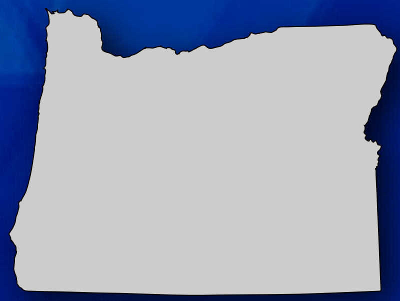
Oregon's Forest Resources, 2001–2005

Five-Year Forest Inventory and Analysis Report



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Technical Editors

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Cover: Oregon Coast. Photo by Don Gedney.

Abstract

Donnegan, Joseph; Campbell, Sally; Azuma, Dave, tech. eds. 2008. Oregon's forest resources, 2001–2005: five-year Forest Inventory and Analysis report. Gen. Tech. Rep. PNW-GTR-765. Portland, OR: U.S. Forest Service, Pacific Northwest Research Station. 186 p.

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

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.

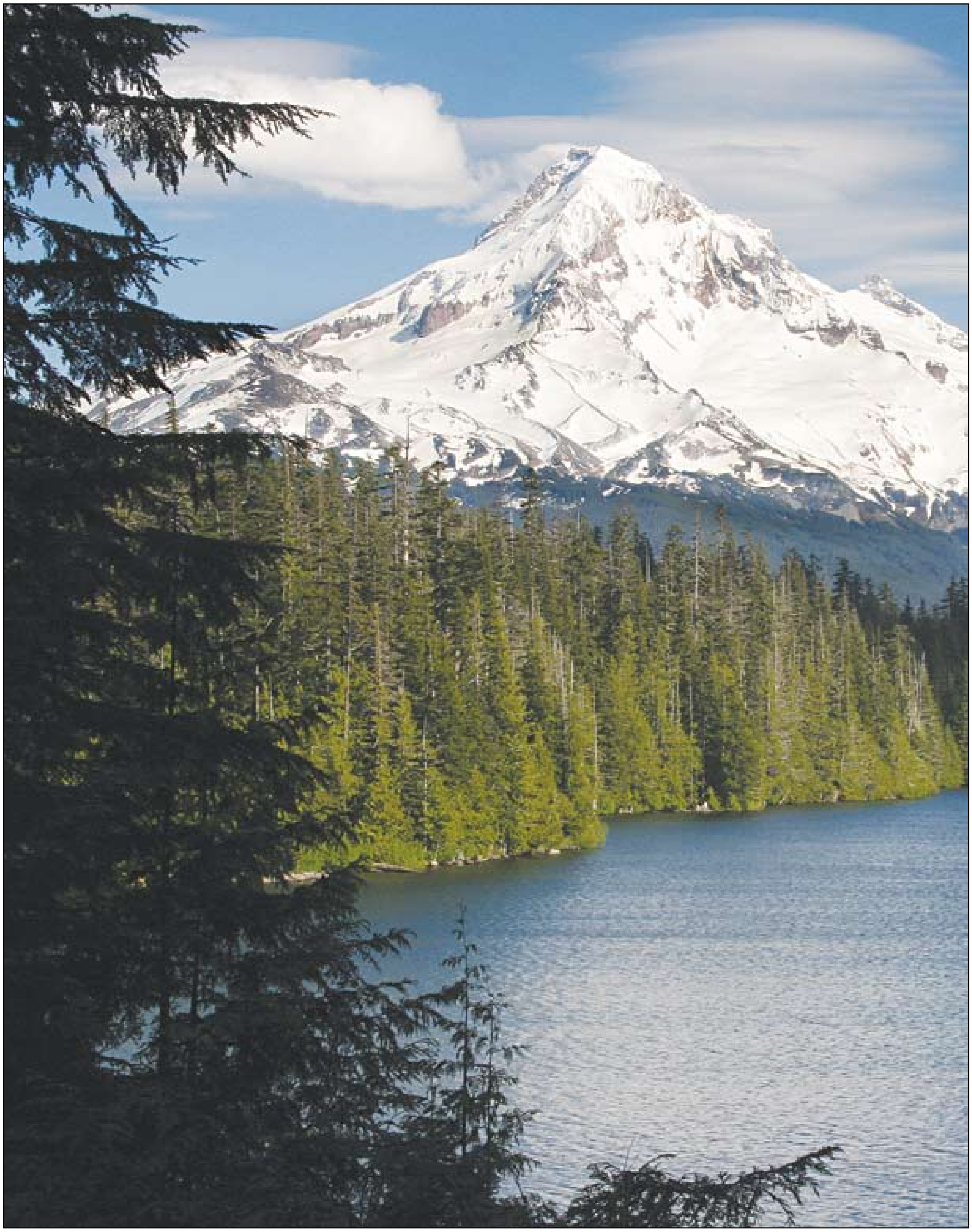
The following summary of key findings shows the importance of monitoring the status and change in our forest resources.

- 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.

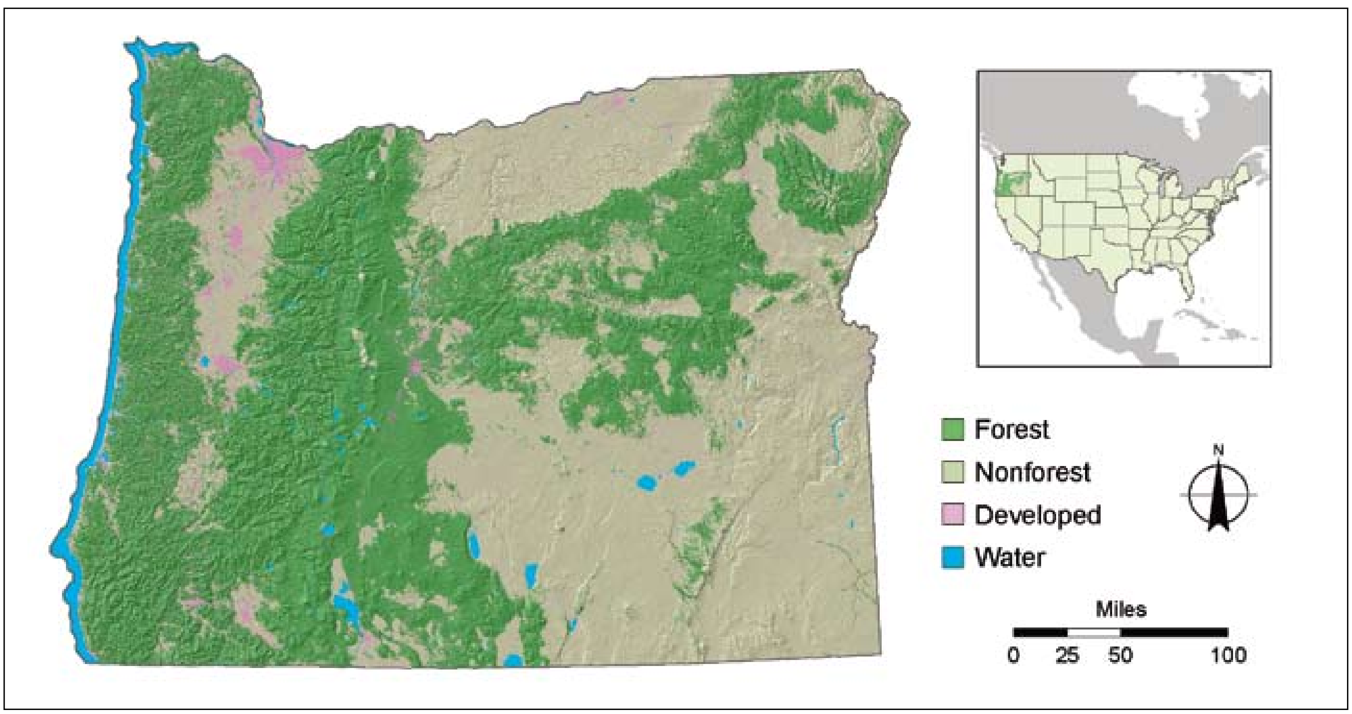


Figure 1—Oregon land cover (forest/nonforest geographic information system (GIS) layer: Blackard et al. 2008; urban/water GIS layer: Homer et al. 2004).

Tom Iraci

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

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.

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/.

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.

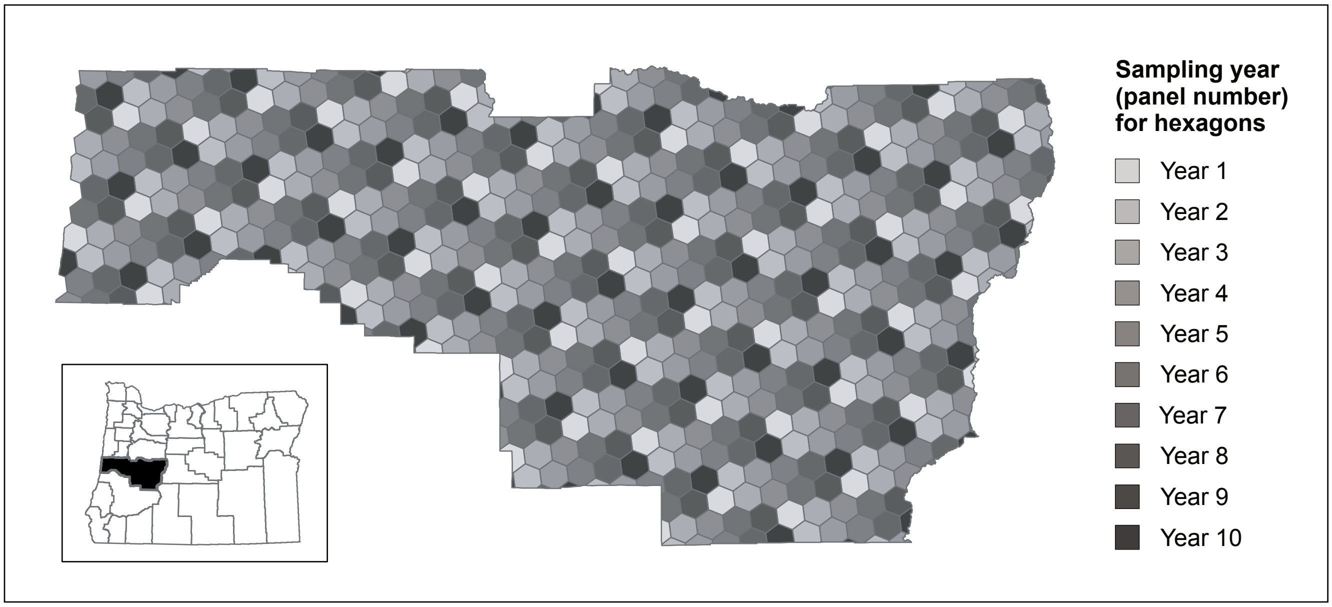


Figure 3—Example of the hexagonal grid and panel system used to locate Forest Inventory and Analysis plots. Although there are over 10,000 phase 2 hexes in Oregon, only about 6,000 of them are forested field plot candidates. One-tenth of the forested plots are visited each year.

