—	2,878	—	14,476	74	—
Bitter cherry	25,150	7,903	2,394	1,482	—	1,064	—	—	—	—	—	74	—	1,257	90	—
Black cottonwood	3,814	1,537	589	375	24	—	—	—	—	—	—	—	—	565	—	—
California black oak	34,646	8,179	14,979	4,345	—	—	72	1,175	—	—	—	1,011	—	13,163	—	—
California-laurel	48,978	16,326	8,975	2,868	135	—	1,442	—	—	—	—	2,348	—	6,514	—	—
Canyon live oak	94,048	21,618	29,900	11,365	—	—	—	5,421	—	—	—	1,911	—	25,668	—	73
Cherry and plum spp.	23,713	18,145	62	69	—	—	—	—	—	—	—	—	—	62	—	—
Chokecherry	11,567	5,350	1,125	942	—	—	—	—	—	—	—	70	—	1,055	—	—
Curl-leaf mountain mahogany	64,367	15,689	6,656	2,620	351	—	—	—	—	—	—	334	—	5,970	—	—
Golden chinquapin	136,583	24,001	28,751	9,900	163	—	2,726	7,519	—	—	—	1,658	—	17,251	846	73
Holly	490	509	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Oregon ash	19,885	6,150	367	179	—	—	—	—	—	—	—	10	—	358	—	—
Oregon crabapple	417	268	269	246	—	—	—	—	—	—	—	90	—	269	—	—
Oregon white oak	141,711	25,790	30,033	6,902	72	—	1,370	403	—	3,041	—	2,473	—	24,093	—	—
Other or unknown tree	361	331	90	83	90	—	—	—	—	—	—	—	—	—	—	—
Pacific dogwood	26,717	7,713	3,500	2,122	—	—	—	—	—	—	—	—	—	3,500	—	—
Pacific madrone	187,337	22,572	52,166	8,423	—	—	892	—	—	—	621	3,686	—	48,327	—	—
Quaking aspen	18,814	10,843	6,455	5,822	—	—	5,089	—	—	—	—	143	—	1,366	—	—
Red alder	349,573	30,323	35,884	6,104	5,286	204	1,245	287	—	—	140	3,422	70	24,962	829	148
Rocky Mountain maple	112,078	49,679	4,061	2,288	218	—	—	—	—	—	—	—	—	4,061	—	—
Tanoak	312,203	56,823	60,400	17,769	1,198	—	162	—	—	—	—	3,305	—	58,640	—	145
White alder	9,507	6,238	63	70	—	—	—	—	—	—	—	—	—	63	—	—
Willow spp.	230	169	75	75	—	—	—	—	—	—	—	—	—	75	—	—
Total, all species	10,020,699	238,064	2,750,332	107,694	52,897	67,933	395,277	70,815	612,159	4,063	64,939	57,635	16,408	1,475,776	366,785	88,567

Note: Data subject to sampling error; SE = standard error; — = less than 500 trees were estimated.

[a] Includes live trees ≥1 inch diameter at breast height.

[b] Number of live trees ≥1 inch diameter at breast height with one or more types of damage recorded.

Table 45—Estimated area of forest land with more than 25 percent of the tree basal area damaged, by forest type and type of damage, Oregon, 2001–2005

Species	Total forest land		Forest land with damage[a]		Type of damage											
	Total	SE	Total	SE	Animal	Bark beetles	Cankers	Defoliators	Dwarf mistletoe	Leafy mistletoe	Foliage diseases	Stem decay	Other insects	Physical damage or defect	Root disease	Weather
	Thousand acres															
Softwoods:																
Douglas-fir	10,363	245	3,806	186	22	57	51	46	466	—	117	198	—	2,247	481	19
Engelman spruce/ subalpine fir	151	42	96	34	—	—	—	—	—	—	—	—	—	85	11	—
Engelmann spruce	124	37	70	28	—	—	—	—	—	—	—	—	—	40	34	—
Fir/spruce/mountain hemlock	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Grand fir	1,096	106	859	95	—	59	—	45	43	—	12	15	15	619	151	3
Incense-cedar	84	30	50	24	—	11	—	—	—	—	—	—	—	39	—	15
Jeffrey pine	29	19	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Juniper woodland	3	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Lodgepole pine	2,039	143	1,736	132	11	107	732	—	760	—	—	19	—	1,037	77	—
Misc. western softwoods	9	5	3	2	—	—	—	—	2	—	—	—	—	3	—	—
Mountain hemlock	578	81	398	67	—	—	—	10	99	—	—	5	—	162	191	1
Noble fir	141	40	60	27	—	—	—	11	17	—	—	—	—	11	—	—
Pacific silver fir	320	61	250	54	—	—	11	—	62	—	—	—	—	137	66	—
Ponderosa pine	5,095	200	3,193	172	101	159	114	64	782	—	40	6	11	2,101	171	—
Port-Orford-cedar	18	7	3	3	—	—	—	—	—	—	—	—	—	3	—	—
Red fir	229	51	132	38	—	—	—	—	23	—	—	—	—	75	33	—
Sitka spruce	87	33	32	19	—	—	—	—	—	—	—	—	—	8	24	—
Subalpine fir	144	39	107	33	—	—	—	—	—	—	—	7	—	96	18	22
Sugar pine	47	24	47	24	—	—	—	—	—	—	—	—	—	11	—	—
Western hemlock	836	94	484	72	—	—	12	—	150	—	—	13	—	279	63	—
Western juniper	3,170	174	1,306	118	37	18	12	12	—	6	342	222	—	816	—	14
Western larch	218	49	162	43	—	—	—	—	77	—	—	—	—	94	—	—
Western redcedar	132	38	80	30	8	3	—	—	20	—	—	—	—	69	—	—
Western white pine	52	26	40	23	—	—	23	—	—	—	—	9	—	40	17	—
White fir	1,175	113	824	96	9	18	11	27	106	—	—	37	—	405	164	8
Whitebark pine	50	25	28	18	—	—	—	—	—	—	—	—	—	14	—	14

