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Oregon's Forest Products Industry and Timber Harvest 2013 With Trends Through 2014

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Cover: Top left to right: Micah Scudder tourimg a facility, circular saw blades, a lumber company. Bottom left to right: Log truck in Douglas County, Oregon; ship being loaded with logs, deck of export logs.

Abstract

Simmons, Eric A.; Scudder, Micah G.; Morgan, Todd A.; Berg, Erik C.; Christensen, Glenn A. 2016. Oregon's forest products industry and timber harvest 2013 with trends through 2014. Gen. Tech. Rep. PNW-GTR-942. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 58 p.

This report traces the flow of Oregon's 2013 timber harvest through the primary wood products industry and provides detailed description of the structure, timber use, operations, and condition of Oregon's forest products sector. It is the third in a series of reports that update the status of the industry every 5 years, and is based on a census of timber-using facilities conducted during 2014. Historical forest products industry changes are discussed, as well as trends in harvest, production, mill residue, and sales. Also examined are employment and worker earnings in the state's primary and secondary forest products industry.

Keywords: Wood products, timber harvest, log exports, timber receipts, log flow, timber-processing capacity, lumber overrun, mill residue, employment, forest economics, sawmills.

Report Highlights

- A total of 188 primary forest products facilities operated in Oregon during 2013 compared to 251 in 2008. These included:
  - 90 sawmills
  - 26 plywood/veneer facilities
  - 19 pulp/paper and board plants
  - 12 log home and 3 log furniture producers
  - 11 roundwood chipping facilities
  - 9 post, pole, piling, and utility pole plants
  - 14 other facilities including biomass, wood pellet, charcoal briquette, artisan wood products, landscape bark/mulch, and animal bedding producers
  - 4 export log concentrating or exporting yards
- Oregon's timber harvest was 4.2 billion board feet (BBF) Scribner in 2013, representing a 17.4 percent increase compared to 2008. Almost 90 percent (3.8 BBF Scribner) of the timber harvest came from counties west of the Cascade Range. Eighty percent of Oregon's 2013 timber harvest came from private lands, 12 percent from federal lands, nearly 7 percent from Oregon Department of Forestry lands, and the remaining harvest from other public sources.
- About 84 percent of the timber harvested in Oregon was processed in-state with nearly 16 percent (662 million board feet (MMBF)) exported internationally to countries in the Pacific Rim. Less than 1 percent (31 MMBF) was exported to surrounding states, while 206 MMBF was imported from neighboring states into Oregon, making Oregon a net exporter of 488 MMBF in 2013.
- Sawmills received 2.6 BBF (70 percent) of the timber processed in Oregon during 2013. Plywood/veneer plants received 713 MMBF. These two sectors combined accounted for nearly 90 percent of Oregon's 2013 timber receipts. Nine percent of the receipts were chipped, primarily for pulp/paper and board products, and the remaining timber was used for "other products."

- Oregon sawmills produced 5.2 BBF of lumber in 2013 with a sales value of nearly $2.3 billion compared to 4.7 BBF of lumber with a sales value of $1.6 billion in 2008. These mills produced an average of 2.12-board-feet lumber tally for every board foot Scribner of log input, the highest overrun for any census year.
- The capacity of Oregon's sawmills to process timber rose by nearly 8 percent from 3.9 BBF Scribner in 2008 to 4.2 BBF in 2013, despite the permanent closure of several facilities since 2008. Sawmill capacity utilization decreased from 62 percent in 2008 to 60 percent in 2013.
- Sales values in 2013 for primary wood products (including export logs) were $7.1 billion, a 9 percent increase from $6.5 billion in 2008 (all sales values comparisons to 2008 are in 2013 dollars). Sales of pulp/paper and board were still the largest portion of total sales (including mill residuals) at 37 percent, a decline from 51 percent of sales value in 2008. Lumber sales were 31 percent of the total in 2013, compared to 23 percent in 2008.
- Sales values from the "other sectors" increased from 2 percent of total sales in 2008 to over 6 percent in 2013. This increase was primarily because of increased international log exports.
- Oregon's primary facilities produced nearly 5.5 million bone-dry units of residue in 2013, with less than 1 percent unutilized. Pulp/paper and board plants received 60 percent of all mill residuals. Most of the remaining residuals were used as fuel.
- About 43,200 workers were employed in Oregon's forest industry during 2013, nearly 8 percent more than the 2011 low of 40,138. Total workers earnings have rebounded as well, increasing over 18 percent from $2.7 billion in 2011 to $3.2 billion in 2013.

In 2013, sawmills produced an average of 2.12-board-feet lumber tally for every board foot Scribner of log input, the highest overrun for any mill census year.

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Introduction

This report describes the utilization of Oregon's 2013 timber harvest and the conditions, structure, and operations of the state's primary forest products industry. Primary forest products manufacturers are firms that receive timber for processing into manufactured goods such as lumber or veneer, or for international export, and facilities such as biomass power or particleboard plants that use the wood fiber residue directly from harvest sites or other timber processors. Also described are recent and historical trends in the state's timber use, including raw material sources, inventory, growth, log exports, and harvest. Other areas covered in this report include the extent and efficiency of Oregon's processing infrastructure and the volume and value of primary products and residues.

Information presented in this report was generated through a statewide census of Oregon's manufacturers of primary forest products active in 2013. The census also includes data from firms in adjacent states utilizing raw material from Oregon during the 2013 calendar year. Although great effort is made to collect data from every primary facility that operated during a census year, facilities that were not surveyed may be added in a subsequent census. Wherever appropriate, data from previous reports have been updated to make comparisons with new results. Both "Eastside Scribner" (short log) and "Westside Scribner" (long log) rules are used for timber measurement in Oregon (Fonseca 2005). Log volumes are presented in this analysis as they were reported by the participating facilities; no distinction or standardization is made between the two Scribner log rules.

This report focuses on industry and harvest changes since the 2008 mill census with information through 2014 where available.

This report focuses primarily on changes since the 2008 census (Gale et al. 2012) with updated information through 2014 where available. Important relationships or trends prior to 2008 have been noted. For a more detailed discussion of historical trends in timber harvesting and processing in Oregon, see Gale et al. (2012) and Brandt et al. (2006), which summarize previous applications of the statewide industry census.

This report is a cooperative effort between The University of Montana's Bureau of Business and Economic Research (BBER) and the U.S. Department of Agriculture, Forest Service, Pacific Northwest (PNW) Research Station. The BBER, in cooperation with the Forest Inventory and Analysis (FIA) program at the PNW Research Station, has been studying the region's forest products industry since 1998. Work on this report was also sponsored in part by the Northwest Advanced Renewables Alliance supported by the Agriculture and Food Research Initiative Competitive Grant No. 2011-68005-30416 from the U.S. Department of Agriculture (USDA) National Institute of Food and Agriculture. In addition, the Oregon Department of Forestry, Oregon Forest Industries Council, and Wood Innovation

Center at Oregon State University provided assistance and information. This report represents BBER's third such study of Oregon's timber harvest and forest products industry since 2003.

Forest Industries Data Collection System

The Forest Industries Data Collection System (FIDACS) was developed by the BBER in cooperation with the FIA programs in the Rocky Mountain and PNW Research Stations to collect, compile, and report data from primary forest products manufacturers.

Primary forest products firms are identified through the use of various phone directories, industry associations, Internet searches, and through previous censuses. Questionnaires are distributed by mail, fax, or e-mail and are administered over the telephone or during onsite visits of timber-processing facilities. A single questionnaire is completed for each wood-processing facility and includes the following information:

- Plant production, capacity, and employment.
- Volume and size of raw material received, by county and ownership.
- Species mix and proportion of standing dead timber received (if applicable).
- Finished product volumes, types (including energy), sales value, and market locations.
- Utilization and marketing of manufacturing residue.

About 54 percent (102 of 188) of active primary timber products manufactures responded to the FIDACS survey, representing 75 percent of the timber processed in Oregon during 2013. Other information sources (Ehinger 2012, Elling 2015, Random Lengths 1976–2013, WWPA 1964–2015) along with prior survey data were used to estimate attributes for firms that did not participate in the 2013 survey. Additional information from federal, state, and private sources was used to verify estimates of the total timber harvest, lumber production, employment, and sales value of products.

Information collected through FIDACS is stored by the University of Montana's BBER. Because of the substantial detail on the industry and its timber use, there is a time lag between the date of the census and the publication of this report. To make this information available to the public at the earliest opportunity, summary tables and highlights are made available online as they are compiled and reviewed (http://www.bber.umt.edu/fir). Additional information is available by request. However, individual firm-level data are confidential and will not be released.

The Operating Environment of Oregon's Forest Products Industry

By the midpoint of the first decade of the 21st century, U.S. wood products demand and consumption had reached record levels; this then gave way to lows not seen since the Great Depression. The 2 million U.S. housing starts in 2005 (fig. 1) and record lumber consumption from 2003 to 2005 could not be sustained, and 2006 saw an increase in inventories of unsold homes, which was a precursor of the bursting of the U.S. housing bubble (Keegan et al. 2012, Woodall et al. 2012). United States housing starts declined further throughout 2007 leading to an official U.S. recession beginning in late 2007 and then, as home values fell, mortgage-backed securities rapidly lost value starting a global financial crisis in the last quarter of 2008. With the global financial crisis, came a near-total collapse in U.S. housing starts and wood products markets. New home starts dropped to 554,000 in 2009, the lowest level in the post-World War II period. Driven by the poor housing market, lumber consumption in the United States fell by more than 50 percent, and lumber prices dropped about 40 percent from 2005 to 2009.

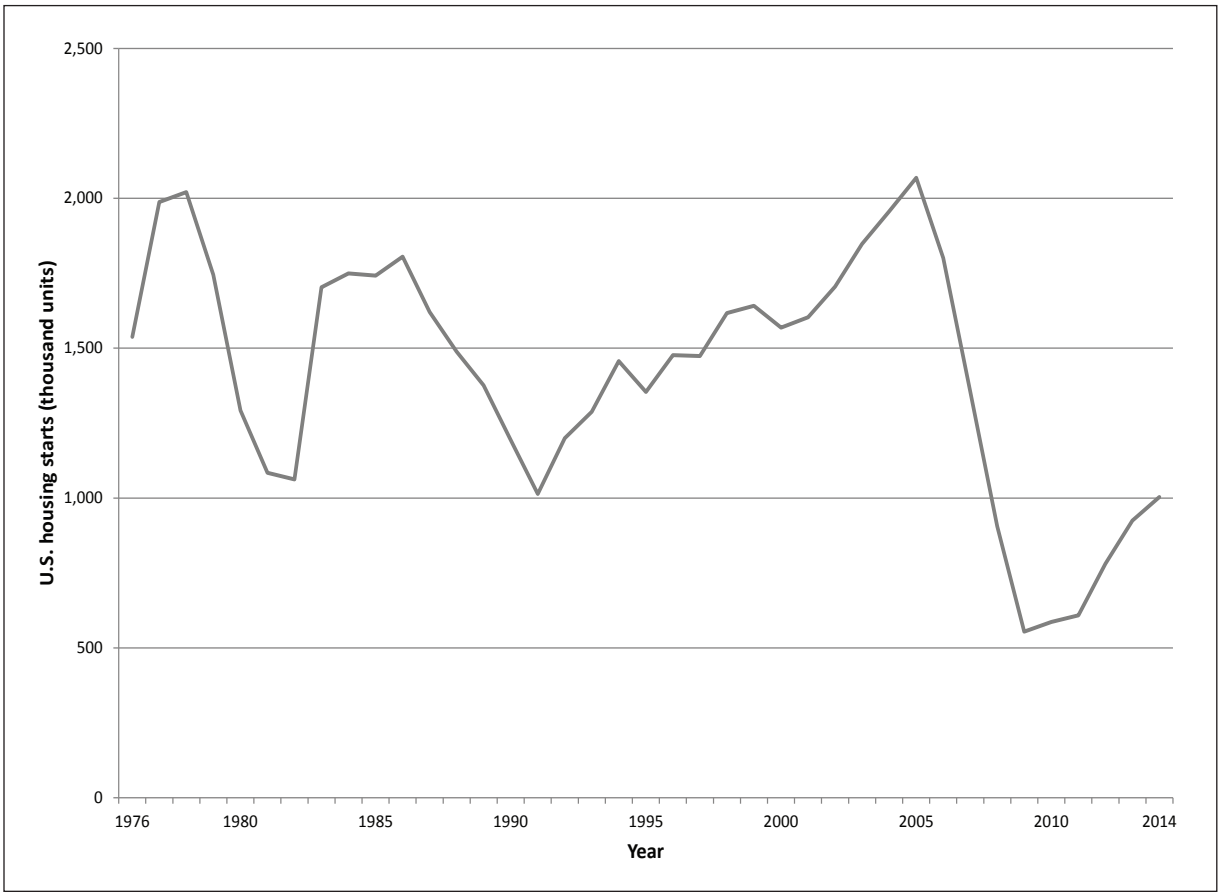

Figure 1—United States housing starts, 1976–2014. Source: USDC CB (2015b).

New U.S. home starts rose somewhat in 2010 and 2011, and lumber prices responded with only modest increases (Random Lengths Yardstick 2008–2014). Housing starts have continued trending slowly upwards but have been inconsistent, reaching 924,900 in 2013 and finally topping 1 million in 2014. Wood product prices are up substantially from the low points in 2009 but have not returned to prerecession highs and have shown considerable variation with increasing but erratic U.S. home starts, higher but inconsistent demand from China and other Asian users, and increased lumber shipments from Canada—driven in part by a strengthening U.S. dollar (Random Lengths Yardstick 2008–2014).

As documented throughout this report, the extreme market conditions and slow recovery substantially affected the structure and operations of Oregon's forest products industry. Timber harvest declined steeply and has been increasing, owing in part to recovering domestic markets and foreign demand for logs. Outputs and value of wood products declined in line with the magnitude of the housing market declines. Lumber production, the major wood product from Oregon's industry, dropped from over 7 billion board feet (BBF) in 2004 and 2005 to under 4 BBF in 2009 (WWPA 2015). The value of output of Oregon's primary forest products industry dropped from over $10.6 billion in 2004 to under $5 billion in 2009.

Although capacity utilization dropped from about 85 percent in the strong market years of 2004 and 2005 to barely 50 percent at the depth of the recession in 2009, utilization increased to 65 percent by 2013 and 2014.

Postrecession recovery in Oregon's industry has been ongoing, but not as fast as many have hoped. Oregon lumber production has increased to around 5.2 BBF, and sales value of products has risen to around $7.2 billion, but many measures of industry output remain well below prerecession levels. Oregon's milling capacity, measured by capacity to process timber, fell during the poor market years—from just over 5 BBF Scribner in 2006 to 4.3 BBF Scribner in 2011. However, primarily because of investments at existing mills, current capacity is slightly higher than prerecession levels. And although capacity utilization dropped from about 85 percent in the strong market years to barely 50 percent at the depth of the recession, utilization increased to 65 percent by 2013 and 2014. Given that normal utilization is more than 80 percent, there is considerable potential for Oregon's is forest industry to witness production increases as markets improve. With housing starts well below the long-term average of 1.5 million per year, future demand for Oregon forest products should be expected to rise from current levels.

Oregon's Timber Harvest, Products, and Flow

This section characterizes Oregon's 2013 timber harvest by land ownership, species, product type, geographic source, and flow to mills in Oregon and other states and countries. Several similar efforts analyzed Oregon's timber harvest in the past (Andrews and Kutara 2005; Brandt et al. 2006; Gale et al. 2012; Gebert et al. 2002; Howard 1984; Howard and Hiserote 1978; Howard and Ward 1988, 1991; Manock et al. 1970; Schuldt and Howard 1974; Ward 1995, 1997; Ward et al. 2000). These sources were used for historical comparisons for this 2013 report. Figure 2 shows a 165-year history of timber harvests in Oregon.

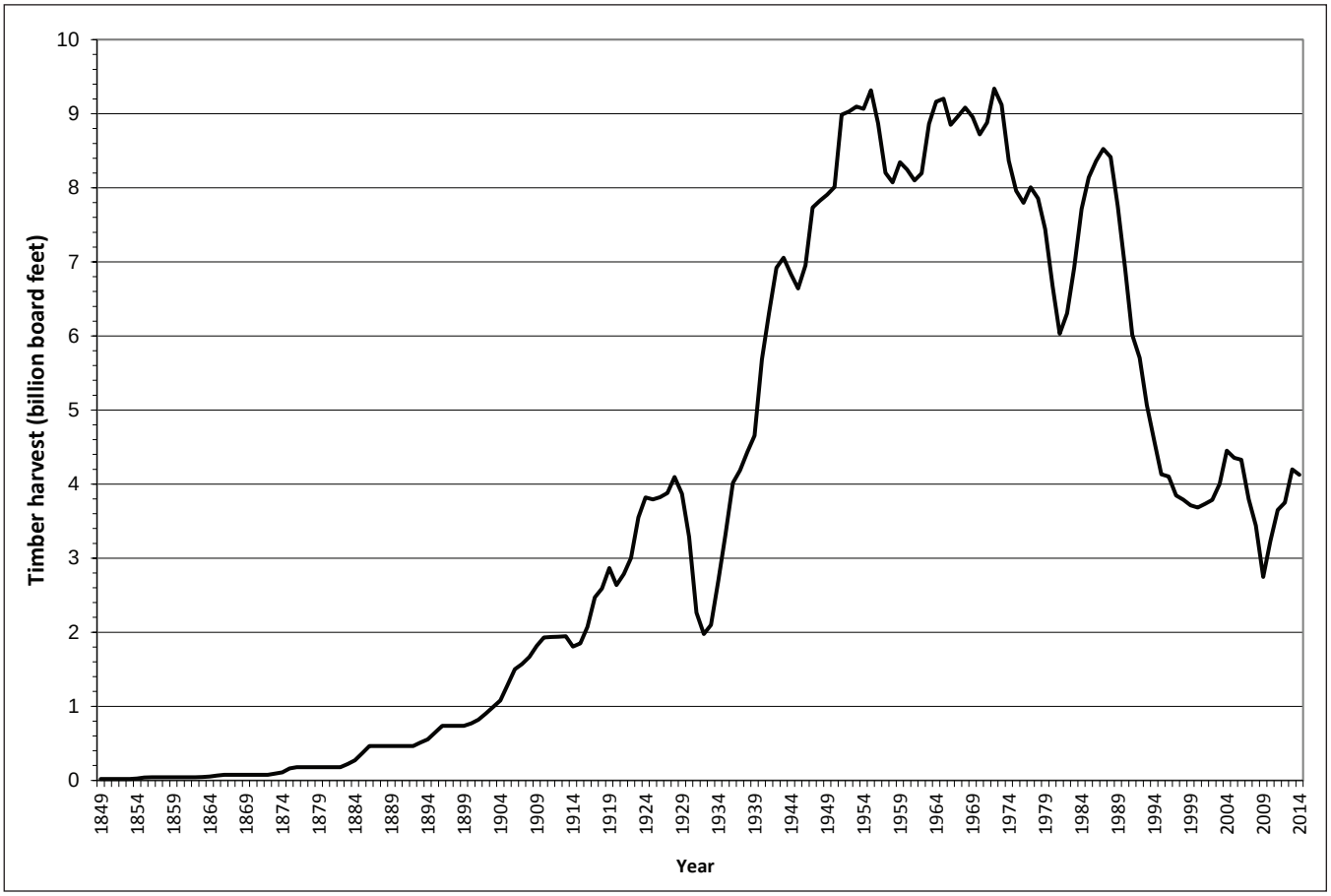

Figure 2—Oregon timber harvest, 1849–2014. Source: Andrews and Kutara 2005, Oregon Department of Forestry 2015.

Oregon Timberlands and Harvest by Ownership

Oregon has about 63 million acres of land area, of which 29.7 million acres are classified as forest land.[1] Of this, about 23.7 million acres (80 percent) are classified as timberland[2] (table 1). Approximately 11.1 million acres (47 percent) of the nonreserved timberland[3] in Oregon is national forest. Private owners (e.g., forest industry, nonindustrial private, and tribal) account for nearly 9.4 million acres (40 percent). The Bureau of Land Management (BLM) has 2.2 million acres (9 percent), and the state and other public owners account for the remaining 0.96 million acres (4 percent).