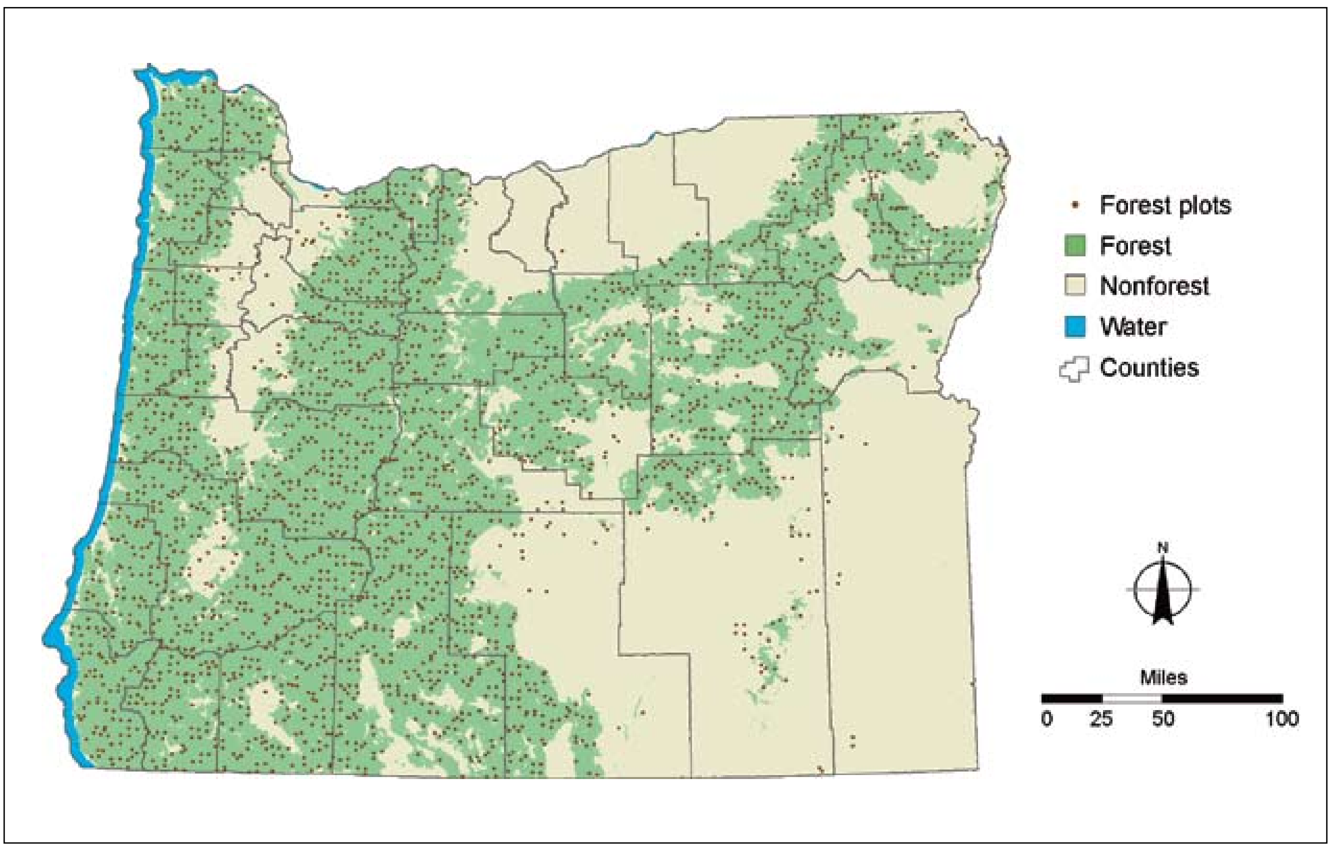


Figure 4—Forested plots measured between 2001 and 2005 provide the data used in this report. Locations are approximate (forest/nonforest geographic information system (GIS) layer: Blackard et al. 2008; urban/water GIS layer: Homer et al. 2004).

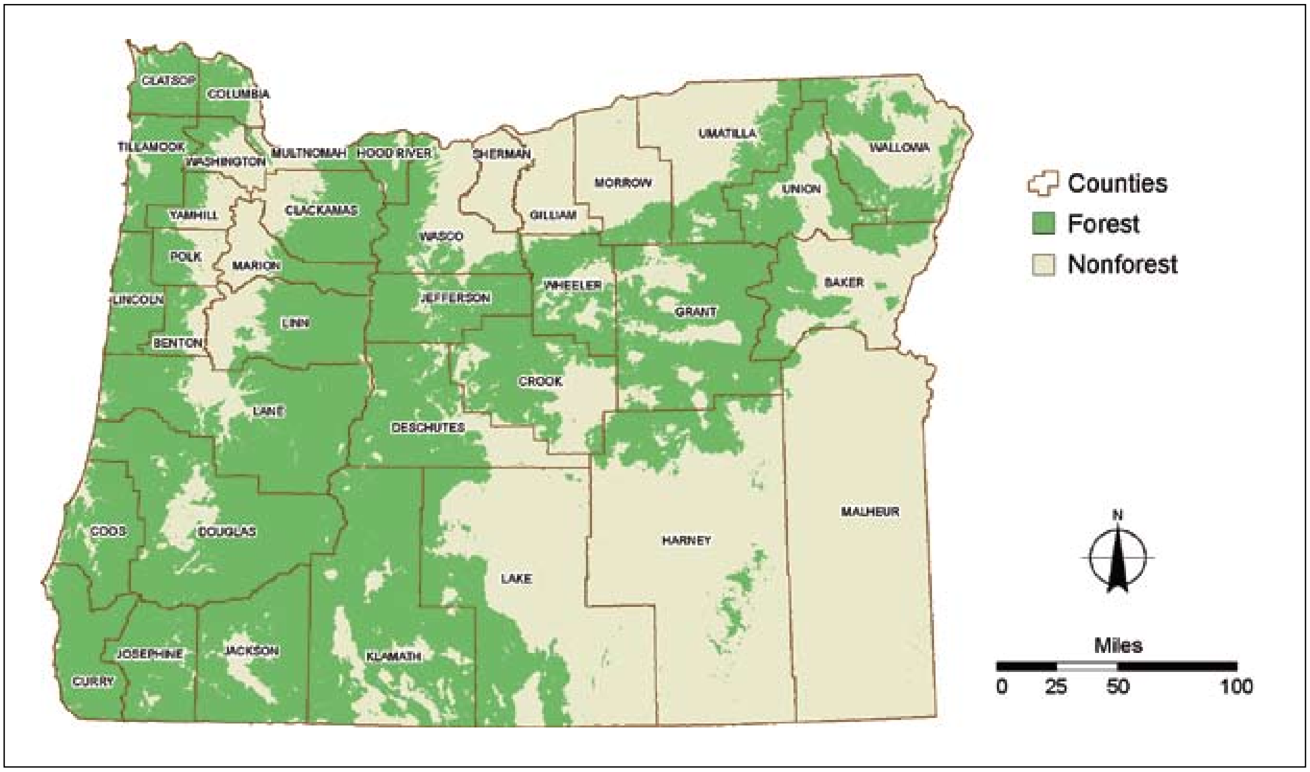


Figure 5—Oregon counties (forest/nonforest geographic information system layer: Blackard et al. 2008).

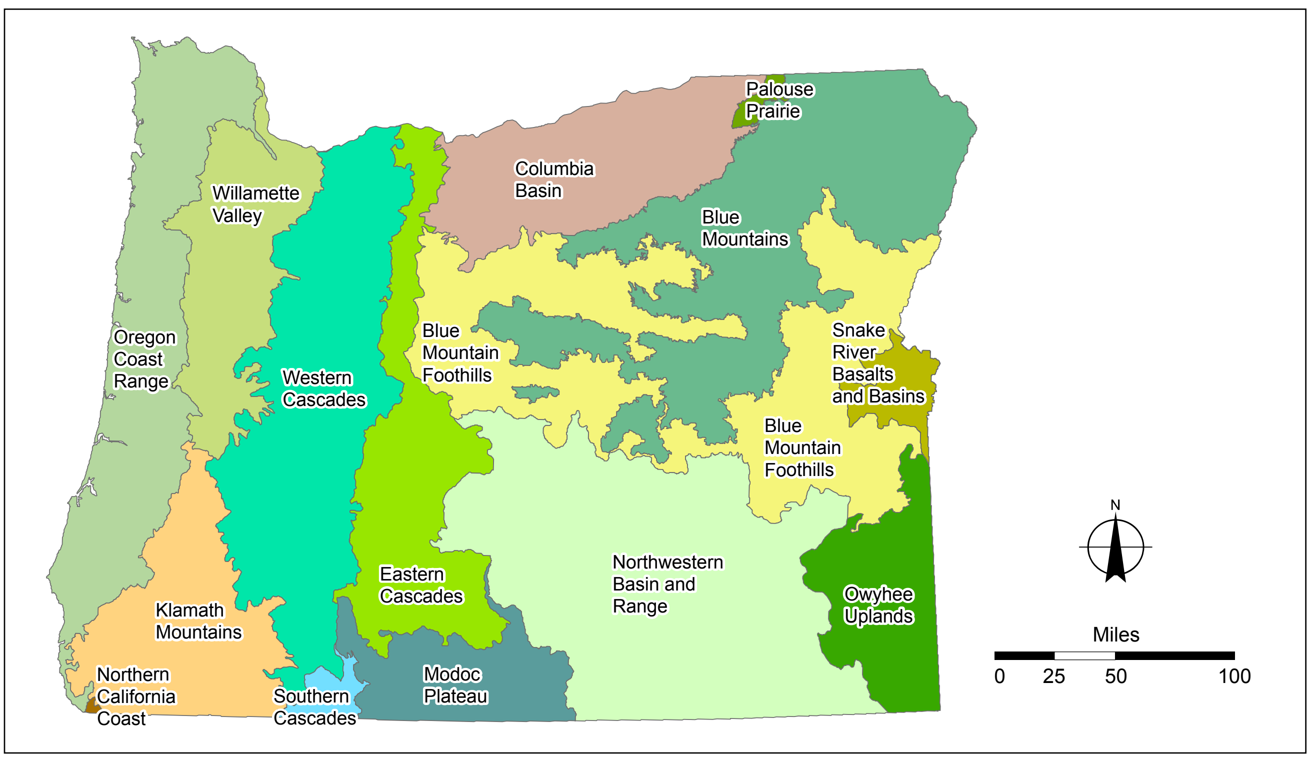


Figure 6—Oregon ecosections (ecosection geographic information system layer: Cleland et al. 2005).

