# United States Forest Inventory and Harvest Trends on Privately-Owned Timberlands

Forest2Market

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# 1 Executive Summary

## 1.1 Overview and Objectives

History demonstrates that strong markets for wood products help keep U.S. forests sustainable. Since 1953, growth has exceeded harvest, and the total volume of growing trees on U.S. timberlands has increased by 50 percent.[1] In recent years (i.e., 1982 to 2007), the total acres of forest land has remained stable.[2]

The National Alliance of Forest Owners (NAFO) contracted Forest2Market to study recent trends in inventories and removals on privately-owned[3] timberlands[4] in forested areas of the contiguous United States to determine whether more wood is growing on U.S. timberlands than is harvested. This first-of-its-kind national report details the results of our analyses. We report annual inventory[5] and removal[6] data by product, species and region and summarize this data at a national level.

## 1.2 Study Scope

### 1.2.1 Geographic Area

Forest2Market analyzed privately-owned timberlands in 32 states in the contiguous U.S. grouped into three regions: South, North and Pacific Coast/Northwest. By region, there were 13 states in the South, 14 in the North and 5 in the Pacific Coast/Northwest as shown in Figure 1-1 on the following page. Data are reported separately for each region and also summarized at the national level.

[1] Future of America's Forests and Rangelands: Forest Service 2010 Resources Planning Act Assessment (p. 47-48)
[2] Future of America's Forests and Rangelands: Forest Service 2010 Resources Planning Act Assessment (p. 30)
[3] Private owners include non-industrial private forest (NIPF) landowners (i.e., individuals, families, trusts, estates, and family partnerships), corporate entities (e.g., Timberland Investment Management Organizations (TIMOs), Real Estate Investment Trusts (REITs), and integrated forest products companies), Native Americans, non-governmental conservation/natural resources organizations and unincorporated local partnerships, associations or clubs.
[4] The U.S. Forest Service classifies any forest capable of producing 20 cubic feet of wood per acre per year at culmination of mean annual increment as "timberland." This category excludes reserved forestland, which will never be subject to harvest.
[5] Refer to Section 1.3.
[6] Refer to Section 1.3.

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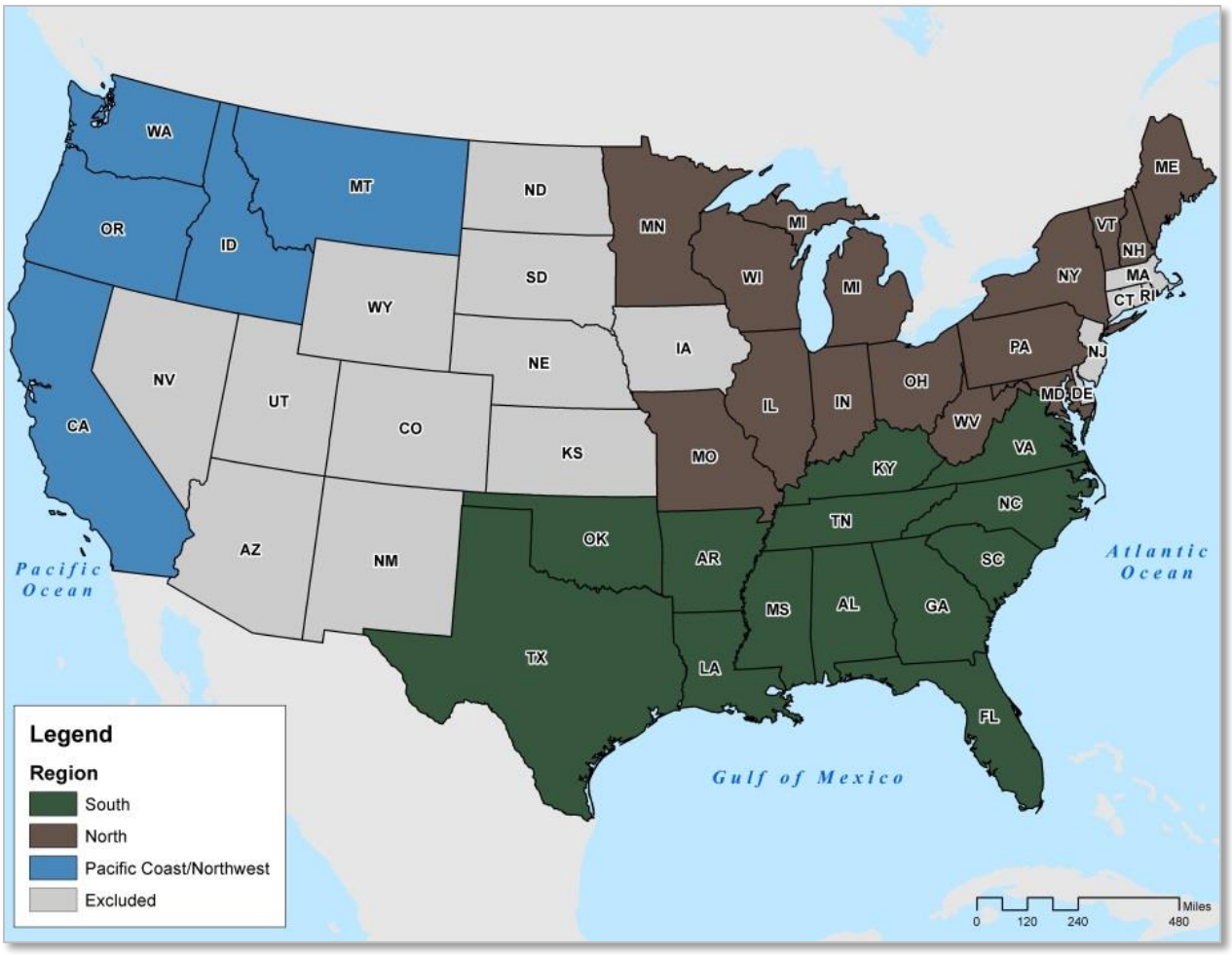


**Figure 1-1 Map of Study Area**

### 1.2.2 Time Period

The U.S. Forest Service's Forest Inventory and Analysis (FIA) Program is mandated to perform periodic assessments of the nation's forests. Due to differences in how FIA data are collected in different regions, the quantity and quality of inventory and removal data from FIA varies by state. In general, the U.S. South has the longest data coverage in the program, while the Pacific Northwest has the shortest. As a result, Forest2Market's analysis covers 2000-2014 in the U.S. South and 2008-2014 in all other regions.

## 1.3 Using the Data in this Report

**Inventory**, as calculated by the U.S. Forest Service, refers to the net volume (in cubic feet) of growing-stock trees at least 5 inches in diameter-at-breast-height on timberland. **Removals**, as described by the U.S. Forest Service, refer to "[t]rees that were growing-stock trees on timberland at the time of the previous inventory and were removed from timberland by the time of the current inventory." Removals include "cut and utilized trees, trees killed as a result of harvest operations but not utilized, and live trees associated with land-use reclassifications." **Growth** refers to increases in volume attributable to

biological tree growth as trees age and grow. Growth rates vary due to many factors, including species, age and the type and intensity of any silvicultural treatments that are used on the stand.

Analyzing **inventory change** over time is one way to gauge the balance of growth and removals in a specific geographic area. Inventory increases indicate that biological tree growth outpaces removals. Inventory decreases indicate that removals outpace tree growth. A more precise way to gauge the balance of growth and removals is to look at the **growth-to-removal ratio (GRR)**, which reflects the extent to which growth outpaces removals or vice versa. In this report, we calculate growth[7] using the following formula:

$$Growth_{T1} = Inventory_{T2} - Inventory_{T1} + Removals_{T1}$$

The GRR is calculated by dividing growth by removals. If the result is over 1.0, more wood was grown than was removed during that time period. If it is less than 1.0, more wood was removed than was grown. This figure also describes the extent to which growth outpaces removals. For example, a GRR of 1.33 means that growth outpaced removals by 33% whereas a GRR of 1.06 means that growth outpaced removals by 6%. Conversely, a GRR of 0.95 means that removals outpaced growth by 5% and a GRR of 0.78 means that removals outpaced growth by 22%. For the North and Pacific Coast/Northwest Regions and in the National summary, we report the average GRR for the period 2008-2013; for the South, we report the average GRR for the period 2000-2013.[8]

Analyzing **removals as a percentage of inventory** is one way to describe the scope of removals in comparison to the total available resource (i.e., inventory). This percentage should not be interpreted as a description of the amount of inventory that was depleted in a given year. This is because while harvest removals occur each year, trees that were not harvested continue to grow, and new trees are replanted or regenerate naturally. Changes in removals as a percentage of inventory reflect changes in inventory and removals. For example, increases in inventory and/or decreases in removals can cause the removals as a percentage of inventory to decrease over time. Conversely, decreases in inventory and/or increases in removals can cause the removals as a percentage of inventory to increase over time.

## 1.4 Overall Trends

Our analysis indicates that overall inventories have increased between 2008 and 2014 and that forest growth exceeds harvest removals on privately-owned timberlands.

- In total, forest inventory has increased 6.2% from 393.6 billion cubic feet (BCF) in 2008 to 418.0 BCF in 2014 (Table 1-1).
- Total removals have declined by 3.3% from 10.45 BCF in 2008 to 10.11 BCF in 2014 (Table 1-1).
- Total removals were equivalent to 2.7% of inventory in 2008 and 2.4% of inventory in 2014 (Figure 1-2).
- Between 2008 and 2013, the average GRR was 1.40; approximately 40% more wood was grown than was harvested on privately-owned timberlands in the study area.

[7] This is a simplified method to calculate growth when inventory and removals are known. Because the U.S. Forest Service uses sampling methods to derive estimates of annual inventory, removals, growth and mortality independently, the growth estimates in this report will differ from the Forest Service's estimates. Additionally, because this formula excludes mortality, growth in this report may be understated.

[8] Because growth is calculated using two consecutive years of inventory data as shown in the above formula, we can only provide an average GRR through 2013 for all regions in this analysis.

**Table 1-1 Total Inventory and Removals, Cubic Feet (billions) – All Regions**

| Year | All Species Total | | All Species Sawtimber | | All Species Pulpwood | |
|---|---|---|---|---|---|---|
| | Inventory | Removals | Inventory | Removals | Inventory | Removals |
| 2008 | 393.6 | 10.45 | 257.5 | 6.99 | 136.1 | 3.46 |
| 2009 | 397.4 | 9.89 | 261.2 | 6.44 | 136.2 | 3.45 |
| 2010 | 401.2 | 10.25 | 264.8 | 6.73 | 136.3 | 3.51 |
| 2011 | 405.4 | 10.43 | 268.5 | 6.86 | 136.9 | 3.57 |
| 2012 | 409.5 | 10.22 | 272.1 | 6.73 | 137.3 | 3.49 |
| 2013 | 413.1 | 10.16 | 275.5 | 6.73 | 137.6 | 3.44 |
| 2014 | 418.0 | 10.11 | 279.7 | 6.68 | 138.3 | 3.43 |
| Compounded annual change | 1.0% | -0.6% | 1.4% | -0.8% | 0.3% | -0.1% |

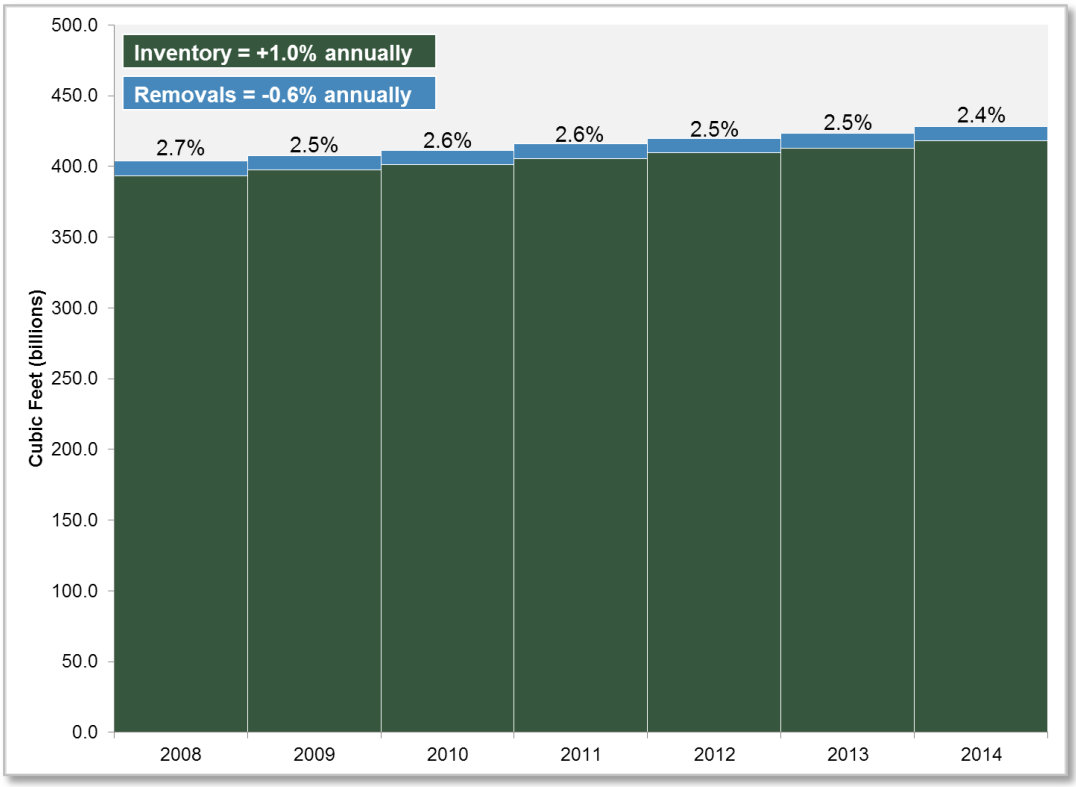


**Figure 1-2 Total Removals Relative to Inventory, 2008-2014 – All Regions**

### 1.4.1 Conifer/Pine Species

- Total conifer/pine inventory increased 10.7% from 196.2 BCF in 2008 to 217.2 BCF in 2014 (Table 1-2).
- Conifer/pine removals increased 1.8% from 7.35 BCF in 2008 to 7.48 BCF in 2014.
- Conifer/pine removals were equivalent to 3.7% of inventory in 2008 and 3.4% of inventory in 2014 (Figure 1-3).
- Between 2008 and 2013, the average conifer/pine GRR was 1.47; approximately 47% more conifer/pine was grown than was harvested on privately-owned timberlands in the study area.

**Table 1-2 Conifer Inventory and Removals, Cubic Feet (billions) – All Regions**

| Year | Total Conifer | | Conifer Sawtimber | | Conifer Pulpwood | |
|---|---|---|---|---|---|---|
| | Inventory | Removals | Inventory | Removals | Inventory | Removals |
| 2008 | 196.2 | 7.35 | 140.8 | 5.02 | 55.5 | 2.33 |
| 2009 | 198.6 | 6.94 | 142.8 | 4.58 | 55.8 | 2.36 |
| 2010 | 201.5 | 7.36 | 145.4 | 4.93 | 56.1 | 2.43 |
| 2011 | 204.8 | 7.56 | 148.1 | 5.06 | 56.8 | 2.50 |
| 2012 | 208.6 | 7.45 | 151.0 | 5.00 | 57.6 | 2.45 |
| 2013 | 212.8 | 7.48 | 154.3 | 5.05 | 58.5 | 2.42 |
| 2014 | 217.2 | 7.48 | 157.8 | 5.04 | 59.4 | 2.45 |
| Compounded annual change | 1.7% | 0.3% | 1.9% | 0.1% | 1.1% | 0.8% |

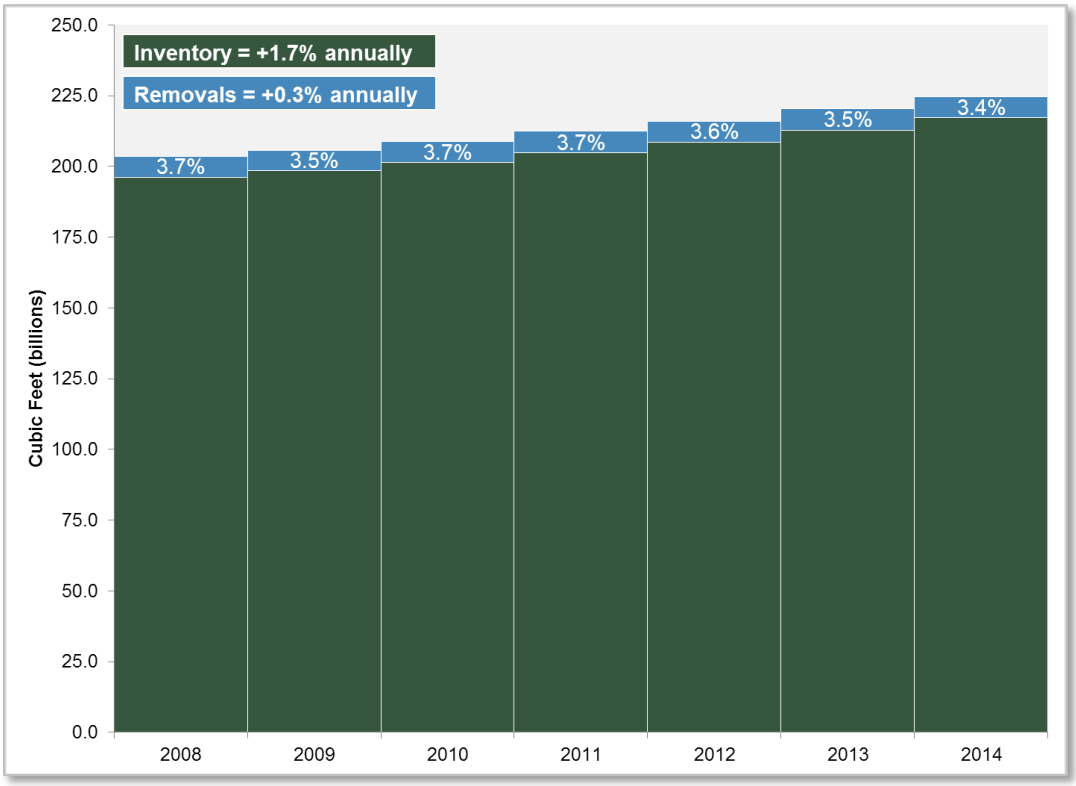


**Figure 1-3 Total Conifer Removals Relative to Inventory, 2008-2014 – All Regions**

### 1.4.2 Hardwood Species

- Total hardwood inventory increased 1.8%, from 197.3 BCF in 2008 to 200.8 BCF in 2014 (Table 1-3).
- Hardwood removals decreased 15.4% from 3.10 BCF in 2008 to 2.62 BCF.
- Hardwood removals were equivalent to 1.6% of inventory in 2008 and 1.3% of inventory in 2014 (Figure 1-4).
- Between 2008 and 2013, the average hardwood GRR was 1.19; approximately 19% more hardwood was grown than was harvested on privately-owned timberlands in the study area.

**Table 1-3 Hardwood Inventory and Removals, Cubic Feet (billions) – All Regions**

| Year | Total All Species | | All Species | | All Species Pulpwood | |
|---|---|---|---|---|---|---|
| | Inventory | Removals | Inventory | Removals | Inventory | Removals |
| 2008 | 197.3 | 3.10 | 116.7 | 1.97 | 80.6 | 1.13 |
| 2009 | 198.9 | 2.96 | 118.4 | 1.86 | 80.5 | 1.10 |
| 2010 | 199.7 | 2.89 | 119.5 | 1.81 | 80.3 | 1.08 |
| 2011 | 200.6 | 2.86 | 120.5 | 1.79 | 80.1 | 1.07 |
| 2012 | 200.9 | 2.77 | 121.1 | 1.73 | 79.8 | 1.04 |
| 2013 | 200.3 | 2.69 | 121.1 | 1.67 | 79.1 | 1.01 |
| 2014 | 200.8 | 2.62 | 121.9 | 1.64 | 78.9 | 0.99 |
| Compounded annual change | 0.3% | -2.7% | 0.7% | -3.1% | -0.3% | -2.2% |

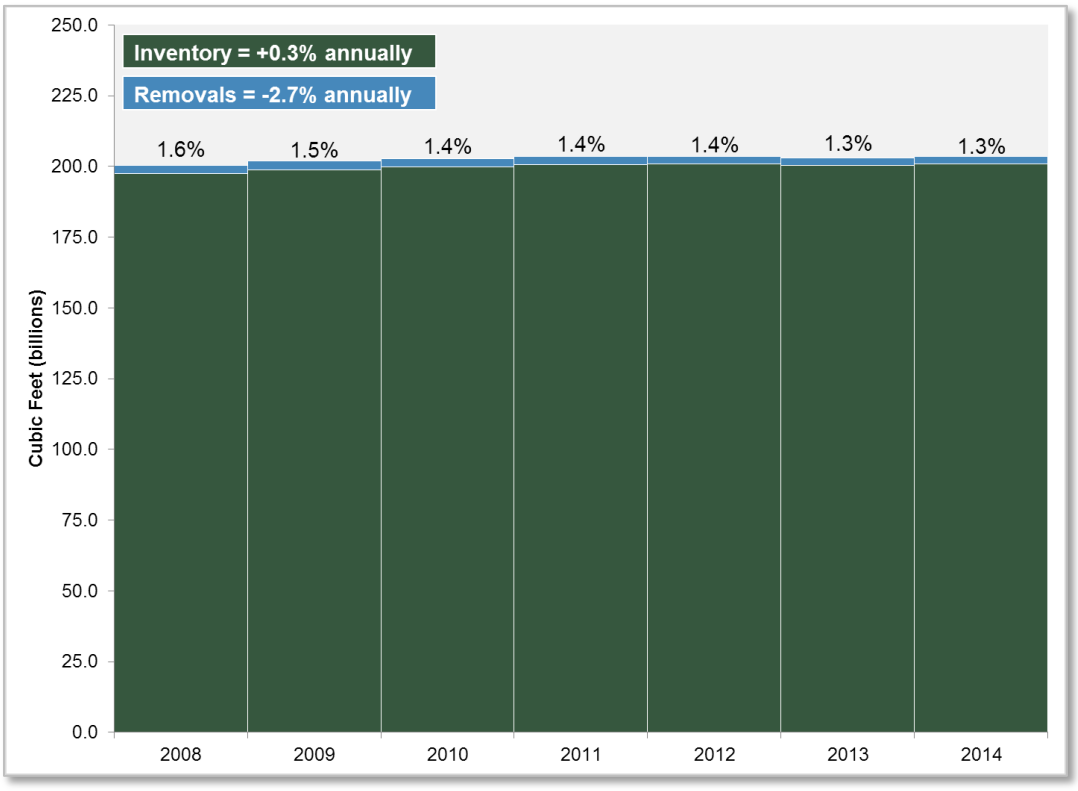


**Figure 1-4 Total Hardwood Removals Relative to Inventory, 2008-2014 – All Regions**

## 1.5 Regional Trends

### 1.5.1 South

- The increase in total study area inventory between 2008 and 2014 was largely driven by increases in Southern inventories during this period. Total inventory in the South increased 8.1% from 231.7 BCF in 2008 to 250.4 BCF in 2014. Between 2000 and 2014, total inventory in the South increased 10.9% from 225.8 BCF to 250.4 BCF (Figure 1-5).
- Total removals in the South declined 4.8% from 7.76 BCF in 2008 to 7.39 BCF in 2014. Between 2000 and 2014, total removals in the South decreased 12.4% from 8.43 BCF in 2000 to 7.39 BCF in 2014 (Figure 1-5).
- In the South, an average of 23% more wood was grown than was harvested between 2000 and 2013 (GRR=1.23). Between 2008 and 2013, 41% more wood was grown than was harvested (GRR=1.41).
- Refer to Section 3.2 for more detailed information about Southern inventory and removals, including a breakdown by species and product class.