Table 45—Estimated area of forest land with more than 25 percent of the tree basal area damaged, by forest type and type of damage, Oregon, 2001–2005 (continued)

Species	Total forest land		Forest land with damage[a]		Type of damage											
	Total	SE	Total	SE	Animal	Bark beetles	Cankers	Defoliators	Dwarf mistletoe	Leafy mistletoe	Foliage diseases	Stem decay	Other insects	Physical damage or defect	Root disease	Weather
							Thousand acres									
Hardwoods:																
Aspen	69	27	49	23	—	—	26	—	—	—	—	—	—	23	—	—
Bigleaf maple	268	53	63	22	—	—	—	—	—	—	12	27	—	44	—	—
California black oak	103	35	33	19	—	—	11	—	—	—	—	11	—	22	—	—
California laurel	96	34	49	25	—	—	—	—	—	—	—	—	—	34	—	—
Canyon live oak	142	38	99	33	—	—	11	—	11	—	—	4	—	69	—	—
Cottonwood	36	18	8	8	—	—	—	—	—	—	—	—	—	—	—	—
Cottonwood / willow	26	17	13	11	—	—	—	—	—	—	—	—	—	13	—	—
Giant chinquapin	134	38	72	28	—	—	11	—	—	—	—	9	—	52	—	—
Intermountain maple	69	28	24	17	—	—	—	—	—	—	—	—	—	15	—	—
Mountain brush woodland	144	40	27	17	—	—	—	—	—	—	12	—	—	15	—	—
Oregon ash	30	17	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Oregon white oak	549	78	316	60	—	—	8	—	—	16	—	14	—	220	—	—
Other hardwoods	126	37	66	27	9	—	9	—	—	—	—	—	—	58	—	—
Pacific madrone	306	59	153	42	—	—	—	—	—	—	—	9	—	142	—	—
Red alder	1,073	101	258	52	6	7	—	—	32	—	—	21	—	192	8	—
Tanoak	367	64	152	41	—	13	—	—	—	—	—	15	—	139	—	—
Willow	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Nonstocked	745	88	174	43	13	11	13	7	31	—	—	—	7	122	14	—
Total	30,473	233	15,321	296	217	462	1,055	222	2,681	21	535	641	33	9,553	1,522	96

Note: Data subject to sampling error; SE = standard error; — less than 500 acres were estimated.

[a] Acres of forest land with >25 percent of tree basal area with recorded damage.

Table 46—Estimated gross volume of live trees with damage on forest land, by species and type of damage, Oregon, 2001–2005