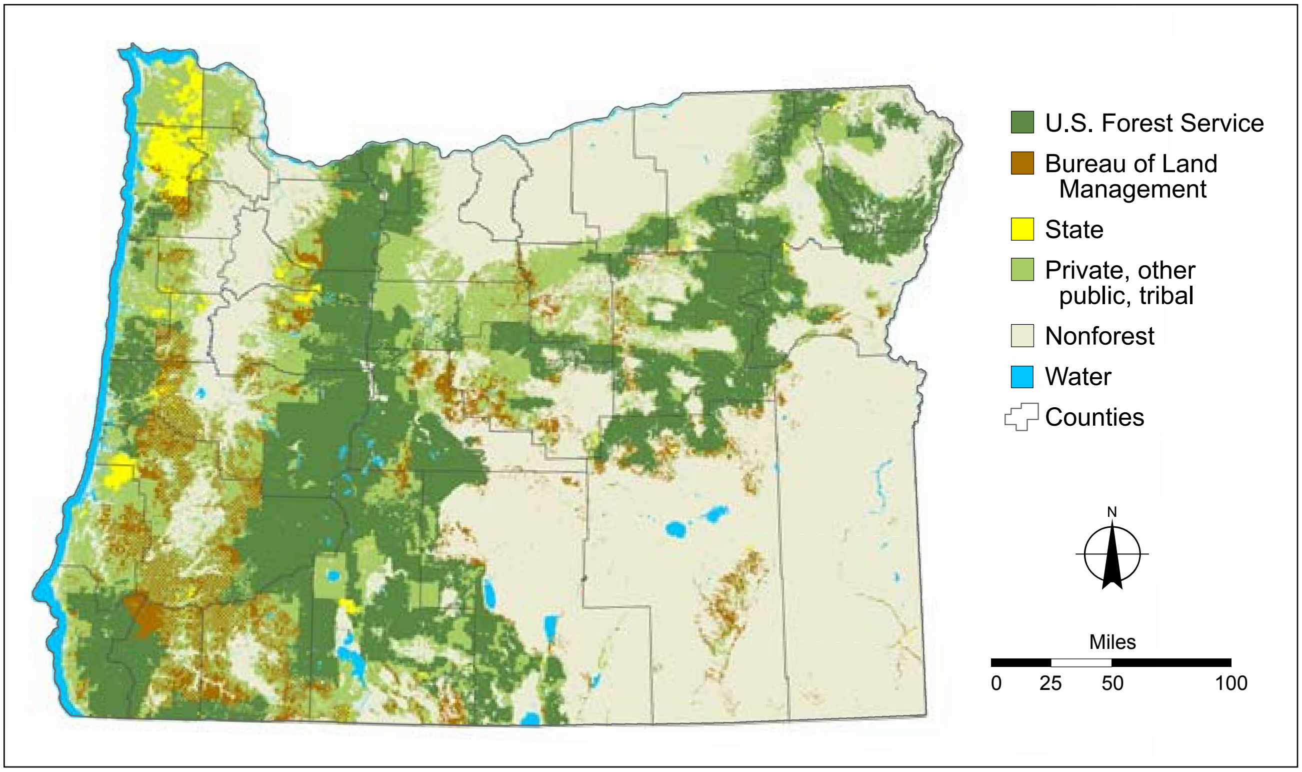


Figure 7—Oregon forest ownership categories (ownership geographic information system (GIS) layer: Oregon Department of Forestry 2006a; urban/water GIS layer: Homer et al. 2004).

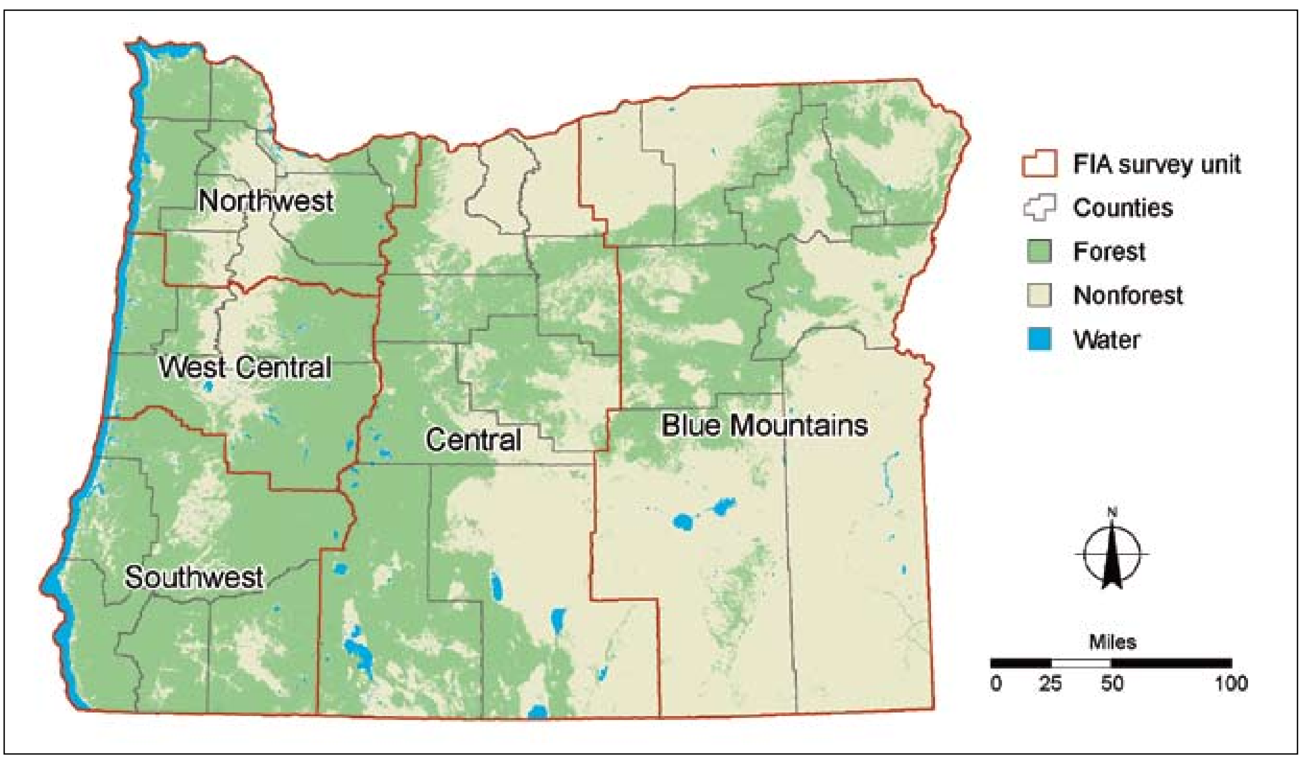


Figure 8—Oregon Forest Inventory and Analysis survey units (county groupings used in this report) (forest/nonforest geographic information system (GIS) layer: Blackard et al. 2008; urban/water GIS layer: Homer et al. 2004).

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	


Tom Iraci

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.

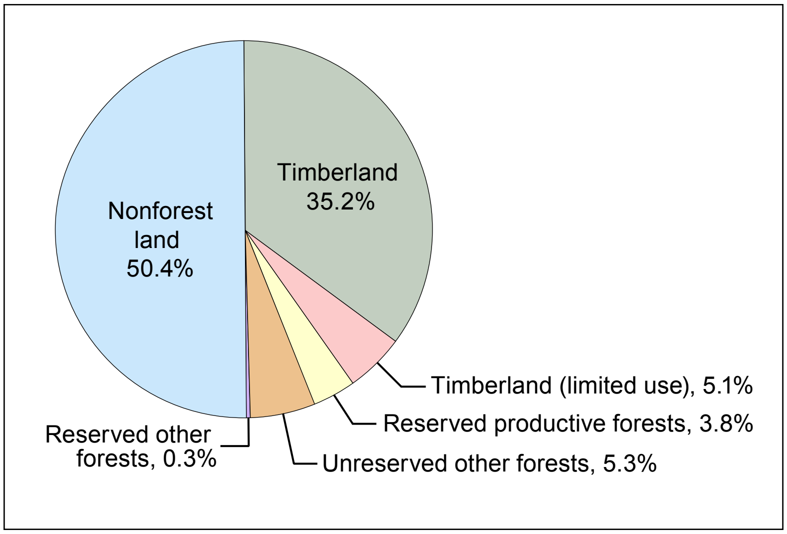


Figure 10—Percentage of area by land class category in Oregon, 2001–2005. Limited-use timberland is not reserved by Congressional act or law, but may be reserved from use for wood production. Examples include riparian corridors, late-successional reserves, administratively withdrawn areas, and adaptive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

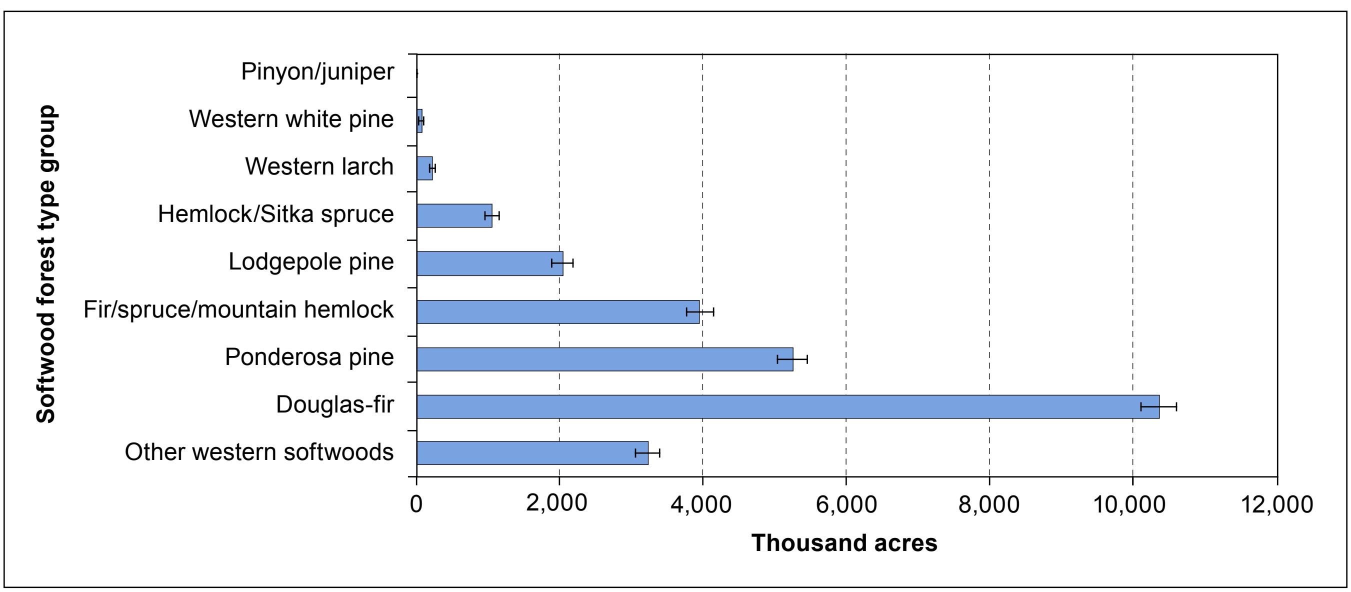


Figure 11—Area of softwood forest type groups on forest land in Oregon, 2001–2005.