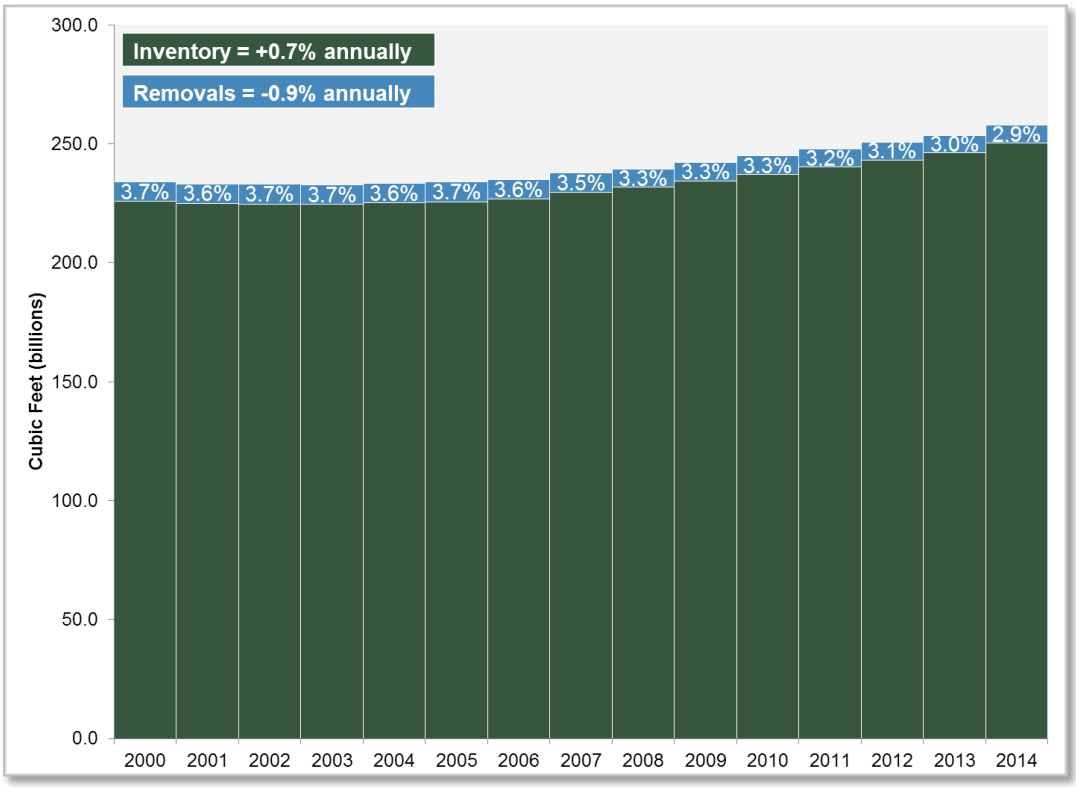


**Figure 1-5 Total Removals Relative to Inventory, 2000-2014 – South**

### 1.5.2 North

- Total inventory in the North increased 2.7% from 76.3 BCF in 2008 to 78.3 BCF in 2014 (Figure 1-6).
- Total removals in the North declined 14.0% from 1.07 BCF in 2008 to 0.92 BCF in 2014 (Figure 1-6).
- Between 2008 and 2013, an average of 32% more wood was grown than was harvested in the North (GRR=1.32).
- Refer to Section 3.3 for more detailed information about Northern inventory and removals, including a breakdown by species and product class.

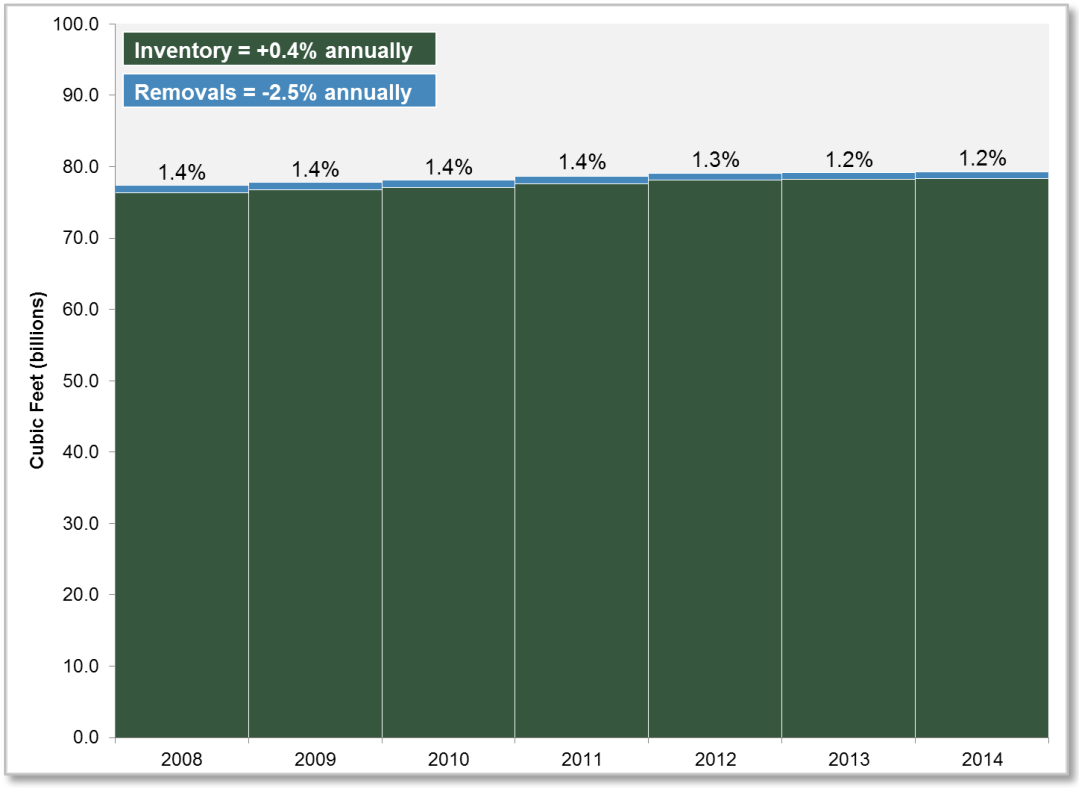


**Figure 1-6 Total Removals Relative to Inventory, 2008-2014 – North**

### 1.5.3 Pacific Coast/Northwest

- Total inventory in the Pacific Coast/Northwest increased 4.4% from 85.5 BCF in 2008 to 89.3 BCF in 2014.
- Total removals in the Pacific Coast/Northwest increased 11.3% from 1.62 BCF in 2008 to 1.80 BCF in 2014.
- Between 2008 and 2013, an average of 42% more wood was grown than was harvested in the Pacific Coast/Northwest (GRR=1.42).
- Refer to Section 3.4 for more detailed information about Pacific Coast/Northwest inventory and removals, including a breakdown by species and product class.

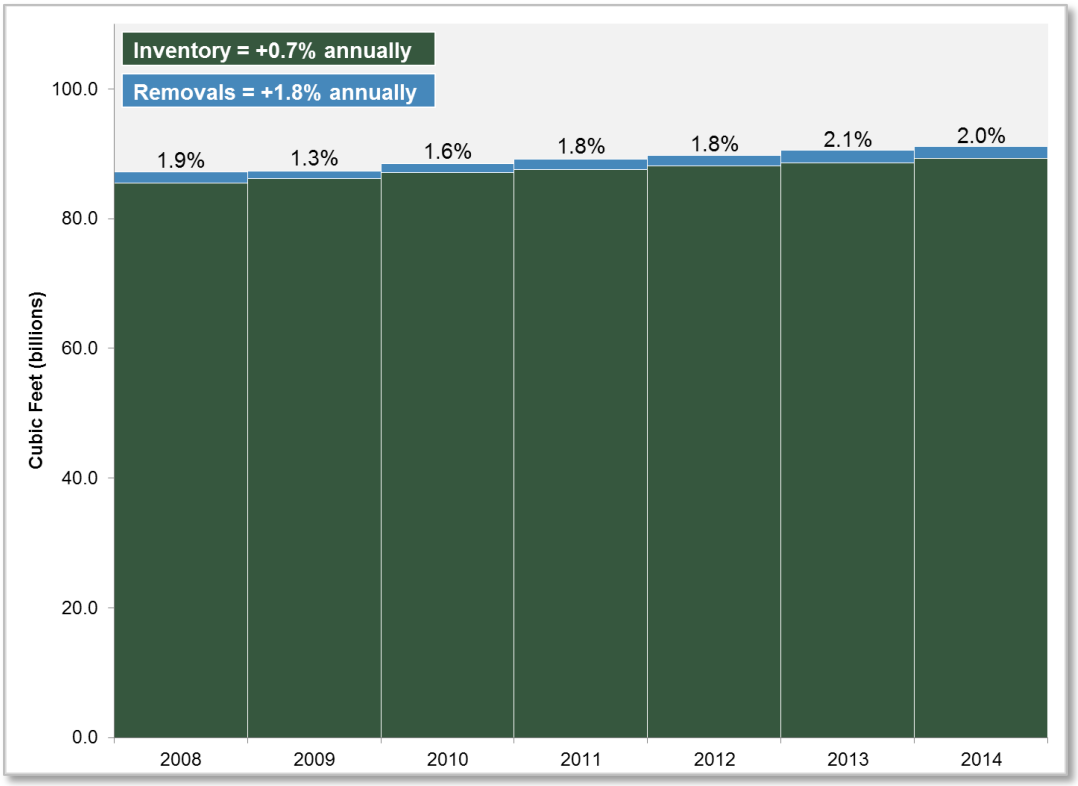


**Figure 1-7 Total Removals Relative to Inventory, 2008-2014 – Pacific Coast/Northwest Region**

# 2 National Removal and Inventory Trends

## 2.1 Historical Overview

As described in a previous Forest2Market publication[9], the forest products industry in the United States has experienced significant change since 2000.

### 2.1.1 Shifts in the Pulp and Paper Market

In response to the dot-com boom of the 1990s, Americans reduced their reliance on newsprint and printing papers, and a series of acquisitions and consolidations in the forest products industry began to occur. In the mid-2000s, the use of printing papers and newsprint continued to decline while healthy growth in GDP led to increased demand for containerboard (i.e., corrugated packaging) and fluff pulp (used for sanitary products). Shifts in the paper market brought about by the digital age increased due to the Great Recession (2007-2009), and several uncoated freesheet (e.g., copy paper) and newsprint mills closed or converted to manufacture other products, such as market pulp (i.e. Southern Bleached Softwood Kraft [SBSK] or Northern Bleached Softwood Kraft [NBSK]), fluff pulp or containerboard.

Following the Great Recession, newsprint and uncoated freesheet capacity continued to close or convert to other products like containerboard, fluff pulp and performance fibers (i.e., specialty fibers used in a range of consumer applications, such as pharmaceuticals, tires, acetate and rayon pulps), especially in the U.S. South.[10] The strength of the dollar and the ever-expanding digital age continue to affect paper producers, most notably in the North as recent paper mill closures—including five in the state of Maine—demonstrate.

As demand for printing and writing papers has declined, demand for hardwood pulpwood, a common feedstock used in coated and uncoated freesheet has also declined. In addition, mills that converted their product lines to fluff pulp, containerboard and other grades typically also converted much of their feedstock to conifer species rather than hardwood, which has resulted in some increases in conifer pulpwood demand.

### 2.1.2 The Great Recession Impact on Solid Wood

The Great Recession had significant detrimental effects on U.S. housing starts and, therefore, solid wood producers. Housing starts fell from a peak of 2.3 million indexed annual starts per year in January 2006 to a historical low of fewer than 500,000 in early 2009. In the U.S. South alone, approximately 20 southern yellow pine (SYP) sawmills, 10 plymills and 3 OSB mills closed between 2007-2009. The period following the Great Recession marked a gradual improvement in domestic solid wood production in response to improving housing starts.

#### *Supply and Demand Effects*

The dramatic reduction in housing starts that occurred during the Great Recession reduced demand for sawtimber leading to significant reductions in sawtimber removals. Conifer/pine-consuming solid wood manufacturers were negatively impacted by the reduction in housing starts as demand for lumber, plywood and OSB dramatically declined. Similarly, demand for hardwood sawtimber, commonly used in the manufacture of specialty solid wood products, such as flooring, furniture, cabinetry and millwork, declined significantly during and following the Great Recession as housing starts and remodeling declined.

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[9] Forest2Market, Inc. 2015. *Wood Supply Market Trends in the US South: 1995-2015*. Accessible at http://www.forest2market.com/uploads/Forest2Market/documents/US-South-Wood-Supply-Trends.pdf.

[10] For more information about mill closures and conversions, refer to 4.1.1 of Forest2Market, Inc. 2015. *Wood Supply Market Trends in the US South: 1995-2015*. Accessible at http://www.forest2market.com/uploads/Forest2Market/documents/US-South-Wood-Supply-Trends.pdf.

Declines in solid wood manufacturing during the Great Recession led to a reduction in the available supply of residual chips, which are produced as byproducts during solid wood manufacturing processes. Reduced residual chip supply required pulp, paper, panel and pellet mills, which can typically use either chipped pulpwood or residual chips, to use more pulpwood.[11] Therefore, increased demand for pulpwood was driven in part by stagnant sawtimber harvests that are still slowly recovering from the Great Recession.

### *Inventory Effects*

The disruptions in typical harvest patterns that occurred during and after the housing market crash and subsequent global economic downturn had notable effects on privately-owned forest inventories. In healthy forest products markets, demand from the forest products industry ensures a continuous cycle wherein a forest is harvested, regenerates into pulpwood that is selectively harvested and continues to grow into sawtimber that is later harvested and regenerated again. When demand for sawtimber wanes, final harvests may be delayed as landowners wait for more favorable market conditions. Because forests continued to grow as demand for sawtimber decreased or remained static during and following the Great Recession, sawtimber inventories increased, sometimes significantly.

When sawtimber is not harvested, pulpwood supply and inventory are also affected. First, pulpwood and topwood that would ordinarily be harvested alongside sawtimber remains on the stump, and this leads to short-term reductions in available pulpwood supply. Second, reduced residual chip supply results in increased pulpwood harvest, which may reduce pulpwood inventory more quickly than is typical. Third, trees left on the stump after thinning will eventually grow into sawtimber-sized trees, which results in increasing sawtimber inventories and an overabundance of potential sawtimber supply over time. Furthermore, when sawtimber trees do not undergo final harvest, they are also not replanted, which further reduces pulpwood inventory in the medium- to long-term. As this and previous[12] Forest2Market analyses indicate, harvest disruptions such as those that occurred during the Great Recession distort the age class distribution of the forest such that sawtimber accumulates and pulpwood declines. Therefore, some "loss" of pulpwood inventory is not loss at all but simply trees growing into a larger product class.

## 2.1.3 Export Markets

In response to renewable energy goals in Europe, industrial wood pellet mills entered the U.S. market for wood fiber in the mid- to late-2000s. Export wood pellet mills primarily located in the South due to the abundance of fast-growing pine[13] in this region. In 2007 and 2008, the first two industrial wood pellet mills were built in the South in Georgia and Florida. By 2014, 16 industrial pellet mills had begun operations in the South. In response to questions on the impact of wood pellet mills on the sustainability of forests in the South, Forest2Market analyzed the impact of pellets on both removals and inventory. [14] Not surprisingly, this analysis showed that pine and hardwood removals attributable to industrial pellet mills have increased

[11] For a more detailed discussion of drivers behind increased pulpwood harvest in the U.S. South, refer to Forest2Market's report entitled *Wood Supply Market Trends in the US South: 1995-2015*, which is accessible at http://www.forest2market.com/uploads/Forest2Market/documents/US-South-Wood-Supply-Trends.pdf.
[12] For an analysis of pine inventory in the U.S. South, see http://blog.forest2market.com/us-south-future-implications-part1-timber-inventory. Note that the "South" area and methodology used in that analysis may vary from the methods used in this report, so it may not be directly comparable.
[13] Refer to Section 3.1
[14] For more information, see *Wood Supply Market Trends in the US South: 1995-2015*. Accessible at http://www.forest2market.com/uploads/Forest2Market/documents/US-South-Wood-Supply-Trends.pdf.

as the number of pellet mills has increased. Notable, however, is the fact that pellet removals are a very small fraction of total removals, and pellet removals represent only 0.08% of total forest inventory.[15]

Since 2009, log exports from the Pacific Northwest to China increased significantly as well. More recently, export demand has declined as China's economy has softened and the US dollar has gained strength against major currencies.

The impacts of these market trends on removals and inventory are discussed further below.

## 2.2 Total (All Species) Inventory and Removals

Over the time periods and geographic areas we analyzed, total[16] removals have decreased, and total forest inventory has increased (Table 2-1). Total removals decreased at a rate of 0.6% compounded annually from 10.45 BCF in 2008 to 10.11 BCF in 2014. On average, growth exceeded removals by 40% (GRR=1.40). Because forest growth outpaced removals over this period, total inventory across all regions increased at a rate of 1.0% compounded annually from 393.6 billion cubic feet (BCF) in 2008 to 418.0 BCF in 2014.

**Table 2-1 Total Inventory and Removals, Cubic Feet (billions) – All Regions**

| Year | All Species Total | | All Species Sawtimber | | All Species Pulpwood | |
|---|---|---|---|---|---|---|
| | Inventory | Removals | Inventory | Removals | Inventory | Removals |
| 2008 | 393.6 | 10.45 | 257.5 | 6.99 | 136.1 | 3.46 |
| 2009 | 397.4 | 9.89 | 261.2 | 6.44 | 136.2 | 3.45 |
| 2010 | 401.2 | 10.25 | 264.8 | 6.73 | 136.3 | 3.51 |
| 2011 | 405.4 | 10.43 | 268.5 | 6.86 | 136.9 | 3.57 |
| 2012 | 409.5 | 10.22 | 272.1 | 6.73 | 137.3 | 3.49 |
| 2013 | 413.1 | 10.16 | 275.5 | 6.73 | 137.6 | 3.44 |
| 2014 | 418.0 | 10.11 | 279.7 | 6.68 | 138.3 | 3.43 |
| Compounded annual change | 1.0% | -0.6% | 1.4% | -0.8% | 0.3% | -0.1% |

In order to understand the driving factors behind these shifts in inventory and removals, a more nuanced analysis by species (i.e., pine/conifer vs. hardwood) and product class (i.e., pulpwood vs. sawtimber) is necessary. This analysis is offered in the following sections.

## 2.3 Conifer/Pine Inventory and Removals

Conifer/pine species, commonly known as "softwood," are used as feedstocks for lumber, plywood, panel, paper and paperboard manufacturing. Conifer/pine-consuming solid wood manufacturers were negatively impacted by the reduction in housing starts that occurred during and following the Great Recession. Conifer/pine removals from privately-owned timberlands have remained fairly flat overall; in total, conifer removals increased 0.3% compounded annually from 7.35 BCF in 2008 to 7.48 BCF in 2014 (Table 2-2). Total conifer inventory increased from 196.2 BCF in 2008 to 217.2 BCF in 2014, at a rate of 1.7% compounded annually.

[15] Removals associated with pellets were 0.09% of the total pine inventory and 0.06% of the total hardwood inventory in the U.S. South.

[16] In the South, total inventory includes the four main pine species (loblolly, slash, shortleaf and longleaf) and all hardwood species. In all other regions, total inventory includes all conifer species and all hardwood species.

Conifer/pine sawtimber removals increased 0.1% compounded annually from 5.02 to 5.04 BCF (Table 2-2). Conifer/pine sawtimber inventory increased from 140.8 BCF to 157.8 BCF at a rate of 1.9% annually. Due to shifts in pulpwood demand described in Section 2.1, conifer/pine pulpwood removals increased 0.8% annually from 2.33 to 2.45 BCF, and conifer pulpwood inventory increased 1.1% annually from 55.5 to 59.4 BCF.

**Table 2-2 Conifer Inventory and Removals, Cubic Feet (billions) – All Regions**

| Year | Total Conifer | | Conifer Sawtimber | | Conifer Pulpwood | |
|---|---|---|---|---|---|---|
| | Inventory | Removals | Inventory | Removals | Inventory | Removals |
| 2008 | 196.2 | 7.35 | 140.8 | 5.02 | 55.5 | 2.33 |
| 2009 | 198.6 | 6.94 | 142.8 | 4.58 | 55.8 | 2.36 |
| 2010 | 201.5 | 7.36 | 145.4 | 4.93 | 56.1 | 2.43 |
| 2011 | 204.8 | 7.56 | 148.1 | 5.06 | 56.8 | 2.50 |
| 2012 | 208.6 | 7.45 | 151.0 | 5.00 | 57.6 | 2.45 |
| 2013 | 212.8 | 7.48 | 154.3 | 5.05 | 58.5 | 2.42 |
| 2014 | 217.2 | 7.48 | 157.8 | 5.04 | 59.4 | 2.45 |
| Compounded annual change | 1.7% | 0.3% | 1.9% | 0.1% | 1.1% | 0.8% |

As shown in Table 2-2, total conifer/pine inventory increased 1.7% compounded annually as removals increased 0.3% compounded annually. Total conifer growth exceeded removals by 47% on average (GRR=1.47) between 2008 and 2013. Because inventory increased at a faster rate than removals, removals as a percentage of inventory declined from 3.7% in 2008 to 3.4% in 2014 (Figure 2-1).