Species	Total gross volume of live trees[a]		Gross volume of trees with damage[a]		Type of damage											
	Total	SE	Total	SE	Bark Animal	beetles	Cankers	Defoliators	Dwarf mistletoe	Leafy mistletoe	Foliage diseases	Stem decay	Other insects	Physical damage or defect	Root disease	Weather
								Thousand cubic feet								
Softwoods:																
Alaska yellow-cedar	7,610	8,520	1,755	1,965	—	—	—	—	—	—	—	1,755	—	—	—	—
California red fir	235,400	95,297	108,183	60,242	—	—	28,060	—	13,932	—	—	7,940	—	34,415	57,961	—
Douglas-fir	52,889,618	1,659,621	14,483,068	723,053	133,766	269,039	443,183	119,425	1,316,573	—	229,021	2,510,568	30,909	8,445,750	2,837,121	122,721
Engelmann spruce	739,481	128,962	190,226	41,625	—	8,239	3,470	9,108	2,540	—	4,631	5,210	611	114,301	57,624	14,156
Grand fir	3,911,120	309,162	1,755,372	170,719	4,068	111,356	16,016	143,738	94,456	—	28,437	178,623	23,456	1,149,697	280,441	103,504
Incense-cedar	909,076	115,679	307,311	54,131	—	—	5,207	3,167	—	7,894	—	78,891	—	245,266	6,035	157
Jeffrey pine	34,168	16,904	3,907	2,801	—	—	—	—	—	—	—	—	—	3,907	—	—
Knobcone pine	9,678	6,305	8,700	6,264	—	—	5,821	—	1,187	—	—	—	—	8,700	—	—
Lodgepole pine	2,844,611	218,179	1,898,030	151,183	20,203	197,941	658,133	13,212	690,635	—	1,440	23,645	6,422	900,530	163,782	17,780
Mountain hemlock	3,058,152	411,403	1,205,664	207,466	10,535	4,604	40,265	8,078	241,141	—	355	115,464	13,568	599,904	499,192	14,118
Noble fir	863,850	179,370	250,837	59,315	89	—	8,086	8,598	55,197	—	—	34,798	—	103,648	82,665	—
Pacific silver fir	2,234,347	449,394	908,246	169,044	2,360	3,257	43,130	33,786	159,901	—	5,250	34,201	3,575	497,940	239,919	22,183
Pacific yew	32,214	9,559	11,845	4,413	—	—	398	—	—	—	—	3,101	—	9,581	—	—
Ponderosa pine	9,479,821	410,884	3,913,506	222,414	162,606	324,791	130,494	88,136	740,093	—	80,382	91,919	8,519	2,809,483	276,426	19,313
Port-Orford-cedar	198,553	70,273	105,017	48,615	3,543	—	1,179	—	—	—	—	8,876	—	98,861	8,510	—
Redwood	1,353	1,444	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Shasta red fir	983,595	229,170	362,496	105,097	—	11,179	20,765	—	4,143	—	—	53,740	—	212,375	122,041	16,864
Sitka spruce	1,056,493	328,683	158,168	57,640	258	—	2,797	2,833	—	—	81	5,292	1,406	109,897	38,002	—
Subalpine fir	409,692	67,943	219,684	42,240	2,035	887	2,035	23,189	13,842	—	3,780	11,786	1,906	156,308	37,668	20,588
Sugar pine	820,710	136,537	311,118	65,400	—	27,553	34,245	—	—	—	9,449	65,124	—	236,069	5,780	—
Western hemlock	8,222,009	607,452	3,258,346	313,218	71,660	19,944	58,149	5,656	1,225,097	—	3,549	315,058	17,473	1,847,606	552,460	55,097
Western juniper	724,687	56,623	258,416	28,578	5,576	—	2,490	3,955	—	6,083	70,978	47,482	—	148,429	—	8,254
Western larch	775,636	98,420	403,470	63,578	157	21,599	5,131	15,566	235,146	—	—	9,027	59	193,593	21,383	10,616
Western redcedar	2,069,135	252,634	914,963	145,170	24,577	—	3,208	—	2,542	—	—	238,295	1,137	754,111	41,645	9,923
Western white pine	477,088	102,776	246,801	63,078	67	4,932	72,788	—	—	—	—	15,202	—	156,152	71,978	4,040
White fir	3,995,624	439,427	1,783,157	222,736	212	50,196	91,151	36,065	306,842	—	121	274,854	468	920,323	436,644	68,720
Whitebark pine	56,300	18,058	29,044	9,438	2,639	66	2,165	—	—	—	269	263	—	22,089	2,489	3,008

Table 46—Estimated gross volume of live trees with damage on forest land, by species and type of damage, Oregon, 2001–2005 (continued)

Species	Total gross volume of live trees[a]		Gross volume of trees with damage[a]		Type of damage											
	Total	SE	Total	SE	Animal	Bark beetles	Cankers	Defoliators	Dwarf mistletoe	Leafy mistletoe	Foliage diseases	Stem decay	Other insects	Physical damage or defect	Root disease	Weather
	Thousand cubic feet															
Hardwoods:																
Bigleaf maple	1,454,575	146,175	319,428	48,646	11,789	—	2,222	—	—	—	—	84,029	—	247,344	896	—
Bitter cherry	31,324	8,759	4,039	2,584	—	281	—	—	—	—	—	2,486	—	1,272	376	—
Black cottonwood	121,729	47,711	20,364	11,862	6,955	—	—	—	—	—	—	—	—	13,409	—	—
California black oak	236,021	45,121	112,251	28,354	—	—	4,016	3,035	—	—	—	37,418	—	86,382	—	—
California-laurel	158,087	59,485	80,269	35,668	770	—	1,320	—	—	—	—	25,972	—	56,139	—	—
Canyon live oak	189,425	44,045	86,319	30,051	—	—	—	—	—	—	—	23,900	—	75,727	—	249
Cherry and plum spp.	11,486	5,622	373	414	—	—	—	—	—	—	—	—	—	373	—	—
Chokecherry	5,925	3,271	527	399	—	—	—	—	—	—	—	304	—	223	—	—
Curl-leaf mountain mahogany	79,474	21,683	11,495	3,672	720	—	—	—	—	—	—	1,150	—	9,625	—	—
Giant chinquapin, golden chinquapin	331,690	60,324	105,916	26,035	590	—	1,590	1,243	—	—	—	24,439	—	81,961	—	204
Holly	1,912	1,985	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Oregon ash	88,189	36,360	15,869	10,609	—	—	—	—	—	—	—	1,989	—	13,879	—	—
Oregon crabapple	4,912	3,931	4,253	3,891	—	—	—	—	—	—	—	2,326	—	4,253	—	—
Oregon white oak	594,498	112,210	195,345	49,345	2,984	—	3,514	1,154	—	20,541	—	52,705	—	130,979	—	—
Other or unknown tree	1,808	1,658	561	515	561	—	—	—	—	—	—	—	—	—	—	—
Pacific dogwood	5,213	1,840	2,606	1,441	—	—	—	—	—	—	—	—	—	2,606	—	—
Pacific madrone	1,048,684	118,483	467,730	72,377	—	—	14,095	—	—	—	2,551	76,757	—	411,570	—	—
Quaking aspen	49,712	26,514	9,915	5,160	—	—	7,176	—	—	—	—	212	—	2,740	—	—
Red alder	2,998,555	251,863	362,762	49,816	4,016	16,398	2,636	3,662	—	—	1,245	55,955	233	285,573	9,795	1,282
Rocky Mountain maple	17,542	6,300	2,028	1,806	1,752	—	—	—	—	—	—	—	—	2,028	—	—
Tanoak	496,842	97,167	187,583	46,510	454	—	3,766	—	—	—	—	50,959	—	153,611	—	210
White alder	25,393	10,559	416	464	—	—	—	—	—	—	—	—	—	416	—	—
Willow spp.	1,596	1,338	145	145	—	—	—	—	—	—	—	—	—	145	—	—
Total	104,994,613	2,055,041	35,087,522	1,008,593	474,941	1,072,265	1,718,703	523,604	5,103,267	34,518	441,536	4,571,714	109,742	21,359,189	5,850,834	512,987