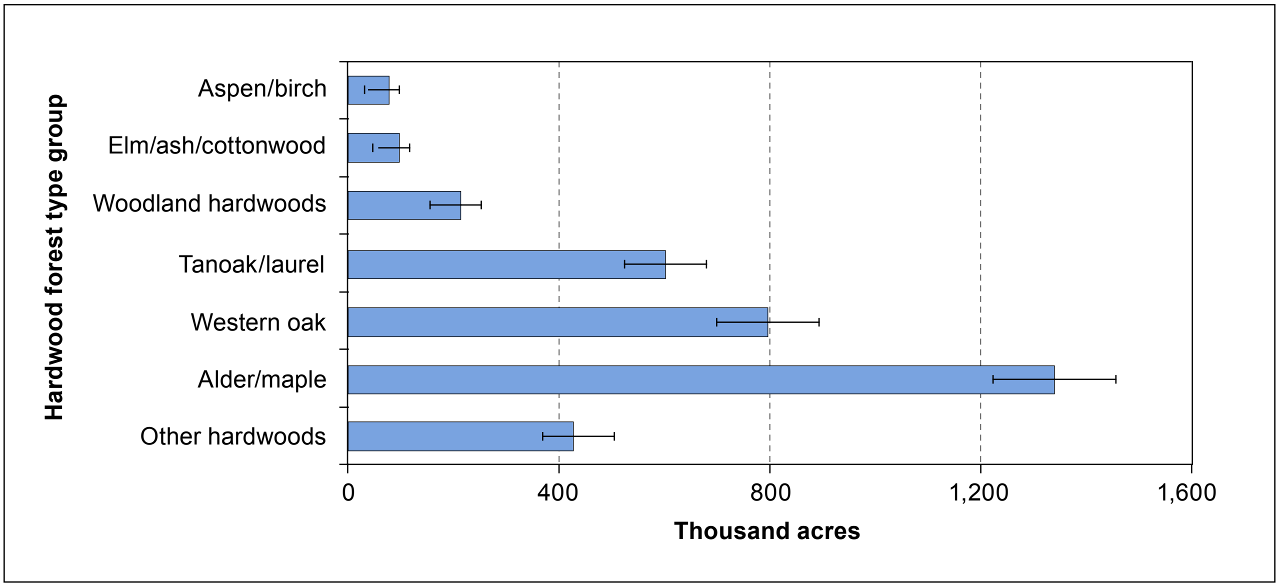


Figure 12—Area of hardwood forest type groups found on forest land in Oregon, 2001–2005.

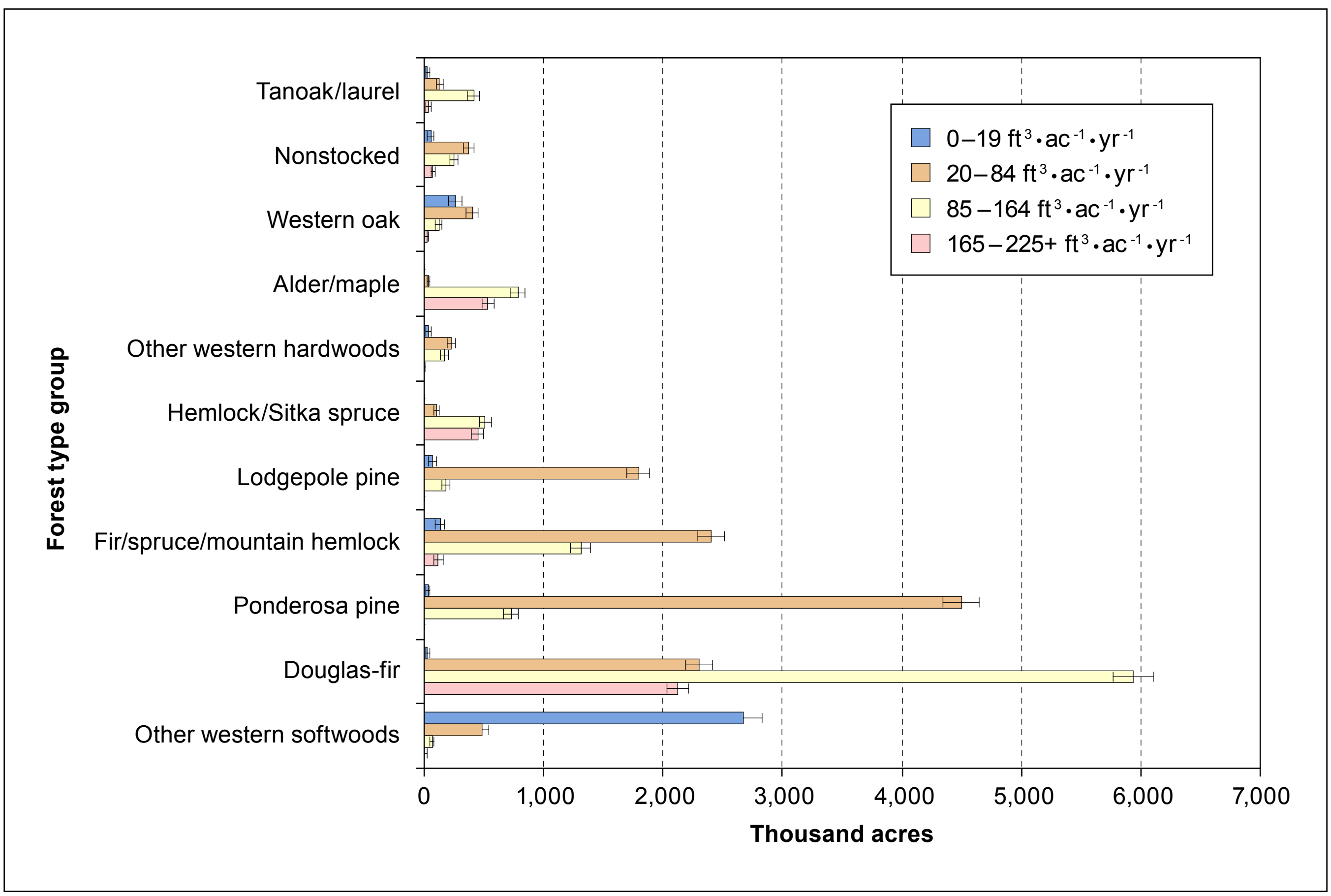


Figure 13—Area of productivity classes by forest type group on forest land in Oregon, 2001–2005.

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

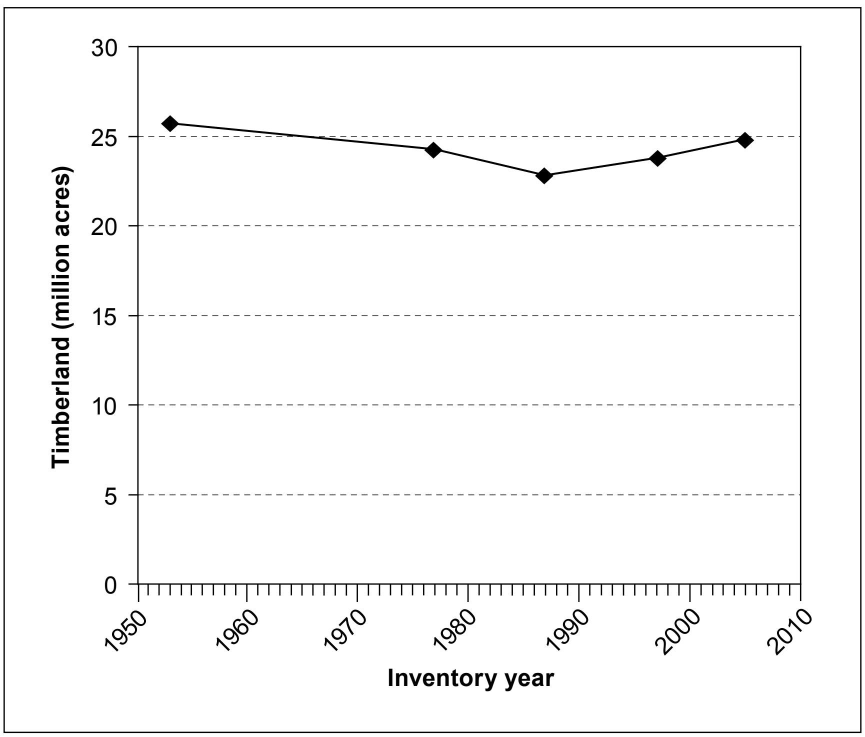


Figure 14—Area of timberland by inventory year in Oregon (Smith et al. 2004), 1953–2005. Note: The 2001–2005 timberland area estimate is based on the annual inventory design and protocols; the previous area estimates are based on periodic inventories with different designs and protocols. Key differences 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.

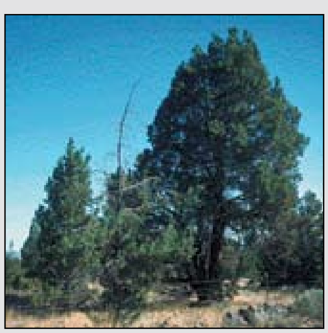
1974 and 2000, and the proportion of wildland forest in proximity to either urban or low-density use also increased. A similar study was conducted in eastern Oregon (Lettman et al. 2004), adding an additional 13,000 points. Below are results from studies on non-federal land in western and eastern Oregon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

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.

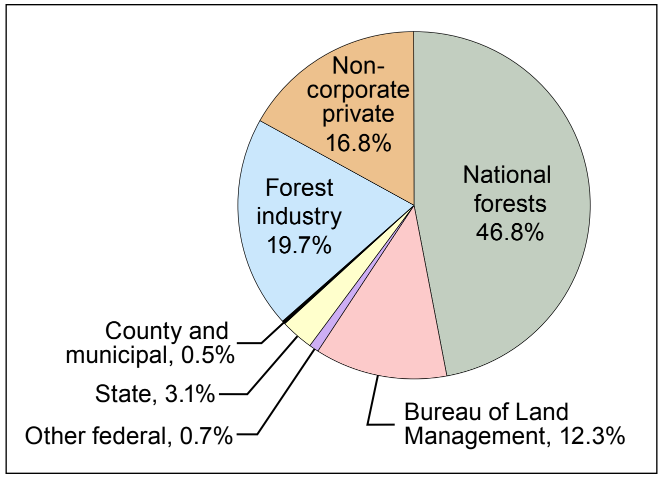


Figure 19—Percentage of forest land area by owner group in Oregon, 2001–2005.

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.

