FOREST INVENTORY AND GROWTH-TO-DRAIN OF PRIVATE FORESTS IN THE UNITED STATES

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NAFO®

National Alliance of Forest Owners

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Conducted by:

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EXECUTIVE SUMMARY

Forestry is the science and practice of establishing, managing, using, and conserving forests, trees, and associated resources in a sustainable manner to meet desired goals.[1] Sustainability is essential for private landowners who want to ensure that their forests remain productive for many years. One sustainability metric, growth-to-drain (GTD), is a ratio of the total volume of wood grown over a given period divided by the total volume of wood harvested during that same period. A GTD ratio of 1.0 indicates a timber market that harvests timber at the same rate of growth. A ratio greater than 1.0 indicates that same annual timber growth exceeds harvest, while a ratio less than 1.0 indicates more timber was harvested than was grown. The National Alliance of Forest Owners (NAFO) retained Forisk to provide an update of inventory, growth, and removals on privately-owned timberlands in the U.S. and to discuss recent forest industry trends. Key findings from this research include:

- **Private forests in the U.S. had a Growth-to-Drain (GTD) ratio of 1.53 from 2011 to 2019, indicating growth exceeded removals by 53%.** GTD increased during the period, from 1.40 in 2011 to 1.73 in 2019.

- Total forest inventory on private lands increased 9.2% from 509.5 billion cubic feet (BCF) in 2011 to 561.0 in 2020. According to the USDA Forest Service, Americans use 10 to 15 BCF per year, so this inventory equates to between 37 and 56 times the annual wood use in the United States.[2]

- Total removals declined by 4.6% from 11.2 BCF in 2011 to 10.7 BCF in 2020.

- Total inventory in the South increased 20.5% from 2000 to 2020, while total removals declined by 12.0%. The South has a total GTD ratio of 1.84 as of 2019, meaning growth exceeds removals by 84%, exceeding the nineteen-year average of 1.35 from 2000 to 2019.

- Total inventory in the West increased 4.3% from 2011 to 2020, while removals decreased by 7.6%. The West has a total growth-to-drain ratio of 1.02 as of 2019, meaning growth exceeds removals by 2%. The average GTD from 2011 to 2019 was 1.25 in the region.

- Total inventory in the North increased 6.0% from 2008 to 2020, while removals declined by 15.8%. The North has a total GTD of 1.89 as of 2019, meaning growth exceeds removals by 89%. This exceeds the twelve-year average of 1.49 from 2008 to 2019.

- Over the past three years, pulp mill closures, conversions to recycled feedstocks, and indefinite idlings impacted all five North American regions: U.S. South, U.S. North, U.S. West, Western Canada, and Eastern Canada. Including closures in 2024, more than two dozen mills reduced pulp fiber consumption by 32 million tons, with the U.S. South accounting for 19 million tons. Increased demand in oriented strand board (OSB) and wood pellet markets help mitigate some pulpwood demand losses in select local basins.

- The large growth of forest inventories on private forest lands in the U.S. South attracted significant softwood sawmill investments, as firms shifted capacity away from supply constrained regions in Western Canada and the Pacific Northwest. Since 2000, softwood lumber production in the U.S. South increased from 16 billion board feet (BBFT) to 22 BBFT in 2023. During that period, lumber production in the West fell from 16 BBFT to approximately 14 BBFT in 2023. Softwood lumber production in the U.S. North has remained between 1-2 BBFT per year.

[1] USDA Forest Service
[2] USDA Forest Atlas of the US: https://apps.fs.usda.gov/forest-atlas/benefits-wood-products.html

FOREST PRODUCTS INDUSTRY OVERVIEW AND CONTEXT

The U.S. forest products industry experienced significant changes over the past 20 years, including shifts in regional production, changes in product demand, and modifications in the types of products produced.

Pulp and Paper Markets

The U.S. pulp and paper market consolidated since 2000 as manufacturers merged with and acquired other firms and overall demand for the sector decreased. Total paper and paperboard production in the U.S. fell from just shy of 90 million metric tons in 2000 to approximately 60 million metric tons in 2023.[3] Production of printing and writing paper dropped by over 70% and newsprint production dropped 96% to only 300,000 metric tons during that time frame. Packaging production surged from 2010 to 2021, then fell to levels produced in the early 2000s around 46 million metric tons per year as firms shed post-COVID accumulated inventories.