Note: Data subject to sampling error; SE = standard error; — less than 500 cubic feet were estimated.

[a] Includes gross volume of live trees ≥5 inches diameter at breast height.

[b] Includes gross volume of live trees ≥5 inches diameter at breast height with one or more damages recorded.

Table 47—Estimated number of live trees with damage, acres of forest land with greater than 25 percent of the basal area damaged, and gross volume of live trees with damage, by geographic region and ownership group, Oregon, 2001–2005

	Number of live trees with damage[a]		Acres of forest land with damage[b]		Gross volume of live trees with damage[c]	
Geographic region and ownership group	**Total**	**SE**	**Total**	**SE**	**Total**	**SE**
	Thousand trees		*Thousand acres*		*Thousand cubic feet*	
Western Oregon:						
Public	704,664	44,904	4,136	155	19,833,352	893,481
Private	289,290	26,048	1,619	121	3,768,367	278,969
Total	993,954	51,651	5,755	194	23,601,719	931,380
Eastern Oregon:						
Public	1,411,721	88,318	7,073	193	9,717,670	378,447
Private	344,657	36,155	2,494	134	1,768,133	129,249
Total	1,756,378	94,845	9,566	229	11,485,803	397,848
Total Oregon:						
Public	2,116,385	98,896	11,208	244	29,551,022	967,266
Private	633,948	44,475	4,113	180	5,536,500	306,941
Total	2,750,332	107,694	15,321	296	35,087,522	1,008,593

Note: Data subject to sampling error; SE = standard error.

[a] Number of live trees ≥1 inch diameter at breast height.

[b] Number of forest land acres with ≥25 percent of the basal area damaged.

[c] Gross volume of live trees ≥5 inches diameter at breast height.

Table 48—Estimated area of forest land covered by selected nonnative vascular plant species and number of sample plots,[a] by life form and species, Oregon, 2001–2005

Plant		Area covered		
Scientific name	Common name	Total	SE	Number of plots
		Acres		
Shrubs:				
Cytisus scoparius	Scotch broom	18,800	6,800	24
Ilex aquifolium	English holly	500	200	8
Rubus discolor	Himalayan blackberry	148,900	24,500	129
Rubus laciniatus	Cutleaf blackberry	11,800	3,500	34
Forbs:				
Centaurea solstitialis	Yellow star-thistle	100	100	1
Cirsium	Thistle species	26,800	8,400	76
Cirsium arvense	Canada thistle	6,900	3,700	17
Cirsium vulgare	Bull thistle	13,900	4,300	74
Digitalis purpurea	Purple foxglove	10,300	2,100	64
Hypericum perforatum	Common St. Johnswort	6,200	1,700	49
Hypochaeris radicata	Hairy cat's ear	5,800	2,800	11
Leucanthemum vulgare	Oxeye daisy	1,300	600	10
Grasses:				
Aira caryophyllea	Silver hairgrass	4,100	2,400	5
Avena fatua	Wild oat	700	600	2
Bromus diandrus	Ripgut brome	300	300	1
Bromus tectorum	Cheatgrass	196,100	21,600	292
Cynosurus echinatus	Bristly dogstail grass	20,100	6,000	29
Dactylis glomerata	Orchardgrass	12,500	3,100	37
Holcus lanatus	Common velvetgrass	22,000	8,200	24
Taeniatherum caput-medusae	Medusahead	18,000	6,700	17

Note: Estimates are likely low for most grasses and some forbs because of short flowering seasons and difficulty of species identification; data subject to sampling error; SE = standard error.
[a] Total number of sample plots was 2,626.

Table 49—Summary of Forest Inventory and Analysis plots sampled for lichen community, air quality index information, western Pacific Northwest (PNW) and western Oregon, 1998–2001, 2003

Parameter	Western PNW	Western Oregon	Klamath Mountains	Coast Ranges	Southern Cascades	Western Cascades	Willamette Valley	Eastern Cascades
Number of plots surveyed[a]	243	140	39	38	6	34	15	8
Number of plots by air quality index category:[b]								
Best: -1.4 to -0.11	111	65	18	15	3	22	0	7
Good: -0.11 to 0.02	26	14	3	4	0	3	0	0
Fair: 0.02 to 0.21	40	25	11	9	0	5	4	0
Degraded: 0.21 to 0.35	21	13	3	7	0	1	1	1
Poor: 0.35 to 0.49	13	8	1	2	1	2	2	0
Worst: 0.49 to 2.00	32	15	3	1	2	1	8	0
Air quality score extremes	-1.28 to 1.59	-1.28 to 1.02	-1.28 to 1.02	-0.71 to 0.91	-0.65 to 0.79	-0.77 to 0.97	0 to 0.87	-0.57 to 0.32
Average score on air quality index	-0.06	-0.05	-0.11	-0.03	0.13	-0.23	0.48	-0.33
Standard deviation on air quality index	0.49	0.43	0.43	0.33	0.58	0.38	0.31	0.3

[a] Plot totals do not include quality assurance surveys or plots without lichens present.