The 2013 nonindustrial private and tribal timber harvest grew by 168 percent from 2008. This large increase reflects increased domestic homebuilding and increased log demand from the Pacific Rim countries, predominantly China.

Total standing[4] volume on Oregon's nonreserved timberland is approximately 386,119 million board feet (MMBF) Scribner log rule, including only softwood trees greater than 9 inches diameter at breast height (d.b.h.[5]) and hardwood trees greater than 11 inches d.b.h. National forests contain the majority, 213,685 MMBF (55 percent) of the volume, while private lands account for 86,843 MMBF (22 percent); 65.7 MMBF (17 percent) is on BLM and other public lands, and the remaining 19.9 MMBF (5 percent) is on state timberlands (table 2). Total timber harvest during 2013 was 4,246 MMBF and declined slightly in 2014 to 4,126 MMBF.

The majority (64.6 percent) of the timber harvested in Oregon in 2013 came from industrial timberlands; nonindustrial private forest (NIPF) and tribal timberlands provided 15.4 percent, national forests 9.0 percent, state lands 6.6 percent, and BLM and other public sources provided the remaining 4.3 percent. The 2013 NIPF and tribal timber harvest grew by 168 percent from 2008. This large increase reflects increased domestic homebuilding and increased log demand from the Pacific Rim countries, predominantly China. Timber harvest on national forest and BLM lands also experienced increases from 2008, with a growth of 58 percent and 16 percent, respectively.

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[1] 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 FS 2006).

[2] Forest land that is producing or capable of producing >20 ft^3 per acre (1.4 m^3 per hectare) per year of wood at culmination of mean annual increment. Timberland excludes reserved forest lands (USDA FS 2006).

[3] Land that has not been permanently reserved from wood products use through statute or administrative designation. Examples of reserved timberland include national forest wilderness areas and national parks and monuments (USDA FS 2006).

[4] Standing volume was calculated for all nonreserved timberland. Total aboveground stem volume net of cull was calculated on a cubic-foot basis for all trees larger than 5-inches diameter at breast height (d.b.h.). Scribner board-foot volume, net of cull, was calculated for all trees larger than 9 inches d.b.h.

[5] Diameter of a tree stem, located at 4.5 ft (1.37 meters) above the ground (breast height) on the uphill side of a tree. The point of diameter measurement may vary on abnormally formed trees (USDA FS 2006).

Table 1—Oregon timberland[a] by ownership class, 2004–2013

Ownership class	Acres[b]	Percentage of nonreserved[c] timberland
National forest	11,086	46.9
Industrial	6,050	25.6
Nonindustrial private and tribal[d]	3,336	14.1
Bureau of Land Management	2,225	9.4
State	817	3.5
Other public	145	0.6
All owners	23,659	100.0

[a] Timberland is forest land that is producing or capable of producing more than 20 cubic feet of wood per acre per year at culmination of mean annual increment and excludes reserved lands (Helms 1998).
[b] Acres: thousands of acres (23,659 = 23.7 million acres).
[c] Forest land 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.
[d] Nonindustrial private and tribal also includes nongovernment organizations and unincorporated local partnership/association/clubs.
Source: PNW-FIADB 2004–2013.

Table 2—Oregon timber harvest and standing volume by ownership, 2013

	Harvest		Standing[a]	
Ownership	Volume	Percentage of total	Volume	Percentage of total
	MMBF[b]	*Percent*	*MMBF*[a]	*Percent*
Industrial	2,745.2	64.6	53,312.7	13.8
Nonindustrial private and tribal[c]	656.0	15.4	33,530.7	8.7
National forest	380.1	9.0	213,685.0	55.3
State	281.7	6.6	19,854.2	5.1
Bureau of Land Management	136.1	3.2	64,096.3	16.6
Other public	47.6	1.1	1,640.4	0.4
Total	4,246.7	100.0	386,119.3	100.0

[a] Represents sawlog portion of growing-stock trees with diameter at breast height ≥ 9 inches on nonreserved timberland. Source: PNW-FIADB 2004–2013.
[b] MMBF = million board feet Scribner.
[c] Nonindustrial private and tribal also includes nongovernment organizations and unincorporated local partnership/association/clubs.

Harvest in 2014 followed a similar trend. In 2014, over 78 percent of the harvest came from private and tribal lands, federal lands supplied about 9 percent, and state lands about 6 percent. The proportion of harvest supplied by private and federal lands has remained relatively consistent since the large drop in federal harvest during the 1990s. State lands have become a more substantial contributor to Oregon's harvest in recent years, accounting for 6 to 9 percent of the harvest since 2000 (fig. 3). Historically, timber harvests on national forest lands provided a majority share of the total harvest volume in Oregon. This trend was altered in the late 1980s resulting in the majority of Oregon timber harvests occurring on private lands (fig. 4).

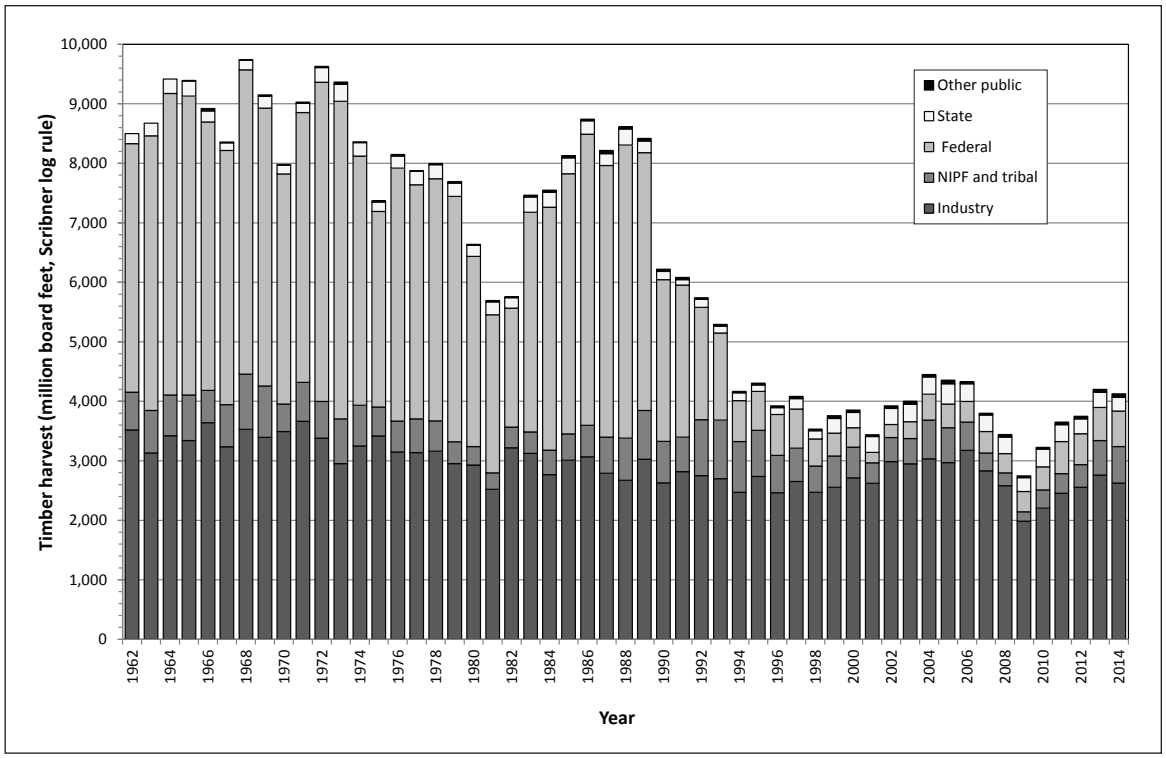

Figure 3—Oregon's timber harvest by ownership, 1962–2014. Source: ODF 2015.
NIPF = nonindustrial private forest.

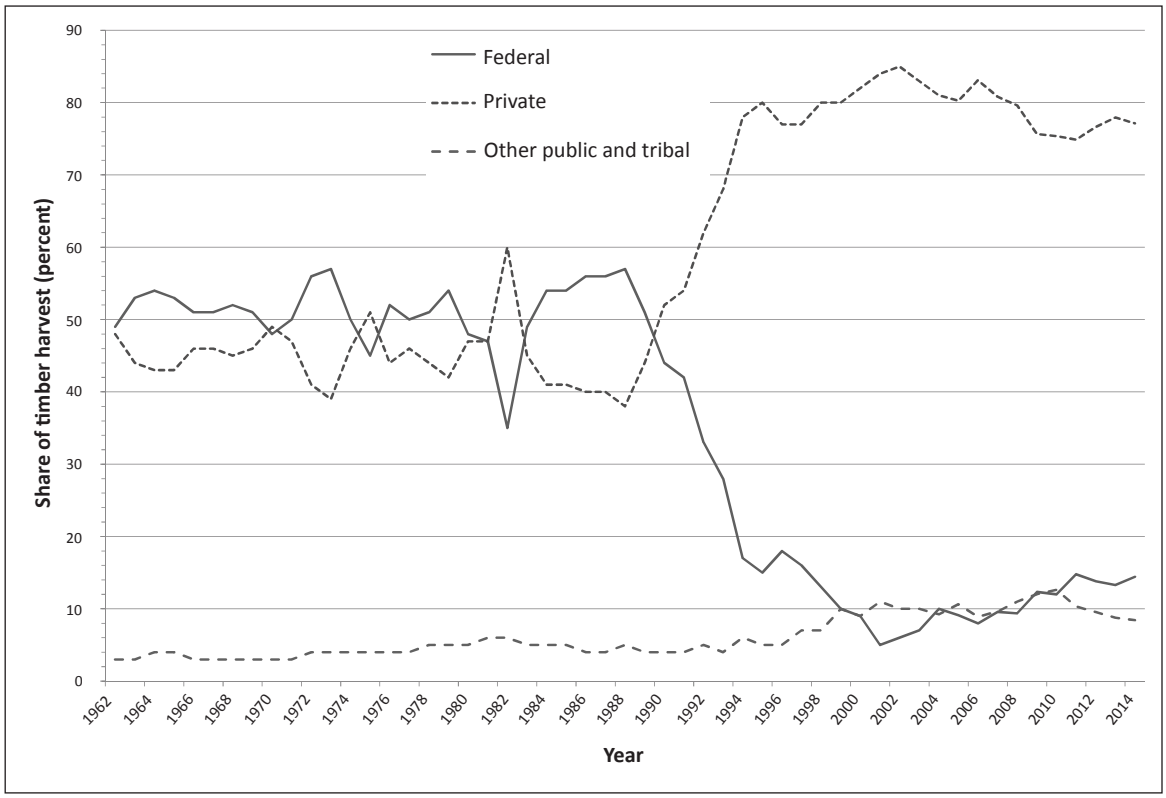

Figure 4—Changing shares of Oregon timber harvest, 1962–2014. Source: Andrews and Kutara 2005, ODF 2015.

Harvest by Species

Softwoods accounted for 96.5 percent of Oregon's 2013 harvest; hardwoods made up the remaining 3.5 percent (table 3). Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) was the leading species harvested, accounting for 69.5 percent of total harvest. Western hemlock (*Tsuga heterophylla* (Raf.) Sarg.) followed with 11.2 percent, and the remaining other softwoods accounted for 15.7 percent. Red alder (*Alnus rubra* Bong.) represented 1.9 percent of the total timber harvest, and other hardwoods represented 1.6 percent. Douglas-fir was the leading species harvested on each ownership followed by western hemlock and true firs, except on national forests where pines (*Pinus*) were the second-most harvested species group by volume (table 4).

The decline in pine harvest corresponds to declines in federal lands harvest, particularly in eastern and central Oregon, as well as reduced standing volumes of large pine trees on private lands as a result of past harvesting.

Table 3—Oregon timber harvest and standing volume by species, 2013

	Harvest		Standing[a]	
Species	**Volume**	**Percentage of total**	**Volume**	**Percentage of total**
	MMBF[b]	*Percent*	*MMBF*[a]	*Percent*
Douglas-fir	2,953.4	69.5	224,214.6	58.1
Hemlock	476.9	11.2	29,488.7	7.6
True firs	340.2	8.0	39,501.7	10.2
Pines	205.9	4.8	49,524.5	12.8
Cedar	63.7	1.5	9,450.8	2.4
Spruce	49.1	1.2	6,292.9	1.6
Other softwoods	8.3	0.2	8,136.2	2.1
All softwoods	4,097.5	96.5	366,609.5	94.9
Red alder	82.3	1.9	10,773.0	2.8
Other hardwoods[c]	66.9	1.6	8,736.9	2.3
All hardwoods	149.2	3.5	19,509.9	5.1
All species	4,246.7	100	386,119.3	100

[a] Represents sawlog portion of growing-stock trees with diameter at breast height ≥ 9 inches on nonreserved timberland (PNW-FIADB 2004–2013).
[b] MMBF = million board feet Scribner.
[c] Other hardwoods include cottonwood/poplar, bigleaf maple, tanoak, Pacific madrone, and others.

Table 4—Oregon timber harvest by species and ownership, 2013

Species	Industry	Nonindustrial private and tribal	National forest	State	Bureau of Land Management	Other public	Total
Softwoods:			*Million board feet, Scribner*				
Douglas-fir	1,959.3	436.2	245.9	179.7	96.6	35.8	2,953.4
Hemlock	330.3	64.3	23.0	43.0	12.0	4.5	476.9
True firs	183.3	64.7	39.4	39.1	11.5	2.2	340.2
Pines	75.5	62.2	62.4	3.7	1.8	0.3	205.9
Cedar	37.7	5.7	4.6	11.6	0	4.0	63.7
Spruce	36.8	9.9	0.5	1.3	0.1	0.5	49.1
Other softwoods	1.2	5.6	1.0	0	0.1	0.3	8.3
All softwoods	2,624.0	648.7	376.8	278.4	122.0	47.6	4,097.5
Hardwoods:							
Red alder	60.2	5.7	2.2	2.2	11.9	0	82.3
Other hardwoods	60.9	1.6	1.2	1.1	2.1	0	66.9
All hardwoods	121.2	7.3	3.3	3.3	14.1	0	149.2
All species	2,745.2	656.0	380.1	281.7	136.1	47.6	4,246.7
Softwoods:			*Percent by ownership*				
Douglas-fir	71.4	66.5	64.7	63.8	71.0	75.2	69.5
Hemlock	12.0	9.8	6.0	15.3	8.8	9.4	11.2
True firs	6.7	9.9	10.4	13.9	8.5	4.6	8.0
Pines	2.7	9.5	16.4	1.3	1.3	0.7	4.8
Cedar	1.4	0.9	1.2	4.1	0	8.5	1.5
Spruce	1.3	1.5	0.1	0.5	0.1	1.1	1.2
Other softwoods	0	0.9	0.3	0	0.1	0.6	0.2
	0	0	0	0	0	0	
All softwoods	95.6	98.9	99.1	98.8	89.7	100.0	96.5
Hardwoods:	0	0	0	0	0	0	
Red alder	2.2	0.9	0.6	0.8	8.8	0	1.9
Other hardwoods	2.2	0.2	0.3	0.4	1.6	0	1.6
All hardwoods	4.4	1.1	0.9	1.2	10.3	0	3.5
	0	0	0	0	0	0	
All species	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Harvest proportions of most species have remained fairly consistent through time (table 5). Historically, Douglas-fir has been the leading species harvested, accounting for 60 to 70 percent of annual harvest volume. The most notable exception is pines, which have declined as a proportion of total harvest. The proportionate decline in pine harvest corresponds to declines in federal lands harvest levels, particularly in eastern and central Oregon, as well as reduced standing volumes of large pine trees on private lands as a result of past harvesting.

Table 5—Proportion of Oregon timber harvest by species in various years

Species	1968	1972	1982	1992	2003	2008	2013
	Percentage of timber harvest						
Softwoods:							
Douglas-fir	65.1	61.1	59.2	61.2	65.6	70.5	69.5
Hemlock	10.6	13.4	11.5	9.9	8.8	12.8	11.2
True firs	5.9	5.1	5.2	8.9	8.9	5.1	8.0
Pines	13.6	14.5	17.7	14.0	6.6	4.1	4.8
Cedar	2.2	2.0	2.1	1.5	2.0	1.5	1.5
Spruce	1.1	1.2	1.3	1.8	2.2	2.0	1.2
Other softwoods	0.1	0.7	2.0	2.2	0.8	0.4	0.2
All softwoods	98.6	98.0	99.0	99.5	94.9	96.4	96.5
Hardwoods:							
Red alder	0.7	[a]	0.6	0.7	3.8	2.9	1.9
Other hardwoods	0.1	0.7	0.2	0.8	1.4	0.7	1.6
All hardwoods	0.8	0.7	0.8	1.5	5.2	3.6	3.5
All species	100	100	100	100	100	100	100

[a] Species not listed for given year.
Sources: Brandt et al. 2006, Gale et al. 2012, Howard 1984, Manock et al. 1970, Schuldt and Howard 1974, Ward 1995.

Harvest by Product

Four general categories of timber products are referred to throughout this report: sawlogs—timber sawn to produce lumber; veneer logs—timber peeled or sliced to make veneer for plywood or laminated veneer lumber; pulpwood/chipped logs—timber chipped or ground to use in pulp manufacturing or as fuel; and other timber products—timber used to manufacture posts, small poles, utility poles, pilings, energy products, log homes, and log furniture.

Sawlogs accounted for 75.3 percent of Oregon's timber harvest, and veneer logs accounted for 14.8 percent in 2013 (table 6). Chipped logs made up about 9 percent, and other timber products accounted for the remaining 0.9 percent. This distribution of timber harvest by product type was similar to findings from the 2008 Oregon mill census (Gale et al. 2012), with a slight decline in plywood/veneer allocation and an increase in pulp/chipped logs. This decline in the plywood/veneer timber harvest allocation is a trend that has been occurring since 1968 (table 7). The cause of this decline is discussed in Brandt et al. (2006) and Gale et al. (2012). The apparent growth in chipped logs represents nearly a doubling in volume compared to 2008. This increase likely resulted from the addition of roundwood chipping facilities that were not identified previously but were operating during 2008.

Table 6—Oregon timber harvest by product type, 2013

Product	Volume	Percentage of total
	Million board feet, Scribner	*Percent*
Sawlog[a]	3,197.7	75.3
Plywood/veneer	627.5	14.8
Pulp/chipped logs[b]	383.7	9.0
Other timber products[c]	37.8	0.9
Total	4,246.7	100.0

[a] Sawlogs include export logs.
[b] Chipped logs are primarily roundwood pulpwood and also include industrial fuelwood.
[c] Other timber products includes posts, small poles, pilings, utility poles, log homes, firewood, and log furniture.

Table 7—Proportion of Oregon timber harvest by product in various years

Product	1968	1972	1982	1992	2003[a]	2008[a]	2013[a]
	Percentage of consumption						
Sawlogs[b]	61.1	58.9	57.2	67.3	72.9	76.7	75.3
Veneer	37.3	35.0	34.1	24.7	21.3	17.1	14.8
Pulp/chipped logs	[c]	[c]	[c]	[c]	4.4	5.4	9.0
Other timber products[b d]	1.6	6.2	8.6	8.0	1.5	0.8	0.9
All products	100.0	100.0	100.0	100.0	100.0	100.0	100.0

[a] Displayed as harvest for specified years, as receipts for other years.
[b] Log export included in "Other timber products" for 1972, 1982, 1992, and in sawlogs for 2003, 2008, and 2013.
[c] Pulp and board included in "Other" for specified years.
[d] Other timber products include firewood, log furniture, log homes, posts, poles, pilings, and utility poles.
Sources: Brandt et al. 2006, Gale et al. 2012, Howard 1984, Manock et al. 1970, Schuldt and Howard 1974, Ward 1995.