Recently, the sector experienced another round of consolidation. Over the past three years, closures, conversions of facilities to recycled feedstocks, and indefinite idling of pulp mills impacted all five North American regions. Including closures in 2024, more than two dozen mills reduced pulp fiber consumption by 32 million tons, with the U.S. South accounting for 19 million tons. Increased demand in oriented strand board (OSB) and wood pellet markets has helped mitigate some pulpwood demand losses in select local basins.

Oriented Strand Board (OSB) Markets

Despite reductions in the pulp/paper industry, the OSB and wood pellet sectors have grown in the U.S. in the past 20 years, increasing pulpwood demand in local markets. OSB, a building material made from small diameter trees, competes with plywood in the structural panels market. OSB firms expanded mill production capacity by 5% over the past five years in North America, and they are building more mills in the U.S. South. For example, RoyOMartin opened a second OSB mill in Corrigan, Texas and Georgia-Pacific is expanding the Clarendon OSB mill in South Carolina. Kronospan and Huber are also building OSB mills in the U.S. South (planned to be completed in 2025).

Lumber Markets

U.S. softwood lumber production peaked in 2005 before collapsing with housing markets during the Great Recession in 2007-2009, falling from approximately 40 billion board feet (BBFT) per year to 23 BBFT. Production increased since 2008 but has yet to recover to pre-recession levels. Production levels are forecasted to reach pre-recession levels by 2026.

Lumber production also shifted in the U.S. since 2000. Reduced harvesting due to endangered species in the Pacific Northwest and insect infestations in Western Canada caused mill capacity to move to or expand to areas where resources are accessible with a higher degree of certainty. The large growth of forest inventories on private forest lands in the U.S. South, coupled with a greater ability to predictably access the forest resources than the Pacific Northwest, attracted significant sawmill investments, as firms shifted capacity from supply constrained regions in Western Canada and the Pacific Northwest. In addition to abundant timber supplies, the South boasts a favorable business climate and forest industry supply chain.

Since 2000, softwood lumber production in the U.S. South increased from approximately 16 BBFT to 22 BBFT in 2023. During that period, lumber production in the West fell from 16 BBFT to approximately 14 BBFT in 2023. Softwood lumber production in the U.S. North has remained flat, hovering between 1-2 BBFT per year. Lumber manufacturers continue to invest in the U.S. South with $2.6 billion in announced projects from 2024 to 2026.

[3] Forisk 2024 Q4 *Forisk Research Quarterly* Report

Export Markets

Pellet mills offer an important market for pulpwood, logging residuals, and mill residuals in certain regions. The wood pellet market has grown significantly in the U.S. since the early 2000s. Currently there are 149 announced or operating pellet mills in the U.S., with 63 of those mills in the U.S. South, 52 in the North, and 34 in the West.[4] The majority of pellets produced in the U.S. are exported (74%)[5], with the United Kingdom being the primary destination, followed by Japan, the Netherlands, and Denmark. Since 2017, U.S. wood pellet exports increased from 5.7 million metric tons to 9.5 million metric tons in 2023.

The U.S. is also a net exporter of pulp. The U.S. exports pulp to China, Mexico, and elsewhere. Pulp export volumes have remained consistent since 2019, generally fluctuating between 6.0 and 8.0 million air-dry tonnes per year.

In addition, the U.S. exports sawlogs, with 85% of U.S. sawlog exports going to Canada, Japan, and China, though this represents a small portion of harvested U.S. sawlogs. In 2023, the U.S. exported 5.8 million short tons of softwood logs and 2.37 million short tons of hardwood logs. Primary destinations for softwood logs were Canada (32%), China (30%) and Japan (24%). The main destinations for hardwood logs were China (51%), Canada (33%) and Vietnam (6%).