[b] Categories are based on the analysis of Geiser and Neitlich (2007).

Table 50—Summary of Forest Inventory and Analysis plots sampled for lichen community, climate index information, western Pacific Northwest (PNW) and western Oregon, 1998–2001, 2003

Parameter	Western PNW	Western Oregon	Klamath Mountains	Coast Ranges	Southern Cascades	Western Cascades	Willamette Valley	Eastern Cascades
Number of plots surveyed[a]	243	140	39	38	6	34	15	8
Number of plots by climate index category:[b]								
Maritime (warmest): -1.4 to -0.25	73	32	5	21	0	3	3	0
Lowland: -0.25 to 0.23	54	29	4	10	0	6	9	0
Montane: 0.23 to 0.66	57	38	13	7	3	9	3	3
High elevation (coolest): 0.66 to 1.73	59	41	17	0	3	16	0	5
Climate index extremes	-1.41 to 1.73	-1.21 to 1.73	-1.12 to 1.11	-1.21 to 0.55	0.49 to 1.73	-0.46 to 1.56	-0.48 to 0.32	0.40 To 1.50
Average score on climate index	0.14	0.27	0.46	-0.30	0.88	0.58	-0.08	0.86
Standard deviation on climate index	0.64	0.63	0.54	0.51	0.46	0.49	0.25	0.43

[a] Plot totals do not include quality assurance surveys or plots without lichens present.

[b] Categories are based on the analysis of Geiser and Neitlich (2007).

Table 51—Ozone injury summary information from ozone biomonitoring plots, by year, Oregon, 2000–2005

Ozone biomonitoring plots	2000	2001	2002	2003	2004	2005	All years
Number of plots	20	22	34	35	35	35	181
Number of plots with injury	0	0	0	0	0	0	0
Biosite index category[a] (percentage of plots):							
0–4.9 (least injured)	100	100	100	100	100	100	100
5.0–14.9	0	0	0	0	0	0	0
15–24.9	0	0	0	0	0	0	0
≥25 (most injured)	0	0	0	0	0	0	0
Average biosite index score	0	0	0	0	0	0	0
Average number of species per plot	1.7	1.6	2.8	2.8	2.9	2.7	2.6
Number of plants evaluated	964	963	2,746	2,909	2,901	2,845	13,328
Number of plants injured	0	0	0	0	0	0	0
Number of plants evaluated by species:							
Blue elderberry	60	60	53	53	74	67	367
Jeffrey pine	30	0	30	30	30	30	150
Ponderosa pine	351	330	690	690	690	686	3,437
Quaking aspen	90	90	420	420	420	420	1,860
Red alder	132	120	198	221	218	215	1,104
Red elderberry	45	30	90	120	120	120	525
Scouler's willow	46	41	455	505	499	431	1,977
Snowberry	150	180	720	780	760	786	3,376
Thinleaf huckleberry	60	112	90	90	90	90	532
Biosite index category[b] (percentage of forest land):							
0–4.9 (least injured)	100	100	100	100	100	100	100
5.0–14.9	0	0	0	0	0	0	0
15–24.9	0	0	0	0	0	0	0
≥25 (most injured)	0	0	0	0	0	0	0

[a] The biosite index is based on the average injury score (amount × severity) for each species averaged across all species on the plot. Biosite categories represent a relative measure of tree-level response to ambient ozone exposure.
[b] Percentage of forest land is estimated after interpolating the biosite values, 2000–2005, to generate a biological response surface across the landscape.

Table 52—Total acres of forest land with a forest fire incident, by year and ecosection group, Oregon, 1995–2004

			Ecosection group[a]					
	Total		Coast/ Western Cascades		Southern/Eastern Oregon Cascades		Eastern Oregon	
Year	Total	SE	Total	SE	Total	SE	Total	SE
					Acres			
1995	122,903	37,731	7,127	7,127	24,750	17,499	91,027	32,678
1996	151,160	42,627	36,799	21,244	12,375	12,375	101,986	34,854
1997	49,268	24,628	—	—	12,375	12,375	36,893	21,297
1998	76,264	29,787	—	—	47,401	23,763	28,863	17,975
1999	116,146	37,182	—	—	37,125	21,430	79,022	30,404
2000	112,498	36,643	12,375	12,375	12,375	12,375	87,748	32,208
2001	131,348	44,028	14,896	14,896	72,205	32,605	44,247	25,602
2002	575,200	106,945	—	—	456,912	95,428	118,288	48,496
2003	219,835	81,206	60,761	42,963	128,323	61,711	30,751	30,751
2004	—	—	—	—	—	—	—	—
Average all years	155,462	16,446	13,196	5,216	80,384	12,525	61,882	9,439