During 2013, sawlogs were, by volume harvested, the leading product utilized from each ownership class followed by veneer logs and chipped logs (table 8). The vast majority of chipped log volume (78.6 percent) came from industrial lands, with just 16.8 percent from nonindustrial and tribal lands, and less than 5 percent from other ownerships combined.

Douglas-fir was the species most harvested for sawlogs (71.3 percent), veneer logs (71.9 percent), pulpwood/chipped logs (51.7 percent), and other timber products (64.3 percent) (table 9). Hemlock represented the second highest proportion of chipped logs (20.8 percent), and cedar represented the second highest proportion of other timber products (27.7 percent). Unlike softwoods, where chipped logs accounted for about 8 percent of softwood harvest, about one-third of hardwood volume was chipped.

Table 8—Oregon timber harvest by ownership class and product type, 2013

Ownership class	Sawlogs[a]	Veneer logs	Chipped logs[b]	Other timber products[c]	All products
			Million board feet, Scribner		
Industrial	2,092.1	324.3	301.7	27.1	2,745.2
Nonindustrial private and tribal	452.2	131.1	64.3	8.4	656.0
National forest	285.9	81.0	10.9	2.4	380.1
State	229.2	52.5	0	0	281.7
Bureau of Land Management	101.0	28.3	6.8	0	136.1
Other public	37.5	10.2	0	0	47.6
All owners	3,197.7	627.5	383.7	37.8	4,246.7
			Percent by product		
Industrial	65.4	51.7	78.6	71.6	64.6
Nonindustrial private and tribal	14.1	20.9	16.8	22.2	15.4
National forest	8.9	12.9	2.8	6.2	9.0
State	7.2	8.4	0	0	6.6
Bureau of Land Management	3.2	4.5	1.8	0	3.2
Other public	1.2	1.6	0	0	1.1
All owners	100.0	100.0	100.0	100.0	100.0

[a] Export logs are included in sawlogs.
[b] Chipped logs are primarily roundwood pulpwood and also include industrial fuelwood.
[c] Other timber products include logs for posts, small poles, pilings, utility poles, log homes, firewood, and log furniture.

Harvest by Geographic Resource Area

Oregon has traditionally been divided into two major wood-producing regions. The Western Region, or Westside, contains all counties lying west of the crest of the Cascade Range; the Eastern Region, or Eastside, consists of all the remaining counties (Manock et al. 1970). This report expands this typology by splitting these two regions into four resource areas: the Northwest and Southwest Resource Areas in the Western Region and the Central and Blue Mountains Resource Areas in the Eastern Region (fig. 5).

The Western Region supplied almost 90 percent of Oregon's 2013 total timber harvest; with a relatively even split between the Northwest (47 percent) and Southwest (43 percent) Resource Areas. However, the Southwest Resource Area contained the greatest volume of standing timber (table 10). The Eastern Region supplied the remaining 10 percent.

The Western Region supplied almost 90 percent of Oregon's 2013 total timber harvest, with a relatively even split between the Northwest (47 percent) and Southwest (43 percent) Resource Areas.

Since the early 1990s, timber harvests have declined in both the Western and Eastern Regions (Andrews and Kutara 2005). Oregon's Eastern Region has experienced the largest decline in harvests during this time, which is primarily attributed to a decline in harvests on federal lands (fig. 6). Although federal timber harvests have also declined west of the Cascades, harvesting from private and state-owned west-side lands have partially offset the impact of reduced federal timber supply.

Table 9—Oregon timber harvest by species and product type, 2013

Species	Sawlogs[a]	Veneer logs	Chipped logs[b]	Other timber products[c]	All products
Softwoods:			*Million board feet, Scribner*		
Douglas-fir	2,279.1	451.4	198.6	24.3	2,953.4
Hemlock	355.2	42.0	79.8	0	476.9
True firs	228.7	93.5	17.7	0.4	340.2
Pines	163.9	23.3	17.0	1.7	205.9
Cedar	51.0	0	2.1	10.5	63.7
Spruce	22.6	7.2	19.2	0.1	49.1
Other softwoods	2.6	4.6	0.4	0.7	8.3
All softwoods	3,103.2	622.0	334.7	37.7	4,097.5
Hardwoods:					
Red alder	63.4	5.5	13.3	0	82.3
Other hardwoods	31.1	0	35.7	0.1	66.9
All hardwoods	94.5	5.5	49.0	0.2	149.2
All species	3,197.7	627.5	383.7	37.8	4,246.7
Softwoods:			*Percent by product*		
Douglas-fir	71.3	71.9	51.7	64.3	69.5
Hemlock	11.1	6.7	20.8	0	11.2
True firs	7.2	14.9	4.6	1.0	8.0
Pines	5.1	3.7	4.4	4.4	4.8
Cedar	1.6	0	0.6	27.7	1.5
Spruce	0.7	1.1	5.0	0.3	1.2
Other softwoods	0.1	0.7	0.1	1.9	0.2
	0	0	0	0	
All softwoods	97.0	99.1	87.2	99.5	96.5
Hardwoods:	0	0	0	0	
Red alder	2.0	0.9	3.5	0.1	1.9
Other hardwoods	1.0	0	9.3	0.3	1.6
All hardwoods	3.0	0.9	12.8	0.5	3.5
All species	100.0	100.0	100.0	100.0	100.0

[a] Export logs are included in sawlogs.

[b] Chipped logs are primarily roundwood pulpwood and also include industrial fuelwood.

[c] Other timber products include logs for posts, small poles, pilings, utility poles, log homes, firewood, and log furniture.

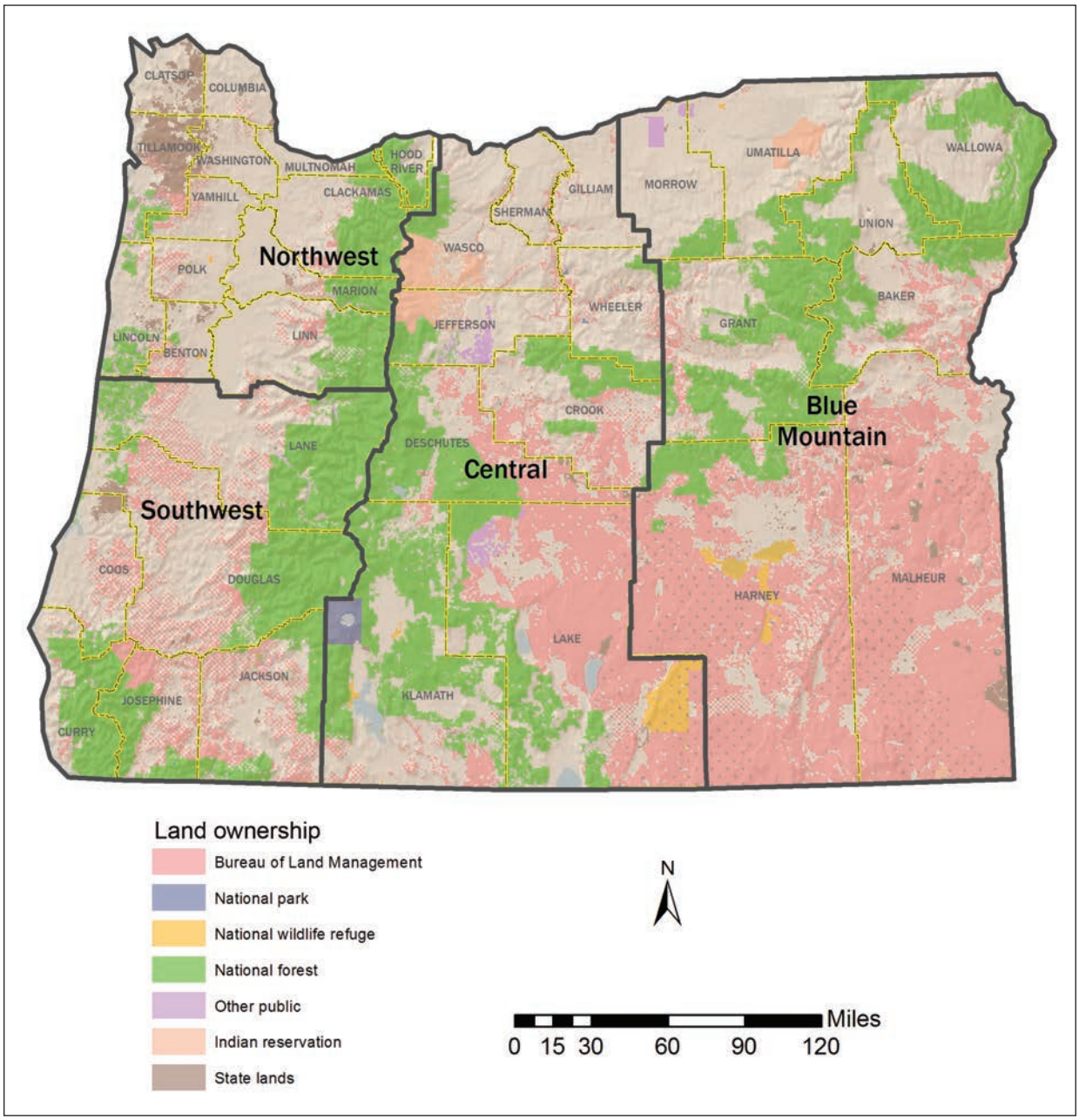

Figure 5—Resource areas and land ownership.

Table 10—Oregon timber harvest and standing volume by resource area, 2013

Resource area	Harvest		Standing volume[a]	
	MMBF[b]	*Percent*	*MMBF*[b]	*Percent*
Northwest	1,986.1	46.8	108,174.3	28.0
Southwest	1,820.9	42.9	190,670.0	49.4
Central	246.3	5.8	49,198.7	12.7
Blue Mountains	193.4	4.6	38,076.3	9.9
State total	4,246.7	100.0	386,119.3	100.0

[a] Represents sawlog portion of growing-stock trees with diameter at breast height ≥ 9 inches on nonreserved timberland (PNW-FIADB 2004–2013).
[b] MMBF = million board feet Scribner.

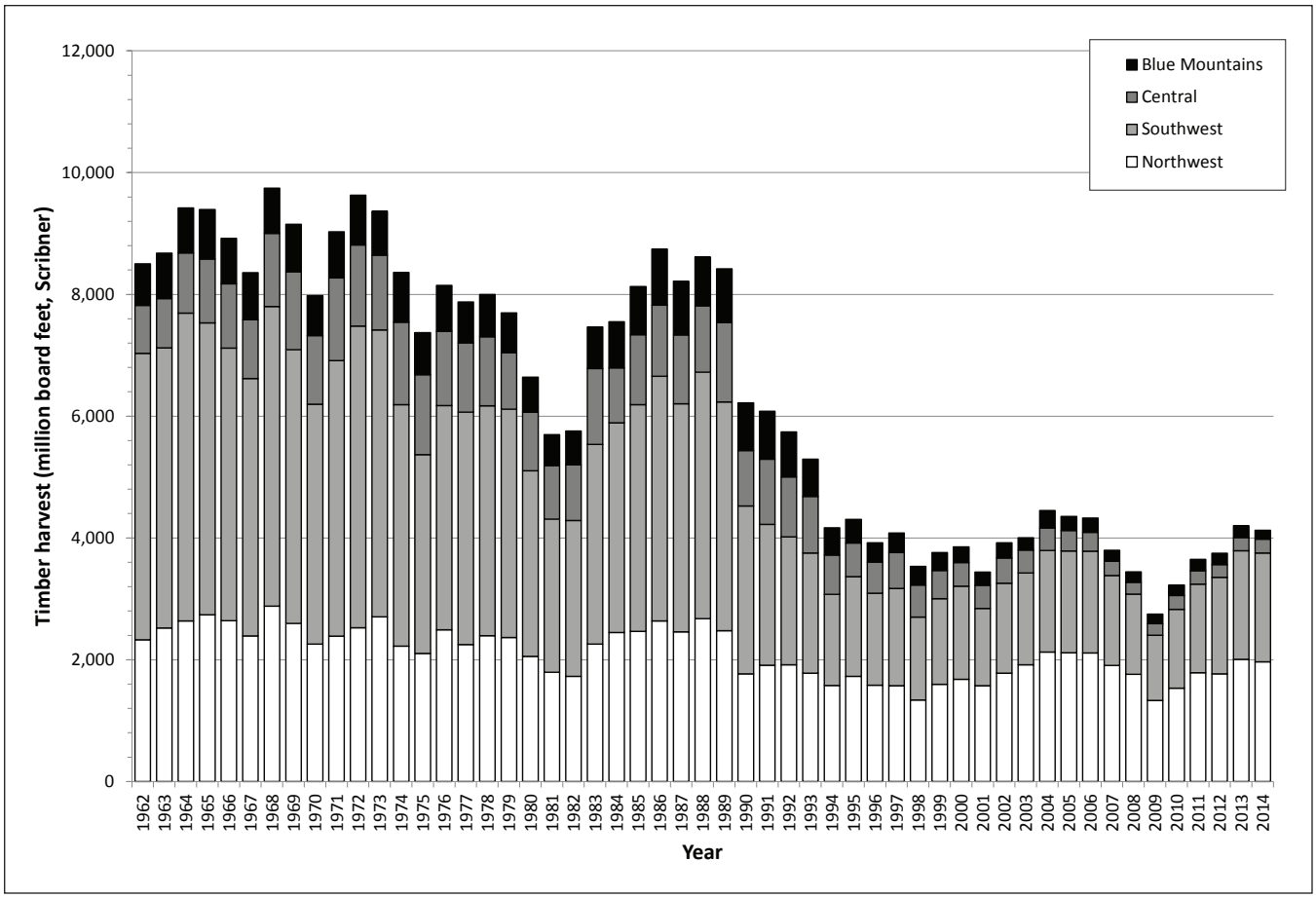

Figure 6—Oregon's timber harvest by resource area, 1962–2014. Source: ODF 2015.

In eastern Oregon, there is relatively little privately held forest land to make up for reduced federal harvest with approximately 70 percent of all forestland existing under federal ownership (Donnegan et al. 2008).

In 2013, Lane and Douglas Counties, both in the Southwest Resource Area, led the state with harvests of 646.5 and 581.2 MMBF, respectively (table 11). The second two leading harvest counties were in the Northwest Resource Area: Linn and Clatsop Counties, with harvests of 286.7 and 284.6 MMBF, respectively. Within the Eastern Region, the proportion of harvest by resource area has been fairly consistent over time, with the Central Resource Area providing slightly more timber than the Blue Mountains Resource Area. Klamath County led the Eastern Region's timber harvest at 126.9 MMBF during 2013.

Timber Flow

Oregon timber processors received more than 3.7 BBF Scribner of timber during 2013. Approximately 94.5 percent of that volume was harvested from Oregon

Table 11—Oregon timber harvest by resource area and county, 2013

Resource area	Harvest volume	Percentage of total
	MMBF[a]	*Percent*
Northwest:		
Benton	136.9	3.2
Clackamas	185.6	4.4
Clatsop	284.6	6.7
Columbia	160.7	3.8
Hood River	44.1	1.0
Lincoln	148.1	3.5
Linn	286.7	6.8
Marion	88.0	2.1
Multnomah	12.2	0.3
Polk	162.4	3.8
Tillamook	165.2	3.9
Washington	201.5	4.7
Yamhill	110.4	2.6
Total Northwest	1,986.1	46.8
Southwest:		
Coos	324.9	7.6
Curry	85.9	2.0
Douglas	581.2	13.7
Jackson	129.6	3.1
Josephine	52.8	1.2
Lane	646.5	15.2
Total Southwest	1,820.9	42.9
Central:		
Crook	4.3	0.1
Deschutes	23.3	0.5
Jefferson	31.4	0.7
Klamath	126.9	3.0
Lake	12.8	0.3
Wasco	47.0	1.1
Wheeler	0.6	0
Total Central	246.3	5.8
Blue Mountains:		
Baker	13.9	0.3
Grant	8.8	0.2
Harney	8.2	0.2
Malheur	0	<.1
Morrow	52.7	1.2
Umatilla	50.3	1.2
Union	29.7	0.7
Wallowa	29.9	0.7
Total Blue Mountains	193.4	4.6
State total[b]	4,246.7	100.0

[a] MMBF = million board feet Scribner.
[b] Columns may not sum to 100 because of rounding.

The majority of Oregon timber was processed in the resource area where it was harvested (table 13). About one-quarter of the harvest in the Northwest Resource Area and 8 percent of the Southwest Resource Area harvest were exported to California, Idaho, Washington, and internationally.

timberlands, consistent with the long-term dominance of in-state sources (table 12). Timber received from sources outside of Oregon totaled 206 MMBF, which represented 5.5 percent of the total volume processed in 2013. The considerable decline in log volume received from Washington can likely be attributed to demand from international log exporters in that state. Like Oregon, Washington exported considerably more timber in 2013 than in 2008, about 60 percent more (Washington Department of Natural Resources 2015). Timber exported to California, Idaho, Washington, and internationally totaled 693.5 MMBF (16.3 percent of harvest).

The majority of Oregon timber was processed in the resource area where it was harvested (table 13). About one-quarter of the harvest in the Northwest Resource Area and 8 percent of the Southwest Resource Area harvest were exported to California, Idaho, Washington, and internationally.

Mills in each resource area received between 82 percent (Southwest) and 92 percent (Northwest) of their timber from within their own resource area. Mills in the Southwest Resource Area received the largest share (41 percent) of out-of-state timber volume, followed by the Blue Mountains (31 percent) and the Central Resource Area (21 percent).

During 2013, Oregon was a net exporter of timber to other states or countries (table 14). Over 99 percent of the 693.5 MMBF of timber flowing out of Oregon was sawlogs. Also, sawlogs were the leading timber product brought into Oregon. However, veneer logs accounted for about one-third (82.5 MMBF) of log imports into Oregon.

Oregon Log Exports: Past and Current Trends

The recent surge in exports of PNW logs has created a large amount of interest among state governments, land managers, and forest product manufacturers. These

Table 12—Log flows to timber processors in Oregon by state of origin in various years

State of origin	1968[a]	1972	1976	1982	1985	1988	1992	1994	1998	2003	2008	2013
	Million board feet, Scribner											
Oregon	9,169	9,892	8,923	5,703	7,756	8,201	3,674	3,203	3,752	3,905	3,200	3,553
Washington	268	458	284	130	224	272	183	289	515	261	222	83
California	152	82	131	127	281	308	155	203	151	67	47	72
Idaho	[a]	1	1	0	11	16	17	47	18	58	42	49
Other[b]	5	0	1	0	0	1	4	33	64	8	10	2
Total	9,595	10,434	9,339	5,961	8,272	8,798	4,033	3,775	4,500	4,299	3,522	3,759

[a] For 1968, Idaho is combined with "Other."
[b] Other contains log flows from states and countries not listed.
Sources: Brandt et al. 2006; Gale et al. 2012; Howard 1984; Howard and Hiserote 1978; Howard and Ward 1988, 1991; Manock et al. 1970; Schuldt and Howard 1974; Ward 1995, 1997; Ward et al. 2000.

Table 13—Oregon timber flow by resource area, 2013

	Geographic source of timber						
Resource area[a]	Northwest	Southwest	Central	Blue Mountains	Total Oregon timber	Out-of-state timber[b]	Total timber received in Oregon
	Million board feet, Scribner						
Destination:							
Northwest	1,155.0	96.1	0.3	0	1,251.4	13.7	1,265.1
Southwest	294.8	1,554.2	47.5	7.7	1,904.2	84.3	1,988.5
Central	3.5	8.4	164.9	1.2	178.0	44.0	222.0
Blue Mountains	5.6	0.0	33.2	180.8	219.6	63.8	283.3
California, Idaho, Washington, and international exports	527.2	162.2	0.5	3.6	3,553.2	205.8	3,758.9
Total Oregon timber harvest by resource area	1,986.1	1,820.9	246.3	193.4	4,246.7		

[a] See table 11 for counties in each resource area.
[b] Imports from California, Colorado, Idaho, Montana, Washington, and international sources were combined to avoid disclosure.