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

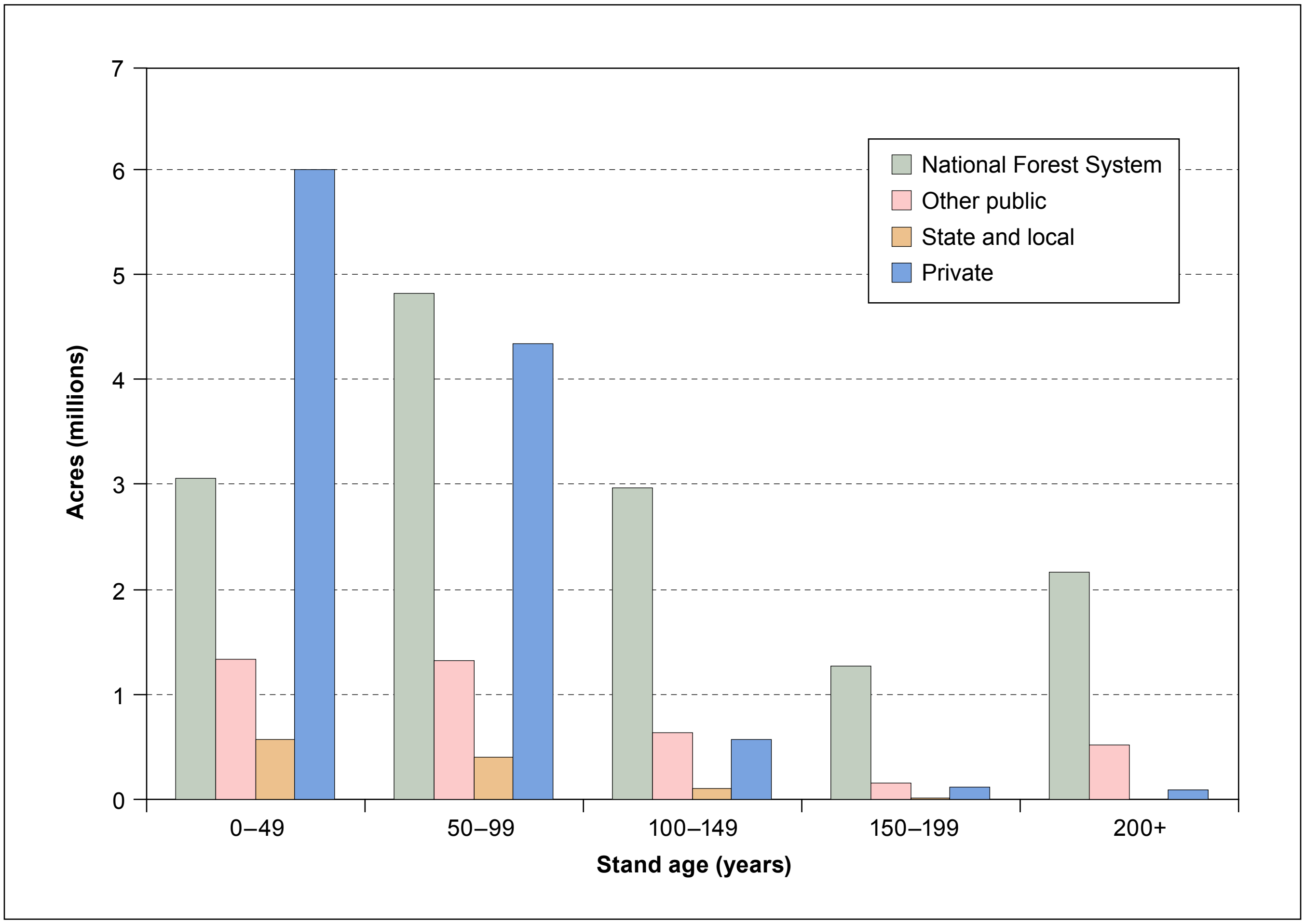


Figure 20—Area of forest land by owner group and stand age class in Oregon, 2001–2005.

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]

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

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.

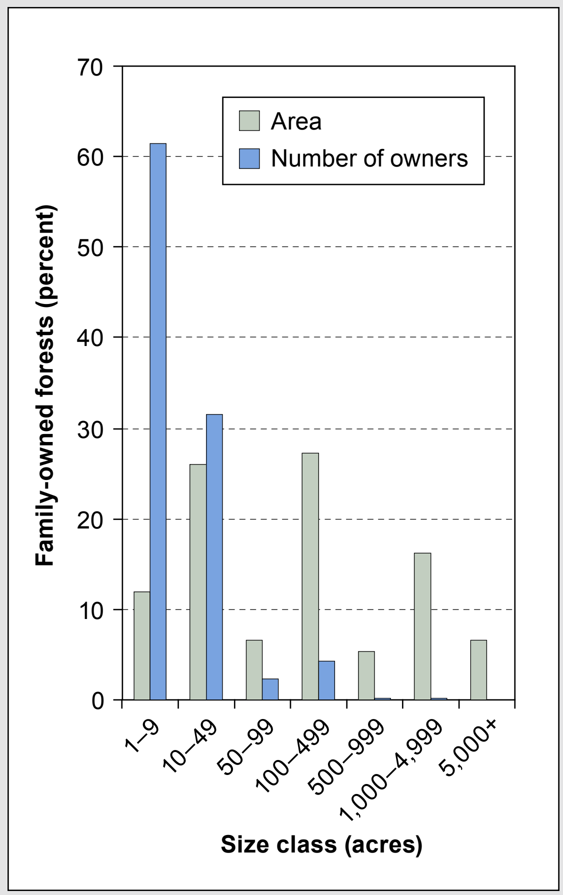


Figure 22—Percentage of area and percentage of the number of family-owned forest holdings by size class in Oregon, 2004.

[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

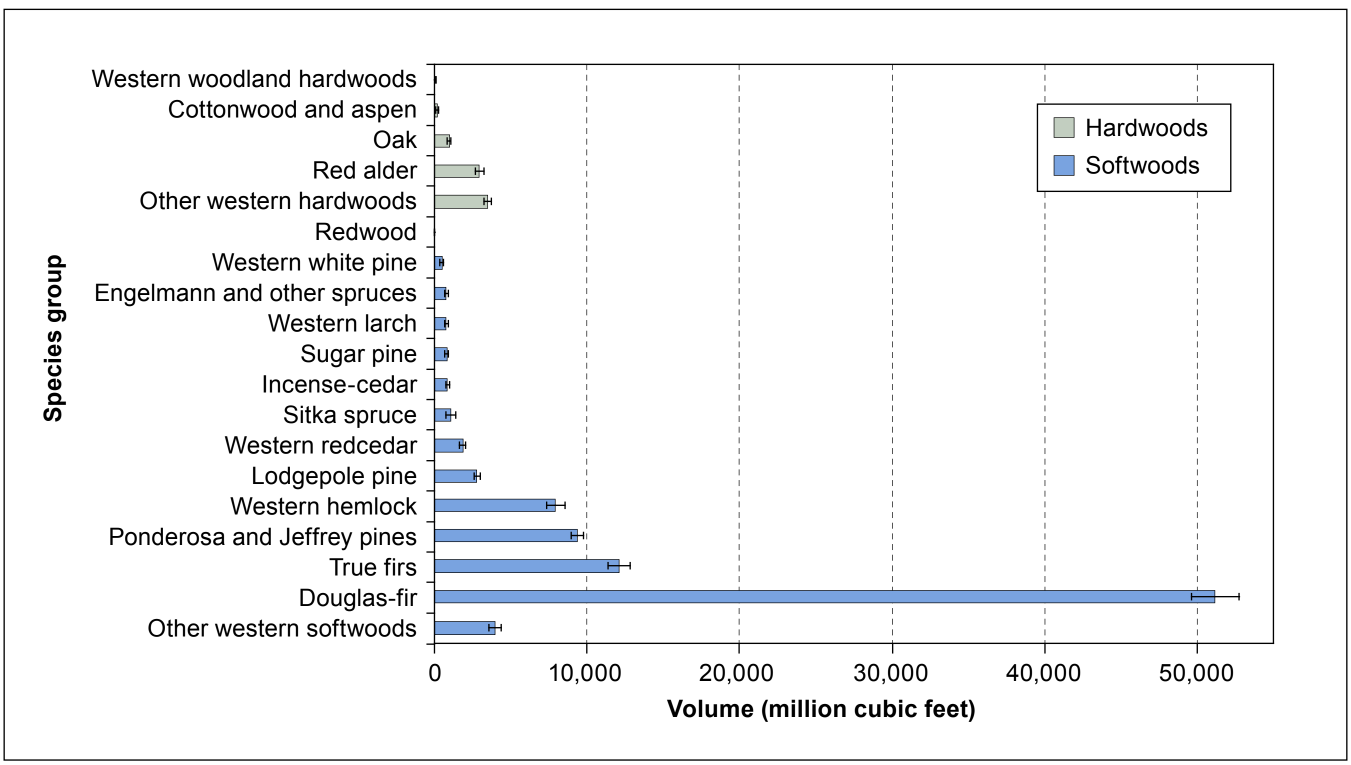


Figure 24—Net volume of all live trees by species group on forest land in Oregon, 2001–2005.

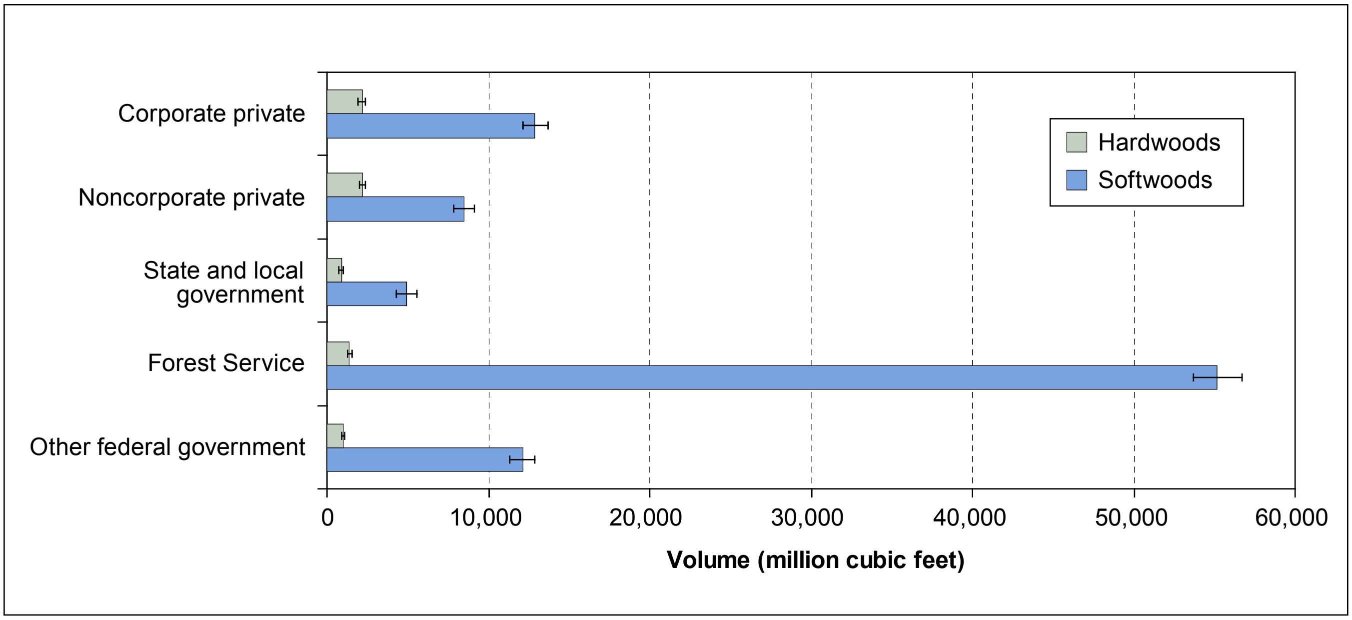


Figure 25—Net volume of all live trees by ownership group on forest land in Oregon, 2001–2005.