Note: Data subject to sampling error; SE = standard error; — = less than 0.5 acre was estimated.
[a] McNab et al. (2005)

Table 53—Estimated gross growth of softwood growing-stock volume on timberland, by location and owner, Oregon, 2001–2005

	All owners		National forest		State and local government		Corporate private		Other private	
Location	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
					Cubic feet/acre/year					
Western Oregon	178.00	8.76	143.05	8.47	219.03	31.95	208.73	14.95	195.86	38.13
Eastern Oregon	50.45	2.16	53.26	2.44	147.21	52.81	39.00	4.85	41.50	6.74
Total Oregon	111.00	4.56	85.83	3.72	211.00	29.15	150.57	10.96	122.11	21.05

Table 54—Estimated ratio of growth to removal and mortality of softwood growing-stock species on timberland, by owner group and location, Oregon, 2001–2005

	Western Oregon		Eastern Oregon		All Oregon	
Owner group	Mean	SE	Mean	SE	Mean	SE
National forest	6.19	8.19	2.36	0.63	3.78	1.98
State and local government	8.14	37.19	2.41	4.02	6.89	24.81
Corporate private	1.24	0.22	0.86	0.39	1.20	0.20
Other private	1.32	0.40	4.00	10.15	1.46	0.46
Total all owners	1.95	0.43	2.02	0.51	1.97	0.36

Note: Data subject to sampling error; SE = standard error.

Table 55—Estimated gross growth, net change, and removals and mortality of softwood growing stock on timberland, by owner and location, Oregon, 2001–2005

Owner group	Current gross annual growth		Annualized net change		Annualized removal and mortality	
	Total	SE	Total	SE	Total	SE
	Thousand cubic feet					
Western Oregon:						
National forest	589,279	43,735	494,111	140,241	95,168	124,115
State and local government	151,515	31,218	132,904	95,568	18,611	84,142
Corporate private	655,613	59,404	127,420	97,904	528,193	88,126
Other private	302,710	57,775	73,107	73,198	229,604	76,835
Total all owners	1,699,117	93,412	827,542	208,901	871,575	189,087
Eastern Oregon:						
National forest	379,724	20,962	218,647	47,450	161,077	41,515
State and local government	12,514	7,132	7,332	9,943	5,182	8,846
Corporate private	59,413	9,485	-9,880	31,515	69,293	32,051
Other private	50,429	9,767	37,834	31,533	12,595	32,423
Total all owners	502,080	25,885	253,933	65,862	248,147	62,281
All Oregon:						
National forest	969,003	44,804	712,758	147,497	256,245	130,782
State and local government	164,029	32,023	140,236	96,084	23,793	84,606
Corporate private	715,026	60,156	117,540	102,852	597,486	93,773
Other private	353,139	58,594	110,941	79,701	242,198	83,395
Total all owners	2,201,197	95,135	1,081,475	218,663	1,119,723	199,020

Note: Data subject to sampling error; SE = standard error.

Table 56—Estimated gross growth, net change, and removals and mortality of softwood growing stock on timberland, by species group and owner, Oregon, 2001–2005

	All owners						National forest					
	Current gross annual growth		Annualized net change		Annualized removal and mortality		Current gross annual growth		Annualized net change		Annualized removal and mortality	
Species group	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Thousand cubic feet											
Softwoods:												
Douglas-fir	1,260,268	70,715	595,471	166,986	664,797	151,289	413,717	35,963	384,276	113,451	29,441	102,951
Ponderosa and Jeffrey pines	227,105	16,561	249,441	48,892	-22,336	42,900	165,378	12,893	177,185	40,324	-11,807	34,759
True fir	284,238	50,533	127,653	67,510	156,585	69,557	180,108	18,512	99,646	60,446	80,462	49,280
Western hemlock	245,680	31,173	85,526	64,786	160,154	56,042	85,819	13,892	12,387	34,110	73,432	29,608
Sugar pine	5,891	1,828	-5,668	11,796	11,559	11,314	5,891	1,828	1,152	10,800	4,739	10,270
Western white pine	1,917	647	-19,296	9,820	21,213	9,744	1,821	639	-17,963	9,661	19,784	9,588
Redwood	314	309	30	324	283	226	—	—	-216	216	216	216
Sitka spruce	23,979	8,127	6,133	19,673	17,847	16,691	3,225	1,785	2,111	3,858	1,115	3,909
Engelmann and other spruces	12,067	3,117	13,230	14,271	-1,162	13,784	9,574	2,516	8,058	10,112	1,516	9,321
Western larch	10,379	2,279	1,463	14,397	8,916	13,527	7,263	1,930	-3,525	7,798	10,788	7,084
Incense-cedar	15,624	4,686	-3,204	14,153	18,828	13,073	5,210	2,223	2,877	10,845	2,333	9,742
Lodgepole pine	67,131	6,954	35,312	16,955	31,819	15,718	55,639	6,243	35,998	14,499	19,641	12,864
Western redcedar	27,068	5,347	-2,869	18,060	29,936	16,943	17,204	4,395	6,864	15,239	10,339	13,552
Other western softwoods	19,537	4,471	-1,747	12,398	21,284	10,870	18,154	4,391	3,907	11,628	14,247	9,983
Total	2,201,197	95,135	1,081,475	218,663	1,119,723	199,020	969,003	44,804	712,758	147,497	256,245	130,782