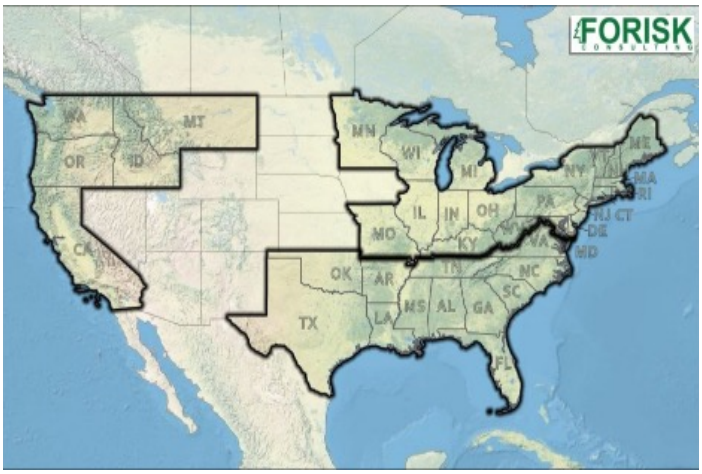
STUDY SCOPE

Geography

Forisk analyzed privately-owned timberlands in 37 states grouped into three regions: South, North, and Pacific Coast/Northwest. The states by region are listed and shown below (Figure 1).

- **South:** Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia
- **North:** Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, Michigan, Wisconsin, Minnesota, New Jersey, Delaware, Maryland, West Virginia, Ohio, Indiana, Illinois, Missouri, and Kentucky
- **Pacific Coast/Northwest (West):** California, Idaho, Montana, Oregon, and Washington

Figure 1. Regions Included in Study



Time Period

Forisk utilized the U.S. Forest Service's Forest Inventory and Analysis (FIA) dataset and for this analysis. FIA data, while collected across the country, has regional differences in its quantity and quality. For this report, Forisk's analysis covers 2000 to 2020 in the U.S. South, 2008 to 2020 in the North, and 2011 to 2020 in the West.

[4] Forisk Wood Bioenergy Database
[5] Forisk 2023 Q2 *Forisk Research Quarterly* Report

Methodology

The FIA dataset calculates inventory and removals for the states covered by the program. Inventory, as defined by the FIA program, is the net volume in cubic feet of growing-stock trees at least five inches in diameter-at-breast-height (DBH) on timberland. The FIA program defines removals as "the net volume of sound (growing-stock) trees removed from the inventory by harvesting or other cultural operations (such as timber-stand improvement), by land clearing, or by changes in land use (such as Wilderness designation)."[6] Growth is a measure of the annual change in volume of trees between inventories net of removals and mortality. For this report, growth was calculated as:

GrowthT1 = InventoryT2 – InventoryT1 + RemovalsT1 [7]

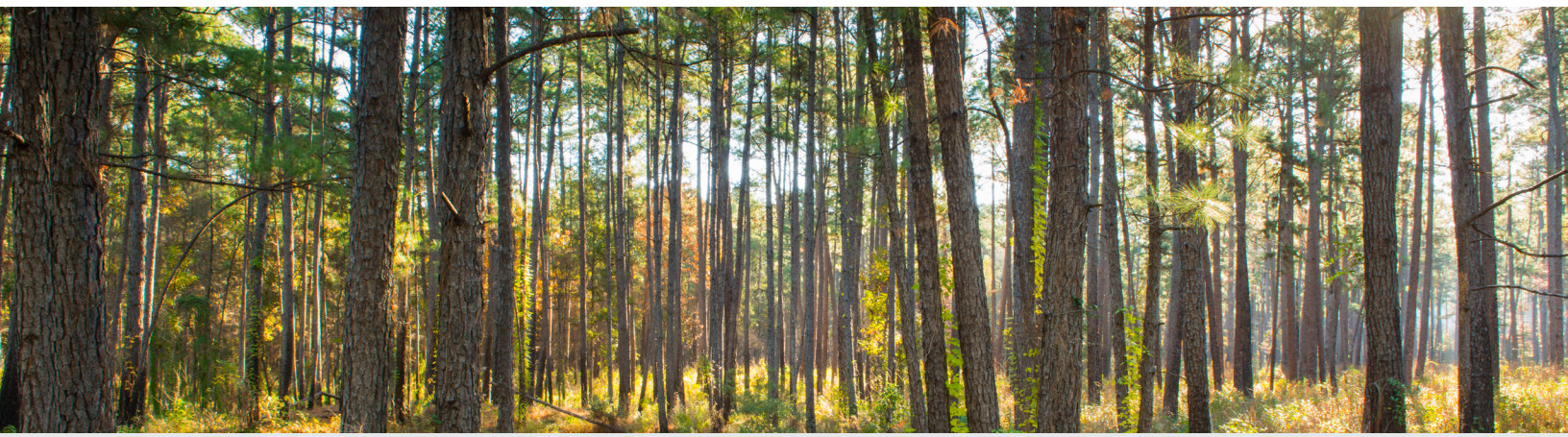
Product specifications by species are defined in Appendix 2. Product specifications for the West are different than the other two regions to acknowledge that timber markets are predominantly driven by sawtimber in this region. Pulp mills mainly purchase mill residuals from sawmills as feedstock, so pulpwood from the woods is a lower volume timber product in the region.