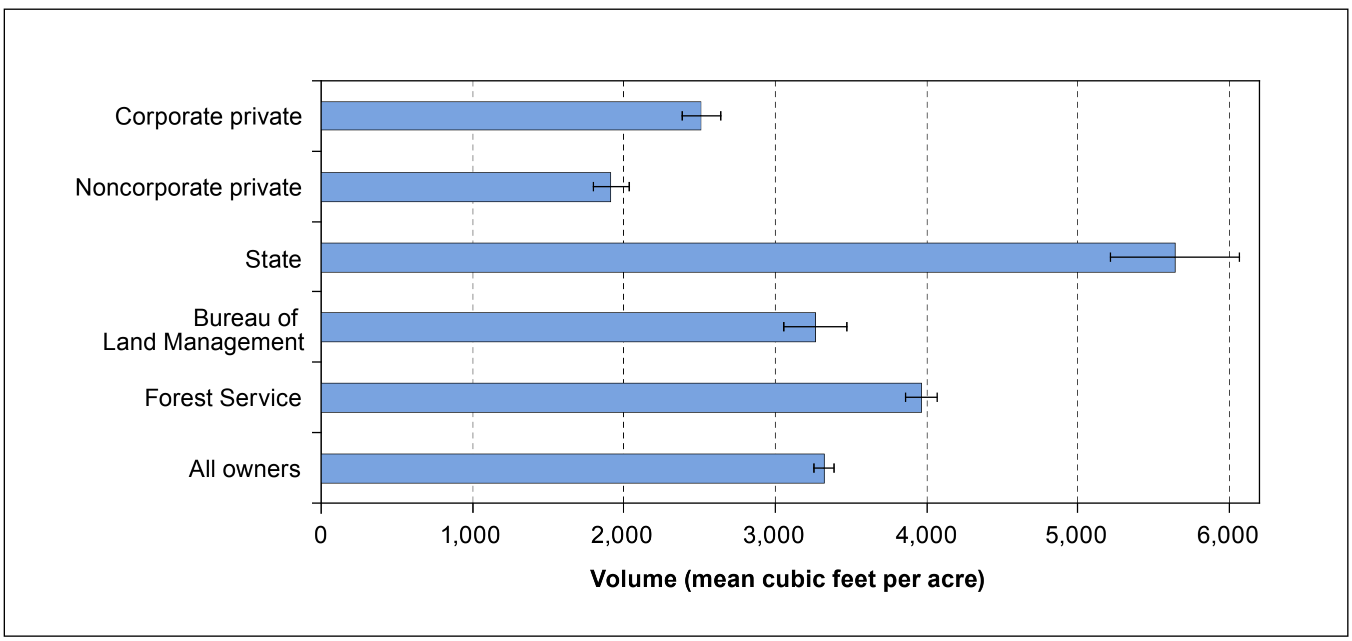


Figure 26—Mean net volume per acre of all live trees by ownership group on forest land in Oregon, 2001–2005.

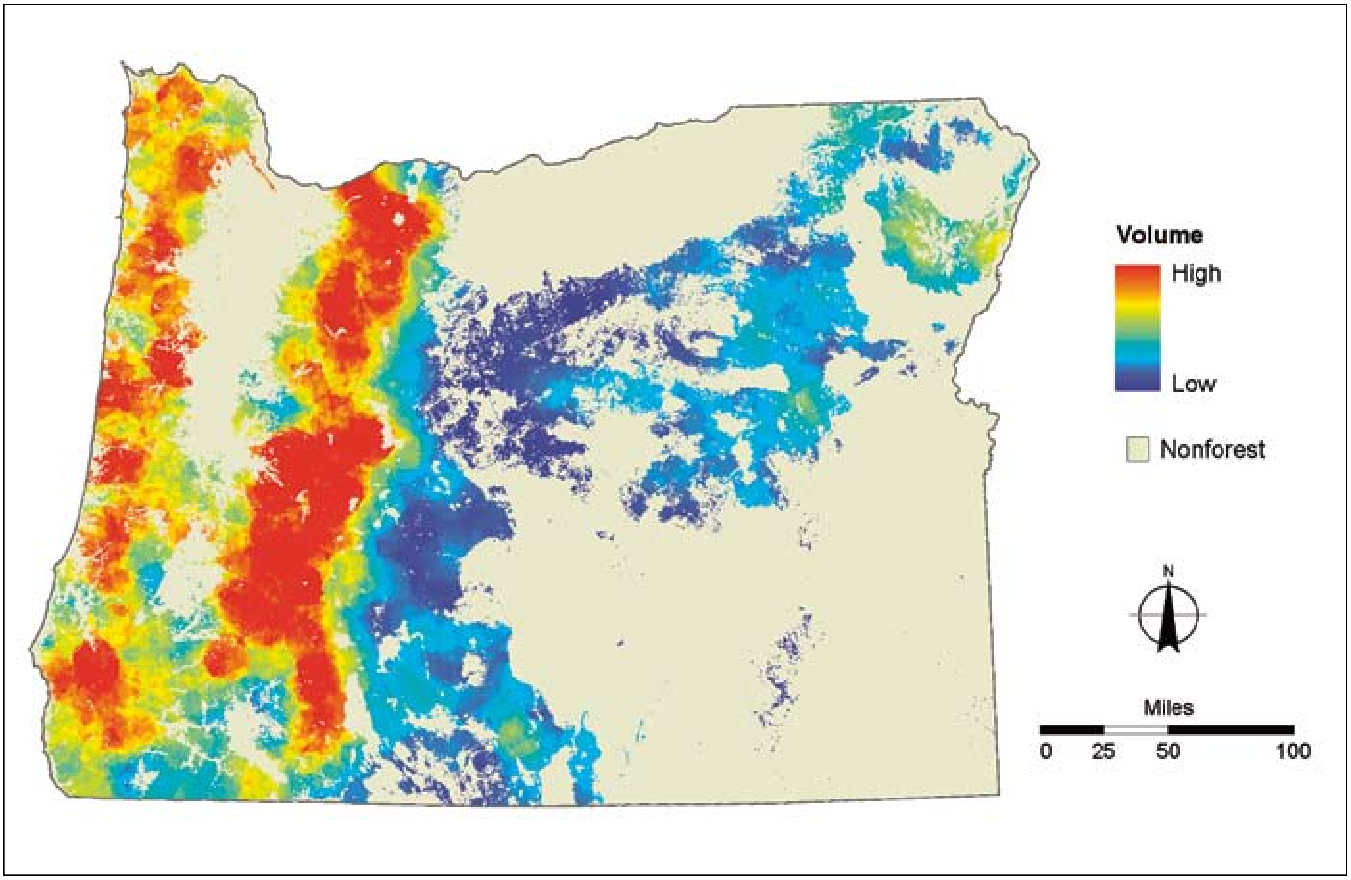


Figure 27—Estimated live-tree volume (net cubic feet per acre), Oregon, 2001–2005. Red color indicates higher predicted per-acre volumes. Estimates are kriged predictions of likely volume per acre on forest land, based on mean net cubic foot volume per plot (forest/nonforest geographic information system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

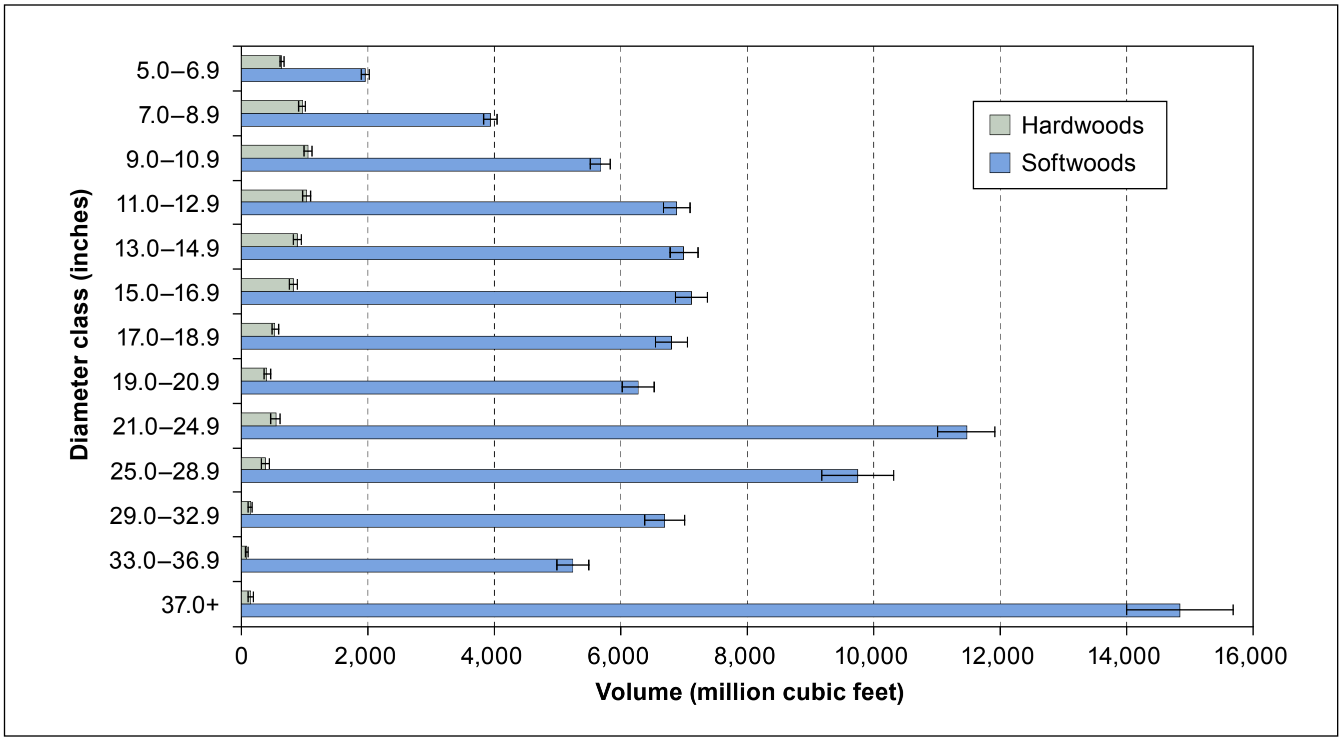


Figure 28—Net volume of all live trees by diameter class on forest land in Oregon, 2001–2005.