	State and local government						Corporate private					
	Current gross annual growth		Annualized net change		Annualized removal and mortality		Current gross annual growth		Annualized net change		Annualized removal and mortality	
Species group	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE	Total	SE
	Thousand cubic feet											
Softwoods:												
Douglas-fir	121,675	24,733	86,875	68,679	34,800	61,880	501,600	50,912	46,738	79,626	454,862	73,950
Ponderosa and Jeffrey pines	9,211	6,214	9,490	7,718	-280	3,009	26,267	5,640	18,310	19,760	7,957	19,043
True fir	5,834	3,418	-1,249	6,677	7,083	6,894	25,575	6,899	7,013	23,451	18,562	23,564
Western hemlock	21,849	9,494	41,509	29,971	-19,660	25,559	123,880	25,914	39,252	42,252	84,628	35,981
Sugar pine	—	—	—	—	—	—	—	—	-3,145	3,092	3,145	3,092
Western white pine	—	—	—	—	—	—	—	—	—	—	—	—
Redwood	—	—	—	—	—	—	314	309	246	242	68	67
Sitka spruce	3,339	3,061	7,155	6,573	-3,816	3,514	15,195	7,224	12,820	13,406	2,375	9,704
Engelmann and other spruces	—	—	—	—	—	—	155	155	-1,285	2,417	1,440	2,361
Western larch	349	349	1,156	1,156	-807	807	2,381	1,129	-795	10,931	3,176	10,434
Incense-cedar	161	161	-2,037	2,037	2,198	2,198	7,214	3,576	-1,085	6,881	8,299	5,068
Lodgepole pine	1,610	1,610	-585	585	2,195	2,195	7,114	2,227	6,040	7,075	1,074	6,944
Western redcedar	—	—	-2,079	2,138	2,079	2,138	4,712	2,236	-4,514	7,748	9,225	7,758
Other western softwoods	—	—	—	—	—	—	620	392	-2,056	2,130	2,676	2,081
Total	164,029	32,023	140,236	96,084	23,793	84,606	715,026	60,156	117,540	102,852	597,486	93,773

Table 56—Estimated gross growth, net change, and removals and mortality of softwood growing stock on timberland, by species group and owner, Oregon, 2001–2005 (continued)

	Other private					
	Current gross annual growth		Annualized net change		Annualized removal and mortality	
Species group	Total	SE	Total	SE	Total	SE
	Thousand cubic feet					
Softwoods:						
Douglas-fir	223,276	32,606	77,582	63,284	145,694	56,875
Ponderosa and Jeffrey pines	26,249	6,226	44,456	17,776	-18,206	16,144
True fir	72,720	46,447	22,243	17,647	50,478	42,517
Western hemlock	14,133	5,923	-7,622	18,810	21,755	17,678
Sugar pine	—	—	-3,676	3,614	3,676	3,614
Western white pine	96	96	-1,332	1,758	1,429	1,738
Redwood	—	—	—	—	—	—
Sitka spruce	2,219	1,352	-15,953	12,201	18,172	12,512
Engelmann and other spruces	2,338	1,833	6,457	9,776	-4,118	9,877
Western larch	385	273	4,626	5,064	-4,241	4,822
Incense-cedar	3,038	2,092	-2,960	5,585	5,998	6,762
Lodgepole pine	2,767	1,366	-6,142	5,177	8,909	5,343
Western redcedar	5,152	2,085	-3,141	5,446	8,293	6,260
Other western softwoods	763	750	-3,598	3,746	4,360	3,777
Total	353,139	58,594	110,941	79,701	242,198	83,395

Note: Data subject to sampling error; SE = standard error; — = less than 500 cubic feet were estimated.

Table 57—Total roundwood output by product, species group, and source of material, Oregon, 2003

Product and species group	Sawtimber	Poletimber	Other sources	All sources
	Thousand cubic feet			
Saw logs:				
Softwoods	659,465	2,445	9,608	671,518
Hardwoods	33,158	123	341	33,622
Total	692,623	2,568	9,950	705,140
Veneer logs:				
Softwoods	197,793	733	2,802	201,342
Hardwoods	14	—	—	14
Total	197,807	733	2,802	201,342
Pulpwood:				
Softwoods	41,497	154	4,020	45,671
Hardwoods	27,419	102	281	27,801
Total	68,915	256	4,301	73,472
Poles and posts:				
Softwoods	1,618	225	46	1,888
Hardwoods	—	—	—	—
Total	1,618	225	46	1,888
Other miscellaneous:				
Softwoods	13,762	51	539	14,352
Hardwoods	—	—	—	—
Total	13,762	51	539	14,352
Total industrial products:				
Softwoods	914,134	3,608	17,015	934,758
Hardwoods	60,591	225	622	61,438
Total	974,725	3,833	17,638	996,195
Fuelwood:				
Softwoods	127	—	55,666	55,793
Hardwoods	327	1	2,772	3,100
Total	455	2	58,437	58,894
All products:				
Softwoods	914,261	3,609	72,681	990,551
Hardwoods	60,918	226	3,394	64,538
Total	975,179	3,835	76,075	1,055,089

Note: Data subject to sampling error; excludes removals from precommercial thinnings; — = less than 500 cubic feet found.