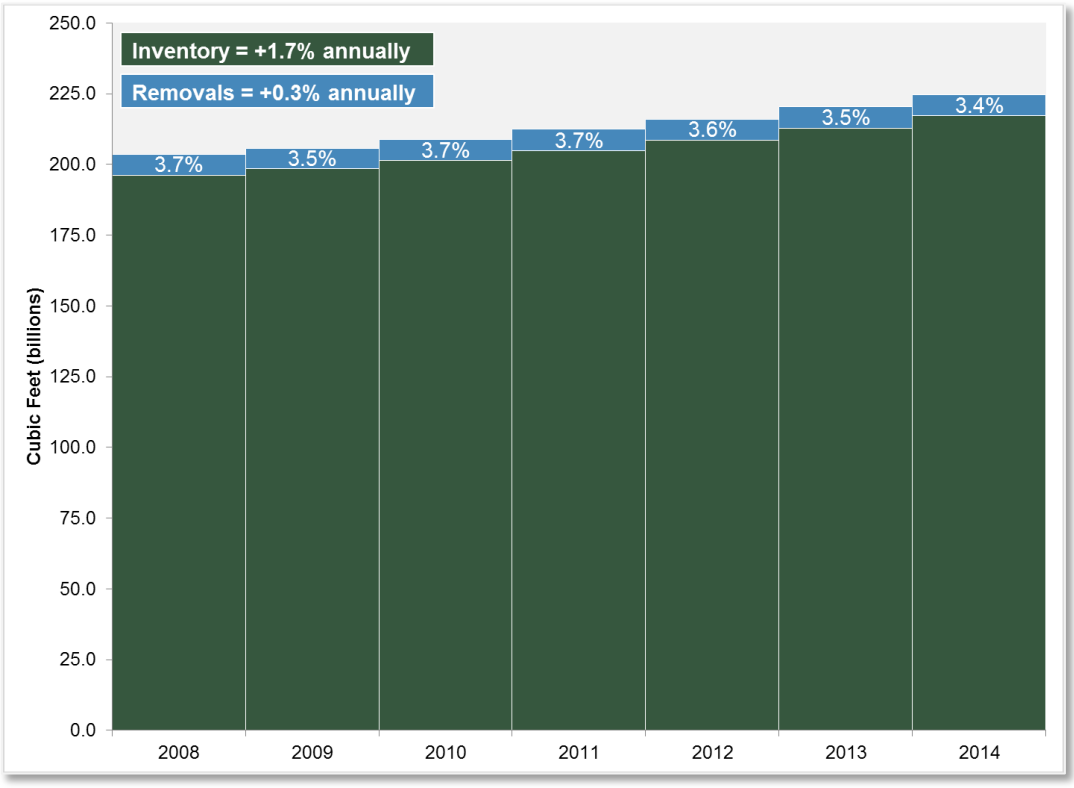


**Figure 2-1 Total Conifer Removals Relative to Inventory, 2008-2014 – All Regions**

### 2.3.1 Conifer/Pine Sawtimber

The trends with conifer/pine sawtimber inventory and removals were even more pronounced. Conifer/pine sawtimber removals increased only 0.1% compounded annually between 2008 and 2014 while inventory increased 1.9% compounded annually. Conifer/pine sawtimber growth exceeded removals by an average of 58% (GRR=1.58) between 2008 and 2013. As a result of flat removals and increased inventories, removals as a percentage of inventory fell from 3.6% in 2008 to 3.2% in 2014 (Figure 2-2).

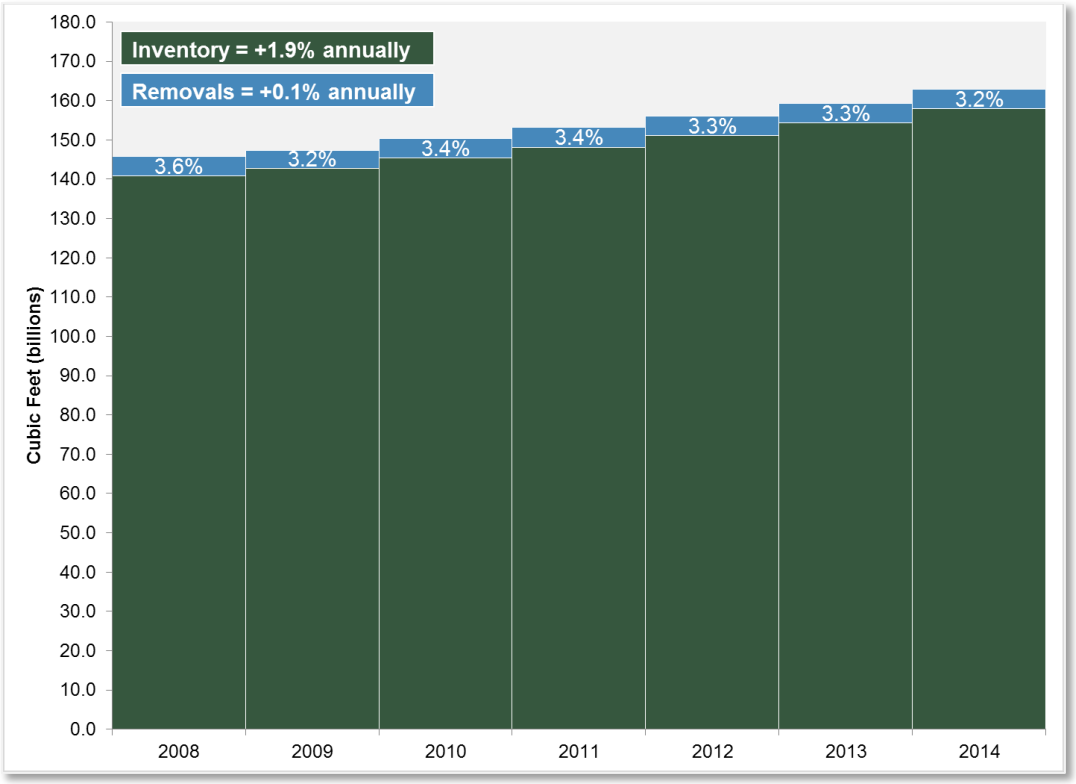


**Figure 2-2 Conifer Sawtimber Removals Relative to Inventory, 2008-2014 – All Regions**

### 2.3.2 Conifer Pulpwood

Due to the factors described in Section 2.1, compounded annual increases in conifer/pine pulpwood inventory (1.1% annually) narrowly outpaced increases in conifer pulpwood removals (0.8% annually) between 2008 and 2014. Conifer/pine pulpwood growth exceeded removals by 27% (GRR=1.27) between 2008 and 2013. As a result, removals were equivalent to 4.2% of inventory in 2008 and 4.1% of inventory in 2014 (Figure 2-3 next page).

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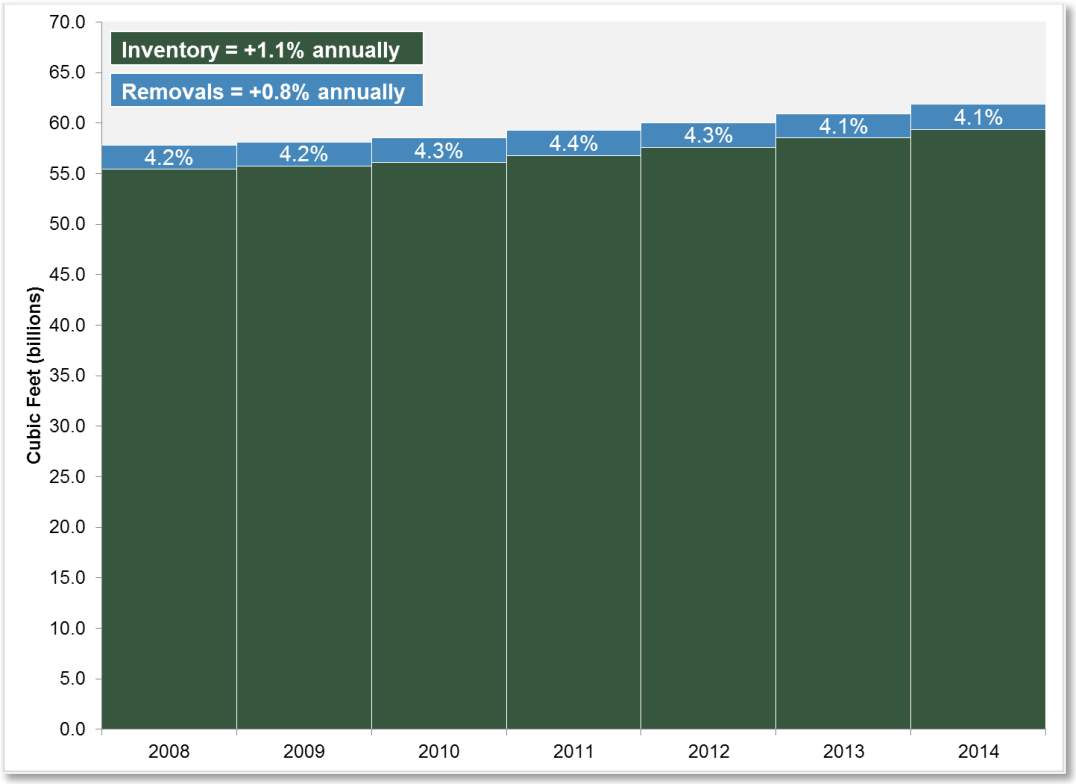


**Figure 2-3 Conifer Pulpwood Removals Relative to Inventory, 2008-2014 – All Regions**

## 2.4 Hardwood Inventory and Removals

Total hardwood removals decreased at a rate of 2.7% compounded annually from 3.10 BCF in 2008 to 2.62 BCF in 2014 (Table 2-3). Total hardwood inventory increased from 197.3 to 200.8 BCF at a rate of 0.3% compounded annually over this period. Hardwood sawtimber removals declined at a rate of 3.1% annually from 1.97 to 1.64 BCF while hardwood sawtimber inventory increased 0.7% compounded annually from 116.7 to 121.9 BCF (Table 2-2). Hardwood pulpwood removals fell 2.2% compounded annually during this period from 1.13 to 0.99 BCF. Hardwood pulpwood inventory decreased 0.3% compounded annually from 80.6 to 78.9 BCF.

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**Table 2-3 Hardwood Inventory and Removals, Cubic Feet (billions) – All Regions**

| Year | Total Hardwood | | Hardwood Sawtimber | | Hardwood Pulpwood | |
|---|---|---|---|---|---|---|
| | Inventory | Removals | Inventory | Removals | Inventory | Removals |
| 2008 | 197.3 | 3.10 | 116.7 | 1.97 | 80.6 | 1.13 |
| 2009 | 198.9 | 2.96 | 118.4 | 1.86 | 80.5 | 1.10 |
| 2010 | 199.7 | 2.89 | 119.5 | 1.81 | 80.3 | 1.08 |
| 2011 | 200.6 | 2.86 | 120.5 | 1.79 | 80.1 | 1.07 |
| 2012 | 200.9 | 2.77 | 121.1 | 1.73 | 79.8 | 1.04 |
| 2013 | 200.3 | 2.69 | 121.1 | 1.67 | 79.1 | 1.01 |
| 2014 | 200.8 | 2.62 | 121.9 | 1.64 | 78.9 | 0.99 |
| Compounded annual change | 0.3% | -2.7% | 0.7% | -3.1% | -0.3% | -2.2% |

Total hardwood growth outpaced hardwood removals by 19% (GRR=1.19) on average between 2008 and 2013. Because total hardwood removals decreased as inventory increased, hardwood removals were a lower percentage of inventory (1.3%) in 2014 than they were in 2008 (1.6%), as shown in Figure 2-4.

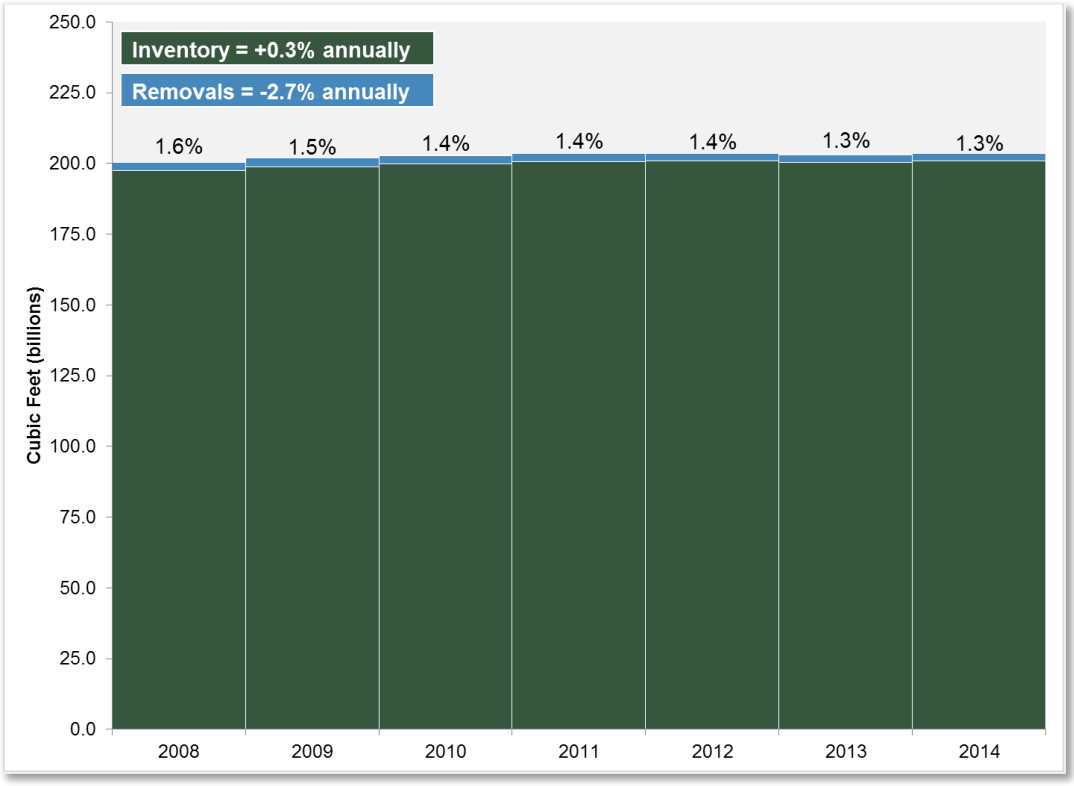


**Figure 2-4 Total Hardwood Removals Relative to Inventory, 2008-2014 – All Regions**

### 2.4.1 Hardwood Sawtimber

In 2008, hardwood sawtimber removals were equivalent to 1.7% of inventory (Figure 2-5). This percentage fell to 1.3% in 2014 due to reduced removals. Between 2008 and 2013, hardwood sawtimber growth outpaced removals by an average of 47% (GRR=1.47).

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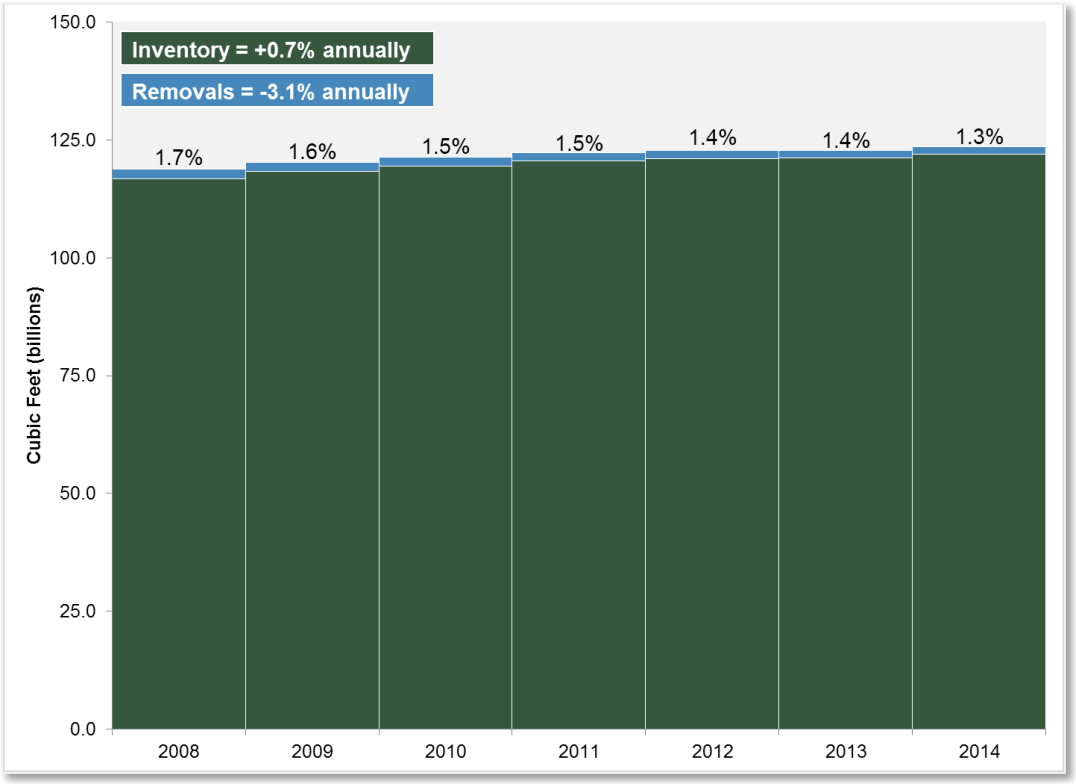


**Figure 2-5 Hardwood Sawtimber Removals Relative to Inventory, 2008-2014 – All Regions**

### 2.4.2 Hardwood Pulpwood

Because hardwood pulpwood removals declined at a faster rate than did hardwood pulpwood inventory, removals fell from the equivalent of 1.4% of inventory in 2008 to 1.3% of inventory in 2014 (Figure 2-6). Removals outpaced hardwood pulpwood growth by 26% on average (GRR=0.74) between 2008 and 2013.

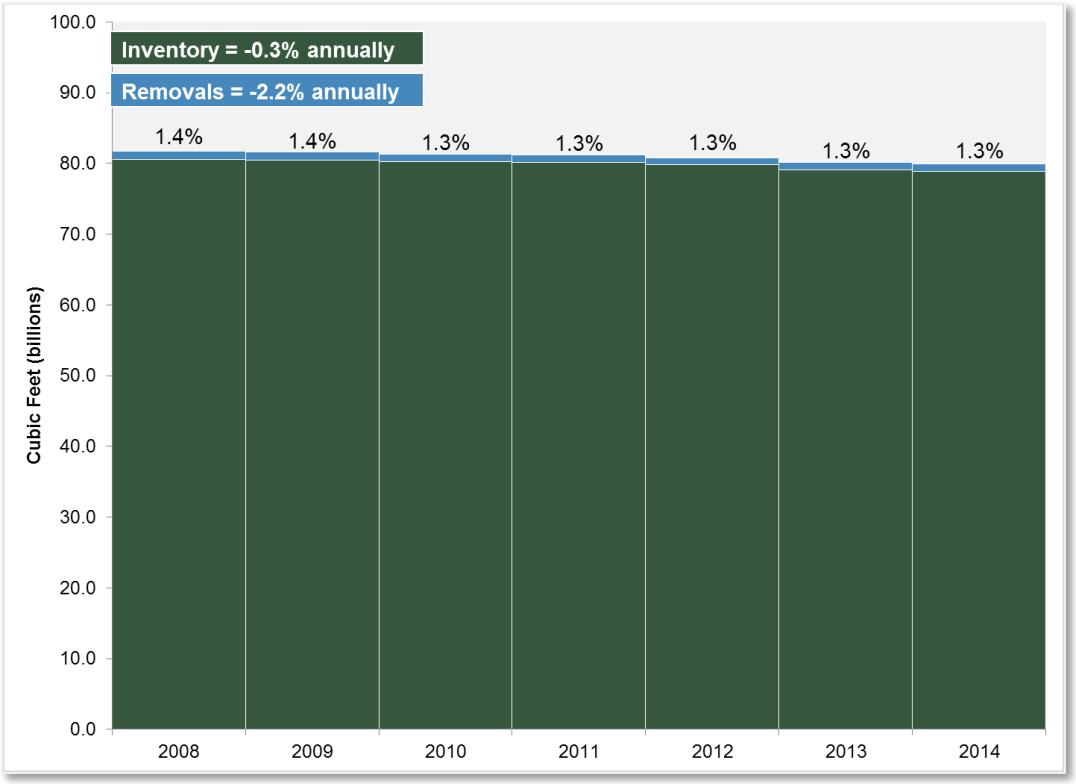


**Figure 2-6 Hardwood Pulpwood Removals Relative to Inventory, 2008-2014 – All Regions**

# 3 Removal and Inventory Trends by Region

## 3.1 Overview

Regionally, forest inventories are a product of the forest types that exist in the different physiographic regions of the United States. In turn, forest inventories also drive harvest removals within each region. Figure 3-1 shows forest type groups in the contiguous United States.