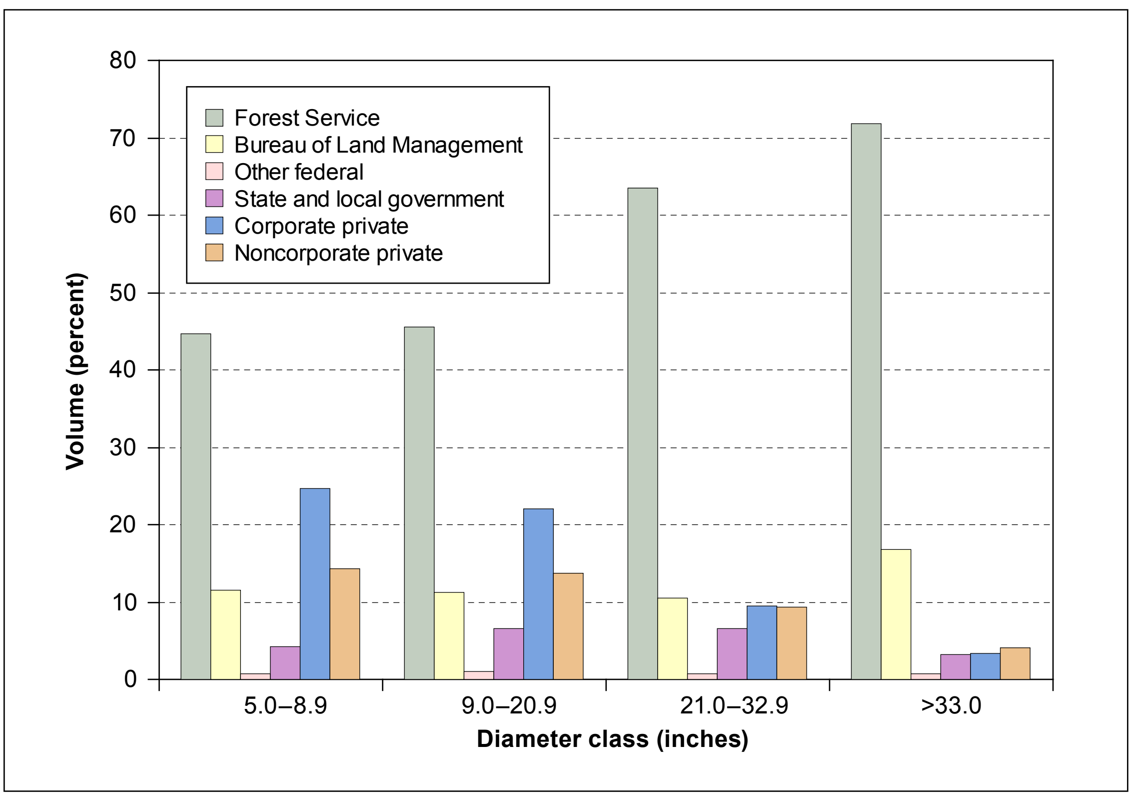


Figure 29—Percentage of net volume of all live trees by diameter class and ownership group on forest land in Oregon, 2001–2005.

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.

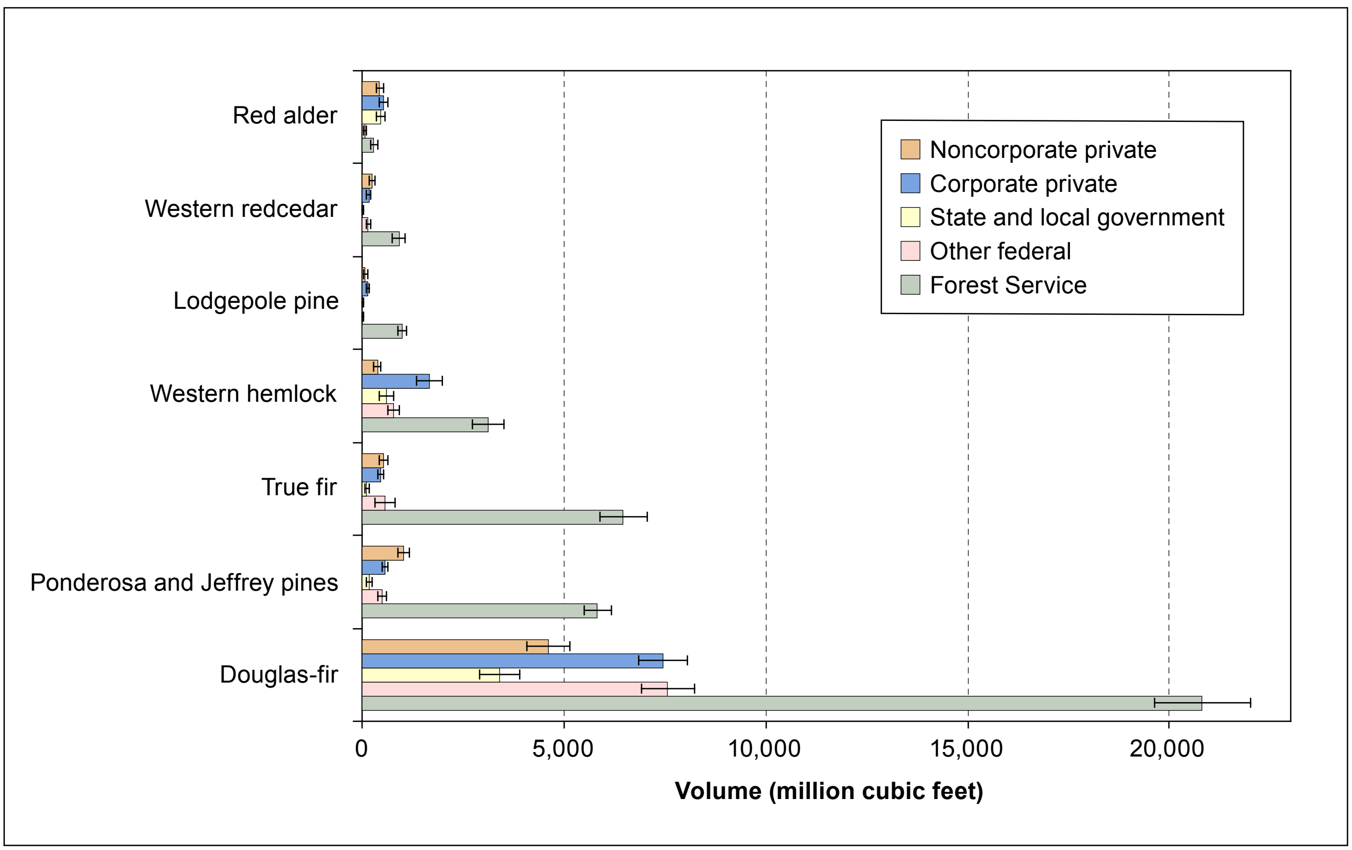


Figure 30—Net volume of sawtimber-sized trees by ownership group on timberland in Oregon, 2001–2005. Excludes miscellaneous mixed softwood and hardwood species groups and species groups that contribute <1 percent of total sawtimber volume.

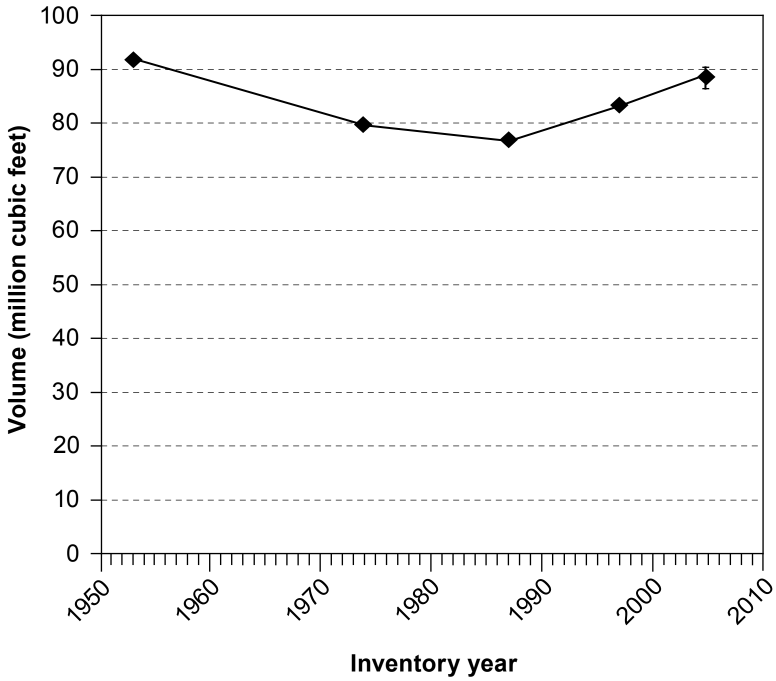


Figure 31—Net volume of growing stock on timberland by inventory year in Oregon (Smith et al. 2004), 1953–2005. Note: The 2001–2005 timberland volume estimate is based on the annual inventory design and protocols; the previous volume estimates are based on periodic inventories with different designs 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.

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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).

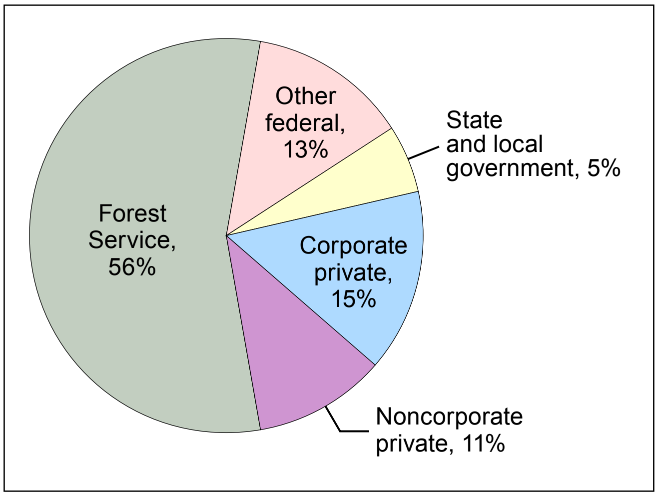

Figure 33—Aboveground live tree biomass by owner group on forest land in Oregon, 2001–2005.

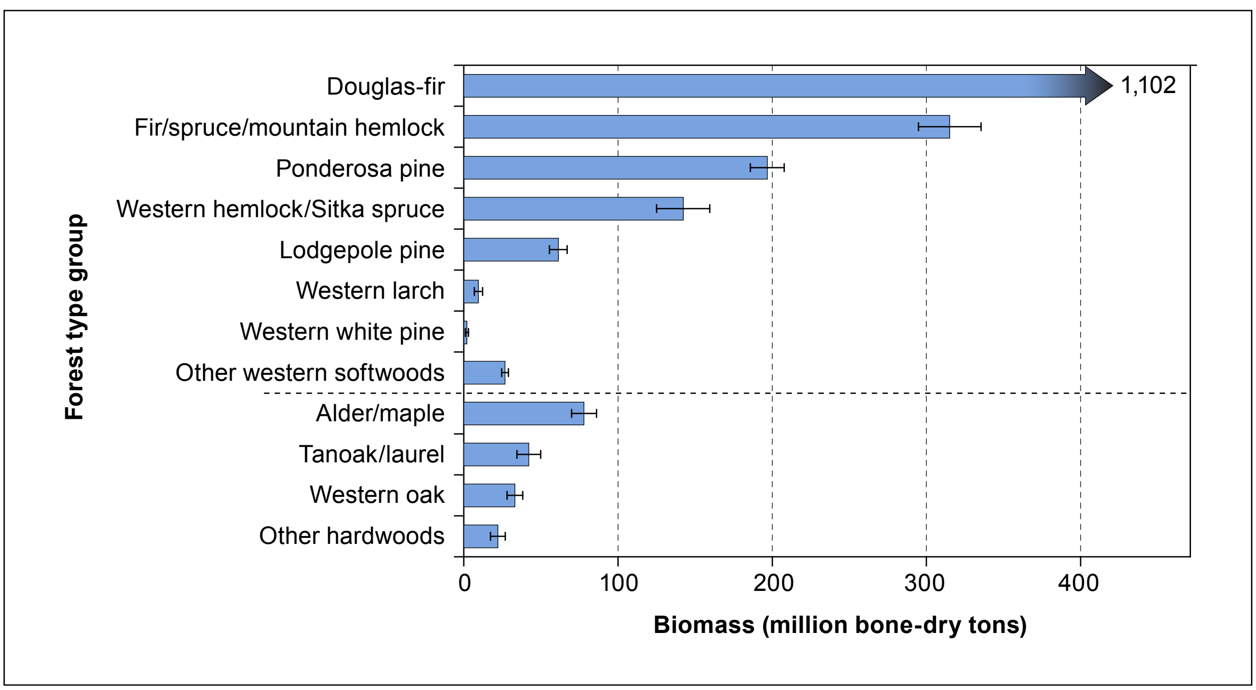

Figure 34—Aboveground live tree biomass by forest type group on forest land in Oregon, 2001–2005.