The FIA data was used to determine trends in inventory, growth, and removals over time and to calculate the growth-to-drain ratio for each region. Growth-to-drain (GTD) is a metric often used to assess the sustainability of a forest. A GTD ratio greater than 1.0 indicates that growth exceeds removals for a given period, while a GTD ratio of less than 1.0 indicates that removals exceeded growth for that period. For the overall U.S. GTD ratios, Forisk utilized data from 2011-2020, as data from that period was available in all three regions. The GTD ratios for the South use data from 2000-2020, the North use 2008-2020, and the West are based on data from 2011-2020.

Additionally, at the time Forisk accessed the FIA database, removals data was not available for all states prior to 2020 in the Pacific Coast/Northwest region. Forisk utilized state-level timber harvest data from the University of Montana's Bureau of Business and Economic Research (BBER) to report removals in the Pacific Coast/Northwest region. In addition, Forisk used product-level removals data from the U.S. Forest Service Timber Product Output (TPO) dataset to split the BBER removals data into species and product categories.

Data in this report is reported in billion cubic feet units (BCF). Different species of trees in different parts of the country have different weights per cubic foot volume. Commercial standards also differ regionally. In the U.S. South, wood is measured by weight in tons. In the Pacific Coast, sawlogs are measured in scaled board feet using different methods. In the U.S. North, sawlogs are measured in scaled board feet while other products are measured in tons or cords. For this reason, the data is reported in a common unit of BCF.[8]

[6] USFS Forest Inventory and Analysis Glossary
[7] T1 = Year 1 and T2 = Year 2. For example, the annual timber growth in 2019 is calculated as: Inventory in 2020 minus Inventory in 2019 plus the Removals in 2019.
[8] This U.S. Forest Service publication includes conversion factors for other standard units of measure by species. Winn, Matthew F.; Royer, Larry A.; Bentley, James W.; Piva, Ronald J.; Morgan, Todd A.; Berg, Erik C.; and Coulston, John W. 2020. Timber products monitoring: unit of measure conversion factors for roundwood receiving facilities. E-Gen. Tech. Rep. SRS-251. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 148 p.



U.S. TRENDS

Based on data from 2011 to 2020:

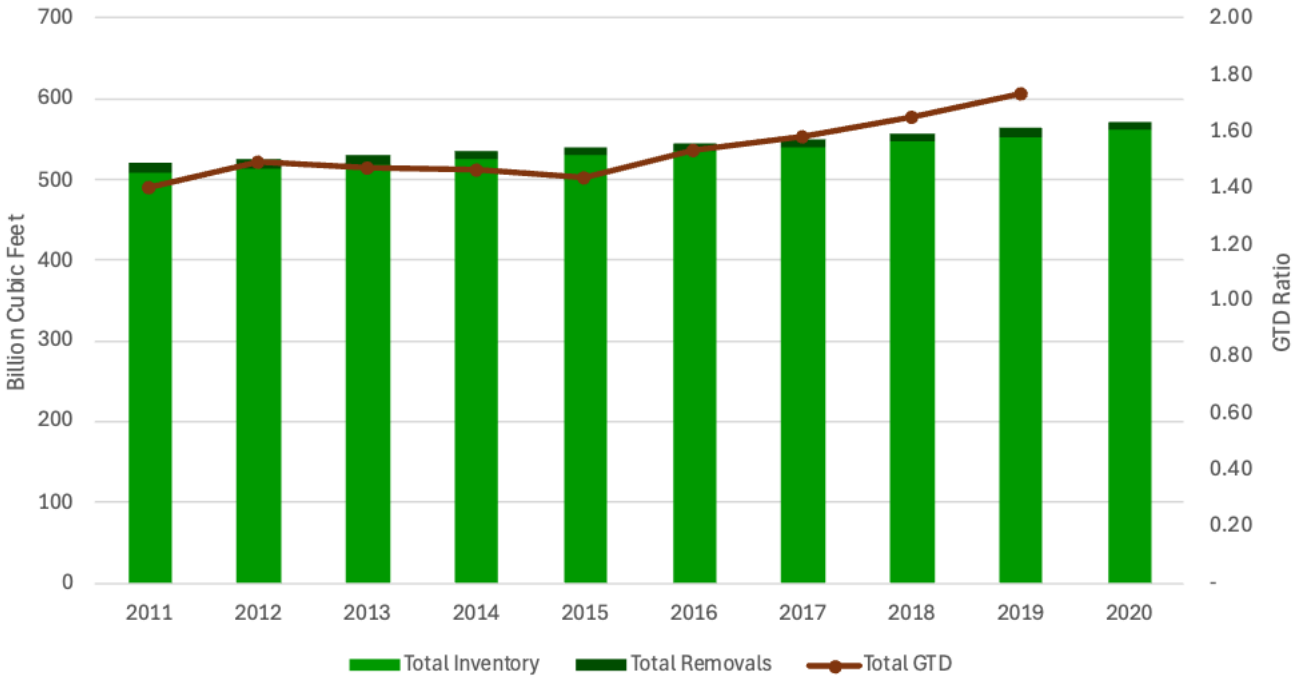
- Total inventory on privately-owned timberland in the regions and states covered in this analysis increased by 9.2%, from 509.5 BCF in 2011 to 561.0 BCF in 2020. For context, Americans use 10 to 15 BCF of wood and paper products per year in the U.S.
- Total growth increased by 15.6%, from 15.7 BCF in 2011 to 18.5 BCF in 2019.
- Total removals fell by 4.6%, from 11.2 BCF in 2011 to 10.7 BCF in 2020.
- In comparing growth to removals between 2011 and 2019[9], private forests had a total GTD ratio of 1.53, indicating growth exceeded removals by 53% between 2011-2019.
- Total growth-to-drain in 2019 was 1.73 (Figures 2 and 3).

Figure 2. U.S. Summary Data, 2011-2020

	2011	2020	% Change
Total Inventory	509.5 BCF	561.0 BCF	9.2%
Total Growth*	15.7 BCF	18.5 BCF	15.6%
Total Removals	11.2 BCF	10.7 BCF	-4.6%
Growth to Drain: 2011-2019	1.53		
Growth to Drain: 2018-2019	1.73		

Total Inventory: net volume of growing-stock trees at least 5" DBH on timberland.
*Total Growth: annual change in volume of trees between inventories net of removals and mortality. The most recent estimate for growth in the table is 2019.
Total Removals: net volume of growing-stock trees removed from the inventory by harvesting, land clearing, or changes in land use.
Growth to Drain: ratio of total growth versus total removals for a given time period.
BCF: Billion cubic feet.

Figure 3. Total Inventory and Removals, All Regions



Source: U.S. Forest Service FIA

[9] Because growth is calculated as the difference in inventory between 2019 and 2020 less removals, and 2020 is the most recent year of data across all three regions, the 2019 is the most recent GTD number available.