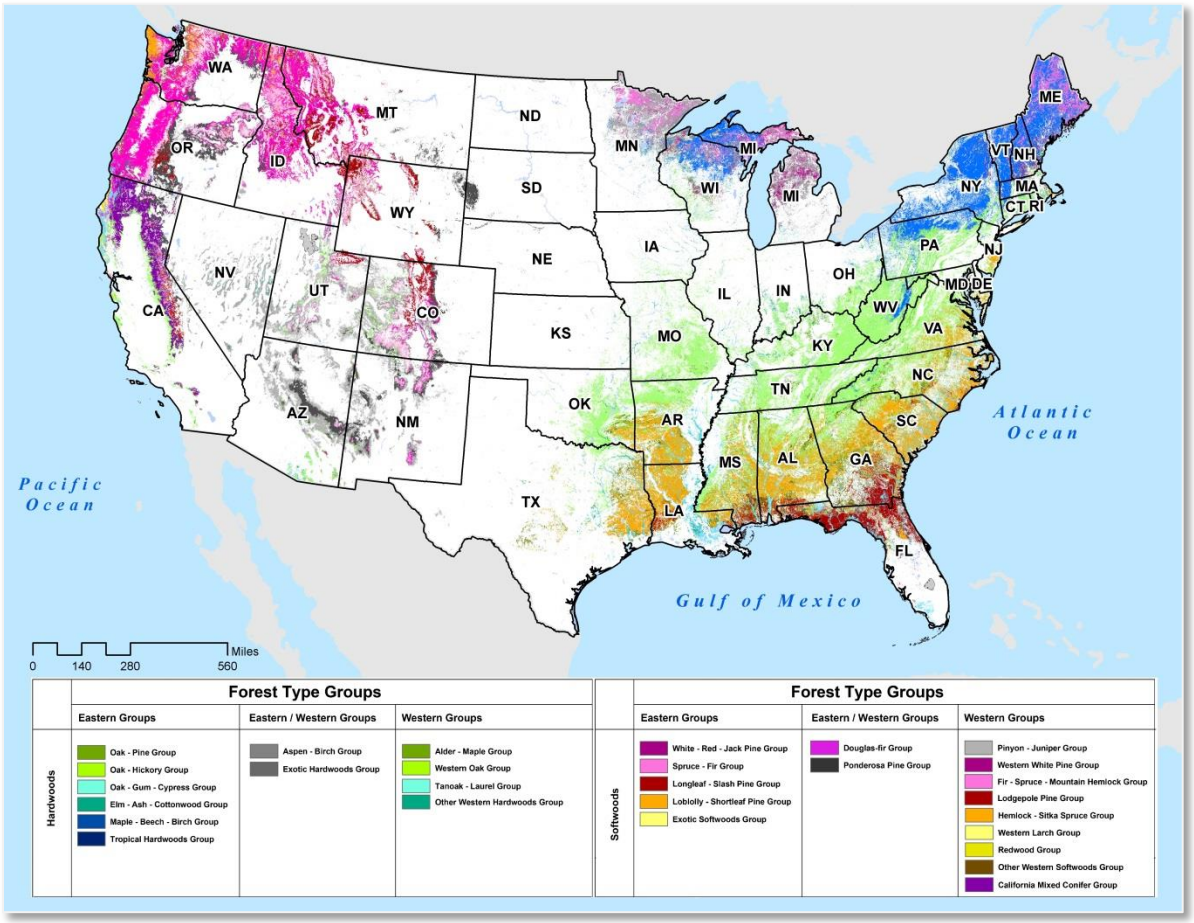


**Figure 3-1 Forest Type Groups in the Contiguous United States**

The South is a mix of conifer and hardwood forest types. Primary conifer forest types include Loblolly/Shortleaf Pine and Longleaf/Slash Pine and are most common in the coastal plains. Hardwood forest types, such as Oak/Hickory and Maple/Beech/Birch, are more common in the northern regions of the South in the piedmont and Appalachian foothills.

In the North, Oak/Hickory hardwood forest extends northward into Appalachia, where it transitions into Maple/Beech/Birch hardwood forest interspersed with pockets of conifer Spruce/Fir forests. Around the Great Lakes, hardwood forest types, such as Aspen/Birch and Maple/Beech/Birch, and conifer forest types, such as White/Red/Jack Pine and Spruce/Fir, co-occur with one another.

In the Pacific Coast/Northwest, conifer forest types, especially Douglas-fir, predominate. Other important forest types include Fir/Spruce/Mountain Hemlock, Hemlock/Sitka Spruce, Lodgepole Pine, Ponderosa Pine and California Mixed Conifer forest types. Some hardwood forest types can be found in California, but hardwood forest types are less common in this region.

### 3.1.1 Total (All Species) Inventory and Removals

The total inventory increase between 2008 and 2014 was largely driven by increases in Southern inventories during this period. Between 2008 and 2014, total inventory in the South increased at a rate of 1.3% compounded annually. Total inventory in the North increased at an annual rate of 0.4% while the Pacific Coast/Northwest increased 0.7% annually.

As discussed in Section 2.2, total removals decreased 0.6% compounded annually. In the South, removals[17] decreased at a rate of 0.8% from 7.76 BCF in 2008 to 7.39 BCF in 2014. Northern removals decreased at a faster rate than the South (2.5% compounded annually) from 1.07 BCF to 0.92 BCF. In contrast to removals in the South and North, Pacific Coast/Northwest removals increased 1.8% compounded annually from 1.62 BCF in 2008 to 1.80 BCF in 2014 due to increasing exports.

### 3.1.2 Conifer/Pine Inventory and Removals

Southern pine inventory increased from 86.8 BCF to 102.0 BCF at a rate of 2.7% compounded annually between 2008 and 2014. Northern conifer inventory increased from 37.3 BCF in 2008 to 39.6 BCF in 2014 at a rate of 1.0% compounded annually. Pacific Coast/Northwest inventory increased 0.8% annually from 72.1 BCF in 2008 to 75.6 BCF in 2014.

In the South, removals increased 0.2% compounded annually between 2008 and 2014 but averaged 5.25 BCF at both the start and end of this period. Northern conifer removals decreased 1.4% compounded annually from 0.54 BCF in 2008 to 0.50 BCF in 2014 due to paper mill closures and declining lumber production. In response to increased export demand for logs, Pacific Coast/Northwest conifer removals increased from 1.56 BCF in 2008 to 1.73 BCF in 2014 at a rate of 1.8% compounded annually.

### 3.1.3 Hardwood Inventory and Removals

In the South, hardwood inventory increased 0.4% compounded annually from 144.9 BCF in 2008 to 148.4 BCF in 2014. Northern hardwood inventory decreased 0.1% compounded annually from 39.0 BCF to 38.7 BCF. Hardwood inventory in the Pacific Coast/Northwest region increased from 13.4 to 13.7 BCF at a rate of 0.3% compounded annually.

In the South, total hardwood removals decreased 2.7% compounded annually from 2.52 BCF in 2008 to 2.14 BCF in 2014. The decrease in total hardwood removals was more pronounced in the North, where hardwood removals decreased from 0.53 BCF to 0.42 BCF at a rate of 3.6% compounded annually. Hardwood removals in the Pacific Coast/Northwest increased at a rate of 2.7% compounded annually from 0.06 to 0.07 BCF.

[17] Southern removals decreased from 8.43 BCF in 2000 to 7.76 BCF in 2008 at a rate of 1.0% compounded annually. Between 2000 and 2014, Southern removals decreased 0.9% compounded annually.

## 3.2 South

### 3.2.1 Pine

The following charts (Figure 3-2, Figure 3-3, Figure 3-4) show the trends in inventory, removals and removals relative to inventory for total pine, pine sawtimber and pine pulpwood. Pine sawtimber inventory increased 1.3% compounded annually since 2000, and pine pulpwood inventory increased 1.0% compounded annually over the same period. Pine sawtimber removals decreased 0.9% compounded annually while pine pulpwood removals increased 1.5%.

Total pine removals as a percentage of inventory decreased from 6.1% in 2000 to 5.1% in 2014. Total pine growth exceeded pine removals by 21% on average (GRR=1.21) between 2000 and 2013. Pine sawtimber removals relative to inventory decreased from 6.4% to 4.7%. During this period, pine sawtimber growth exceeded removals by an average of 25% (GRR=1.25). Pine pulpwood removals relative to inventory increased marginally from 5.7% in 2000 to 6.1% in 2014. During this period, pine pulpwood growth exceeded removals by an average of 16% (GRR=1.16). These trends are discussed in greater detail in the following sections.

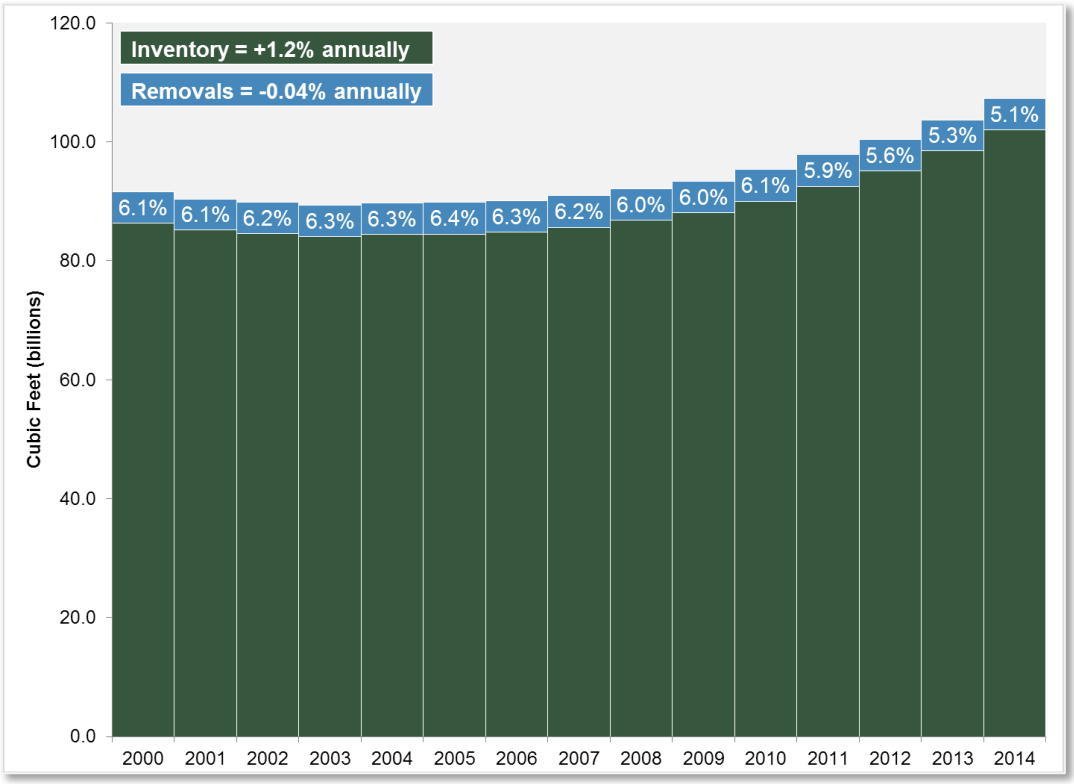


**Figure 3-2 Total Pine Removals Relative to Inventory, 2000-2014 – South Region**

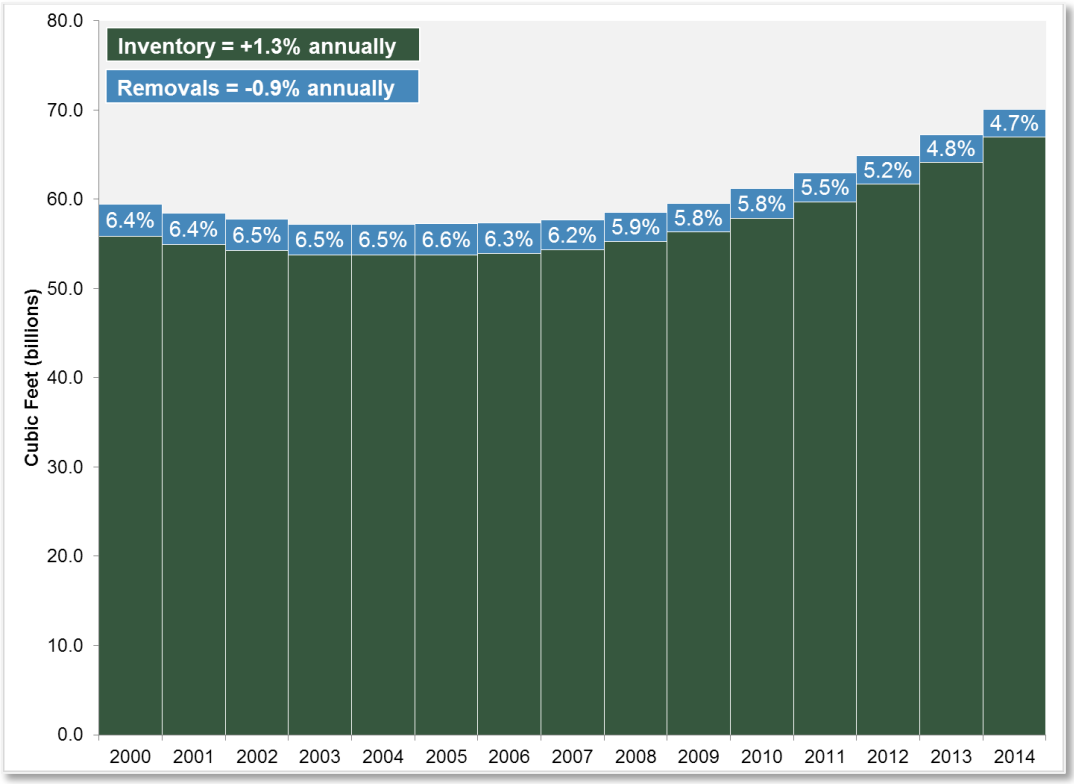


**Figure 3-3 Pine Sawtimber Removals Relative to Inventory, 2000-2014 – South Region**

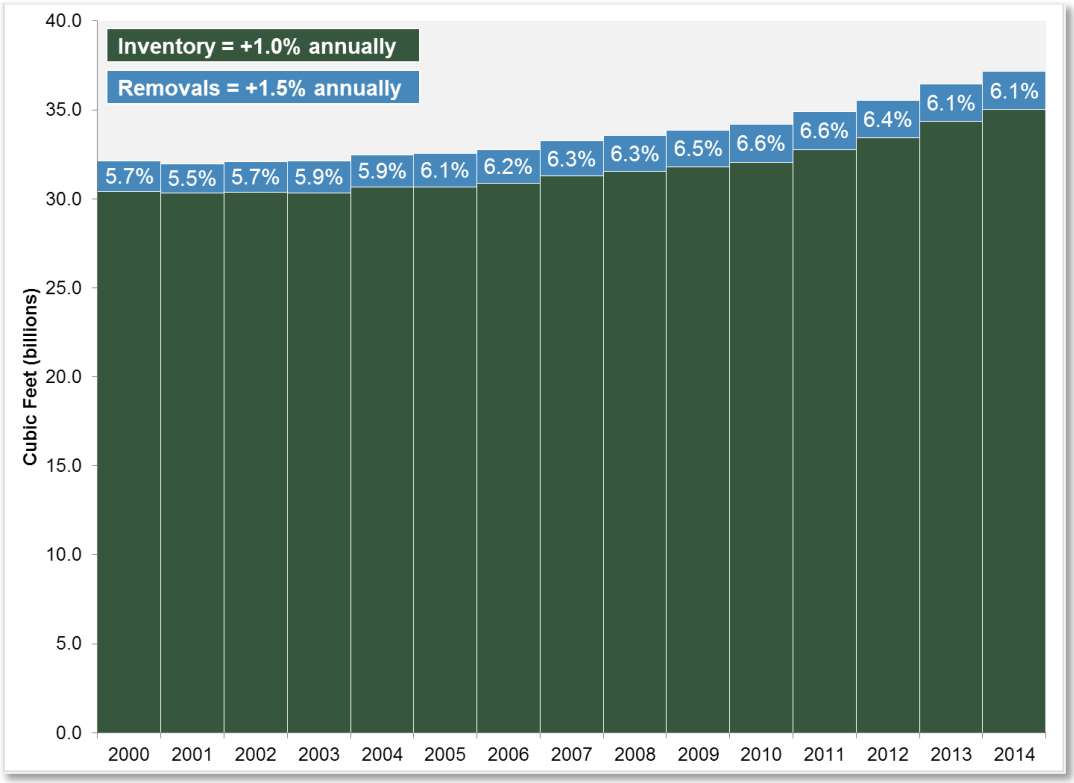


**Figure 3-4 Pine Pulpwood Removals Relative to Inventory, 2000-2014 – South Region**

### *Pine Inventory and Removals*

Total pine inventory increased at a rate of 1.2% compounded annually from 86.3 billion cubic feet (BCF) in 2000 to 102.0 BCF in 2014 (Table 3-1). Over this period, total pine removals remained flat at around 5.3 BCF annually. Pine sawtimber and pine pulpwood inventory each increased over 1.0% compounded annually; pine sawtimber inventory increased from 55.9 BCF to 67.0 BCF while pine pulpwood inventory increased from 30.4 BCF to 35.0 BCF.

Pine sawtimber removals have decreased 0.9% compounded annually from 3.6 BCF in 2000 to 3.1 BCF in 2014, primarily a result of the Great Recession and its aftermath (see Section 2.1). Pine sawtimber removals have been on an upward trend since 2013 but have not yet increased to pre-Recession levels. Pine pulpwood removals have increased 1.5% compounded annually from 1.7 BCF in 2000 to 2.1 BCF in 2014. During and following the Recessionary period, pulpwood removals remained constant at around 2.1 BCF.

**Table 3-1 Pine Inventory and Removals, Cubic Feet (billions) – South Region**

| | Total Pine | | Pine Sawtimber | | Pine Pulpwood | |
|---|---|---|---|---|---|---|
| Year | Inventory | Removals | Inventory | Removals | Inventory | Removals |
| 2000 | 86.3 | 5.3 | 55.9 | 3.6 | 30.4 | 1.7 |
| 2001 | 85.2 | 5.2 | 54.9 | 3.5 | 30.3 | 1.7 |
| 2002 | 84.6 | 5.3 | 54.2 | 3.5 | 30.4 | 1.7 |
| 2003 | 84.1 | 5.3 | 53.7 | 3.5 | 30.3 | 1.8 |
| 2004 | 84.4 | 5.3 | 53.7 | 3.5 | 30.7 | 1.8 |
| 2005 | 84.4 | 5.4 | 53.8 | 3.5 | 30.7 | 1.9 |
| 2006 | 84.8 | 5.3 | 53.9 | 3.4 | 30.9 | 1.9 |
| 2007 | 85.6 | 5.3 | 54.3 | 3.4 | 31.3 | 2.0 |
| 2008 | 86.8 | 5.2 | 55.3 | 3.2 | 31.6 | 2.0 |
| 2009 | 88.1 | 5.3 | 56.3 | 3.2 | 31.8 | 2.1 |
| 2010 | 89.9 | 5.5 | 57.9 | 3.3 | 32.1 | 2.1 |
| 2011 | 92.5 | 5.5 | 59.7 | 3.3 | 32.7 | 2.2 |
| 2012 | 95.1 | 5.3 | 61.7 | 3.2 | 33.4 | 2.1 |
| 2013 | 98.5 | 5.2 | 64.2 | 3.1 | 34.3 | 2.1 |
| 2014 | 102.0 | 5.3 | 67.0 | 3.1 | 35.0 | 2.1 |
| Compounded annual change | 1.2% | -0.04% | 1.3% | -0.9% | 1.0% | 1.5% |

### *Pine Removals Relative to Inventory*

Total pine removals relative to inventory have declined from the equivalent of 6.1% of inventory in 2000 to 5.1% of inventory in 2014 (Table 3-2 next page), primarily a result of increasing inventory. Pine sawtimber removals relative to inventory have declined from 6.4% in 2000 to 4.7% in 2014 due to declining sawtimber removals and increasing sawtimber inventories. Pine pulpwood removals relative to inventory have increased from 5.7% in 2000 to 6.1% in 2014 due primarily to increased pine pulpwood removals and the movement of pulpwood inventory into sawtimber inventory.

**Table 3-2 Pine Removals Relative to Inventory – South Region**

| Year | Total Pine | Pine Sawtimber | Pine Pulpwood |
|---|---|---|---|
| 2000 | 6.1% | 6.4% | 5.7% |
| 2001 | 6.1% | 6.4% | 5.5% |
| 2002 | 6.2% | 6.5% | 5.7% |
| 2003 | 6.3% | 6.5% | 5.9% |
| 2004 | 6.3% | 6.5% | 5.9% |
| 2005 | 6.4% | 6.6% | 6.1% |
| 2006 | 6.3% | 6.3% | 6.2% |
| 2007 | 6.2% | 6.2% | 6.3% |
| 2008 | 6.0% | 5.9% | 6.3% |
| 2009 | 6.0% | 5.8% | 6.5% |
| 2010 | 6.1% | 5.8% | 6.6% |
| 2011 | 5.9% | 5.5% | 6.6% |
| 2012 | 5.6% | 5.2% | 6.4% |
| 2013 | 5.3% | 4.8% | 6.1% |
| 2014 | 5.1% | 4.7% | 6.1% |
| Compounded annual change | -1.2% | -2.2% | 0.5% |

### 3.2.2 Hardwood

The following charts (Figure 3-5, Figure 3-6, Figure 3-7) show the trends in inventory, removals and removals relative to inventory for total hardwood, hardwood sawtimber and hardwood pulpwood. Total hardwood, hardwood sawtimber, and hardwood pulpwood removals relative to inventory have declined since 2000 driven by declining removals for both hardwood sawtimber (-2.3% compounded annually) and hardwood pulpwood (-3.4% compounded annually) and increasing inventories for hardwood sawtimber (0.9% compounded annually).

Between 2000 and 2013, total hardwood growth exceeded removals by an average of 24% (GRR=1.24). During the same period, hardwood sawtimber growth exceeded sawtimber removals by 48% on average (GRR=1.48). Hardwood pulpwood removals exceeded growth by an average of 17% (GRR=0.83) during this period. These trends are discussed in greater detail below.