Table 14—Log flow in and out of Oregon, 2013

Timber products	Log flow into Oregon	Log flow exported (international)	Log flow out of Oregon (domestic)	Net in (net out)
	Million board feet, Scribner			
Saw logs	109.7	662.5	26.7	(579.5)
Veneer logs	82.5	0	0.6	81.9
Chipped logs[a]	11.3	0	3.5	7.8
Other timber products[b]	2.1	0	0.2	1.9
All products	205.7	662.5	31.0	(487.8)

[a] Chipped logs are primarily roundwood pulpwood.
[b] Other timber products include logs for posts, small poles, pilings, utility poles, log homes, firewood, and log furniture.

organizations and individuals have sought information on the origins of exported logs, the proportion of total annual harvest they represent, and overall international trade flows. The information contained in this section focuses on export sort yards, Oregon port facilities, and international log brokers. Note that there are regulations prohibiting the export of federal- and state-owned timber. Export logs can only originate from private lands.

Beginning in 2010, there was significant growth in the volume of Oregon-grown logs exported overseas, which persisted through 2013 (fig. 7). During this period, Asian markets experienced a large increase in their demand for log imports, which was primarily dominated by China. In 2013, China imported approximately 14,699 MMBF of logs. The other two leading log importers in this region in 2013 were Japan and South Korea, which imported approximately 1,227 and 1,009

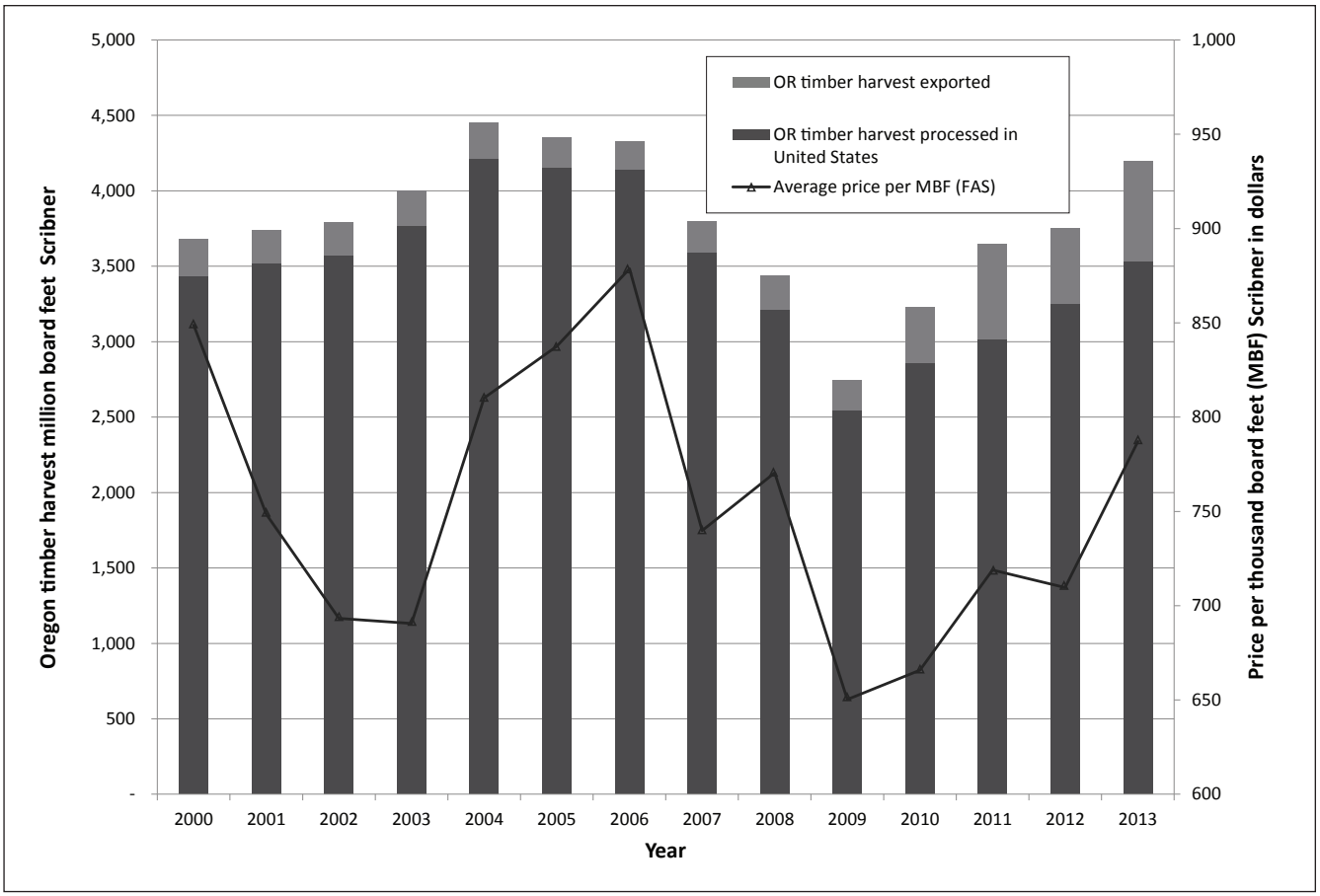

Figure 7—Comparison of Oregon (OR) timber harvest exported to total harvest. Source: USITC 2015. FAS = free along sideship.

MMBF, respectively (FAOSTAT 2015[6]). During this period, numerous industrial and nonindustrial private timberland owners in Oregon were able to receive higher prices for their logs from the Chinese market than they were from the U.S. domestic market.

Log exporting out of the PNW to Pacific Rim countries (China, Japan, and South Korea) is not a new phenomenon and regularly occurred throughout the 20th century (Daniels 2005). In the early part of the 20th century, the export market was predominantly specialized in small niche markets. Beginning in 1962, the volume of PNW log exports began to increase dramatically as the excess supply of PNW logs was used to satisfy excess demand for softwood logs in Japan (Daniels 2005). The log trade with Japan drove the expansion of log exports through the remaining part of the 20th century, eventually bringing in China and South Korea. The peak

[6] FAOSTAT is a reporting tool of the United Nation's Food and Agricultural Organization that reports volumes of internationally traded goods in cubic meters. To convert the log volumes in cubic meters to board feet other entities, use a conversion factor of 4.53 m^3/MBF (Zhou 2013, 2015; Zhou and Warren 2012). This same conversion factor was applied to convert all cubic meter data to board feet.

year for PNW log exports to Japan occurred in 1989 at 2,400 MMBF, and the peak year for China was in 1988 at 1,052 MMBF (Daniels 2005). Export volumes began to decline in 1990 and continued into the early 2000s, owing to supply-side shocks in the PNW and demand-side shocks in the Pacific Rim (Daniels 2005). In 2009, China became the dominant destination for PNW log exports, which continued through 2013 (FAOSTAT 2015).

Just over 662 MMBF of Oregon-grown logs were estimated to have been exported to Pacific Rim countries in 2013. This volume represents approximately 15.6 percent of Oregon's total timber harvest in 2013. Log trade-flow data produced by the Food and Agriculture Organization lists the total U.S. log exports to Pacific Rim countries at approximately 2,009 MMBF in 2013 (FAOSTAT 2015). The estimated portion occurring from Oregon timberland represents 33 percent of this U.S. Pacific Rim export total. The total log volume imported by Pacific Rim countries from all source countries in 2013 was estimated to be 16,935 MMBF (FAOSTAT 2015). Log volume from Oregon represents approximately 3.9 percent of total Pacific Rim log imports.

Just over 662 MMBF of Oregon-grown logs were estimated to have been exported to Pacific Rim countries in 2013. This represents approximately 15.6 percent of Oregon's total timber harvest in 2013.

The majority of Oregon log exports originated in the Northwest Resource Area (75.8 percent), with the remainder from counties in the Southwest Resource Area (table 15). Based on information from log exporters, Oregon export logs generally have to originate on the western side of the Cascade Mountains in order for total costs (including stumpage, harvest, and haul costs) to be competitive with export market rates. Douglas-fir was the primary softwood species exported in 2013 (72 percent), followed by western hemlock (23 percent), and other conifers (5 percent). Hardwood species represented less than 1 percent of 2013 total export volume (USITC 2015).

The majority of logs exported from Oregon are break-bulk[7] shipments, shipped from three primary ports; Astoria, Coos Bay, and Longview. While the Longview port is located in Washington, its proximity to the Oregon border has resulted in a large portion of Oregon logs being exported through this facility. It is estimated that less than 1 percent of the total log volume exported was shipped in containers from other Oregon ports. To estimate the relative proportion of log export volumes for these ports, two data sources were used; WISERTrade, (WISERTrade 2013) and the U.S. International Trade Commission Dataweb tool (USITC 2015).[8] The total value of softwood logs exported out of each of these three ports in 2013 (WISERTrade

[7] Break-bulk refers to a shipping system of transporting cargo as separate pieces rather than in containers.

[8] Log export volume data are reported by the U.S. International Trade Commission in cubic meters. Other entities have then republished this annual data in thousand board feet (MBF) by using a conversion factor of 4.53 m^3/MBF (Zhou 2013, 2015; Zhou and Warren 2012).

Table 15—Oregon international log exports by resource area, 2013

Resource area/county groups	Harvest volume	Percentage of total
	MMBF	*Percent*
Northwest:		
Columbia/Clatsop	169.3	25.6
Tillamook/Washington	46.2	7.0
Clackamas/Yamhill	116.3	17.6
Benton/Linn/Polk	170.0	25.7
Total Northwest	501.8	75.8
Southwest:		
Coos/Curry/Josephine	42.3	6.4
Douglas/Lane	118.4	17.9
Total Southwest	160.6	24.2
State total	662.5	100.0

MMBF = million board feet Scribner.

2013) was compared with the average 2013 FAS[9] value for 1 MBF of softwood logs exported out of the Columbia-Snake Customs District[10] (USITC 2015).[11] Using these data, an estimate was made of the total softwood log volume exported out of these three ports: Longview represented approximately 85 percent, Coos Bay 9 percent, and Astoria 6 percent. Of the total softwood log volume exported out of Longview in 2013, 54 percent was estimated to have originated in Oregon with the remaining 46 percent originating in Washington.

End Uses of Timber

This section traces the path of Oregon's harvested timber through the various primary processing sectors. Timber, primary wood products, and mill residues from manufacturing are commonly quantified in different units of measure. Timber inputs are generally reported in board feet Scribner Westside or Eastside log rule. Volumes of mill outputs are provided in the measurement unit common to each product, such as board feet lumber tally or square feet of plywood ⅜th inch basis. Mill residue is commonly reported in bone-dry units (BDU) or bone-dry tons (BDT). In this section, volumes are expressed in cubic feet because expressing input, output, and residue volumes in a common unit of measure allows for more complete accounting of wood fiber through primary processing.

[9] Free Alongside Ship.

[10] The Columbia-Snake Customs District includes all Oregon ports as well as Longview and Vancouver in Washington.

[11] Log export volume data are reported by the U.S. International Trade Commission in cubic meters. Other entities have then republished this annual data in MBF by using a conversion factor of 4.53 m^3/MBF (Zhou 2013, 2015; Zhou and Warren 2012).

In this report, 1 BDU of residue is assumed to contain 96 cubic feet of wood, 1-MBF lumber tally is assumed to contain approximately 50 to 60 cubic feet of wood, and board-foot-Scribner-to-cubic conversions for timber vary by timber product type, which reflect log size and quality. See Blatner et al. (2013) and Keegan et al. (2010a, 2010b) for more detail on the conversions and relationships of timber, lumber, and mill residue volumes. The following factors were used to convert board-foot Scribner log volume to cubic-foot volume for the various timber products.

- 4.08 board feet per cubic foot for sawlogs
- 4.79 board feet per cubic foot for veneer logs
- 2.64 board feet per cubic foot for chipped logs
- 4.85 board feet per cubic foot for other timber products

The following cubic volumes refer to Oregon's timber harvest and include timber products shipped to out-of-state mills; the figures do not include timber that was harvested in other states and processed in Oregon. Other manufacturers include producers of posts and poles, utility poles, energy products, log furniture, log homes, and house logs; these were combined to avoid disclosing proprietary information on individual firms. Figure 8 outlines timber flows by sector beginning with total statewide harvest and ending with finished primary products.

The 4,246.7 MMBF of timber harvested in 2013 equates to 1,057 million cubic feet (MMCF) of wood fiber, excluding bark. Of this volume, 626 MMCF (59 percent) was delivered as sawlogs to sawmills; 131 MMCF (12.4 percent) was veneer logs shipped to veneer and plywood plants; 152 MMCF (14.4 percent) was shipped to export facilities; 137 MMCF (13 percent) was chipped for pulp mills and board plants; and 9.8 MMCF (0.9 percent) was delivered as other timber products to various facilities (fig. 8).

Of the 626 MMCF of timber delivered to sawmills, 309.7 MMCF (49.4 percent) became finished lumber or other sawn products, 302 MMCF (48 percent) became mill residue, and approximately 14.5 MMCF (2.3 percent) was lost from shrinkage of green lumber. About 264 MMCF of sawmill residue was sold as raw material to manufacturers of pulp and paper, particleboard, medium-density fiberboard, and hardboard in Oregon and other states. About 32 MMCF of sawmill residue was used for energy. Residues used for miscellaneous purposes such as livestock bedding accounted for 6 MMCF, and about 0.1 MMCF of sawmill residue was reported as unused.

Of the 131 MMCF of Oregon's timber harvest delivered to veneer plants in Oregon and other states, approximately 82 MMCF (63 percent) was processed into veneer, and 49 MMCF (37 percent) became residue. Of the residue, most

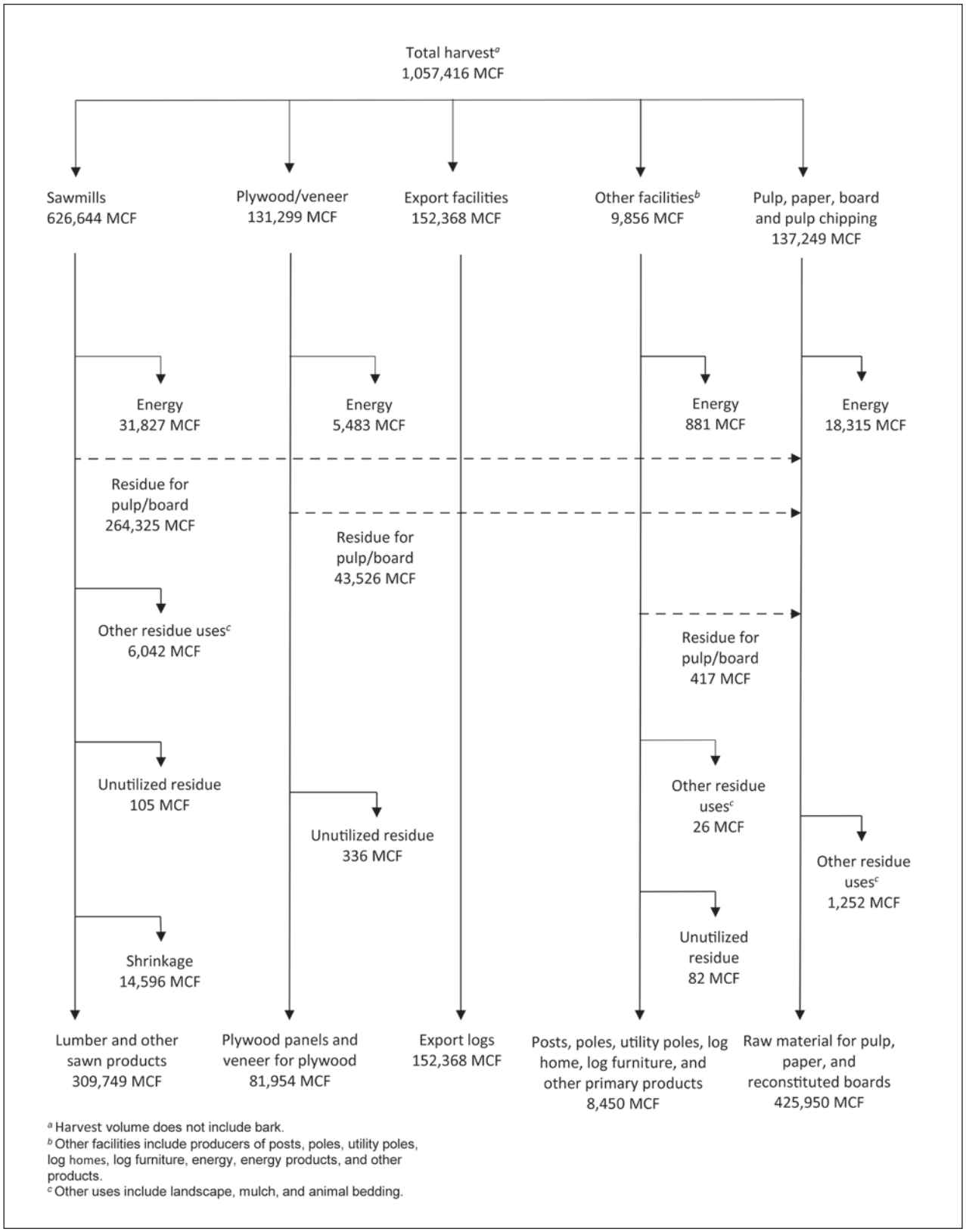

Figure 8—Oregon's timber harvest and products flow, 2013. MCF = thousand cubic feet.

(43.5 MMCF) was sold as raw material to pulp and paper and board manufacturers, approximately 5.5 MMCF was used for energy purposes, and 0.3 MMCF was unused.

About 137.2 MMCF (9 percent) of Oregon's timber harvest was in the form of pulpwood that was chipped and used to manufacture pulp, paper, and reconstituted board. These facilities received an additional 308.3 MMCF of mill residues from sawmills and plywood plants for use as raw material. In total, 425.9 MMCF of raw material was used for pulp, paper, and board products, and 32 percent of that volume was from roundwood pulpwood. This sector received about 13 percent of the raw log volume and ended up with 40 percent of the total wood fiber from the 2013 timber harvest.

Other manufacturers, which include producers of posts and poles, utility poles, energy products, log furniture, and house logs and log homes, received 9.9 MMCF of Oregon's timber harvest. About 8.4 MMCF of this material became finished products; 0.4 MMCF was sold as raw material to pulp, paper, and board manufacturers; and 0.02 was used for other uses.

In total, 1,057 MMCF of wood fiber, excluding bark, was harvested from Oregon timberlands during 2013. About 425.9 MMCF was used as raw material to produce pulp, paper, or reconstituted board products such as particleboard or medium-density fiberboard; 309.7 MMCF became finished lumber; 152.3 MMCF was exported; 81.9 MMCF became veneer or plywood; 56.5 MMCF was used to generate energy, usually in the form of steam or electricity; 7.3 MMCF went to other uses such as animal bedding or mulch; 14.6 MMCF was lost in shrinkage from green to dry lumber; and only 0.5 MMCF (0.05 percent) of wood fiber went unused.

Timber Receipts

Timber receipts are the volumes of timber received for processing by Oregon mills for the census year. This includes timber received from within and outside Oregon but excludes timber exported out of the state, distinguishing receipts from harvest. Oregon timber receipts by mill type in 2013 (table 16) closely mirrored the harvest by timber product type (table 5). Sawmills received 70 percent of all the timber processed in Oregon, plywood/veneer plants 19 percent, roundwood chipping facilities 9 percent, and the remainder was received by other timber processors (excluding log exporters). Private timberlands (industrial, nonindustrial and tribal) provided 76 percent of the volume received by all processors. Federal lands (National Forest System and Bureau of Land Management) supplied 14 percent, state lands 8 percent, and 2 percent came from other public lands or unidentified out-of-state ownerships.