Table 58—Volume of timber removals by type of removal, source of material, and species group, Oregon, 2003

	Growing stock			Other sources			All sources		
Removal type	**Softwoods**	**Hardwoods**	**Total**	**Softwoods**	**Hardwoods**	**Total**	**Softwoods**	**Hardwoods**	**Total**
					Thousand cubic feet				
Roundwood products:									
Saw logs	661,910	33,281	695,191	9,608	341	9,950	671,518	33,622	705,140
Veneer logs	198,526	14	198,540	2,802	—	2,802	201,328	14	201,342
Pulpwood	41,651	27,520	69,171	4,020	281	4,301	45,671	27,801	73,472
Fuelwood	128	329	456	55,666	2,772	58,437	55,793	3,100	58,894
Posts, poles, and pilings	1,843	—	1,843	46	—	46	1,888	—	1,888
Miscellaneous products	13,813	—	13,813	539	—	539	14,352	—	14,352
Total	917,870	61,144	979,014	72,681	3,394	76,075	990,551	64,538	1,055,089
Logging residues	57,055	3,781	60,835	220,519	20,331	240,850	277,573	24,112	301,685
Total all removals	974,925	64,925	1,039,850	23,725	316,925	1,268,124	1,356,775	—	—

Note: Data subject to sampling error; excludes removals from precommercial thinnings; — = less than 500 cubic feet found.

Table 59—Estimated area of forest land covered by vascular plant nontimber forest products, by plant group and species, Oregon, 2001–2005

Plant group and scientific name	Common name	Total	SE
		Acres	
Tree seedlings and saplings:			
Abies magnifica	California red fir	2,000	1,000
Abies procera	Noble fir	8,800	2,200
Calocedrus decurrens	Incense-cedar	23,400	2,300
Crataegus	Hawthorn spp.	9,100	4,300
Juniperus occidentalis	Western juniper	45,200	3,100
Pseudotsuga menziesii	Douglas-fir	201,500	11,700
Taxus brevifolia	Pacific yew	13,900	2,700
Thuja plicata	Western redcedar	22,200	2,500
Shrubs:			
Acer circinatum	Vine maple	935,300	54,500
Arctostaphylos	Manzanita spp.	14,500	7,700
Arctostaphylos columbiana	Hairy manzanita	26,200	8,200
Arctostaphylos nevadensis	Pinemat manzanita	89,300	11,700
Arctostaphylos patula	Greenleaf manzanita	108,700	14,900
Arctostaphylos uva-ursi	Kinnikinnick	39,400	10,600
Arctostaphylos viscida	Sticky whiteleaf manzanita	35,700	9,500
Ceanothus velutinus	Snowbrush ceanothus	189,600	23,800
Chimaphila umbellata	Pipsissewa	71,200	6,200
Cytisus scoparius	Scotchbroom	18,800	6,800
Eriodictyon californicum	California yerba santa	400	400
Frangula purshiana	Pursh's buckthorn	75,800	10,500
Gaultheria shallon	Salal	890,800	57,800
Mahonia aquifolium	Oregon grape	11,300	3,000
Mahonia nervosa	Dwarf Oregon grape	546,400	32,600
Mahonia repens	Creeping barberry	31,800	3,400
Oplopanax horridus	Devilsclub	18,100	4,900
Paxistima myrsinites	Oregon boxleaf	26,300	4,600
Ribes	Currant spp.	83,900	6,100
Rosa	Rose spp.	94,500	6,800
Sambucus nigra	European black elderberry	2,400	1,100
Sambucus racemosa	Red elderberry	33,400	7,100
Vaccinium membranaceum	Thinleaf huckleberry	252,300	25,900
Vaccinium ovatum	California huckleberry	185,300	26,600
Herbs:			
Achillea millefolium	Common yarrow	79,800	6,000
Anaphalis margaritacea	Western pearly everlasting	9,400	2,500
Arnica cordifolia	Heartleaf arnica	136,500	12,400
Asarum caudatum	British Columbia wildginger	12,300	2,400
Equisetum	Horsetail spp.	7,500	2,000
Hypericum perforatum	Common St. Johnswort	6,200	1,700
Polystichum munitum	Western swordfern	1,506,600	69,600
Pteridium aquilinum	Western brackenfern	262,700	22,200
Trillium ovatum	Pacific trillium	2,900	500
Urtica dioica	Stinging nettle	8,400	2,600
Xerophyllum tenax	Common beargrass	152,300	19,200

Note: Data subject to sampling error; SE = standard error.

Table 60—Percentage of forested plots[a] with selected lichen nontimber forest products present, by species, Oregon, 2001–2005

Scientific name	Common name	Percent
Alectoria sarmentosa	Witch's hair lichen	34.25
Bryoria fremontii	Old man's beard	34.25
Letharia vulpina	Wolf lichen	56.85
Lobaria pulmonaria	Lungwort	16.44
Parmelia saxatilis	Crottle	2.05
Usnea	Beard lichens	56.51
Usnea hirta	Beard lichen	0.34
Vulpicida canadensis	Brown-eyed sunshine lichen	20.21

Note: Data subject to sampling error.
[a] 292 forested plots were sampled.

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