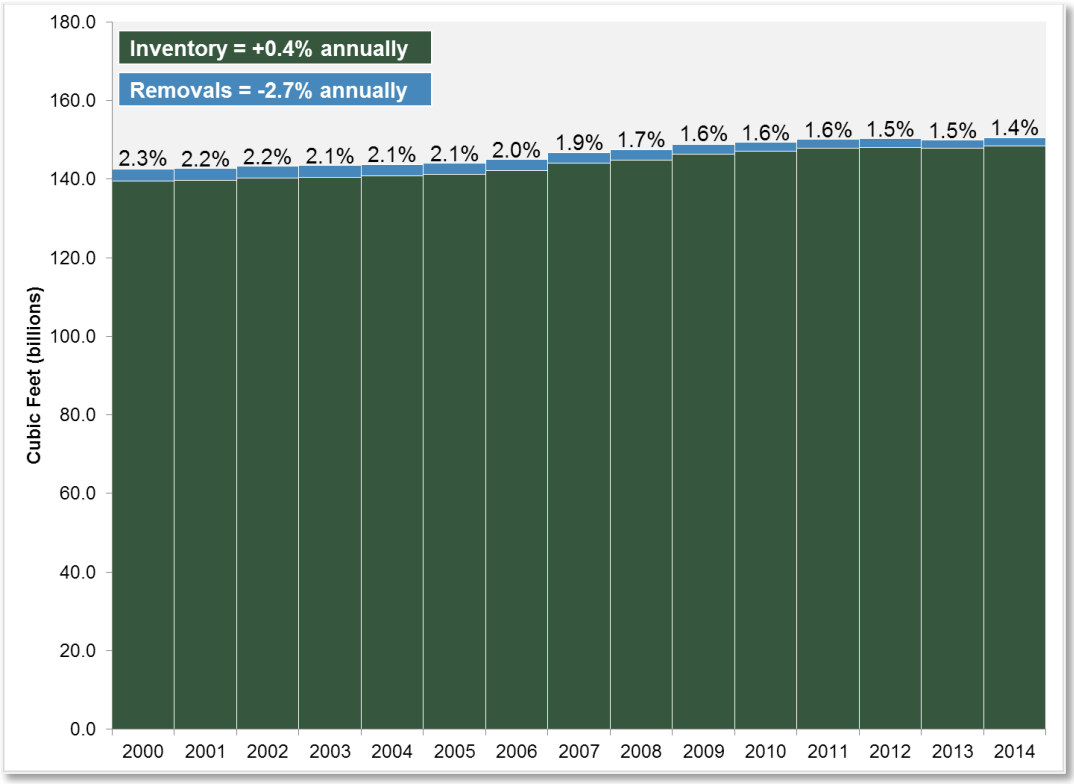


**Figure 3-5 Total Hardwood Removals Relative to Inventory, 2000-2014 – South Region**

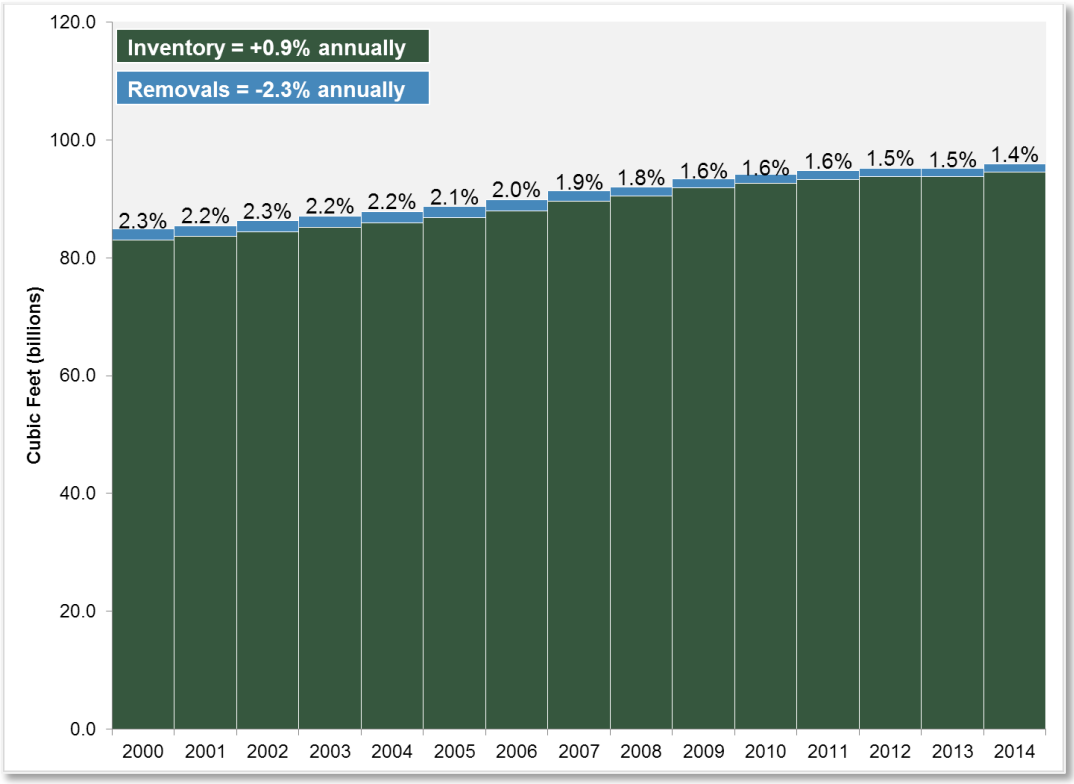


**Figure 3-6 Hardwood Sawtimber Removals Relative to Inventory, 2000-2014 – South Region**

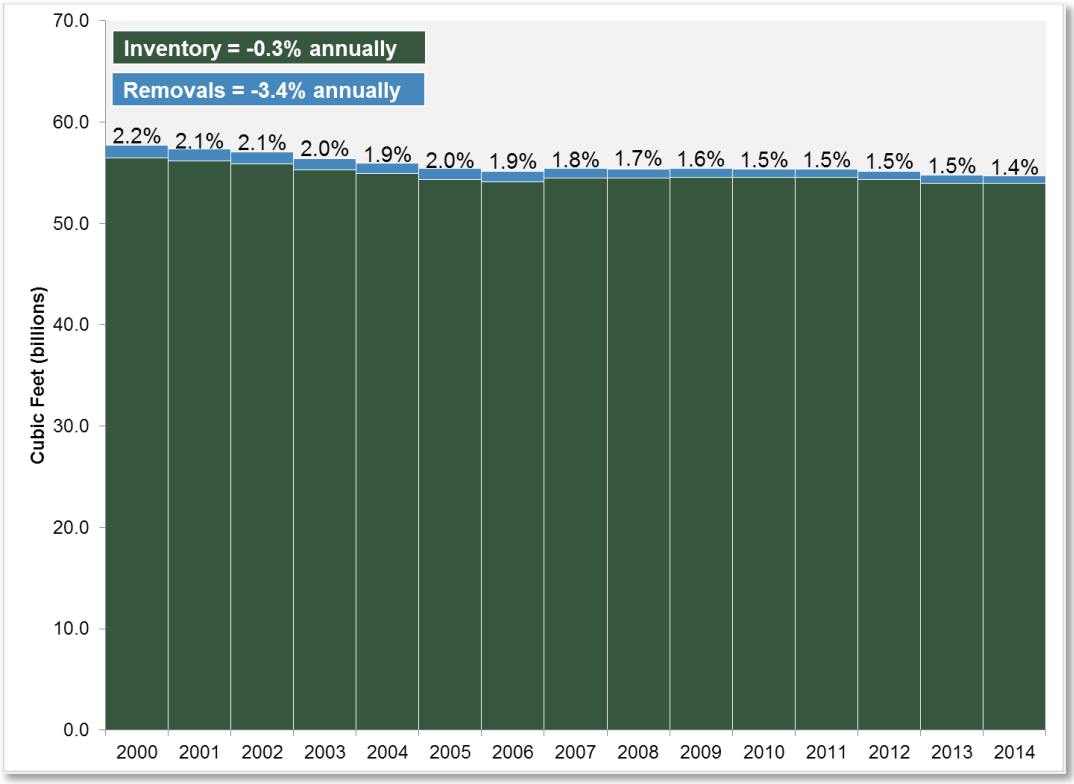


**Figure 3-7 Hardwood Pulpwood Removals Relative to Inventory, 2000-2014 – South Region**

### *Hardwood Inventory and Removals*

Total hardwood inventory increased (0.4% compounded annually) from 139.4 BCF in 2000 to 148.4 billion cubic feet in 2014 (Table 3-3). Total hardwood removals declined at an annual rate of 2.7% over this period.

Hardwood sawtimber removals decreased 2.3% compounded annually from 1.9 BCF in 2000 to 1.4 BCF in 2014, primarily driven by declines in hardwood manufacturing during the Recession. Hardwood sawtimber inventory increased from 83.0 BCF in 2000 to 94.5 BCF in in 2014 at a rate of 0.9% compounded annually.

Hardwood pulpwood removals decreased from 1.3 BCF in 2000 to 0.8 BCF in 2014 at a rate of 3.4% compounded annually in response to decreasing demand for hardwoods. Hardwood pulpwood inventory declined from 56.5 BCF in 2000 to 53.9 BCF at a rate of 0.3% compounded annually. As described in Section 2.1, declining demand for sawtimber has led to a shift in timberland age classes in the South. In 2008, 7.5% of private hardwood timberland acres were in the 0-5 age class, but only 4.9% were in this age class in 2014. This has contributed to the loss of hardwood pulpwood inventory as inventory has aged into sawtimber.

**Table 3-3 Hardwood Inventory and Removals, Cubic Feet (billions) – South Region**

| Year | Total Hardwood | | Hardwood Sawtimber | | Hardwood Pulpwood | |
|---|---|---|---|---|---|---|
| | Inventory | Removals | Inventory | Removals | Inventory | Removals |
| 2000 | 139.4 | 3.2 | 83.0 | 1.9 | 56.5 | 1.3 |
| 2001 | 139.8 | 3.0 | 83.6 | 1.9 | 56.2 | 1.2 |
| 2002 | 140.2 | 3.1 | 84.3 | 1.9 | 55.8 | 1.2 |
| 2003 | 140.5 | 3.0 | 85.2 | 1.9 | 55.3 | 1.1 |
| 2004 | 140.9 | 2.9 | 85.9 | 1.9 | 54.9 | 1.0 |
| 2005 | 141.1 | 2.9 | 86.8 | 1.9 | 54.3 | 1.1 |
| 2006 | 142.1 | 2.8 | 88.0 | 1.8 | 54.1 | 1.0 |
| 2007 | 144.1 | 2.7 | 89.6 | 1.7 | 54.5 | 1.0 |
| 2008 | 144.9 | 2.5 | 90.4 | 1.6 | 54.5 | 0.9 |
| 2009 | 146.4 | 2.4 | 91.8 | 1.5 | 54.6 | 0.9 |
| 2010 | 147.2 | 2.3 | 92.6 | 1.5 | 54.5 | 0.8 |
| 2011 | 147.8 | 2.3 | 93.3 | 1.5 | 54.5 | 0.8 |
| 2012 | 148.1 | 2.2 | 93.8 | 1.4 | 54.3 | 0.8 |
| 2013 | 147.8 | 2.2 | 93.8 | 1.4 | 54.0 | 0.8 |
| 2014 | 148.4 | 2.1 | 94.5 | 1.4 | 53.9 | 0.8 |
| Compounded annual change | 0.4% | -2.7% | 0.9% | -2.3% | -0.3% | -3.4% |

### *Hardwood Removals Relative to Inventory*

Hardwood sawtimber, hardwood pulpwood and total hardwood removals have decreased from 2.2-2.3% of inventory in 2000 to 1.4% of inventory in 2014 (Table 3-4, next page), primarily as a result of reduced removals and increased inventory.

**Table 3-4 Hardwood Removals Relative to Inventory – South Region**

| Year | Total Hardwood | Hardwood Sawtimber | Hardwood Pulpwood |
|---|---|---|---|
| 2000 | 2.3% | 2.3% | 2.2% |
| 2001 | 2.2% | 2.2% | 2.1% |
| 2002 | 2.2% | 2.3% | 2.1% |
| 2003 | 2.1% | 2.2% | 2.0% |
| 2004 | 2.1% | 2.2% | 1.9% |
| 2005 | 2.1% | 2.1% | 2.0% |
| 2006 | 2.0% | 2.0% | 1.9% |
| 2007 | 1.9% | 1.9% | 1.8% |
| 2008 | 1.7% | 1.8% | 1.7% |
| 2009 | 1.6% | 1.6% | 1.6% |
| 2010 | 1.6% | 1.6% | 1.5% |
| 2011 | 1.6% | 1.6% | 1.5% |
| 2012 | 1.5% | 1.5% | 1.5% |
| 2013 | 1.5% | 1.5% | 1.5% |
| 2014 | 1.4% | 1.4% | 1.4% |
| Compounded annual change | -3.2% | -3.2% | -3.1% |

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## 3.3 North

### 3.3.1 Conifer

The following charts (Figure 3-8, Figure 3-9, Figure 3-10) show the trends in inventory, removals and removals relative to inventory for total conifer, conifer sawtimber and conifer pulpwood. Conifer sawtimber inventory has increased 1.5% compounded annually since 2008, and conifer pulpwood inventory has increased 0.2% compounded annually over the same period. Conifer sawtimber removals decreased 0.8% compounded annually while conifer pulpwood removals decreased 2.6%.

Between 2008 and 2013, total conifer growth exceeded conifer removals by an average of 71% (GRR=1.71). Total conifer removals decreased from 1.5% of inventory in 2008 to 1.3% in 2014. Between 2008 and 2013, conifer sawtimber growth exceeded conifer sawtimber removals by 101% (GRR=2.01). Conifer sawtimber removals decreased from 1.5% to 1.3% of inventory between 2008 and 2014. Conifer pulpwood growth exceeded conifer pulpwood removals by 14% (GRR=1.14) on average between 2008 and 2013. Conifer pulpwood removals relative to inventory decreased from 1.4% to 1.2% over this period. These trends are discussed in greater detail in the following sections.

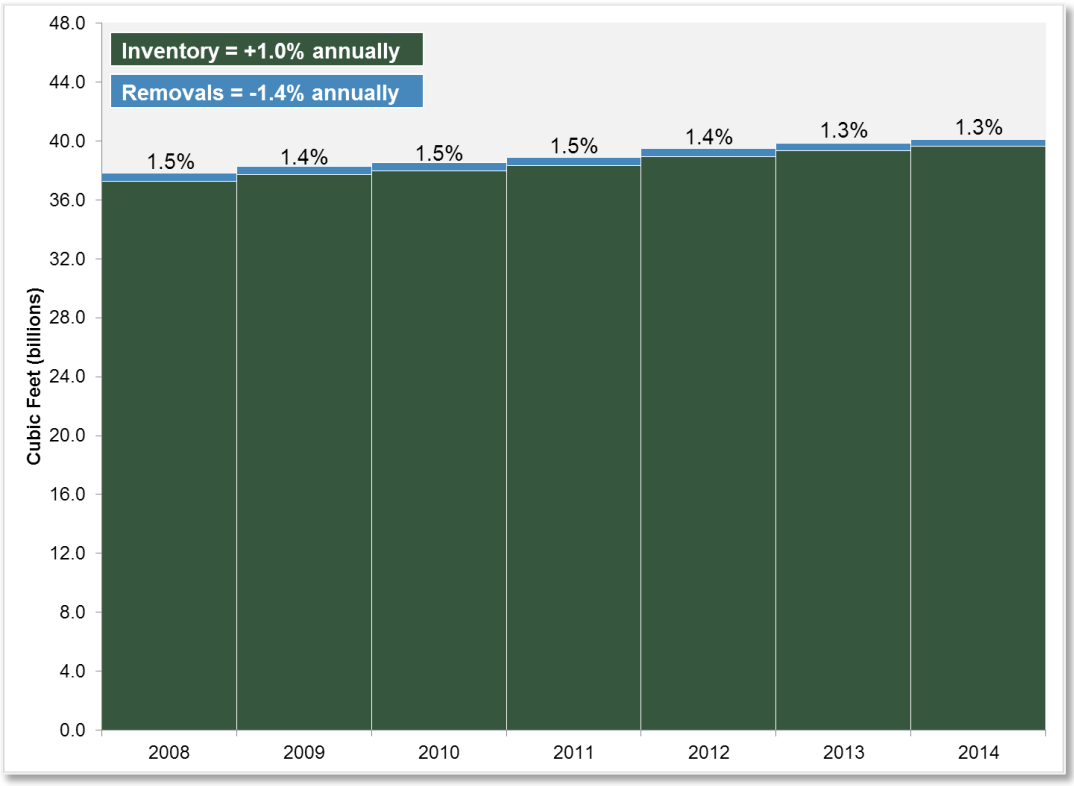


**Figure 3-8 Total Conifer Removals Relative to Inventory, 2008-2014 – North Region**

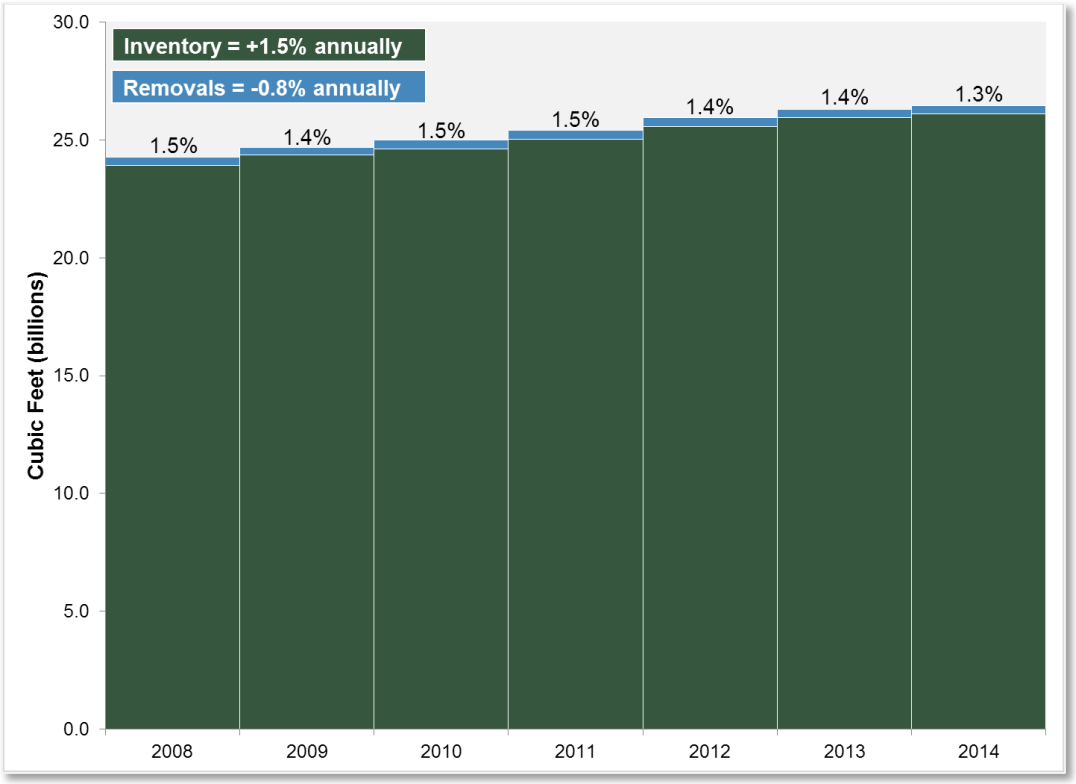


**Figure 3-9 Conifer Sawtimber Removals Relative to Inventory, 2008-2014 – North Region**

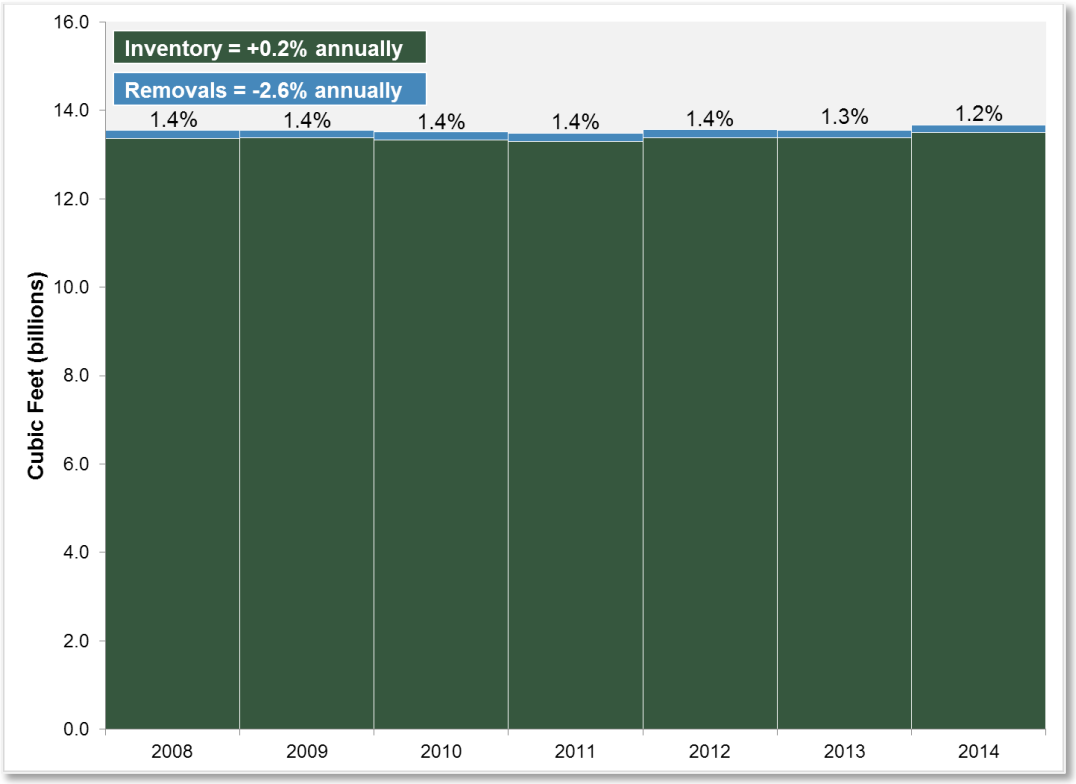


**Figure 3-10 Conifer Pulpwood Removals Relative to Inventory, 2008-2014 – North Region**

### *Conifer Inventory and Removals*

Total conifer inventory increased at a rate of 1.0% compounded annually from 37.3 BCF in 2008 to 39.6 BCF in 2014 (Table 3-5). Over this period, total conifer removals remained flat at around 0.54 BCF annually. Conifer sawtimber inventory increased from 23.9 BCF to 26.1 BCF (1.5% compounded annually) while conifer pulpwood inventory increased from 13.4 BCF to 13.5 BCF between 2008 and 2014 (0.2% compounded annually).

Conifer sawtimber removals during this period peaked in 2011 but experienced an overall decline of 0.8% compounded annually from 0.35 BCF to 0.33 BCF in 2014. Conifer pulpwood removals remained at around 0.19 BCF annually between 2008 and 2011. Overall, conifer pulpwood removals decreased 2.6% compounded annually from 0.19 BCF in 2008 to 0.16 BCF in 2014.