Table 16—Timber received by Oregon processors (excluding log exporters) by ownership class and mill type, 2013

Ownership class	Sawmills	Plywood/ veneer	Chipping facilities[a]	Other timber products[b]	All products
			Million board feet, Scribner		
Industrial	1,589	382	279	49	2,299
Nonindustrial, private and tribal	341	142	56	8	547
National forest	304	85	2	1	391
State	252	66	0	0	318
Bureau of Land Management	105	28	3	0	136
Other[c]	53	10	5	0	68
All owners	2,643	713	345	58	3,759
			Percentage of total receipts		
Industrial	42	10	7	1	61
Nonindustrial, private and tribal	9	4	1	0	15
National forest	8	2	0	0	10
State	7	2	0	0	8
Bureau of Land Management	3	1	0	0	4
Other[c]	1	0	0	0	2
All owners	70	19	9	2	100

[a] Chipping facilities chip pulpwood primarily for pulp and board but also for industrial fuelwood.
[b] Other timber products facilities include cedar products, posts, small poles, pilings, utility poles, log homes, and log furniture.
[c] Includes other public ownerships and unidentified out-of-state ownerships.

Oregon's Primary Forest Products Industry

The FIDACS census identified 188 primary forest products facilities operating in Oregon during 2013 (table 17) compared to 251[12] in 2008 (Gale et al. 2012). The sharp declines in certain sectors, particularly lumber, were related to the collapse of new home starts and very weak lumber and other markets throughout the Great Recession. The general reduction in the number of facilities operating in Oregon since the late 1960s mirrored the industry throughout the Western United States (Gale et al. 2012, Keegan et al. 2006). The increase in total facilities between 1998 and 2003 was primarily the result of differences in how data were collected over time and the types of facilities included in census years. Changes in the structure and size of Oregon's industry since 2008 are discussed more thoroughly in the "Trends by Sector" section of this report.

[12] Facility counts from 2008 (Gale et al. 2012) were revised based on new information.

Table 17—Active Oregon primary forest products facilities by sector

Year	Lumber	Veneer and plywood	Pulp and board	Cedar products	Export	Posts, poles, pilings, and utility poles	Chipping	Log homes	Log furniture	Other facilities[a]	All sectors
1968	300	168	37	48	[b]	[b]	[b]	[b]	[b]	[b]	553
1972	262	133	40	43	38	10	[b]	[b]	[b]	[b]	526
1976	243	132	40	46	28	9	[b]	[b]	[b]	[b]	498
1982	161	101	36	34	32	8	[b]	[b]	[b]	[b]	372
1985	173	89	35	26	35	7	[b]	[b]	[b]	[b]	365
1988	165	87	33	24	33	18	[b]	[b]	[b]	[b]	360
1992[c]	115	64	30	16	13	15	[b]	[b]	[b]	[b]	253
1994[c]	106	34	31	10	10	10	[b]	[b]	[b]	[b]	201
1998[c]	93	43	29	7	[b]	8	20	[b]	[b]	[b]	200
2003[d]	126	33	23	2	2	12	9	25	6	9	25,112
2008[d]	122	30	22	2	3	14	12	22	4	17	248
2013	90	26	19	[e]	4	9	11	12	3	14	188

[a] Other facilities include biomass/energy, bark products, and fuel pellets/fire logs.
[b] Log export, posts, small poles, pilings, chipping, log homes, and log furniture facilities not included in the specified years.
[c] All the mills did not participate in the specified survey years.
[d] 2008 facility counts revised to reflect updated information.
[e] Only two cedar sawmills operated in Oregon during 2013. Their data were combined with lumber to prevent disclosure.
Sources: Brandt et al. 2006; Gale et al. 2012; Howard 1984; Howard and Hiserote 1978; Howard and Ward 1988, 1991; Manock et al. 1970; Schuldt and Howard 1974; Ward 1995, 1997; Ward et al. 2000.

Industry Concentrations

Douglas County encountered the largest decline in the number of active sawmills, with 6 (43 percent) fewer facilities operating in 2013 than during 2008.

Traditionally, western Oregon has had the highest concentration of primary wood products facilities (Brandt et al. 2006; Gale et al.2012; Howard 1984; Howard and Hiserote 1978; Howard and Ward 1988, 1991; Manock et al. 1970; Schuldt and Howard 1974; Ward 1995, 1997; Ward et al. 2000). In 2013, 143 active primary forest products facilities were located in western Oregon, 29 fewer facilities than 2008 (fig. 9; table 18). The Southwest Resource Area contained the largest proportion of lumber producers (39 percent) and plywood and veneer operations (73 percent). Lane County was home to the largest number of active forest products facilities in the state, with 28 mills operating during 2013. Coos County followed with 17. Douglas and Linn Counties each had 16. Douglas County encountered the largest decline in the number of active sawmills, with 6 (43 percent) fewer facilities operating in 2013 than during 2008. The Northwest Resource Area was home to 69 active facilities and the largest concentrations of pulp and board plants (47 percent), chipping operations (45 percent), and other facilities (50 percent).

The remaining 44 primary wood products facilities were located in eastern Oregon, just three fewer facilities than operated in 2008. The Central Resource Area and the Blue Mountains Resource Area each had 22. Three board facilities were located in the Central and Blue Mountains Resource Areas combined. Deschutes and Grant Counties had the majority of mills in their respective resource areas. The greatest concentration of house log manufacturers (36 percent) in Oregon was located in Deschutes County. Of the 22 primary facilities in the Blue Mountains Area, the majority were lumber producers. Most of these mills were in Grant County. The Blue Mountains Area was the only resource area to show an increase in the number of facilities since the 2008 census, with three more facilities operating during 2013.

Sales Value, Product Markets, and Market Areas

Annual sales from Oregon's primary wood processors (fig. 10) demonstrate the strength of the industry's recovery from the recession. Prior to the recession, sawmills and plywood/veneer plants, combined, typically had the largest share of Oregon's wood products sales. This changed during 2008–2011, when weak housing starts resulted in poor markets for lumber and plywood. Between 2001 and 2007, sawmills and plywood/veneer sales were 60 percent of total sales, while pulp/paper/board sales were 38 percent. In 2009, at the depth of the recession, pulp/paper/board facilities accounted for 62 percent and sawmills, plywood/veneer for 35 percent. In the last few years, sales have been shifting toward the prerecession "norms," with

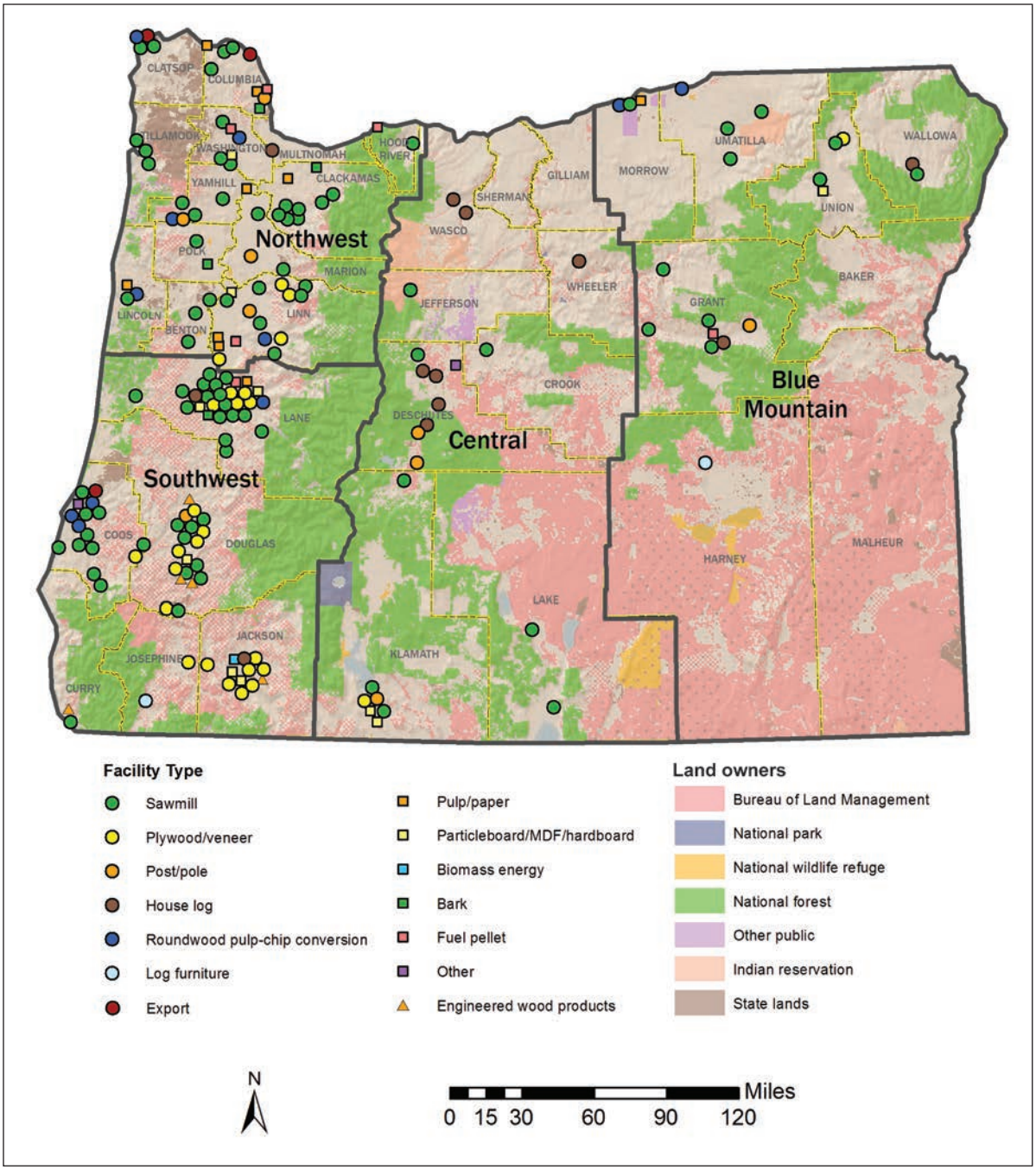

Figure 9—Active Oregon primary forest products facilities, 2013. MDF = medium density fiberboard. BLM = Bureau of Land Management.

Table 18—Active Oregon primary forest products manufacturing facilities by resource area, county, and product, 2013

Resource area/county	Lumber	Veneer and plywood	Pulp and board	Cedar products	Export facilities	Posts, poles, pilings, and utility poles	Chipping	Log homes	Log furniture	Other facilities[a]	Total
Northwest:											
Benton	3	—	—	—	—	—	—	—	—	—	3
Clackamas	7	—	1	[b]	—	—	—	—	—	1	9
Clatsop	2	—	—	—	1	—	1	—	—	—	4
Columbia	3	—	2	—	1	1	—	—	—	2	9
Hood River	1	—	—	—	—	—	—	—	—	1	2
Lincoln	1	—	1	—	—	—	1	—	—	—	3
Linn	6	4	3	—	—	1	1	—	—	1	16
Marion	2	—	—	—	—	1	—	—	—	—	3
Multnomah	—	—	—	—	—	—	—	1	—	—	1
Polk	1	—	—	—	—	—	—	—	—	1	2
Tillamook	3	—	—	—	—	—	—	—	—	—	3
Washington	3	—	1	—	1	—	1	—	—	1	7
Yamhill	3	1	1	—	—	1	1	—	—	—	7
Northwest total	35	5	9	[b]	3	4	5	1	0	7	69
Southwest:											
Coos	10	1	—	—	1	—	3	—	1	1	17
Curry	1	1	—	—	—	—	—	—	—	—	2
Douglas	9	5	1	[b]	—	1	—	—	—		16
Jackson	—	6	2	—	—	—	—	1	—	1	10
Josephine	—	1	—	—	—	—	—	—	1	—	2
Lane	16	5	3	—	—	—	1	1	—	2	28
Southwest total	36	19	6	[b]	1	1	4	2	2	4	75

Table 18—Active Oregon primary forest products manufacturing facilities by resource area, county, and product, 2013 (continued)

Resource area/county	Lumber	Veneer and plywood	Pulp and board	Cedar products	Export facilities	Posts, poles, pilings, and utility poles	Chipping	Log homes	Log furniture	Other facilities[a]	Total
Central:											
Crook	1	—	—	—	—	—	—	—	—	—	1
Deschutes	1	—	—	—	—	2	—	4	—	1	8
Gilliam	—	—	—	—	—	—	—	—	—	—	0
Jefferson	1	—	—	—	—	—	—	—	—	—	1
Klamath	3	1	2	—	—	1	—	—	—	—	7
Lake	2	—	—	—	—	—	—	—	—	—	2
Sherman	—	—	—	—	—	—	—	—	—	—	0
Wasco	—	—	—	—	—	—	—	2	—	—	2
Wheeler	—	—	—	—	—	—	—	1	—	—	1
Central total	8	1	2	0	0	3	0	7	0	1	22
Blue Mountains:											
Baker	—	—	—	—	—	—	—	—	—	—	0
Grant	4	—	—	—	—	1	—	1	—	1	7
Harney	—	—	—	—	—	—	—	—	1	—	1
Malheur	—	—	—	—	—	—	—	—	—	—	0
Morrow	1	—	1	—	—	—	1	—	—	—	3
Umatilla	3	—	—	—	—	—	1	—	—	1	5
Union	2	1	1	—	—	—	—	—	—	—	4
Wallowa	1	—	—	—	—	—	—	1	–	—	2
Blue Mountains total	11	1	2	0	0	1	2	2	1	2	22
2013 state total	90	26	19	[b]	4	9	11	12	3	14	188

— = no facilities.

[a] Other facilities include biomass/energy, bark products, and fuel pellets/fire logs.

[b] Only two cedar sawmills operated in 2013, data for these facilities were combined with lumber to prevent disclosure.

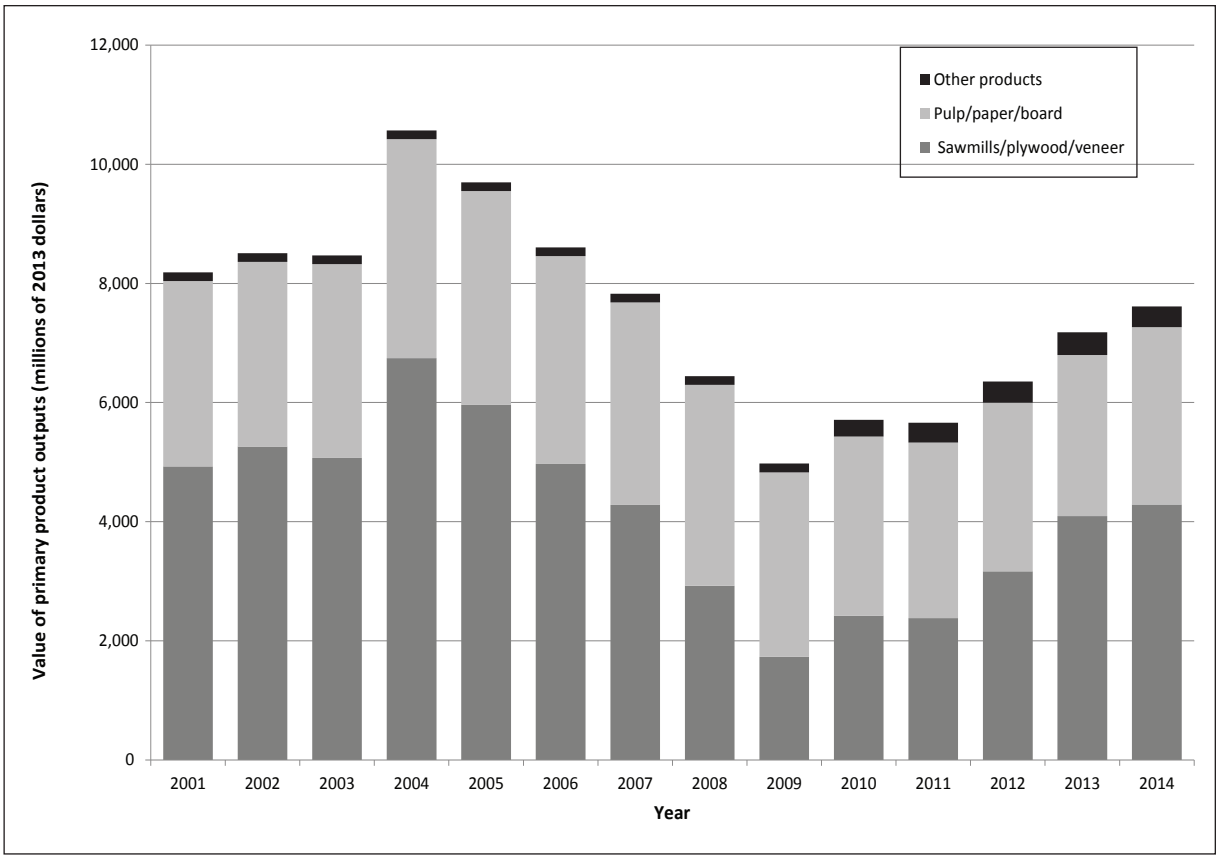

Figure 10—Oregon sales value of primary wood products output, 2001–2014. Source: Brandt et al. 2006, Keegan et al. 2010b, USDC CB 2015b.

56 percent from sawmills and plywood/veneer, and 39 percent from pulp/paper/board in 2014. Also since the recession, sales of other products have grown from 2 percent to 5 percent of total sales, levels not seen before the recession.

Primarily because of higher lumber and plywood/veneer sales, pulp/paper and board sales ($2.7 billion) dropped from an all-time high of 53 percent of total primary wood products sales in 2008 to about 38 percent during 2013.

All sales are reported free on board (f.o.b.) the producing mill and all comparisons are in constant 2013 dollars. Oregon's primary wood products facilities reported 2013 sales of finished products at nearly $7.1 billion, a 9 percent increase from $6.5 billion in sales during 2008 (table 19). Sales were led by the pulp/paper and board sector followed by sawmills and plywood/veneer producers. These three industry sectors represented over 93 percent of total primary wood product sales. Pulp/paper and board sales ($2.7 billion) dropped from an all-time high of 53 percent of total primary wood products sales in 2008 to about 38 percent during 2013. Sawmills and plywood/veneer sales rebounded from 2008 levels, increasing by 46 percent and 29 percent, respectively. Sales by sawmills were just under $2.3 billion and 32 percent of total sales. Plywood and veneer sales ($1.6 billion) represented nearly 23 percent of the total.

Table 19—Product sales value of Oregon primary wood product sectors, select years

Sector	2008	2013
	Millions of 2013 dollars	
Pulp/paper and board facilities[a]	3,429.3	2,713.7
Sawmills	1,567.8	2,295.2
Plywood and veneer plants	1,239.0	1,600.9
Other sectors[b]	146.7	291.7
Chipping facilities[c]	61.0	105.0
Posts, poles, pilings, utility poles and log furniture plants[c]	58.5	61.4
Log homes plants	8.6	4.3
Total	6,510.8	7,072.2

[a] Pulp and board includes pulp, paper, and reconstituted board products.
[b] Other sectors includes bark products, biomass/energy, export logs, and fuel pellet/fire logs.
[c] 2008 sales value adjusted to reflect facilities not reported previously.

Sales from "other sectors" were nearly double that in 2008, increasing from $147 million to $292 million, and grew to 4 percent of total sales in 2013. Increases in this sector were driven primarily by a robust international log export market. The remaining 3 percent of total product sales came from smaller primary wood products sectors, with a 72 percent increase in sales for chipping facilities and a modest increase for posts, poles, pilings, and log furniture plants. At only $4.3 million, 2013 log home-sector sales were half of what they were in 2008.

Sales from "other sectors" were nearly double that in 2008, and grew to 4 percent of total sales in 2013, driven primarily by a robust international log export market.

During 2013, Oregon's primary wood products and mill residues were marketed within the United States and internationally (table 20). Mills usually distributed their products through their own distribution channels or through independent wholesalers and selling agents. Because of subsequent downstream transactions, the geographic destination reported here may not precisely reflect the final delivery points of shipments.