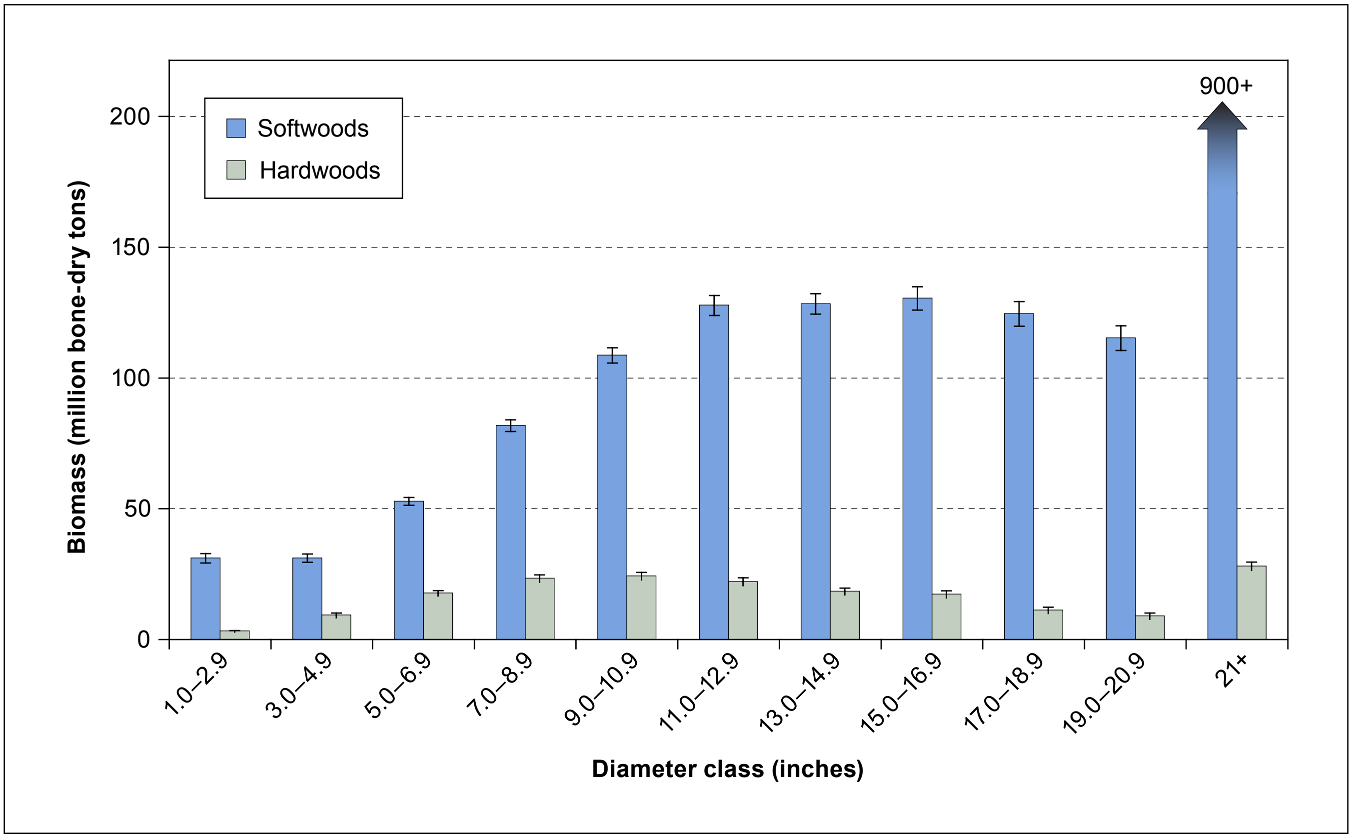

Figure 35—Aboveground live tree biomass by diameter class on forest land in Oregon, 2001–2005.

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,

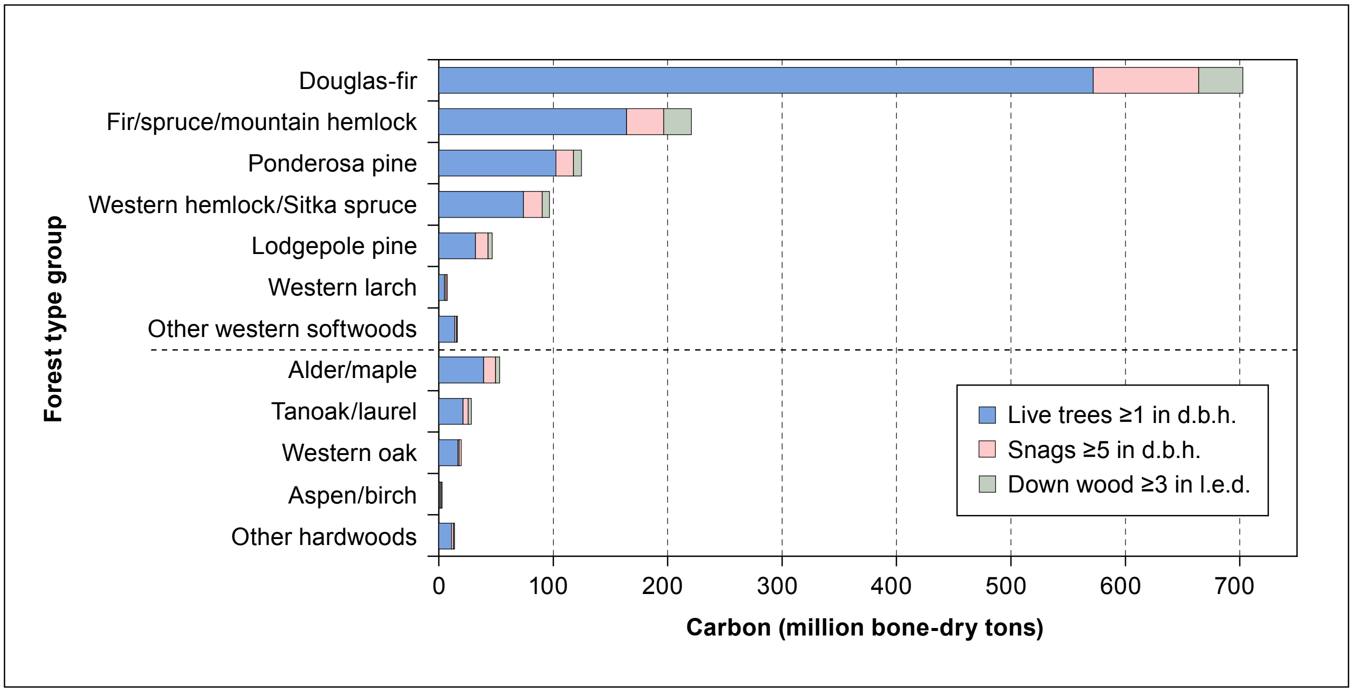

Figure 36—Carbon mass of live trees, snags, and down wood (coarse woody material) by forest type group on forest land in Oregon, 2001–2005; d.b.h. = diameter at breast height; l.e.d. = large end diameter.

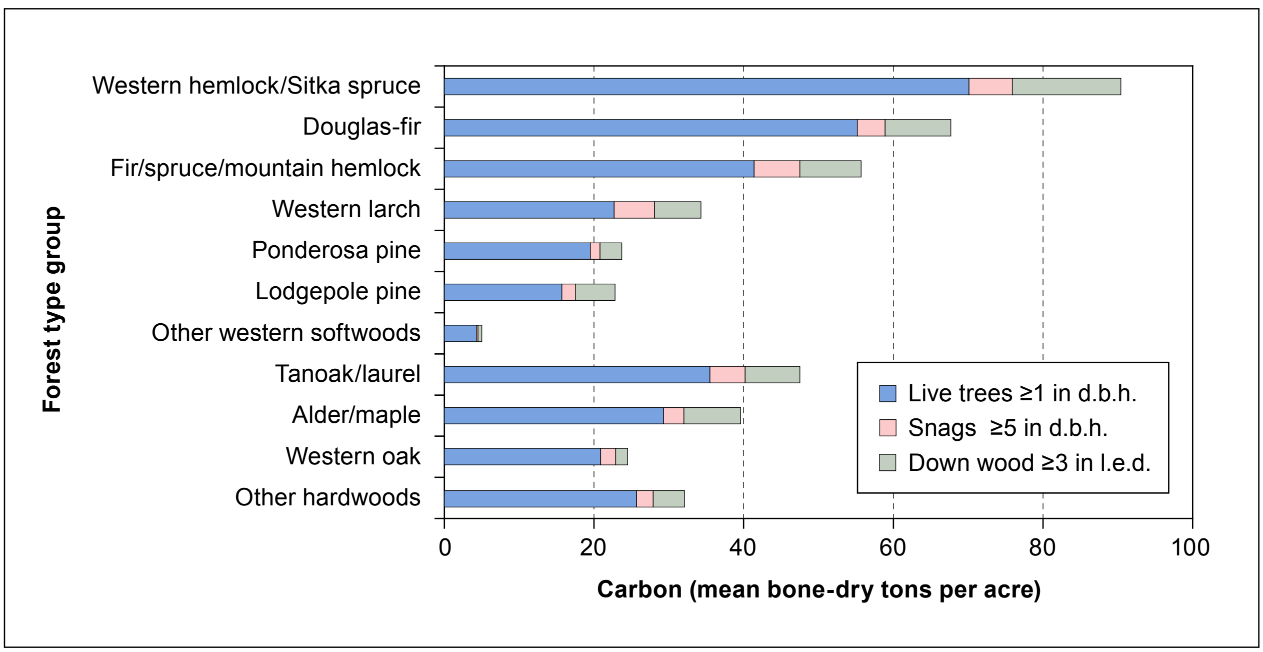

Figure 37—Mean carbon mass of live trees, snags, and down wood (coarse woody material) by forest type group on forest land in Oregon, 2001–2005; d.b.h. = diameter at breast height; l.e.d. = large end diameter.

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