**Table 3-5 Conifer Inventory and Removals, Cubic Feet (billions) – North Region**

| | Total Conifer | | Conifer Sawtimber | | Conifer Pulpwood | |
|---|---|---|---|---|---|---|
| Year | Inventory | Removals | Inventory | Removals | Inventory | Removals |
| 2008 | 37.3 | 0.54 | 23.9 | 0.35 | 13.4 | 0.19 |
| 2009 | 37.7 | 0.53 | 24.3 | 0.34 | 13.4 | 0.19 |
| 2010 | 38.0 | 0.56 | 24.6 | 0.36 | 13.3 | 0.19 |
| 2011 | 38.3 | 0.57 | 25.0 | 0.38 | 13.3 | 0.19 |
| 2012 | 38.9 | 0.55 | 25.6 | 0.36 | 13.4 | 0.18 |
| 2013 | 39.3 | 0.52 | 25.9 | 0.35 | 13.4 | 0.17 |
| 2014 | 39.6 | 0.50 | 26.1 | 0.33 | 13.5 | 0.16 |
| Compounded annual change | 1.0% | -1.4% | 1.5% | -0.8% | 0.2% | -2.6% |

### *Conifer Removals Relative to Inventory*

Total conifer removals relative to inventory decreased from 1.5% of inventory in 2008 to 1.3% of inventory in 2014 (Table 3-6) in response to decreased removals and building inventories. Conifer sawtimber removals similarly decreased from 1.5% to 1.3% of inventory over this period. Conifer pulpwood removals decreased from 1.4% of inventory in 2008 to 1.2% of inventory in 2014.

**Table 3-6 Conifer Removals Relative to Inventory – North Region**

| Year | Total Conifer | Conifer Sawtimber | Conifer Pulpwood |
|---|---|---|---|
| 2008 | 1.5% | 1.5% | 1.4% |
| 2009 | 1.4% | 1.4% | 1.4% |
| 2010 | 1.5% | 1.5% | 1.4% |
| 2011 | 1.5% | 1.5% | 1.4% |
| 2012 | 1.4% | 1.4% | 1.4% |
| 2013 | 1.3% | 1.4% | 1.3% |
| 2014 | 1.3% | 1.3% | 1.2% |
| Compounded annual change | -2.4% | -2.3% | -2.8% |

### 3.3.2 Hardwood

The following charts (Figure 3-11, Figure 3-12, Figure 3-13) show the trends in inventory, removals and removals relative to inventory for total hardwood, hardwood sawtimber and hardwood pulpwood. With the exception of hardwood pulpwood removals, which have remained steady between 1.0-1.1% of inventory annually, removals relative to inventory have decreased since 2008. This is due in large part to a 5.9% decrease in hardwood sawtimber removals between 2008 and 2014.

Hardwood sawtimber growth exceeded removals by 38% on average (GRR=1.38) between 2008 and 2013. Hardwood pulpwood removals exceeded growth by 81% during the same period (GRR=0.19). Total hardwood removals exceeded growth by 12% (GRR=0.88) on average between 2008 and 2013. These trends are discussed in greater detail below.

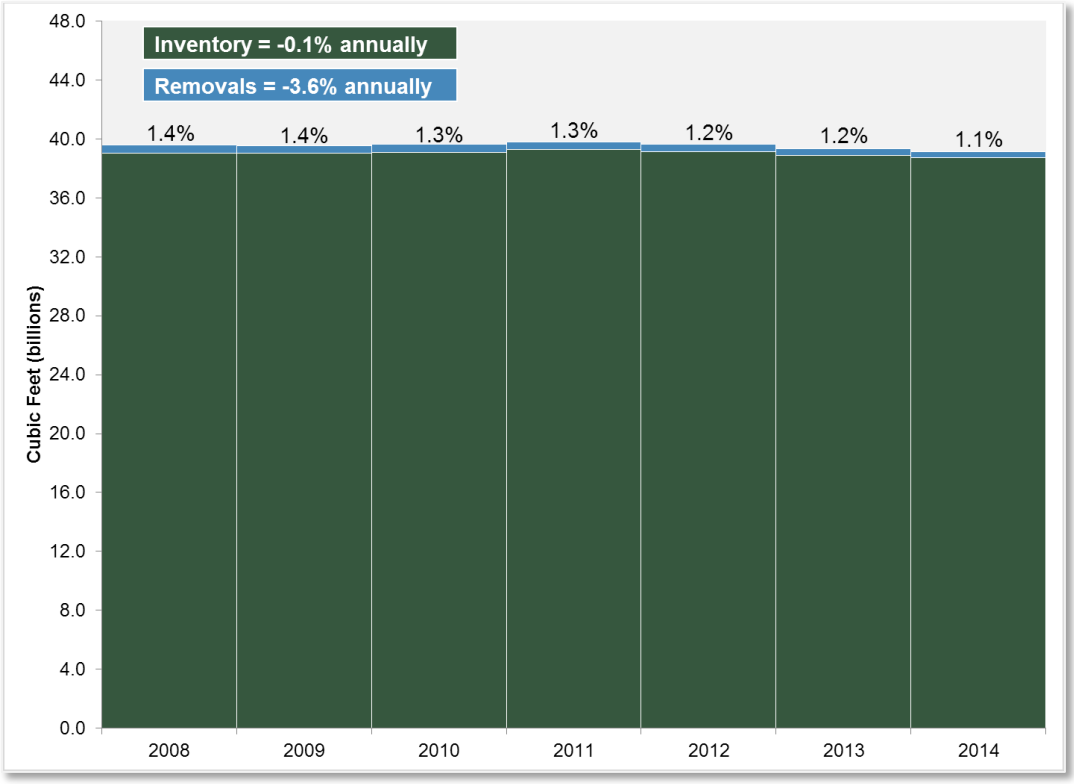


**Figure 3-11 Total Hardwood Removals Relative to Inventory, 2008-2014 – North Region**

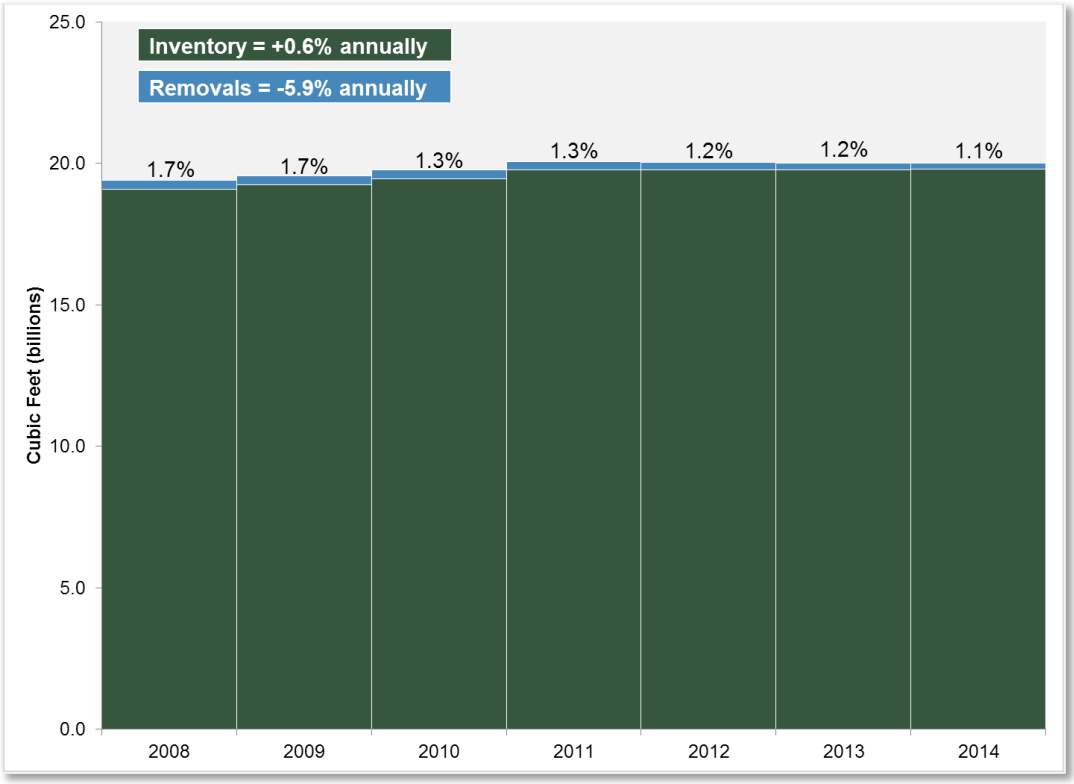


**Figure 3-12 Hardwood Sawtimber Removals Relative to Inventory, 2008-2014 – North Region**

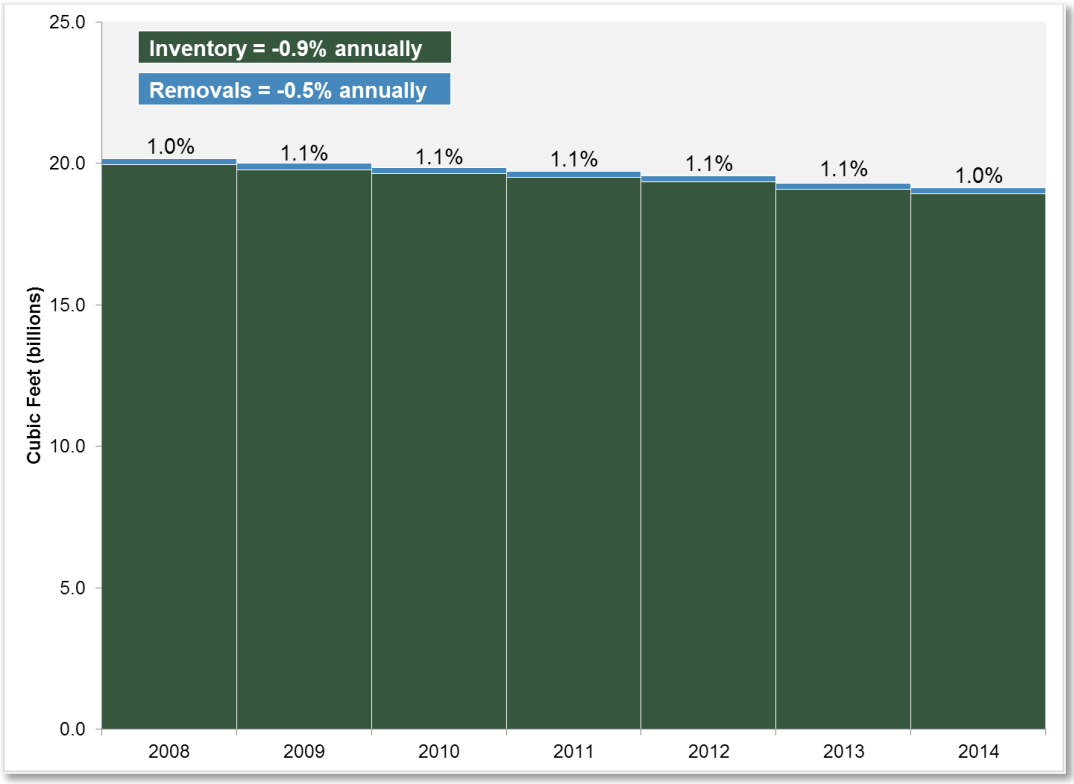


**Figure 3-13 Hardwood Pulpwood Removals Relative to Inventory, 2008-2014 – North Region**

### *Hardwood Inventory and Removals*

From 2008 to 2014, total hardwood removals decreased from 0.53 to 0.42 BCF at a rate of 3.6% compounded annually (Table 3-7). Despite decreased removals, total hardwood inventory decreased at a rate of 0.1% compounded annually from 39.0 BCF in 2008 to 38.7 BCF in 2014.

Hardwood sawtimber inventory increased from 19.1 BCF in 2008 to 19.8 BCF in 2014 at a rate of 0.6% compounded annually. This trend was primarily driven by lower hardwood sawtimber removals, which decreased 5.9% compounded annually from 0.32 BCF in 2008 to 0.23 BCF in 2014.

Hardwood pulpwood removals remained fairly constant during the period but decreased from 0.204 BCF in 2008 to 0.198 BCF in 2014 at a rate of 0.5% compounded annually. Hardwood pulpwood inventory decreased at a rate of 0.9% compounded annually from 20.0 BCF in 2008 to 18.9 BCF in 2014. Declines in hardwood pulpwood inventory in the North were driven by similar shifts in hardwood age classes that occurred in the South. Between 2008 and 2014, hardwood acres in the 0-5 age class decreased by 35%, and hardwood acres in the 6-15 age class decreased by 9%. Meanwhile, the number of acres that were older than 61 years increased by 12%.

**Table 3-7 Hardwood Inventory and Removals, Cubic Feet (billions) – North Region**

| | Total Hardwood | | Hardwood Sawtimber | | Hardwood Pulpwood | |
|---|---|---|---|---|---|---|
| Year | Inventory | Removals | Inventory | Removals | Inventory | Removals |
| 2008 | 39.0 | 0.53 | 19.1 | 0.32 | 20.0 | 0.204 |
| 2009 | 39.0 | 0.54 | 19.2 | 0.33 | 19.8 | 0.214 |
| 2010 | 39.1 | 0.53 | 19.5 | 0.30 | 19.6 | 0.220 |
| 2011 | 39.3 | 0.51 | 19.8 | 0.29 | 19.5 | 0.221 |
| 2012 | 39.1 | 0.48 | 19.8 | 0.27 | 19.4 | 0.208 |
| 2013 | 38.9 | 0.45 | 19.8 | 0.24 | 19.1 | 0.205 |
| 2014 | 38.7 | 0.42 | 19.8 | 0.23 | 18.9 | 0.198 |
| Compounded annual change | -0.1% | -3.6% | 0.6% | -5.9% | -0.9% | -0.5% |

### *Hardwood Removals Relative to Inventory*

Total hardwood removals were equivalent to 1.4% of inventory in 2008 and 1.1% of inventory in 2014 (Table 3-8). In 2008, hardwood sawtimber removals were equivalent to 1.7% of inventory, but this percentage fell to 1.1% in 2014, primarily as a result of decreased sawtimber removals during this period. Hardwood pulpwood removals were 1.0% of inventory in both 2008 and 2014 and averaged 1.1% of inventory over the period.

**Table 3-8 Hardwood Removals Relative to Inventory – North Region**

| Year | Total Hardwood | Hardwood Sawtimber | Hardwood Pulpwood |
|---|---|---|---|
| 2008 | 1.4% | 1.7% | 1.0% |
| 2009 | 1.4% | 1.7% | 1.1% |
| 2010 | 1.3% | 1.6% | 1.1% |
| 2011 | 1.3% | 1.5% | 1.1% |
| 2012 | 1.2% | 1.4% | 1.1% |
| 2013 | 1.2% | 1.2% | 1.1% |
| 2014 | 1.1% | 1.1% | 1.0% |
| Compounded annual change | -3.5% | -6.5% | 0.4% |

## 3.4 Pacific Coast/Northwest

### 3.4.1 Conifer

The following charts (Figure 3-14, Figure 3-15, Figure 3-16) show the trends in inventory, removals and removals relative to inventory for total conifer, conifer sawtimber and conifer pulpwood. Conifer sawtimber inventory has increased 0.8% compounded annually since 2008, and conifer pulpwood inventory has increased 0.5% compounded annually over the same period. Conifer sawtimber removals increased 1.7% compounded annually while conifer pulpwood removals increased 2.1%.

Total conifer growth outpaced removals by 41% on average between 2008 and 2013. Total conifer removals as a percentage of inventory increased marginally from 2.2% in 2008 to 2.3% in 2014. Conifer sawtimber growth outpaced sawtimber removals by an average of 41% (GRR=1.41) between 2008 and 2013. Conifer sawtimber removals relative to inventory increased from 2.3% to 2.4%. Conifer pulpwood growth exceeded pulpwood removals by an average of 39% between 2008 and 2013. Conifer pulpwood removals relative to inventory increased from 1.3% to 1.5%. These trends are discussed in greater detail in the following sections.

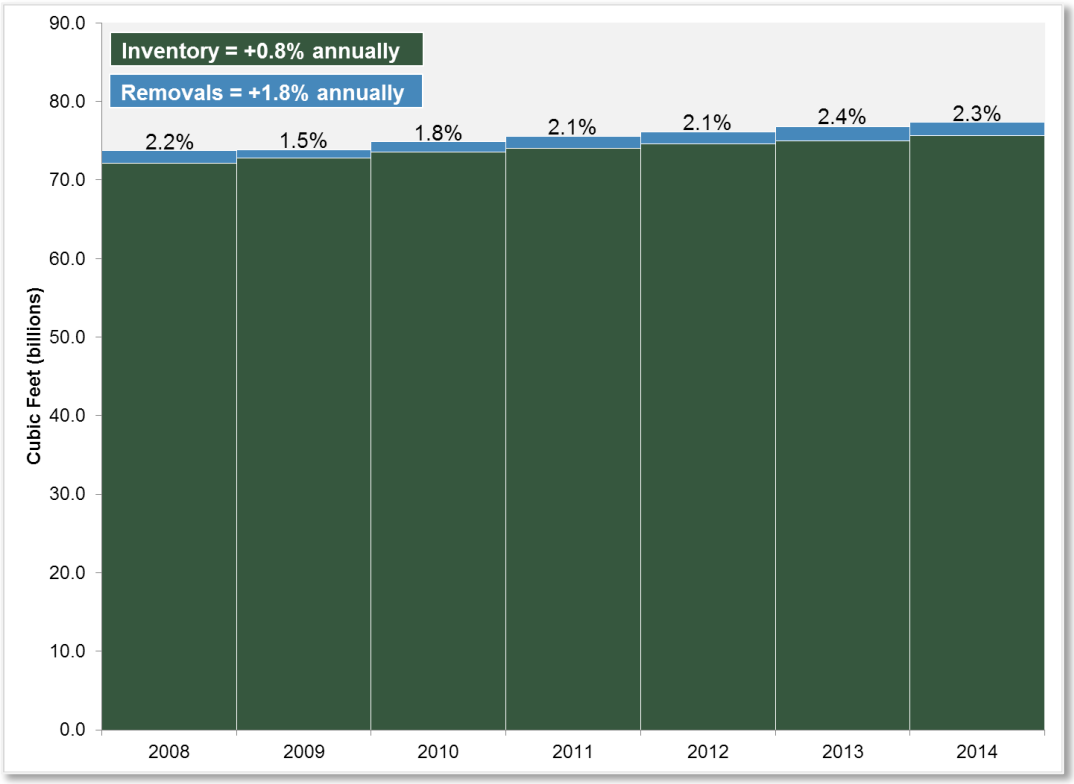


**Figure 3-14 Total Conifer Removals Relative to Inventory, 2008-2014 – Pacific Coast/Northwest Region**

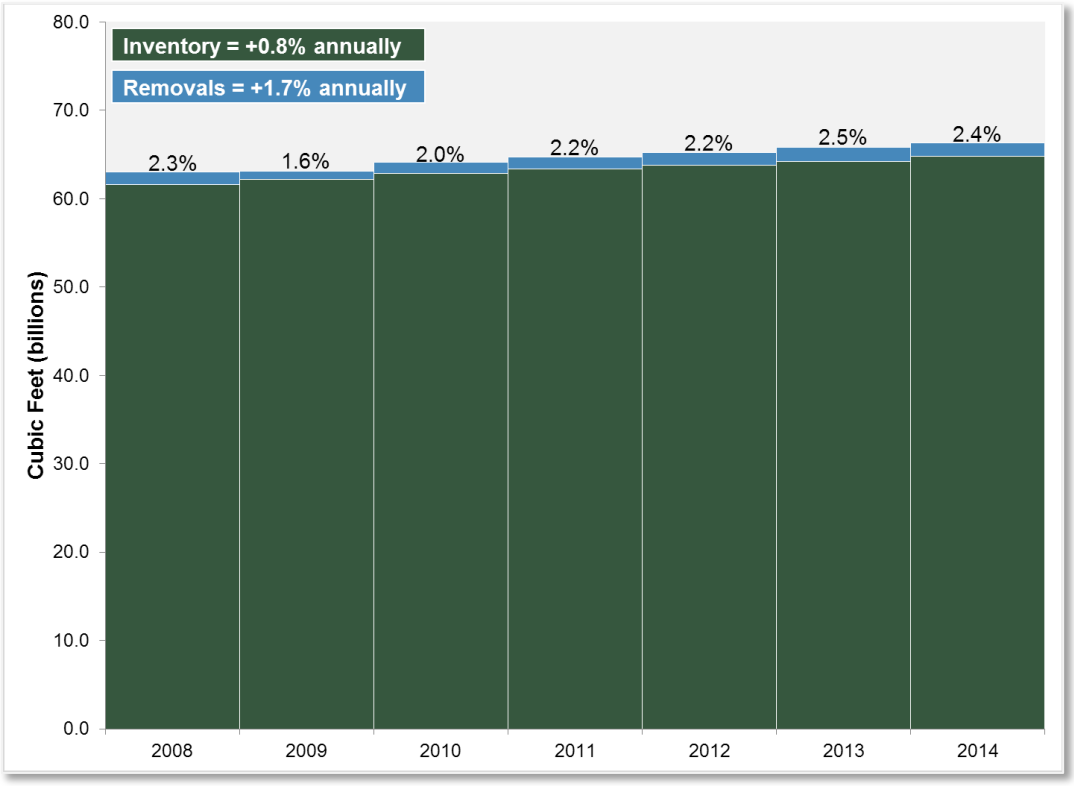


**Figure 3-15 Conifer Sawtimber Removals Relative to Inventory, 2008-2014 – Pacific Coast/Northwest Region**

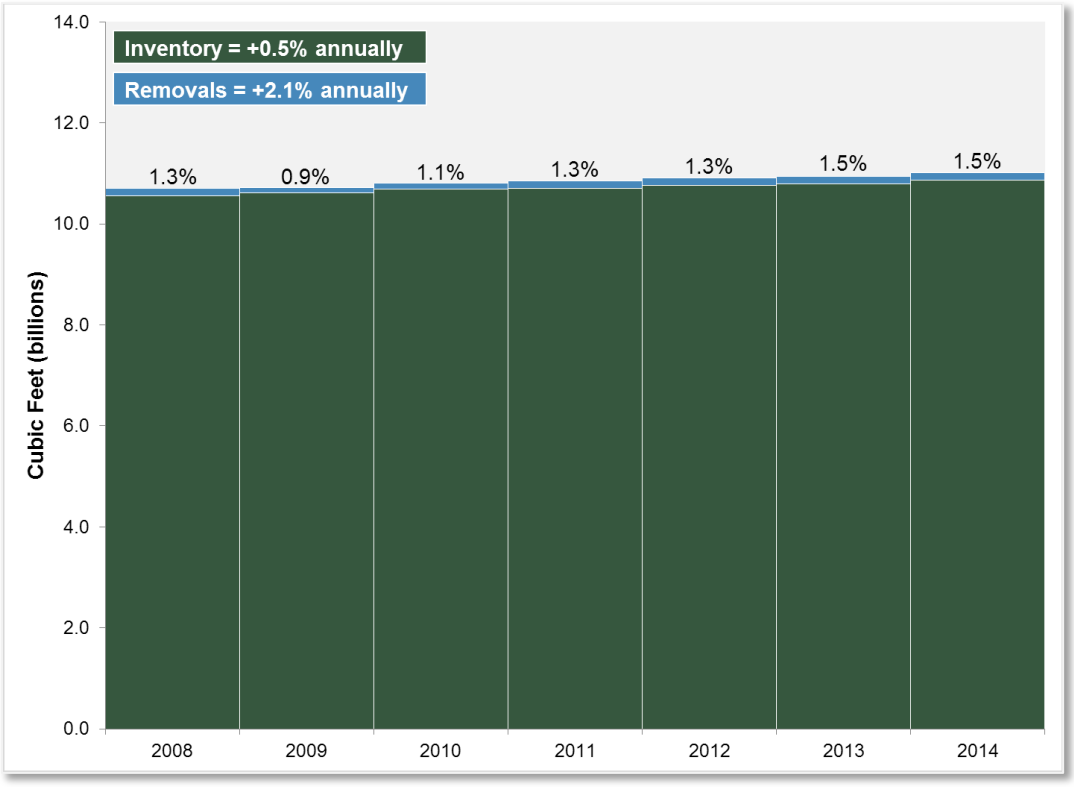


**Figure 3-16 Conifer Pulpwood Removals Relative to Inventory, 2008-2014 – Pacific Coast/Northwest Region**

### *Conifer Inventory and Removals*

Total conifer inventory increased at a rate of 0.8% compounded annually from 72.1 billion cubic feet (BCF) in 2008 to 75.6 BCF in 2014 (Table 3-9). Over this period, total conifer removals averaged 1.6 BCF annually.