Market destinations for Oregon products in 2013 were similar to trends found in earlier reports (Brandt et al. 2006, Gale et al. 2012). The majority of sales for all products were to the Far West and within Oregon. Sales to these market areas combined were 70 percent of the total, the same proportion as in 2003 and 5 percentage points less than in 2008. Sales to the Pacific Rim increased from 2 percent to 6 percent of total sales. The other market areas were stable or had modest increases.

The Far West States once again comprised the largest market for Oregon's primary wood products and mill residues. At $3.2 billion, 2013 sales were nearly 44 percent of the total, a decrease from 52 percent in 2008. The majority of these sales occurred in pulp and board followed by the lumber sector. Plywood and veneer

Table 20—Destination and sales value of Oregon primary wood products and mill residues, 2013

Product	Oregon	Far West[a]	Rockies[b]	North Central[c]	Northeast[d]	South[e]	Pacific Rim	Canada	Other countries[f]	Total
					Millions of 2013 dollars					
Pulp/paper and board[g]	513.2	1,691.2	146.4	107.5	19.3	56.1	116.1	25.6	38.4	2,713.7
Lumber	626.2	860.8	293.2	179.6	85.3	139.9	90.1	7.1	3.1	2,285.3
Plywood and veneer	387.0	509.7	171.4	239.7	148.4	108.4	10.3	23.4	0	1,598.4
Other primary wood products[h]	185.3	91.6	13.0	2.0	0	0	183.0	0	0	474.8
Total primary product	1,711.7	3,153.2	624.0	528.7	253.0	304.5	399.5	56.1	41.5	7,072.2
Mill residues[i]	172.3	12.4								184.7
Total sales value in 2013	1,884.0	3,165.6	624.0	528.7	253.0	304.5	399.5	56.1	41.5	7,256.9
Percent total 2013	26.0	43.6	8.6	7.3	3.5	4.2	5.5	0.8	0.6	100.0
Percent total 2008	23.0	52.4	8.7	6.2	3.4	3.3	1.7	0.9	0.3	100.0
Total sales value in 2008	1,554.7	3,543.7	591.8	422.5	230.1	225.2	115.5	60.9	19.2	6,763.8

[a] Far West includes Alaska, California, Hawaii, and Washington.
[b] Rockies includes Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming.
[c] North Central includes Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.
[d] Northeast includes Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont.
[e] South includes Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia.
[f] Other countries includes Europe and Mexico.
[g] Pulp and board includes pulp, paper, and reconstituted board products.
[h] Other primary wood products include bark, chipped logs, export logs, log furniture, house logs, posts, small poles, pilings, utility poles, wood pellets, and other energy products.
[i] Mill residues in Far West include all out-of-state mill residue sales.

sales to the Far West surpassed in-state sales, increasing from $326 million in 2008 to $509 million during 2013. In the "other primary wood products category," sales to the Pacific Rim increased dramatically from less than 1 percent to 38 percent ($183 million) of other product sales, primarily owing to increased log exports. In-state sales increased in all product categories, except plywood/veneer and mill residue, contributing to an overall increase from 23 percent ($1.5 billion) of total sales in 2008 to 26 percent ($1.9 billion) of total sales in 2013. Sales of mill residue, primarily as raw material for in-state pulp and board producers, added $185 million in sales to Oregon's primary wood products industry, 40 percent less than in 2008. The mill residues produced in the greatest volume and with the highest value are coarse residues, primarily in the form of clean chips. Low chip prices would contribute to a decrease in overall residue sales. In 2008, the average price per oven-dry metric ton of Northwest conifer chips was $123. In 2013, it was $88, 30 percent less (Random Lengths Yardstick 2008–2014).

Timber-Processing Capacity

Timber-processing capacity is the volume of timber that could be processed given sufficient supply of logs and firm market demand for products, and was calculated by applying each facility's product recovery ratio to the production capacity provided by each facility (Keegan et al. 2006). Through the FIDACS census, Oregon timber processors reported their 8-hour shift and annual production capacities. Production capacities were reported in different units of volume corresponding to different products. Sawmill production capacity was reported in thousand-board-feet (MBF), lumber tally. Veneer production capacity was reported in thousands of square feet (MSF), ⅜-inch basis. Cedar product facilities reported capacity in both hundreds of square feet and MBF. Log home manufacturers measured capacity in thousands of lineal feet (MLF); log furniture, posts, small poles, and pilings reported capacity in pieces; and utility pole producers use MLF or pieces. Capacity in chipping facilities was reported in BDTs. These production capacities were converted to a board-foot Scribner equivalent of timber input based on each facility's recovery ratio (i.e., the quantity of product divided by the board-foot volume of timber received). For example, a sawmill's timber-processing capacity was calculated by dividing the mill's reported production capacity in board-feet-lumber tally by the mill's overrun, and a veneer plant's timber-processing capacity was calculated by dividing production capacity in square feet of veneer by the facility's veneer recovery.

Annual timber-processing capacity in Oregon for all sectors combined was just over 10 billion board feet Scribner in the 1970s and 1980s (fig. 11), with about 70 percent of total capacity utilized (Keegan et al. 2006). Capacity declined

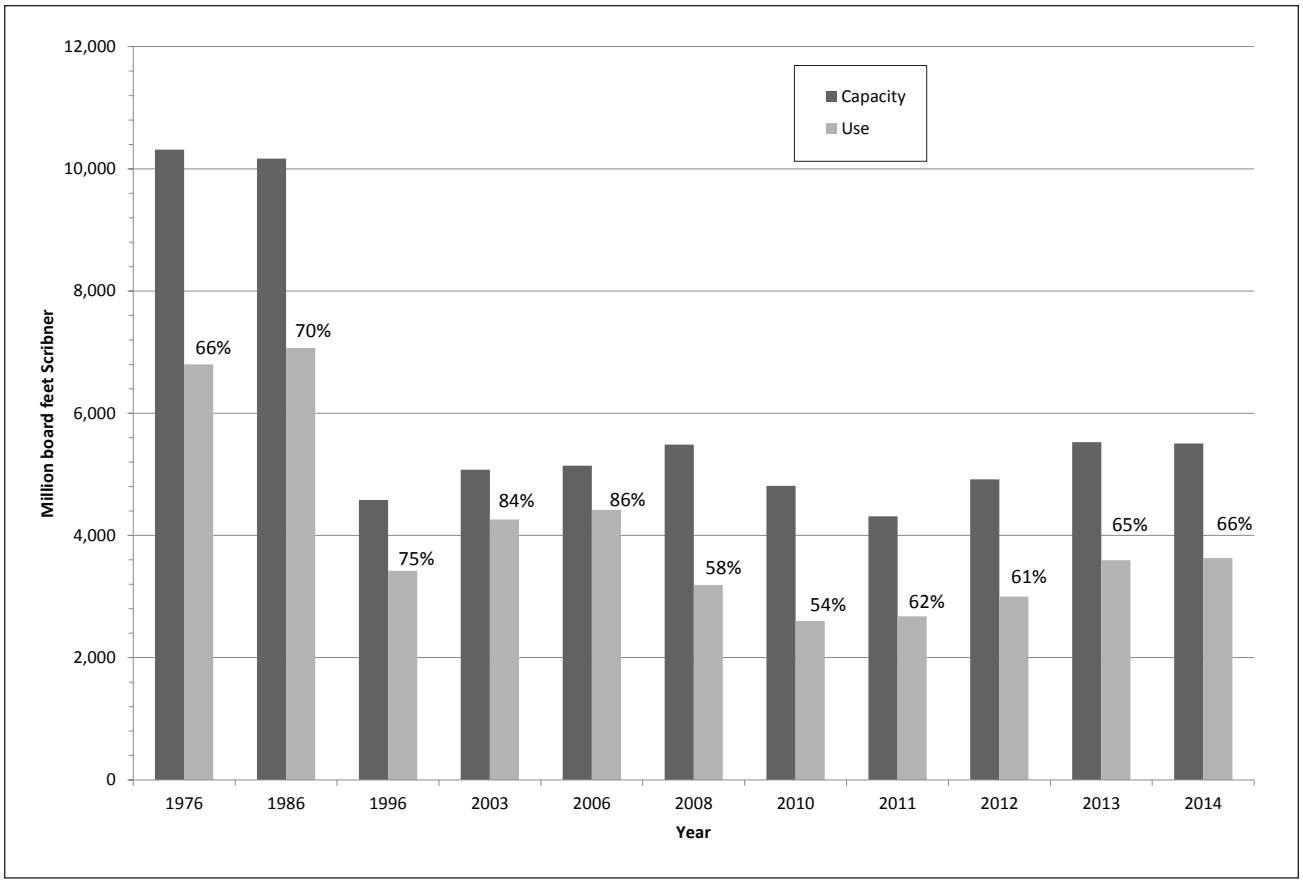

Figure 11—Oregon's timber processing capacity and use, various years. Source: Brandt et al. 2006; Gale et al. 2012; Howard and Hiserote 1978; Keegan et al. 2006, 2010a; Schuldt and Howard 1974.

dramatically with the closure of many sawmills during the collapse of federal timber harvesting in the 1990s. Since 2003, processing capacity has ranged from an all-time low of 4.3 BBF in 2011 to 5.5 BBF in 2013, the highest for the period. Capacity utilization peaked at 86 percent in 2006 just prior to the Great Recession and bottomed out at 54 percent in 2010. Since then, capacity utilization has increased to 66 percent in 2014.

Oregon's timber-processing capacity during 2013 was 5.5 BBF Scribner, and capacity utilization for all sectors combined was 65 percent (table 21). Sawmills accounted for almost 4.2 BBF (76 percent) of the total-timber-processing capacity in the state, and processed just over 2.5 BBF of timber, a utilization rate of 60 percent. The plywood and veneer sector accounted for 15 percent of statewide capacity and the utilization rate was 81 percent. Chipping facilities processed 345 MMBF of timber in 2013 but had capacity to process 423 MMBF; their utilization rate of 82 percent was the highest of all sectors. The capacity to process timber increased in

Table 21—Oregon timber-processing capacity and use, 2013

Facility type	Timber processed	Timber-processing capacity	Utilized capacity
	Million board feet, Scribner		*Percentage*
Sawmills	2,520	4,181	60
Plywood and veneer	690	850	81
Chipping	345	423	82
Other facilities[a]	35	66	53
All facilities	3,589	5,518	65

[a] Other facilities includes log furniture, log homes, posts, small poles, pilings, and utility poles.

all sectors from 2008 as did capacity utilization—except for sawmills, which saw capacity utilization decline slightly as a result of increased timber-processing capacity.

Trends by Sector

This section discusses industry trends and mill survey results by sector. Specifically, changes in number of facilities, capacity, production, sales, and product recovery are examined for the sawmill, plywood, pulp and board, and other primary products sectors.

Sawmills

There were 90[13] sawmills active in Oregon during 2013, a decrease from 124[14] in 2008. However, 16 facilities that were active in 2008 were inactive in 2013 (i.e., not permanently closed or dismantled). Since 2013, two of these inactive facilities have resumed production (Random Lengths Woodwire 2015). As in other Western States, the number of sawmills has decreased in Oregon (table 17), with changes in mill efficiency, timber supply, and industry consolidation (Keegan et al. 2006, McIver et al. 2013, Morgan et al. 2012, Simmons et al. 2014).

Sawmills produced over 5 BBF lumber tally in 2013, 8 percent more than in 2008 (fig. 12). Lumber production in Oregon has decreased overall since 1954. Annual production peaked in 1955 at 9.2 BBF, in 1987 at 8.8 BBF, and in 2005 at 7.4 BBF. Significant lows coincided with domestic economic crises in 1982 at 4.6 BBF, the early to mid-1990s, and in 2009 at 3.8 BBF, the lowest point in more than 60 years. Since 2009, lumber production has increased to over 5.4 BBF in 2014 (WWPA 2015). Sales by sawmills were just under $2.3 billion in 2013, a 44 percent increase from 2008 ($1.6 billion).

[13] Includes two cedar products facilities, combined with sawmills to prevent disclosure.

[14] Facility counts from 2008 (Gale et al. 2012) were revised based on new information.

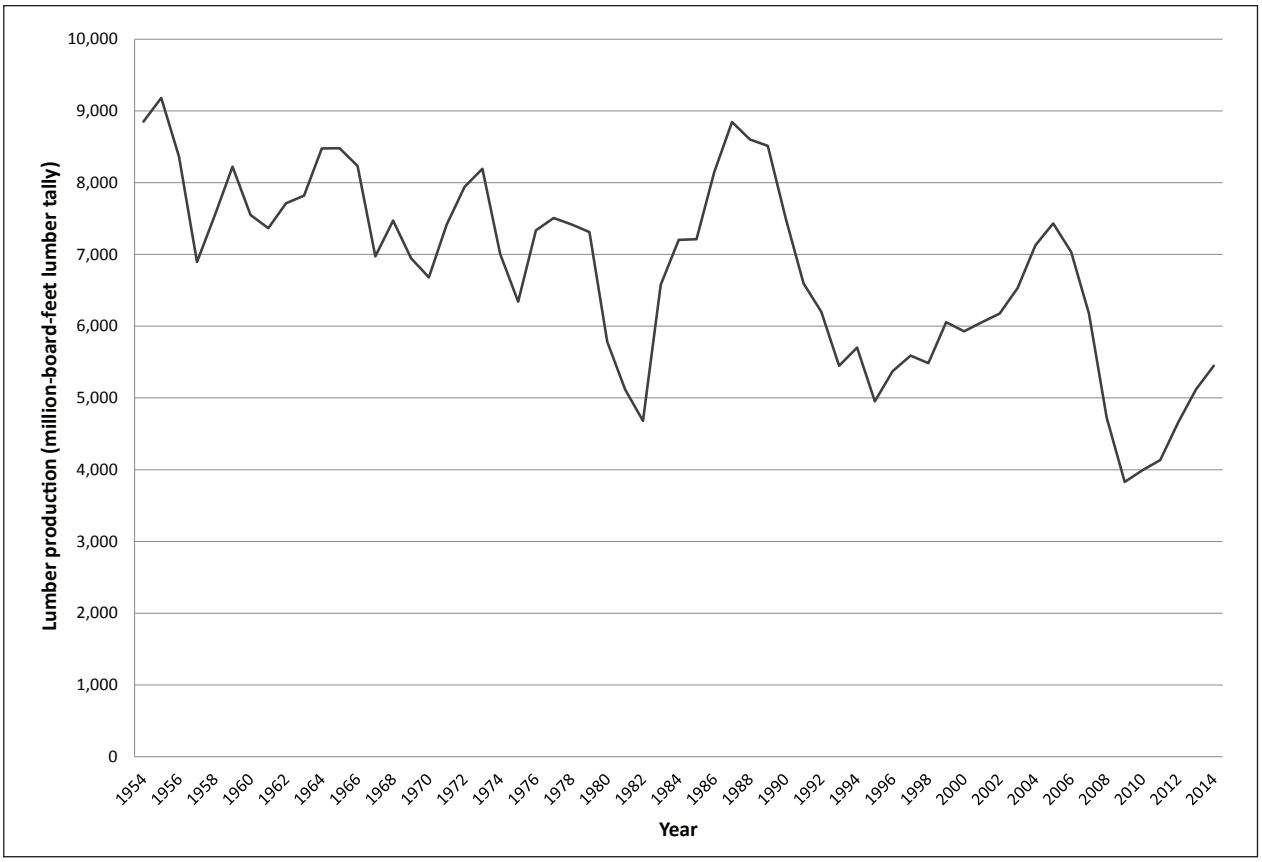

Figure 12—Oregon's lumber production, 1954–2014. Source: Brodie et al. 1978, WWPA 1954–2015.

Sawmill Lumber Recovery

Product recovery ratios, or the volume of output per unit of input, are measures of efficiency calculated from the data provided by Oregon's sawmills. Lumber overrun (LO) is the amount of lumber actually recovered in excess of the volume predicted by the Scribner log scale, expressed as a percentage of the log scale. Lumber recovery factor (LRF) is the ratio of lumber output expressed in thousand board feet lumber tally divided by the timber input expressed in thousand cubic feet (Keegan et al. 2010b).

Although LO is the most commonly quoted measure of lumber recovery and mill efficiency, LO fails to accurately portray changes in lumber recovery. Nuances of the Scribner log scale complicate the interpretation of changes in LO. As log diameters decrease, the Scribner log rule disproportionately underestimates the log input volume. Thus, LO increases when smaller logs are processed, not because more lumber is actually being recovered from the smaller logs but because the Scribner log scale underestimates the log input volume. The LRF, on the other

hand, will tend to decrease when smaller diameter logs are being used (all other conditions being the same), because less lumber is being recovered from fewer cubic feet of log input volume. Because it is not disproportionately affected by changes in log diameter, LRF may better illustrate the long-term relationship between rising lumber output and improvements in technology and sawing techniques (Keegan et al. 2010b).

Oregon sawmills recovered an average of 2.12 board feet lumber tally per board feet Scribner of log input in 2013, a nearly 4 percent increase in LO from 2008 (fig. 13). The LO ranged from 1.15 to just under 2.70, with the 21 mills that produced over 100 MMBF averaging 2.27. The increase in LO is primarily thought to reflect an increase in the proportion of smaller diameter logs used by sawmills in 2013 (table 22). The 2013 LRF (8.63 board feet of lumber per cubic foot of timber) for Oregon sawmills was about 4 percent lower than in 2008. The reduction in LRF is likewise believed to be associated with the increased use of smaller diameter logs during 2013.

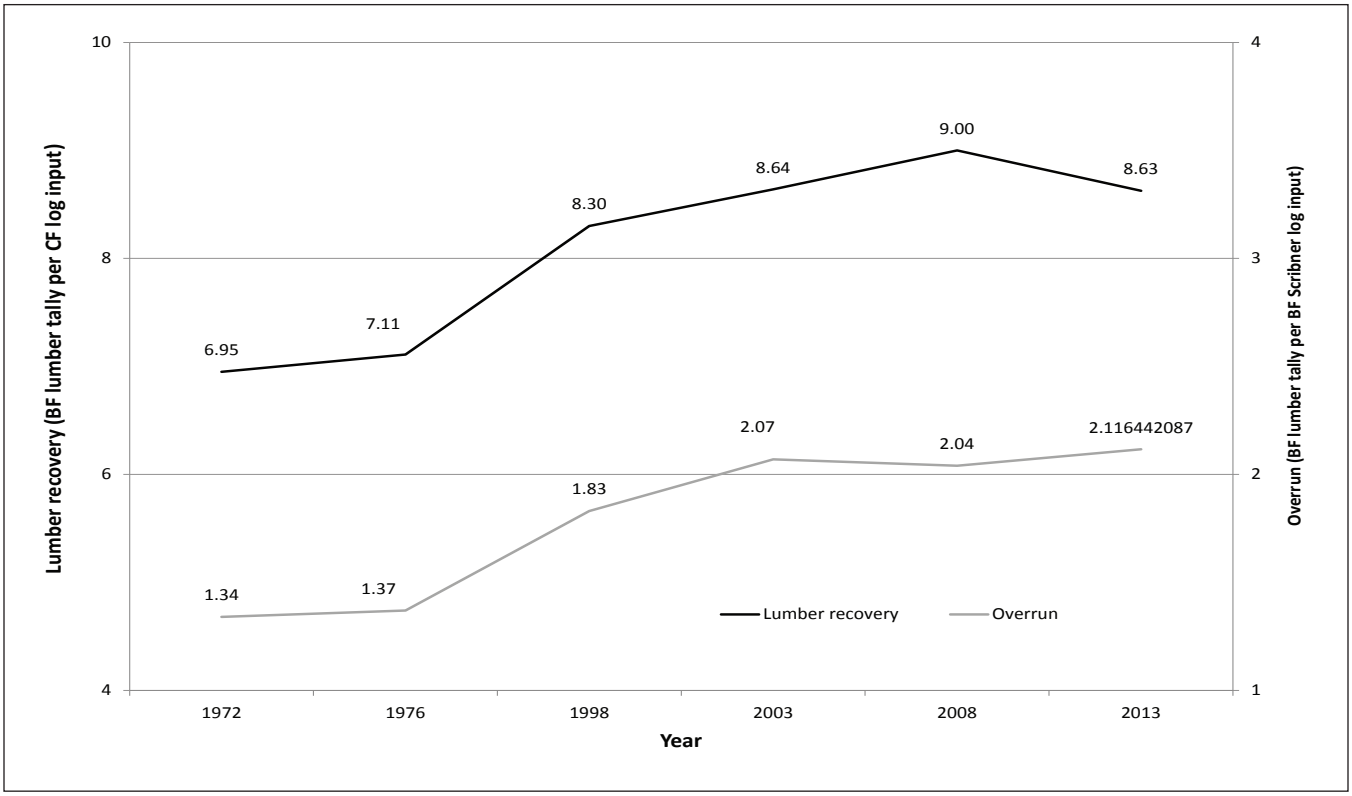

Figure 13—Oregon lumber recovery and overrun, various years. Source: Brandt et al. 2006; Gale et al. 2012; Howard 1984; Howard and Hiserote 1978; Howard and Ward 1988, 1991; Manock et al. 1970; Schuldt and Howard 1974; Ward 1995, 1997; Ward et al. 2000. BF = board feet, CF = cubic feet.