Conifer sawtimber removals increased from 1.42 BCF in 2008 at a rate of 1.7% compounded annually to reach 1.58 BCF in 2014. Conifer sawtimber removals were lowest in 2009 and 2010 but increased above pre-Recession levels thereafter as export demand increased, particularly for hemlock destined for China. Despite increased export demand, domestic solid wood manufacturing was flat. Conifer sawtimber inventory increased from 61.6 BCF in 2008 to 64.8 BCF in 2014 at a rate of 0.8% compounded annually.

Because the majority of pulp and paper mills in the Pacific Coast/Northwest Region do not have on-site chipping facilities, they consume their wood feedstock in the form of residual chips or chipped pulpwood from area chipmills. As discussed in Section 2.1, the supply of residual chips from area solid wood manufacturers was constrained during this period, so pulp and paper mills consumed more of their feedstock as chipped roundwood, which resulted in increased conifer pulpwood removals. Conifer pulpwood removals increased 2.1% compounded annually from 0.14 BCF in 2008 to 0.16 BCF in 2014. Despite increased removals, conifer pulpwood inventory increased at a rate of 0.5% compounded annually from 10.6 BCF in 2008 to 10.9 BCF in 2014.

**Table 3-9 Conifer Inventory and Removals, Cubic Feet (billions) – Pacific Coast/Northwest Region**

| | Total Conifer | | Conifer Sawtimber | | Conifer Pulpwood | |
|---|---|---|---|---|---|---|
| Year | Inventory | Removals | Inventory | Removals | Inventory | Removals |
| 2008 | 72.1 | 1.56 | 61.6 | 1.42 | 10.6 | 0.14 |
| 2009 | 72.8 | 1.10 | 62.1 | 1.00 | 10.6 | 0.10 |
| 2010 | 73.6 | 1.35 | 62.9 | 1.23 | 10.7 | 0.12 |
| 2011 | 74.0 | 1.54 | 63.3 | 1.40 | 10.7 | 0.14 |
| 2012 | 74.6 | 1.56 | 63.8 | 1.42 | 10.8 | 0.14 |
| 2013 | 75.0 | 1.78 | 64.2 | 1.62 | 10.8 | 0.16 |
| 2014 | 75.6 | 1.73 | 64.8 | 1.58 | 10.9 | 0.16 |
| Compounded annual change | 0.8% | 1.8% | 0.8% | 1.7% | 0.5% | 2.1% |

### *Conifer Removals Relative to Inventory*

Total conifer removals relative to inventory have increased from 2.2% of inventory in 2008 to 2.3% of inventory in 2014 (Table 3-10) as removals have gradually increased since the Recession. Conifer sawtimber removals relative to inventory have increased from 2.3% in 2008 to 2.4% in 2014. Conifer pulpwood removals relative to inventory have increased from 1.3% in 2008 to 1.5% in 2014.

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**Table 3-10 Conifer Removals Relative to Inventory – Pacific Coast/Northwest Region**

| Year | Total Conifer | Conifer Sawtimber | Conifer Pulpwood |
|---|---|---|---|
| 2008 | 2.2% | 2.3% | 1.3% |
| 2009 | 1.5% | 1.6% | 0.9% |
| 2010 | 1.8% | 2.0% | 1.1% |
| 2011 | 2.1% | 2.2% | 1.3% |
| 2012 | 2.1% | 2.2% | 1.3% |
| 2013 | 2.4% | 2.5% | 1.5% |
| 2014 | 2.3% | 2.4% | 1.5% |
| Compounded annual change | 1.0% | 0.9% | 1.7% |

### 3.4.2 Hardwood

As described in Section 3.1, the Pacific Coast/Northwest Region is dominated by conifer species. As such, hardwood is a much smaller market in this region. The following charts (Figure 3-17, Figure 3-18, Figure 3-19) show the trends in inventory, removals and removals relative to inventory for total hardwood, hardwood sawtimber and hardwood pulpwood. Total hardwood, hardwood sawtimber, and hardwood pulpwood removals relative to inventory have increased since 2008 driven by increased harvest removals as the region recovers from the Great Recession, but these percentages remain less than 1%. In total, hardwood growth exceeded hardwood removals by 83% on average (GRR=1.83) between 2008 and 2013. Hardwood sawtimber growth exceeded sawtimber removals by 165% (GRR=2.65) while hardwood pulpwood removals exceeded pulpwood growth by 90% (GRR=0.10). These trends are discussed in greater detail below.

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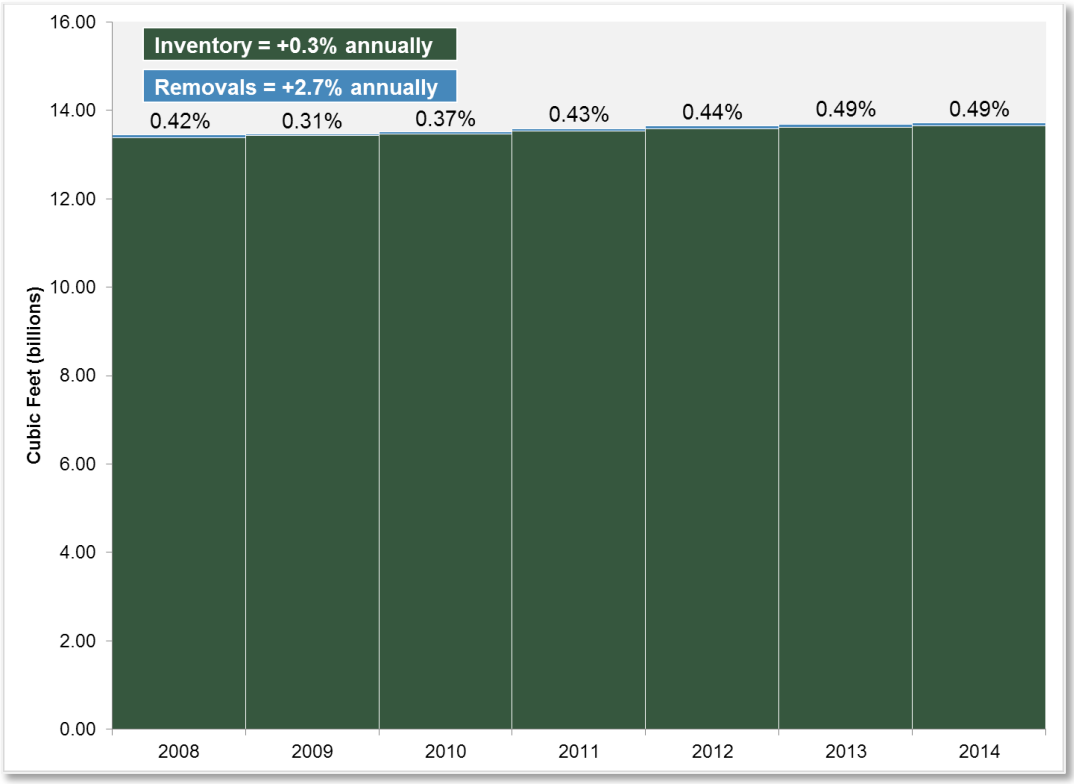


**Figure 3-17 Total Hardwood Removals Relative to Inventory, 2008-2014 – Pacific Coast/Northwest Region**

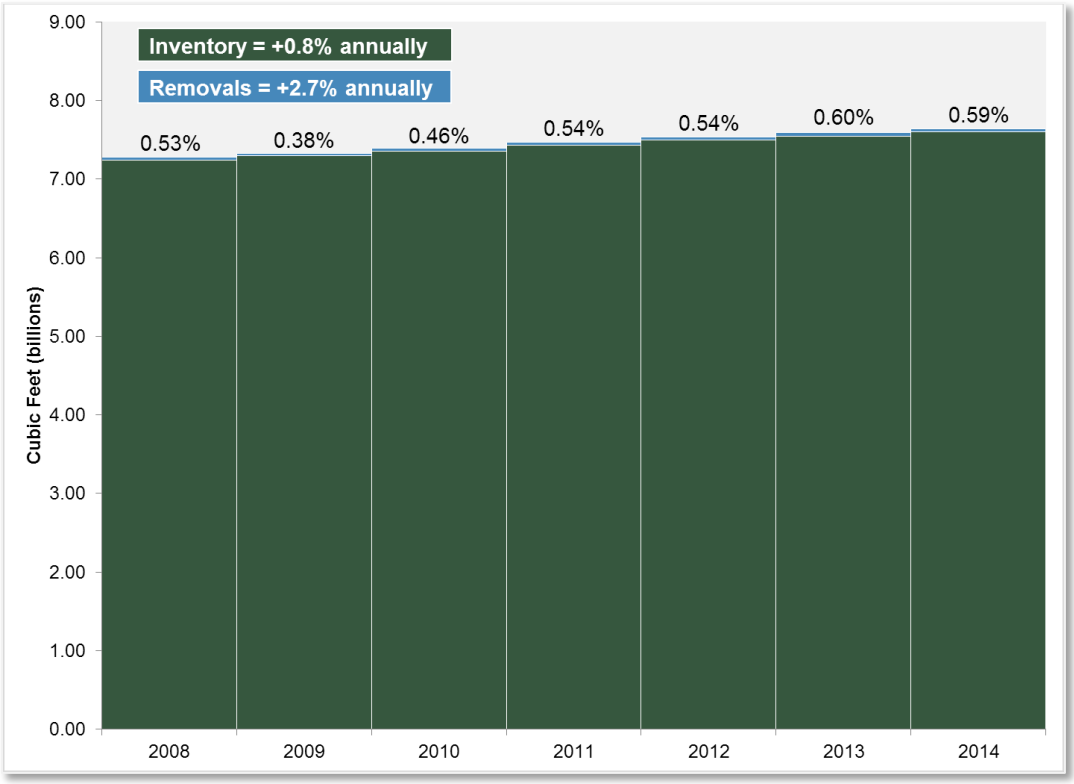


**Figure 3-18 Hardwood Sawtimber Removals Relative to Inventory, 2008-2014 – Pacific Coast/Northwest Region**

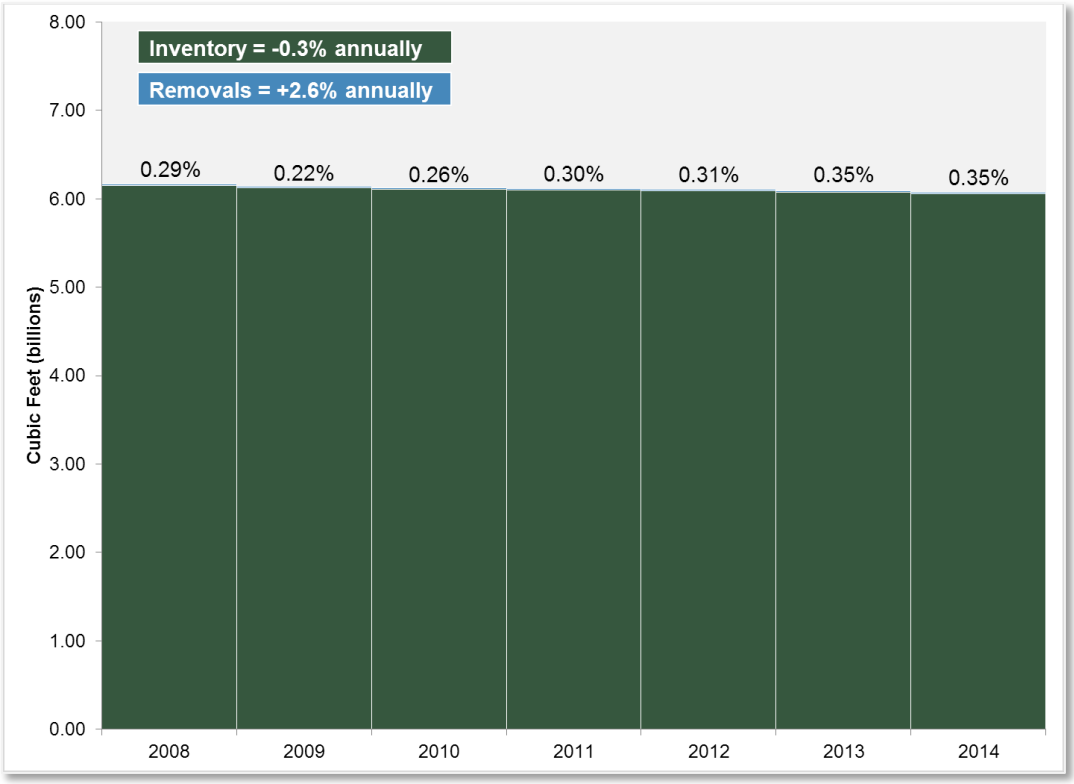


**Figure 3-19 Hardwood Pulpwood Removals Relative to Inventory, 2008-2014 – Pacific Coast/Northwest Region**

### *Hardwood Inventory and Removals*

As wood consumption increased following the Recession, total hardwood removals increased at an annual rate of 2.7% from 0.057 BCF in 2008 to 0.066 BCF in 2014 (Table 3-11). Despite increased removals, total hardwood inventory increased from 13.39 BCF in 2008 to 13.65 BCF in 2014 at a rate of 0.3% compounded annually.

Hardwood sawtimber removals increased 2.7% compounded annually from 0.038 BCF in 2008 to 0.045 BCF in 2014. Over this period, hardwood sawtimber inventory increased from 7.24 to 7.60 BCF at a rate of 0.8% compounded annually.

Hardwood pulpwood removals increased from 0.018 BCF in 2008 to 0.021 BCF in 2014 at a rate of 2.6% compounded annually. Hardwood pulpwood inventory decreased at a rate of 0.3% compounded annually from 6.15 BCF in 2008 to 6.06 BCF in 2014 as hardwood pulpwood removals exceeded growth and declining sawtimber demand contributed to age class disruptions that reduced hardwood pulpwood inventory: The number of private hardwood acres in the 0-15 age class decreased by 11% between 2008 and 2014.

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**Table 3-11 Hardwood Inventory and Removals, Cubic Feet (billions) – Pacific Coast/Northwest Region**

| Year | Total Hardwood | | Hardwood Sawtimber | | Hardwood Pulpwood | |
|---|---|---|---|---|---|---|
| | Inventory | Removals | Inventory | Removals | Inventory | Removals |
| 2008 | 13.39 | 0.057 | 7.24 | 0.038 | 6.15 | 0.018 |
| 2009 | 13.43 | 0.041 | 7.30 | 0.028 | 6.13 | 0.013 |
| 2010 | 13.47 | 0.050 | 7.36 | 0.034 | 6.11 | 0.016 |
| 2011 | 13.53 | 0.058 | 7.43 | 0.040 | 6.10 | 0.018 |
| 2012 | 13.59 | 0.059 | 7.50 | 0.041 | 6.09 | 0.019 |
| 2013 | 13.62 | 0.067 | 7.55 | 0.046 | 6.07 | 0.022 |
| 2014 | 13.65 | 0.066 | 7.60 | 0.045 | 6.06 | 0.021 |
| Compounded annual change | 0.3% | 2.7% | 0.8% | 2.7% | -0.3% | 2.6% |

### *Hardwood Removals Relative to Inventory*

Hardwood sawtimber, hardwood pulpwood and total hardwood removals relative to inventory have increased marginally since 2008, primarily a result of increased removals (Table 3-12). Hardwood sawtimber removals increased from 0.53% of inventory in 2008 to 0.59% of inventory in 2014. Hardwood pulpwood removals increased from 0.29% of inventory in 2008 to 0.35% of inventory in 2014. Total hardwood removals increased from 0.42% of inventory in 2008 to 0.49% of inventory in 2014.

**Table 3-12 Hardwood Removals Relative to Inventory – Pacific Coast/Northwest Region**

| Year | Total Hardwood | Hardwood Sawtimber | Hardwood Pulpwood |
|---|---|---|---|
| 2008 | 0.42% | 0.53% | 0.29% |
| 2009 | 0.31% | 0.38% | 0.22% |
| 2010 | 0.37% | 0.46% | 0.26% |
| 2011 | 0.43% | 0.54% | 0.30% |
| 2012 | 0.44% | 0.54% | 0.31% |
| 2013 | 0.49% | 0.60% | 0.35% |
| 2014 | 0.49% | 0.59% | 0.35% |
| Compounded annual change | 2.3% | 1.9% | 2.8% |

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# 4 Significant Findings

## 4.1 Conifer/Pine Inventory and Removals

Declines in pine sawtimber removals in the South and conifer sawtimber removals in the North were offset by growth in the export conifer sawlog market in the Pacific Coast/Northwest. As pulp and paper mills worked to replace reduced sawmill residual chip feedstocks, pine and conifer pulpwood removals increased in the South and Pacific Coast/Northwest. Conifer pulpwood removals decreased in the North. In total, conifer removals increased at a rate of 0.3% compounded annually between 2008 and 2014 (Figure 4-1).

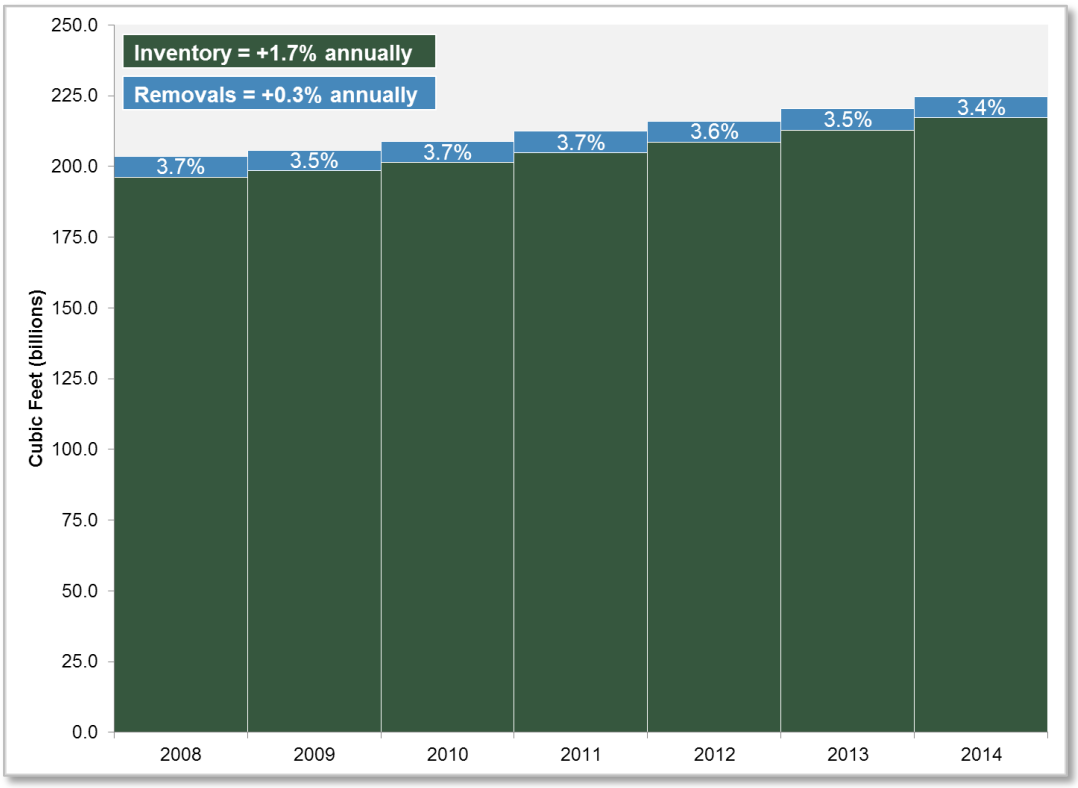


**Figure 4-1 Total Conifer Removals Relative to Inventory, 2008-2014 – All Regions**

Because conifer/pine removals were fairly flat during this period, inventories for both conifer pulpwood and sawtimber increased in all regions. In total, conifer/pine inventory increased at a rate of 1.7% compounded annually as an average of 47% more wood was grown than was harvested annually. Because conifer inventories increased at a faster rate than did removals, removals represented a smaller percentage of inventory in 2014 (3.4%) than they did in 2008 (3.7%).