Table 22—Percentage of log volume[a] processed by sawmills by small-end diameter

Small-end diameter	2003	2008	2013
<7 inches	14	12	16
7 to 10 inches	32	26	31
10 to 24 inches	49	48	50
>24 inches	5	14	3
<10 inches[b]	46	38	47
≥10 inches	54	62	53

[a] Volume = thousand board feet Scribner.
[b] Bold values indicate total percentage per size group.

The increased use of smaller diameter logs by Oregon sawmills during 2013 (table 22) may be attributed to a combination of improved lumber markets, shorter harvest rotations on industrial private timberlands, and competition for larger diameter logs from log exporters. Stronger lumber markets can make it more profitable to produce lumber from small and low-quality logs—even though lumber recovery may be somewhat lower from smaller diameter logs. Oregon lumber production was 8 percent higher in 2013 compared to 2008, whereas lumber sales were 44 percent higher in 2013. This was due in part to softwood lumber prices being about 42 percent higher in 2013 versus 2008 (Random Lengths Yardstick 2008–2014).

Annual lumber production capacity for Oregon's 90 active sawmills was approximately 8.1 BBF lumber tally in 2013, and capacity utilization was nearly 66 percent.

Sawmill Capacity

Because three-quarters of Oregon's total 2013 timber-processing capacity was located in sawmills (table 23), this section focuses specifically on the sawmill sector. Sawmill **timber-processing capacity** increased since 2008, from 3.9 to almost 4.2 BBF Scribner. This increase in capacity was primarily the result of mill upgrades and the construction of two high-capacity sawmills, replacing older lower capacity mills. However, owing to a lack of proportional increase in timber volume processed, capacity utilization actually decreased from 62 percent in 2008 to 60 percent in 2013.

Annual **lumber production** capacity for Oregon's 90 **active** sawmills was approximately 8.1 BBF lumber tally in 2013, up one percent from 2008 (Gale et al. 2012). Up to 370 MMBF of additional processing capacity could become available, if the 16 sawmills that were idle (i.e., not permanently closed) in 2013 renew operations. Production capacity utilization in 2013 was nearly 66 percent. Annual production capacity varied widely among sawmills, ranging from under 1 MMBF to more than 500 MMBF per year. In 2013, 94 percent of lumber production (5.0 BBF) and 95 percent of total lumber-producing capacity resided in the 45 largest mills

Table 23—Active Oregon sawmills, lumber production capacity, and utilized capacity by size class, 2013

Production capacity class	Annual capacity				Annual production			
	Number of mills	Capacity	Percentage of total capacity	Average capacity by mill class	Production	Percentage of total production	Average production by mill class	Utilized capacity
Annual capacity:		*MMBF*[a]	*Percent*	*MMBF*[a]	*MMBF*[a]	*Percent*	*MMBF*[a]	*Percent*
Over 100 MMBF annual capacity	28	6,593.0	81.1	235.5	4,122.5	77.3	147.2	62.5
Over 50 to 100 MMBF annual capacity	17	1,129.4	13.9	66.4	895.2	16.8	52.7	79.3
Over 10 to 50 MMBF annual capacity	11	361.0	4.4	32.8	293.9	5.5	26.7	81.4
10 MMBF or less annual capacity	34	44.7	0.5	1.3	21.6	0.4	0.6	48.3
Total	90[b]	8,128.1	100	84	5,333.2	100	56.8	65.6
Shift capacity:		*MBF*[c]	*MBF*[c]	*MBF*[c]				
120 MBF or greater shift capacity	46	7,587.2	93.3	164.9	4,966.0	93.1	108.0	65.5
80 to 120 MBF shift capacity	8	401.2	4.9	50.2	283.7	5.3	35.5	70.7
40 MBF to 80 MBF shift capacity	4	93.0	1.1	23.3	60.0	1.1	15.0	64.5
Less than 40 MBF shift capacity	32	46.7	0.6	1.5	23.6	0.4	0.7	50.5
Total	90[b]	8,128.1	100	61.8	5,333.2	100	41	65.6

[a] MMBF = million board feet lumber tally.
[b] Includes two cedar sawmills.
[c] MBF = thousand board feet lumber tally.

with annual capacities greater than 50 MMBF. Despite four fewer mills operating during 2013, production capacity of the larger mills increased, and capacity utilization was 65 percent, compared to 60 percent utilization in 2008.

The 11 sawmills with capacities of 10 to 50 MMBF accounted for 4 percent (361 MMBF) of total capacity and 5 percent (294 MMBF) of lumber production during 2013. There were six fewer active sawmills in this capacity class than in 2008, resulting in an 18-percent reduction in production capacity. Mills with annual capacities of 10 MMBF or less accounted for only 0.5 percent (45 MMBF) of total Oregon lumber production capacity and 0.4 percent of lumber production in 2013. About one-third fewer sawmills in this smallest size class were active in 2013 than in 2008, yet production capacity increased about 15 percent, and utilization increased almost 40 percent among the remaining active mills. Most of the mills in this size class were small, portable, or producers of specialty timber products. It is likely that given an adequate supply of timber and demand for product, the active facilities were able to add employees, add shifts, or make process improvements that affected production capacity and capacity utilization.

Oregon's plywood and veneer sector produced 3,408 million square feet (MMSF), ⅜-inch basis of plywood, of which more than 575 MMSF was hardwood plywood, making Oregon the leading producer of plywood in the United States.

Mill-level detail on annual capacity is not available prior to 2003, but summaries of 8-hour-shift capacity are available for several earlier years and offer insights into how mill sizes in Oregon have changed over time (fig. 14). During the mid-1950s and again in the late 1980s, total annual lumber production capacity exceeded 10 BBF.

The number of active low-capacity sawmills in 2003 and 2008 was noticeably greater than in previous reports primarily as a result of increased FIDACS efforts to identify and include all active sawmills. Although direct comparisons of shift capacities by class throughout time would be problematic, general observations of the long-term trends are reliable for some classes. Also, looking at data from 1992 to the present would characterize trends only since the collapse of the federal timber harvest. Strictly on the basis of number of facilities, the highest capacity class is likely the most accurate. The number of mills in the 120-MMBF-or-greater shift capacity class has declined by 18 percent since 1992. In the same period, the number of mills in the 40 to 80 MMBF classes has declined by 30 percent. The trend toward concentration of capacity into fewer and larger sawmills in Oregon is consistent with findings in Idaho (Simmons et al. 2014).

Plywood and Veneer Sectors

In Oregon, veneer is used to produce plywood, laminated veneer lumber (LVL), and other engineered wood products (EWP). Oregon's plywood and veneer sector

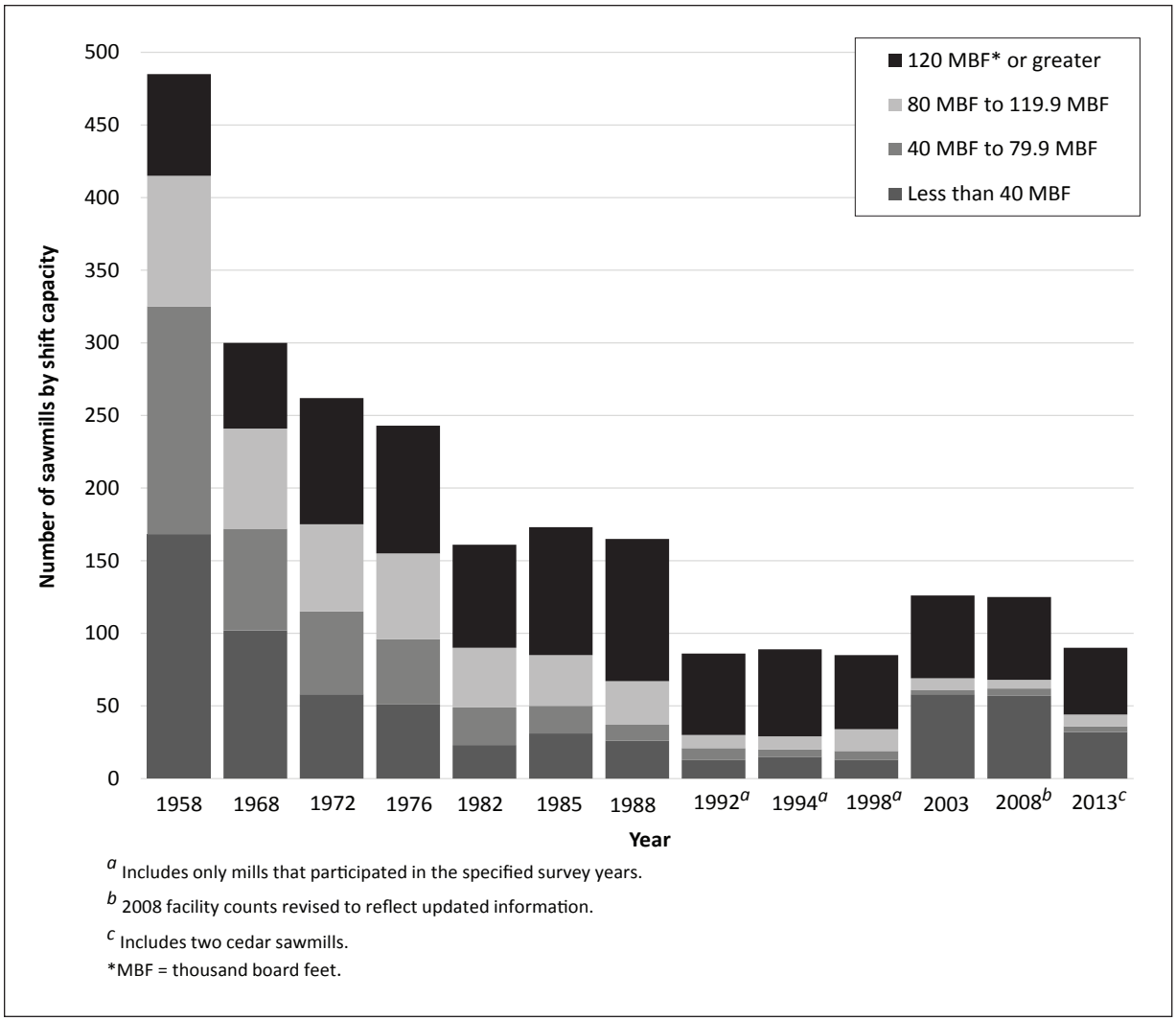

Figure 14—Active Oregon sawmills by shift capacity, selected years 1958-2013. Sources: Brandt et al. 2006; Gale et al 2012; Howard and Hiserote 1978; Howard 1984; Howard and Ward 1991, 1988; Manock et al 1970; Schuldt and Howard 1974; Ward 1995, 1997; Ward et al. 2000.

produced 3,408 million square feet, ⅜-inch basis (MMSF-⅜-inch) of plywood, of which more than 575 MMSF ⅜-inch was hardwood plywood, and an additional 1,372 MMSF ⅜-inch of veneer in 2013, making Oregon the leading producer of plywood in the United States (Elling 2015). In 2013, more than 75 percent of all the veneer produced in Oregon was used to produce plywood in Oregon. Sales for this sector were about $1.6 billion during 2013, an increase of nearly 29 percent from 2008. Figure 15 shows Oregon plywood production from 1954 to 2014.

There were 26 plywood and veneer plants operating in Oregon during 2013; 4 fewer than in 2008. Of these 26 plants, 4 produced veneer only, 9 were both veneer

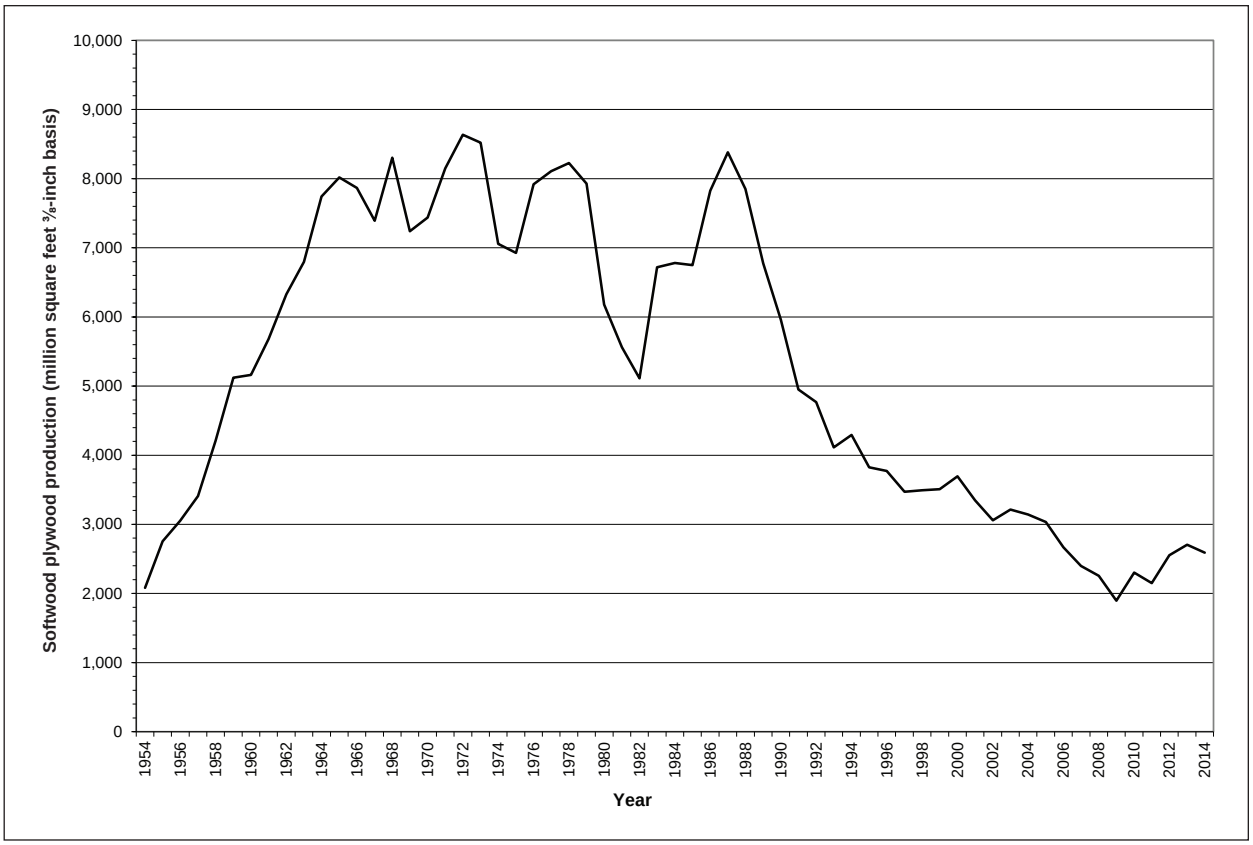

Figure 15—Oregon's softwood plywood production, 1954–2014. Source: Adair 2005, APA 1954–2015, Brodie et al. 1978, Warren 1988.

and plywood layup operations, and 13 plants produced only plywood layup (table 24). Like most sectors of the industry, the number of plywood and veneer facilities has decreased substantially over time, from 138 in 1968 to present levels. For more information on the causes of the decline in facilities, see Gale et al. 2012.

Plywood and veneer recovery decreased slightly from 4.19 thousand square feet ⅜-inch basis per MBF Scribner of timber input in 2008 to 4.17 in 2013. The 2013 FIDACS total plywood production volume (3,408 MMSF) was substantially higher than the softwood plywood production volume (2,589 MMSF) published by APA—The Engineered Wood Association (Elling 2015). Different production estimates were a result of both softwood and hardwood plywood production being included in the FIDACS estimate, whereas APA included just softwood plywood. Furthermore, the FIDACS identified 22 facilities, 5 producing primarily hardwood plywood and 2 producing other specialty plywood panels, whereas the APA yearbook listed 15.

Table 24—Number of Oregon plywood and veneer mills, selected years 1968–2013

Year	Veneer only	Veneer and layup	Layup only	All
1968	59	58	21	138
1972	46	58	29	133
1976	52	52	28	132
1982	45	37	19	101
1985	36	32	21	89
1988	33	33	21	87
1992	16	13	11	40
1994	[a]	[a]	[a]	26
1998	15	14	13	42
2003	11	13	9	33
2008[b]	9	9	12	30
2013	4	9	13	26

[a] For 1994, plywood and veneer mills not separated.
[b] 2008 facility counts revised to reflect updated information.
Sources: Brandt et al. 2006; Gale et al. 2012; Howard 1984; Howard and Hiserote 1978; Howard and Ward 1988, 1991; Manock et al. 1970; Schuldt and Howard 1974; Ward 1997, 1995; Ward et al. 2000.

Engineered Wood Products

Engineered wood products include specialty panels (other than plywood), I-joists, LVL, and glued laminated lumber products (glu-lam). Because EWP facilities do not process logs, EWP are considered secondary wood products. In Oregon, EWP facilities are closely linked to primary manufactures, purchasing substantial quantities of veneer and lumber, and are significant contributors to the wood products industry as a whole. Because they are secondary manufacturers, BBER researchers did not attempt a complete census of EWP facilities, but 5 of the 11 EWP manufacturers listed in the 2015 APA yearbook (Elling 2015) participated in the FIDACS survey. These facilities had $312 million in sales in 2013, equivalent to one-quarter of Oregon plywood/veneer sales. Future FIDACS studies will attempt to census all the active EWP facilities in Oregon to produce more complete and detailed information on the sector incorporating the emerging cross-laminated timber industry.

The contraction in pulp/paper production and sales is likely related to the dynamics of global markets combined with Oregon's loss of nearly 600,000 tons of production capacity (15 percent) since 2008 from closed facilities.

Pulp and Board Sector

Oregon had 19 pulp and board facilities operating in 2013, three less than in 2008. All but four of these facilities were located in western Oregon. Ten were board plants that produced particleboard, hardboard, and medium-density fiberboard (MDF). Board facilities produced a total of 1,368 MMSF of products including particleboard, MDF, and hardboard, 32 percent less than in 2008. At $414 million, 2013 sales values were 5 percent less than in 2008 ($433 million 2013 dollars). Oregon's pulp and paper sector produced more than 3.3 million dry tons of pulp and paper in

2013 with a sales value close to $2.3 billion, representing a 25 percent decrease in production and a 21 percent decrease in sales value since 2008. The contraction in production and sales is likely related to the dynamics of global markets combined with the loss of nearly 600,000 tons of production capacity (15 percent) since 2008 from closed pulp and paper facilities. Pulp and paper milling capacity was concentrated in the Northwest Resource Area, which contained seven of the state's nine pulp and paper plants.

Remaining Sectors

Other primary forest product sectors operating in Oregon during 2013 included both timber- and residue-utilizing manufacturers. Timber-utilizing manufacturers included roundwood pulp-chip conversion operations, export operations; log home manufacturers; log furniture manufacturers; post, pole, piling, and utility pole facilities. Other residue-utilizing sectors included pellets and charcoal producers, bark/mulch product plants, and biomass/energy production facilities.