## 4.2 Hardwood Inventory and Removals

In both the South and the North, hardwood sawtimber and hardwood pulpwood removals have decreased since 2008 in response to reduced demand from solid wood and paper manufacturers. Hardwood pulpwood and sawtimber removals increased in the Pacific Coast/Northwest, but the hardwood market is much smaller in this region, and these increases were not enough to offset the decreases in the North and South. As a result, total hardwood removals decreased in the study area at a rate of 2.7% compounded annually (Figure 4-2).

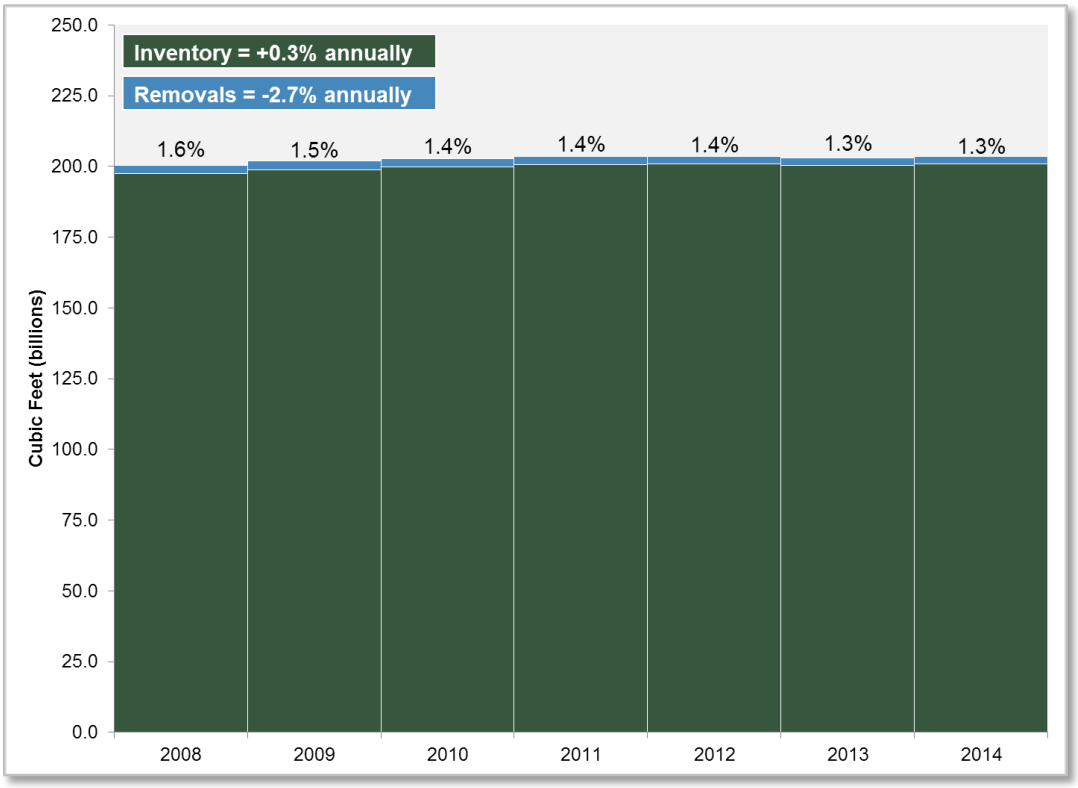


**Figure 4-2 Total Hardwood Removals Relative to Inventory, 2008-2014 – All Regions**

Due to reduced hardwood removals, total hardwood inventory across the study area increased at a rate of 0.3% compounded annually between 2008 and 2014. This increase was driven by increases in hardwood sawtimber inventory as reduced sawtimber and pulpwood harvest led to the accumulation of hardwood sawtimber inventory in the forest. Hardwood pulpwood inventories declined in each region as pulpwood-sized trees grew into sawtimber-sized trees, and reduced sawtimber harvests reduced pulpwood regeneration. Overall, hardwood removals declined from an equivalent of 1.6% of inventory in 2008 to 1.3% of inventory in 2014. On average, approximately 19% more hardwood was grown than was harvested annually.

## 4.3 Total Inventory and Removals

In response to the economic downturn and subsequent impacts of the Great Recession, total harvest removals from privately-owned timberlands in the study area have decreased at a rate of 0.6% compounded annually since 2008 (Figure 4-3). Tree growth exceeded removals by an average of 40% (GRR=1.40) during this period, which resulted in a 6.2% increase in privately-held inventory (1.0% compounded annually) between 2008 and 2014.

Compared to the total available private timberland resource, very little is removed annually. In 2008, removals were equivalent to 2.7% of inventory. Driven by decreased harvest removals and increasing inventories, removals as a percentage of inventory fell to 2.4% of inventory by 2014. On average, approximately 40% more wood was grown than was harvested annually.

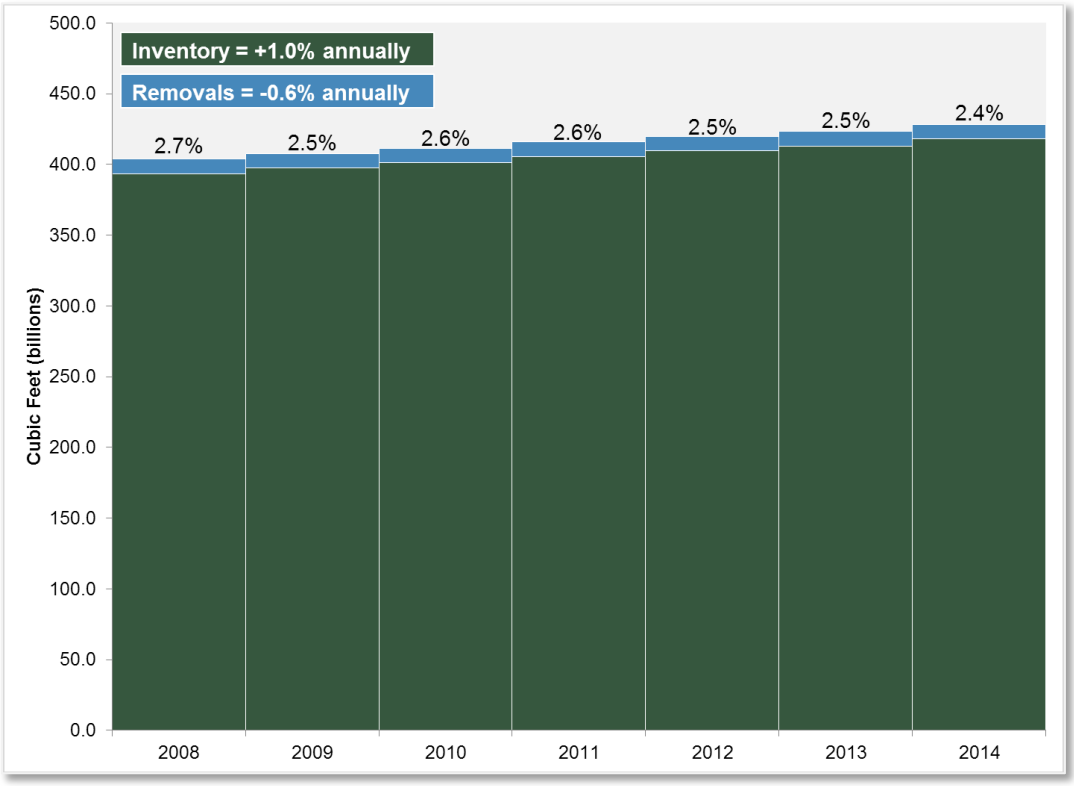


**Figure 4-3 Total (All Species) Removals Relative to Inventory, 2008-2014 – All Regions**

## 4.4 Conclusion

The results of this analysis indicate that the Great Recession has caused several disruptions to harvest removal and inventory patterns on privately-owned timberlands in the study area. First, as demand for wood-based manufactured products has waned, the forest products industry in the United States is harvesting less wood than it did in 2008.

Second, this reduction in harvest removals, especially sawtimber removals, has caused private forest inventories to increase above pre-Recession norms as unutilized sawtimber inventory accumulates. This trend is clearly evident in the South, where available FIA data make it possible to look at inventory trends both before and after the Great Recession, as shown in Figure 4-4 (next page).

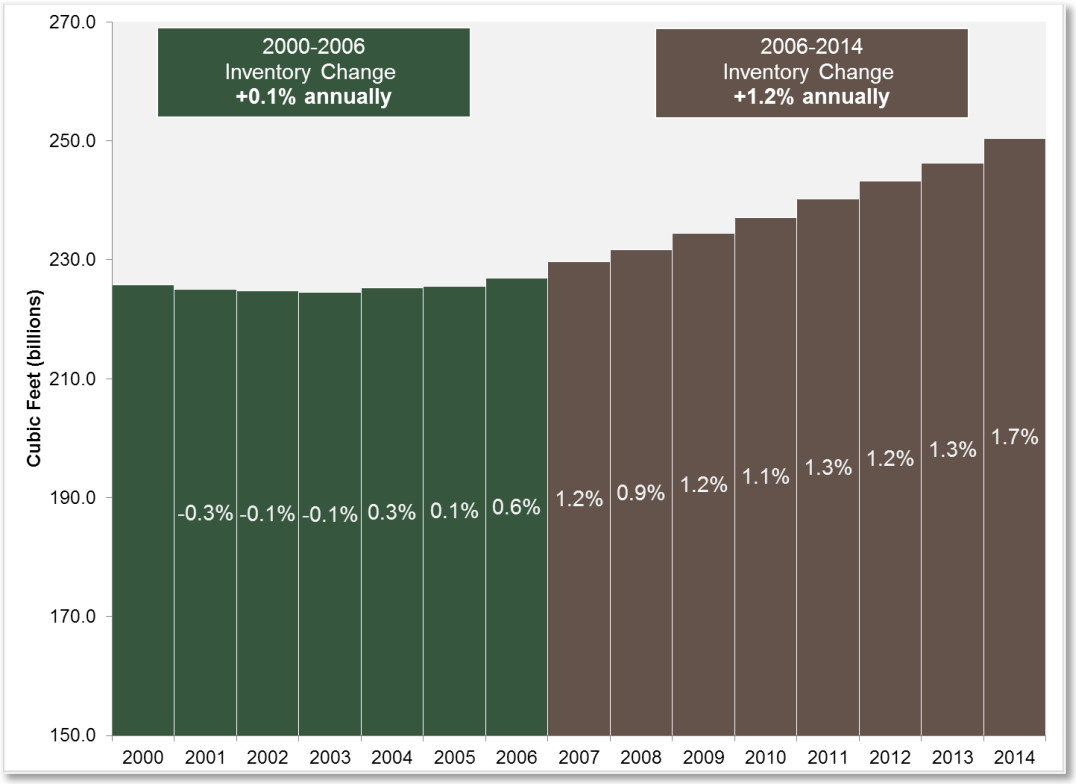


**Figure 4-4 Total Inventory and Inventory Change, 2000-2014 – South Region**

Between 2000 and 2006, inventory in the South increased at a compounded annual rate of only 0.1% as demand generally kept pace with forest growth. During this period, total inventory increased by 1.1 billion cubic feet (BCF) to 226.9 BCF in 2006. From 2006 to 2014, however, forest growth dramatically exceeded demand for wood fiber, and total inventory increased by 23.5 BCF (1.2% compounded annually) to reach 250.4 BCF in 2014.

Finally, when demand for timber—especially higher-value sawtimber—declines, private timberland owners feel pressure to optimize the return on their investment in one of two ways. The first is to delay sawtimber harvest, which increases inventories, as described above. The second is to seek alternate uses of their land that do not involve growing trees, such as by converting it to agricultural land or selling it for development.[18] Robust, long-term demand for forest products promotes continued investment in forested lands and ensures that they remain forested. In the absence of that demand, significant disruptions to forested land occur, placing forested lands at risk for conversion to other uses.

[18] See Alig, Ralph, et al. 2010. "Conversions of Forest Land: Trends, Determinants, Projections, and Policy Considerations." General Technical Report PNW-GTR-802.

# Appendix A: Methodology and Data Sources

## Research Identification

### Indicators

Forest2Market analyzed the following indicators during its analysis:

- Average annual removals of growing-stock trees on timberland
- Net volume of growing-stock trees on timberland

### Time Period

The U.S. Forest Service's Forest Inventory and Analysis (FIA) Program is mandated to perform periodic assessments of the nation's forests. The 1998 Farm Bill allowed FIA to shift from a periodic survey to an annual survey. During each annual inventory, a portion of FIA's sample plots are measured each year. At minimum, plots within each Eastern state are sampled at least once every seven years and plots within each Western state are sampled at least once every ten years. However, some states have reduced their inventory cycle to five years by providing additional funding to support FIA.

Due to differences in how FIA data are collected in different regions, the quantity and quality of inventory and removal data from FIA varies. In general, the U.S. South has the longest data coverage in the program, while the Pacific Northwest has the least. As a result, Forest2Market's analysis covers 2000-2014 in the U.S. South and 2008-2014 in all other regions.

### Geographic Study Area

The states included in the study area for the analysis were the same states used in Forest2Market's economic impact analysis report. Regions were revised to match regions used in other NAFO publications (Figure A-2). Three regions were represented: South, North and Pacific Coast/Northwest.

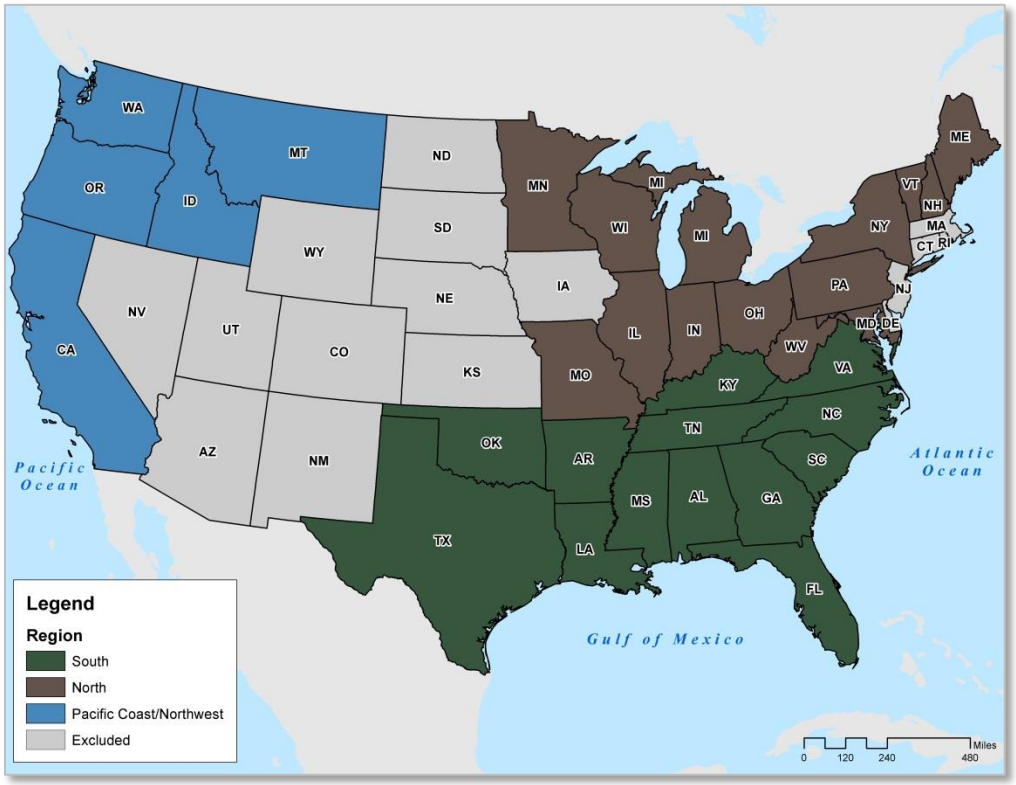


**Figure A-2 Map of Study Area**

# Data Collection

Forest2Market collected data from multiple proprietary and public databases. These sources are described below.

## U.S. Forest Service: Forest Inventory and Analysis

The United States Department of Agriculture (USDA) provides the principal source of timber resource information available for the United States *via* the U.S. Forest Service's Forest and Inventory Analysis (FIA) program. The Forest Service is mandated to conduct periodic assessments of timber inventories across the United States. During these assessments, measurements regarding forest characteristics (e.g., inventory, annual growth and annual removals) are taken for a portion of the FIA's sample plots in a state each year. In addition, FIA collects Timber Products Output (TPO) survey data, which tracks roundwood consumption at primary mills. FIA data were used to determine annual forest inventories for all regions and removals for all regions except the Pacific Northwest. Data are accessible at http://www.fia.fs.fed.us/tools-data/.

## Forest2Market: Proprietary Databases

In July of 2006, Forest2Market launched the industry's first ***Delivered Raw Material Cost Benchmark***. Over 90% of the wood fiber that is sold on a delivered basis in the US South is represented in the benchmark. Innovative companies use the benchmark reports to measure the effects of strategic and operational changes over time. Many also use the benchmark as an index for supply agreements or to set intra-company transfer prices. This service was added for the Western United States and Canada in 2007, in the Great Lakes region of the United States and Canada in 2012 and the Eastern United States and Canada in 2013. These databases and other public data sources provided roundwood consumption data that confirmed and supplemented the FIA data, particularly for years where FIA data were unavailable. More information about these services is available at http://www.forest2market.com/products/forest2mill.


## Other Public Sources

For the Pacific Northwest, the primary sources of removal data were FIA TPO data and data from various public entities, including the California Board of Equalization, Oregon Department of Forestry, Washington Department of Revenue, and the Bureau of Business and Economic Research at the University of Montana.

# Appendix B: Glossary

**Conifer** species are coniferous needle-leaved species of trees, such as pine, fir and spruce. They may also be referred to as softwood trees or evergreens.

**Containerboard** includes corrugated medium and linerboard, which are used in corrugated packaging.

**Diameter-at-breast height (DBH)** is a measurement of the diameter of a standing tree taken at 4.5 feet off of the ground (the breast height of a forester taking a forest inventory). DBH is an indication of the size of the logs that could result from the tree (e.g., pulpwood or sawtimber).

**Fluff pulp** is an absorbent chemical pulp commonly used in diapers and feminine hygiene products.

**Growing-stock trees**, according to the U.S. Forest Service's definition, include: "All live trees of commercial species that meet minimum merchantability standards. In general, these trees have at least one solid 8-foot section, are reasonably free of form defect on the merchantable bole, and at least 34 percent or more of the volume is merchantable. For the California, Oregon, and Washington inventories, a 26 percent or more merchantable volume standard is applied, rather than 34 percent or more. Excludes rough or rotten cull trees."

**Growth**, as used in this report, is calculated using the following formula: $Growth_{T1} = Inventory_{T2} - Inventory_{T1} + Removals_{T1}$.

**Growth-to-Removal Ratio (GRR)** is the ratio of growth over removals. GRRs over 1.0 indicate that more wood was grown than was removed during that time period. If it is less than 1.0, more wood was removed than was grown.

**Hardwood** species are deciduous broad-leaved species of trees, such as oak, maple, aspen, beech and birch.

**Inventory**, as calculated by the U.S. Forest Service, refers to the net volume (in cubic feet) of growing-stock trees at least 5 inches in diameter-at-breast-height on timberland. **Inventory** may also refer to the annual or periodic assessments conducted by the U.S. Forest Service to measure and assess the nation's forests.

**MBF** is a volumetric measure of the quantity of lumber. It is equivalent to one thousand board feet. See Board foot.

**MMBF** is a volumetric measure of the quantity of lumber. It is equivalent to one million board feet. See Board foot.

**Net cubic foot volume**, according to the U.S. Forest Service's definition, varies by timber species, as follows: "For timber species (trees where the diameter is measured at breast height [DBH]), this is the net volume of wood in the central stem of a sample tree >=5.0 inches in diameter, from a 1-foot stump to a minimum 4-inch top diameter, or to where the central stem breaks into limbs all of which are <4.0 inches in diameter. For woodland species (trees where the diameter is measured at root collar [DRC]), this is the net volume of wood and bark from the DRC measurement point(s) to a 1-1/2 inch top diameter; includes branches that are at least 1-1/2 inches in diameter along the length of the branch."

**Oriented Strand Board**, or OSB, is an engineered wood product used in construction and building applications.

**Pellet** mills use wood fiber to manufacture condensed wood pellets that are burned as a fuel in domestic heating stoves or in industrial electricity-generating facilities.

**Performance or specialty fiber** mills produce cellulose that is used in a range of specialized products, such as pharmaceutical additives, biochemicals, rayon and various other consumer product applications.

**Plywood**, manufactured by plymills, is a solid wood product used in construction and building applications.

**Pulpwood** includes logs from conifer trees that are generally 5 to 9 inches in DBH and hardwood trees that are generally 5 to 11 inches in DBH. **Topwood** from sawtimber trees and low-quality trees and that are not suitable for veneer or lumber may also be merchandized as pulpwood. Pulpwood is used by chip mills, Oriented Strand Board (OSB) mills, pellet mills and pulp and paper mills.

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**Removals**, as described by the U.S. Forest Service, refer to "[t]rees that were growing-stock trees on timberland at the time of the previous inventory and were removed from timberland by the time of the current inventory." Removals include "cut and utilized trees, trees killed as a result of harvest operations but not utilized, and live trees associated with land-use reclassifications."

**Sawlogs**, as defined by the U.S. Forest Service, are logs "meeting minimum standards of diameter, length, and defect, including logs at least 8 feet long, sound and straight, and with a minimum diameter inside bark of 6 inches for softwoods [i.e., conifers] and 8 inches for hardwoods, or meeting other combinations of size and defect specified by regional standards."

**Sawtimber** includes stemwood from conifer trees that are over 9 inches in DBH and hardwood trees that are over 11 inches in DBH.

**Stemwood** refers to wood from the main part of a tree and excludes the branches, stump and roots.

**Timberland**, according to the U.S. Forest Service's definition, is: "Forest land that is producing or is capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation. …Areas qualifying as timberland are capable of producing at least 20 cubic feet per acre per year of industrial wood in natural stands. Currently inaccessible and inoperable areas are included."

**Topwood** is the portion of the sawtimber tree above the **sawlog** portion. Topwood of sufficient quality is sold on the open-market as **pulpwood**.

**Uncoated freesheet** is a grade of paper commonly used to produce copy and office paper.