Four facilities operated as concentration points and log exporters in Oregon during 2013. The processing of timber for exporting primarily consists of debarking and sorting the logs by size, grade, or destination. These facilities received about 662 MMBF Scribner, making this sector the third largest recipient of timber in 2013. Most of these logs were exported from the Longview Port in Washington. See the "Oregon Log Exports" section of this report for more details.

The 11 roundwood pulp-chip conversion facilities produced 1.2 million BDT of clean chips and shavings with a sales value of $105 million. Production and sales for these facilities are dramatically higher than in 2008 owing to the inclusion of facilities not previously reported. As in other Western States (McIver et al. 2013, 2014; Simmons et al. 2014), the number of log home facilities in Oregon declined drastically during the Great Recession, from 22 in 2008 to 12 in 2013. Production and sales were essentially 50 percent of what they were in 2008. There were nine post, pole, piling, utility pole, three log furniture; and two miscellaneous users of roundwood operating in Oregon during 2013, producing 771,000 pieces with a sales value of $61.1 million.

Six fuel pellet producers, one commercial biomass energy plant, and one charcoal manufacturer operated during 2013. The pellet and charcoal facilities produced 402,000 BDT of products, and all eight facilities had combined sales of about $103.7 million. The remaining users of mill residue, primarily for landscape and mulch products, produced about 630,000 cubic yards and generated $9.3 million in sales.

Mill Residue Production and Use

For the 2013 Oregon FIDACS effort, mills reported the volumes of residue produced and sold and how residue was used on a percentage basis. From these percentages, total residue and residue volume factors (mill residue generated per unit of lumber, plywood, or other product) were calculated. Mill residue falls into three general categories: (1) coarse residue including chippable material such as slabs, edging, trim, log ends, and defective veneer; (2) fine residue including sawdust, sander dust, and planer shavings; and (3) bark. The volume of mill residue produced during a given year is closely linked to lumber and plywood production in that year. In addition, milling equipment, species and size of logs, amount of defect in logs, and market conditions also influence the amount of residue generated by timber processors.

Mill residue generated by processing timber into primary wood products is the largest source of material for pulp and paper mills, board plants, and other manufacturers of residue-based products, as well as fuel for producing process heat and steam at wood products facilities. Selling mill residue also provides considerable revenue to the mills. Oregon's primary facilities produced nearly 5.5 million BDU of mill residue with sales values totaling nearly $185 million. Sawmills and plywood/veneer plants produced 4.8 million BDU of residue, of which only 2.7 thousand BDU (less than 0.1 percent) was not used (table 25). All other primary processors produced 620,000 BDU of residue and 2.1 thousand BDU went unused (0.34 percent).

Sawmills and plywood/veneer plants processed just over 89 percent of the timber used in Oregon and generated about the same percentage of all mill residue,

Table 25—Production and disposition of wood residues from Oregon primary wood processing facilities, 2013

Type of residue	Total used	Pulp and board	Fuel	Other uses[a]	Unused	Total
Sawmills, plywood/veneer			*Thousand bone-dry units*[b]			
Coarse[c]	2,567.7	2,415.2	124.5	28.0	0.1	2,567.8
Sawdust	749.2	590.4	142.3	16.5	0.1	749.4
Planer shavings	435.4	285.7	132.2	17.5	0.8	436.3
Bark	1,092.9	7.0	962.1	123.8	1.7	1,094.6
Total	4,845.3	3,298.3	1,361.1	185.9	2.7	4,848.0
All other facilities						
Total	618.4	3.9	535.1	79.5	2.1	620.5
All residues	5,463.7	3,302.2	1,896.1	265.4	4.8	5,468.5

[a] Other uses primarily include animal bedding and landscape material.
[b] Bone-dry unit = 2,400 pounds of oven-dry wood.
[c] Peeler cores are included in coarse residue.

4 percent more residue than in 2008. About 68 percent of these residues were used as raw material by the pulp and paper and reconstituted board industries, about the same as in 2008. Of the remaining 32 percent, most was used as fuel (28 percent); other uses such as animal bedding and landscape material accounted for nearly 4 percent.

Mill residue from other sectors was mostly used as fuel onsite or sold as firewood (86 percent); 13 percent went to other uses, and a fraction (0.6 percent) went to pulp and board plants. Facilities other than sawmills and veneer/plywood plants produced almost half of Oregon's unused mill residue in 2013. These facilities often generate relatively small quantities of residue and are frequently not located near larger residue-utilizing facilities. Developing financially viable onsite uses or local markets for these smaller volumes of residue can often be challenging for facilities.

For sawmills and plywood/veneer plants, coarse residue was the state's most common wood products residue, comprising 53 percent of all residues. About 94 percent of coarse residue was used in pulp and paper industry and reconstituted board plants, nearly 5 percent was used as fuel, and about 1 percent was sold for other uses. Fines—sawdust and planer shavings together—made up the second largest component (24 percent) of residue, at 1.0 million BDU in 2013. The vast majority (over 99 percent) of all fines were used. Oregon facilities generated 1.0 million BDU of bark while processing timber, 88 percent of which was used as fuel, most of the remaining 12 percent was used for landscaping or soil additives.

Long-term declines in residue factors (i.e., the volume of residue produced per unit of mill output) have been directly related to gains in milling efficiency, with a greater proportion of timber converted into useable products and less of each log becoming mill residue. Technologies that have increased mill efficiency include log-size sensing capabilities, curve sawing abilities designed to optimize lumber production from logs with sweep and crook, precision sawing patterns, thinner kerf saw blades, improved edging and trimming, improved chucks to allow veneer logs to be peeled to smaller core diameters, and improved drying techniques (Blatner et al. 2013). However, year-to-year variations in markets for lumber and other finished products versus markets for clean chips can lead mills to reduce lumber output and generate additional residue. Also, variations in the mix of log sizes and log quality received by mills can affect annual residue production.

Sawmill residue factors were slightly higher in 2013 than 2008 (table 26). Factors increased for all types of residue except planer shavings. Factors for 2013 are the same as in 2003 when log sizes were similar and somewhat smaller than in 2008 (table 22).

Table 26—Oregon sawmill residue factors, various years

Type of residue	1972	1976	1998	2003	2008	2013
		BDU[a] per thousand board feet lumber tally				
Coarse	0.45	0.45	0.40	0.37	0.36	0.37
Sawdust	0.24	0.22	0.14	0.13	0.11	0.13
Planer shavings	0.18	0.17	0.09	0.08	0.08	0.08
Bark	0.22	0.20	0.19	0.17	0.16	0.17
All residues	1.09	0.84	0.63	0.75	0.71	0.75

[a] BDU = bone-dry unit = 2,400 pounds of oven-dry wood.
Sources: Brandt et al. 2006; Gale et al 2012; Howard and Hiserote 1978; Howard 1984; Howard and Ward 1991, 1988; Manock et al. 1970; Schuldt and Howard 1974; Ward 1995, 1997; Ward et al. 2000.

Economic Aspect of Oregon's Forest Products Industry

The forest products industry has long been an important component of the statewide and regional economies in Oregon. This section looks specifically at forest products industry employment and labor income statewide and analyzes trends since the 2008 FIDACS (Gale et al. 2012). Because the U.S. government changed the way in which it reported economic data and classified employment by sector in 2001, reliable and consistent data are available only for the recent period of 2001 to 2014 (U.S. Department of Commerce 2015a). This period formed the basis of the analysis in this section. A few key data points have been estimated for earlier years to provide historical perspective; in particular, for the period since 1990 to capture the dramatic drop in timber availability during the early 1990s.

Employment and labor income data for Oregon were derived from a number of federal and state data sources, including the Regional Economic Information System, Bureau of Economic Analysis, U.S. Department of Commerce, and the Quarterly Census of Employment and Wages, Bureau of Labor Statistics (U.S. Department of Labor 2014). The classification of forest industries used here follows the North American Industrial Classification System (NAICS) available online via the U.S. Department of Commerce (2012). Specifically, we examined employment in the following categories:

- NAICS 113—forestry and logging.
- NAICS 1153—support activities for forestry.
- NAICS 321—wood products manufacturing.
- NAICS 322—paper manufacturing.

These four categories probably understate total employment in the forest products industry because they do not include a number of activities. For example, log hauling, forest management performed by government employees, and log exporting occupations such as longshoremen are not included in these NAICS categories.

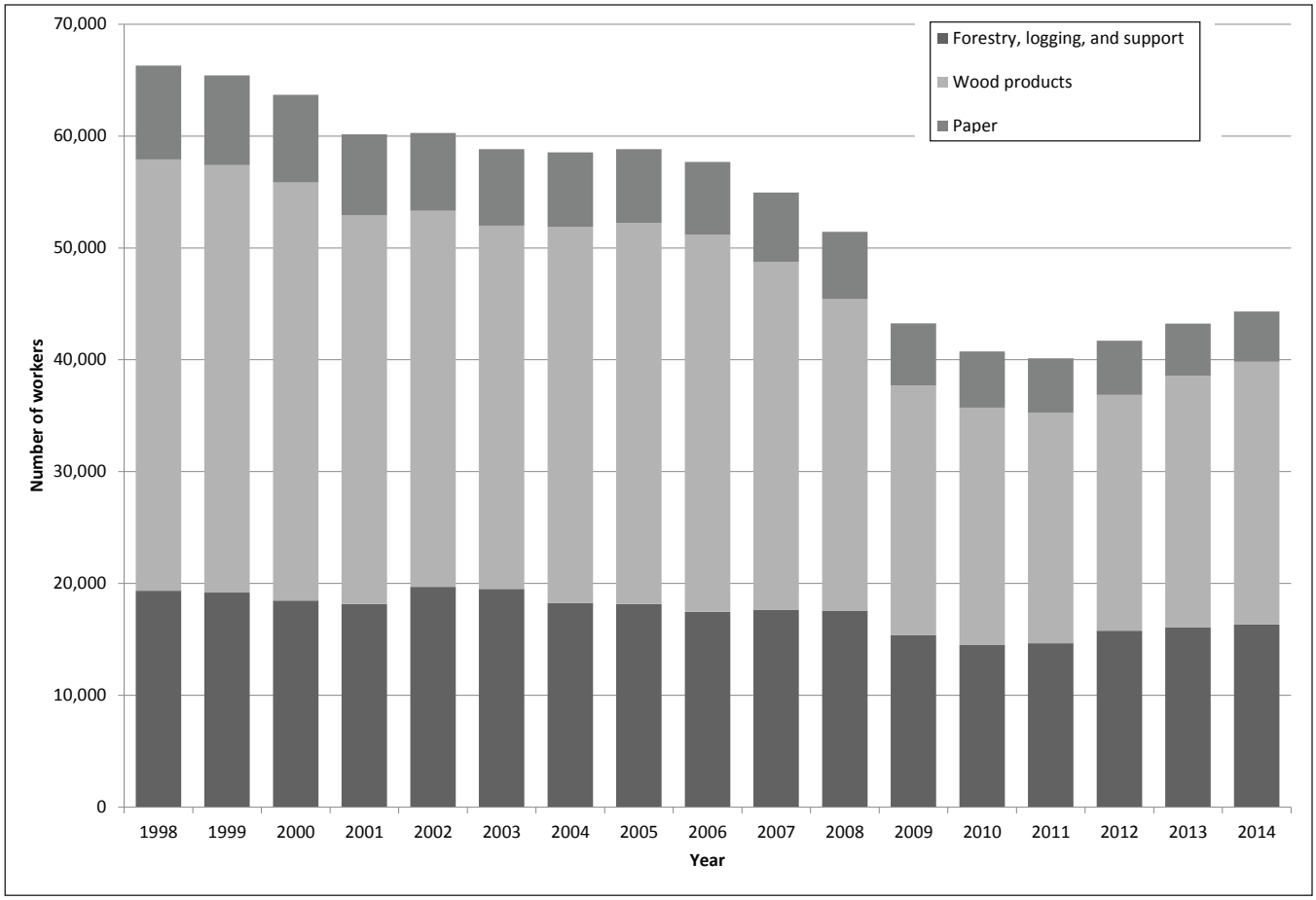

Figure 16—Employment in Oregon's forest products industry, 1998–2014. Source: USDC BEA 2015.

The Oregon forest products industry employed about 43,200 workers and paid approximately $3.18 billion (2013 dollars) in labor income in 2013 (figs. 16 and 17). The primary industry accounted for over 73 percent of these employees (31,700 workers), and the secondary industry employed the remaining 11,500 workers. The primary forest products industry includes logging; processing logs into lumber and other wood products; and processing wood residues from timber-processing plants into outputs such as paper, particleboard, fiberboard, or electricity. The secondary industry includes the further processing of the outputs from the primary manufacturers regardless of the location of the primary manufacturers. The distinction is not always clear, and portions of the secondary industry, such as cut stock manufacturers and portions of the laminated veneer lumber sector, which processes veneer but not timber, are directly linked and highly integrated with the primary industry. The Oregon Forest Resource Institute (OFRI 2014) in cooperation with the Oregon Employment Department, and the Oregon Department of Forestry reported 58,814

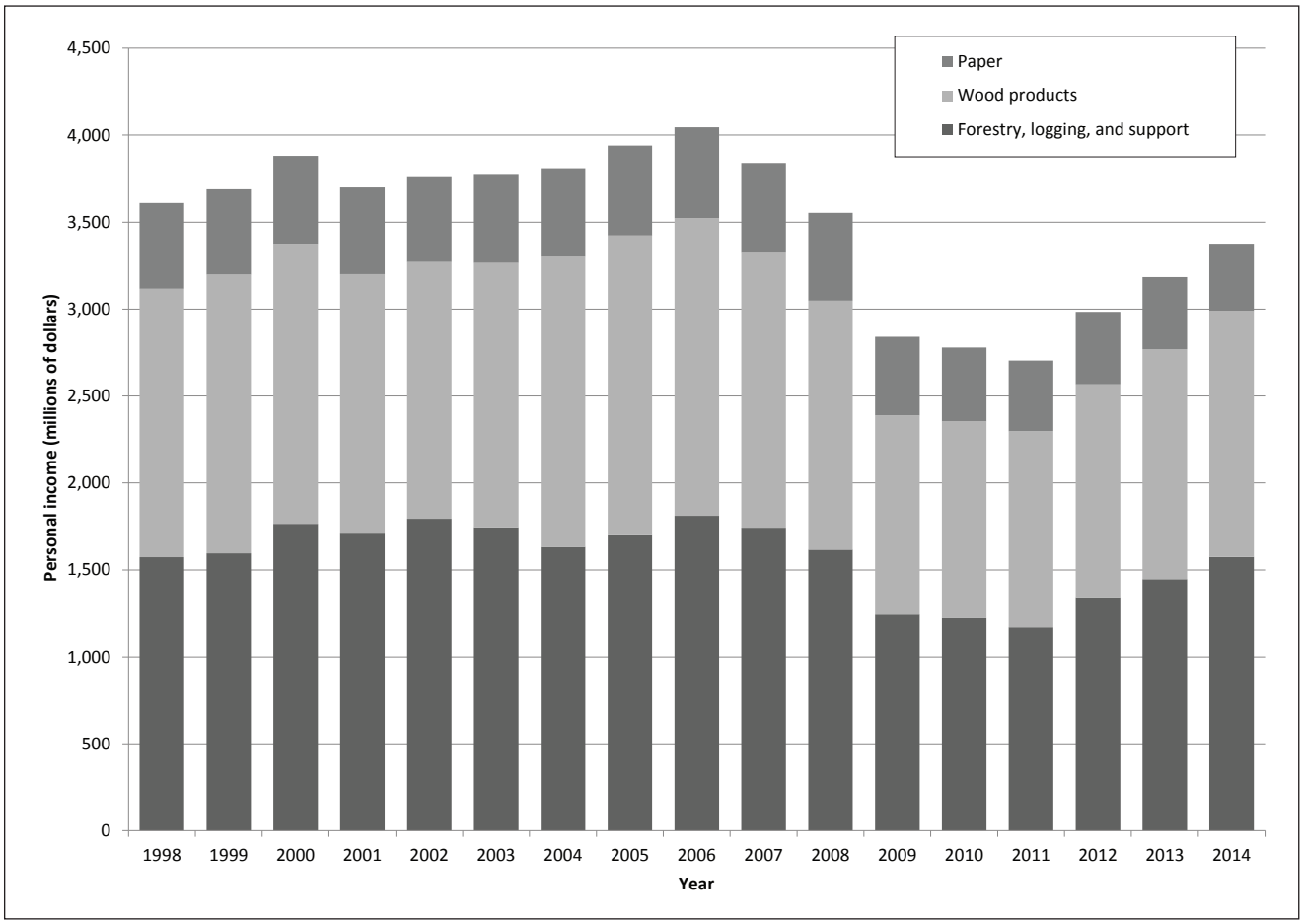

Figure 17—Personal income in Oregon's forest products industry, 1998–2014. Source: USDC BEA (2015).

forest sector jobs for 2013, including federal agency forestry workers, wood and paper wholesaling, transportation, and secondary forest products.

Many factors influence forest industry employment and labor income. These can be related to the volume, size, and quality of timber; how and where it is harvested and processed; the level of processing; the degree of utilization of wood fiber residue; market conditions; technological innovations; and other factors such as public policy, regulations, and shifts in forest management regimes/objectives.

Although changing timber availability was a major factor influencing Oregon's forest products industry in the 1990s (Brandt et al. 2006, Keegan et al 2006), market conditions have been the driving force over the past decade (Gale et al. 2012, Keegan et al. 2012). As Oregon's timber harvest fell from 6.9 BBF Scribner in 1990 to 3.8 BBF in 2000, total forest industry employment declined from approximately 72,000 workers in 1990 to just over 65,000 in 1999.

Although market conditions improved in the early 2000s, Oregon's wood product and paper industry employment actually declined about 2.7 percent from about 59,000 workers in 2001 to 57,400 workers in 2005 (U.S. Department of Labor 2014). This reduction resulted from a number of factors including investment in labor-saving wood-processing technology, more efficient use of existing plants and equipment, and a shift in log processing from the more labor-intensive plywood and large-log sawmill industry to capital-intensive small-log mills. As markets dramatically weakened and harvest and production fell from the peak levels of 2004 and 2005, employment dropped by more than 18,000 workers from 2005 to 2011. Most of the job losses occurred in the wood product sector (72 percent) followed by the forestry, logging, and support sector (19 percent). Since 2011, there has been a slow recovery with about 3,300 jobs added by 2013. Most of these jobs have occurred in the wood products sector (57 percent), followed by the forestry, logging, and support sectors (43 percent). The paper manufacturing sector continues to experience decline.

Labor income includes wages, salaries, and selected employer-paid benefits (such as retirement). Because mill managers can adjust labor (e.g., by changing workers' hours) more easily than other factors of production, labor income is more closely correlated with output than employment. Also, labor income provides a consistent measure of economic activity at different scales; values can be scaled up for statewide estimates and scaled down for county-level estimates. There was 6.5-percent growth in labor income from 2001 to 2005 after adjusting for inflation (fig. 17). From 2005 to 2011, labor income experienced a dramatic decline of 31 percent, associated with the financial crisis and resultant housing market collapse. By 2013, labor income had recovered somewhat, increasing 18 percent from 2011.

Acknowledgments

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Metric Equivalents

When you know:	Multiply by:	To find:
Inches	2.54	Centimeters
Feet	0.305	Meters
Miles	1.609	Kilometers
Acres	0.405	Hectares
Square feet	0.0929	Square meters
Square feet per acre	0.229	Square meters per hectare
Cubic feet	0.0283	Cubic meters
Cubic feet per acre	0.07	Cubic meters per hectare
Ounce	28,349.5	Milligrams
Pounds	0.454	Kilograms
Pounds per cubic foot	16.02	Kilograms per cubic meter
Tons per acre	2.24	Megagrams per hectare
Pounds per cubic foot	0.016	Grams per cubic centimeter
Degrees Fahrenheit	.56 (°F–32)	Degrees Celsius

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