U.S. SOFTWOOD

Based on data from 2011 to 2020:

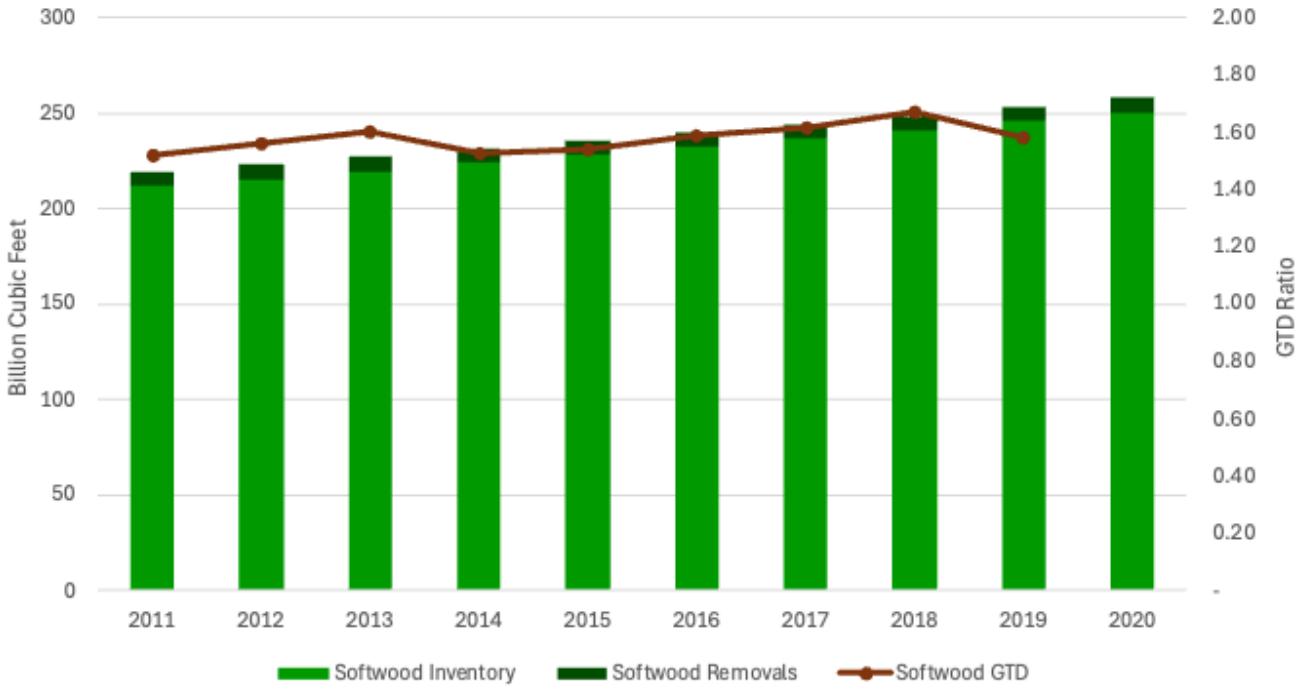
- Total softwood inventory in the U.S. increased 15.5%, from 211.9 BCF in 2011 to 250.6 BCF in 2020.
- Total softwood removals remained flat, declining by 0.5% from 7.52 BCF in 2011 to 7.49 BCF in 2020.
- Softwood growth increased by 3.2%, from 11.4 BCF to 11.8 BCF.
- Total U.S. softwoods had a GTD ratio of 1.58, meaning approximately 58% more softwood was grown than harvested.
- The GTD ratio of U.S. softwoods in 2019 was 1.59 (Figures 4 and 5).

Figure 4. U.S. Softwood Summary Data, 2011-2020

	2011	2020	% Change
Total Inventory	211.9 BCF	250.6 BCF	15.5%
Total Growth*	11.4 BCF	11.8 BCF	3.2%
Total Removals	7.52 BCF	7.49 BCF	-0.5%
Growth to Drain: 2011-2019	1.58		
Growth to Drain: 2018-2019	1.59		

Total Inventory: net volume of growing-stock trees at least 5" DBH on timberland.
*Total Growth: annual change in volume of trees between inventories net of removals and mortality. The most recent estimate for growth in the table is 2019.
Total Removals: net volume of growing-stock trees removed from the inventory by harvesting, land clearing, or changes in land use.
Growth to Drain: ratio of total growth versus total removals for a given time period.
BCF: Billion cubic feet.

Figure 5. Total Softwood Inventory and Removals, All Regions



Source: U.S. Forest Service FIA

U.S. HARDWOOD

Based on data from 2011 to 2020:

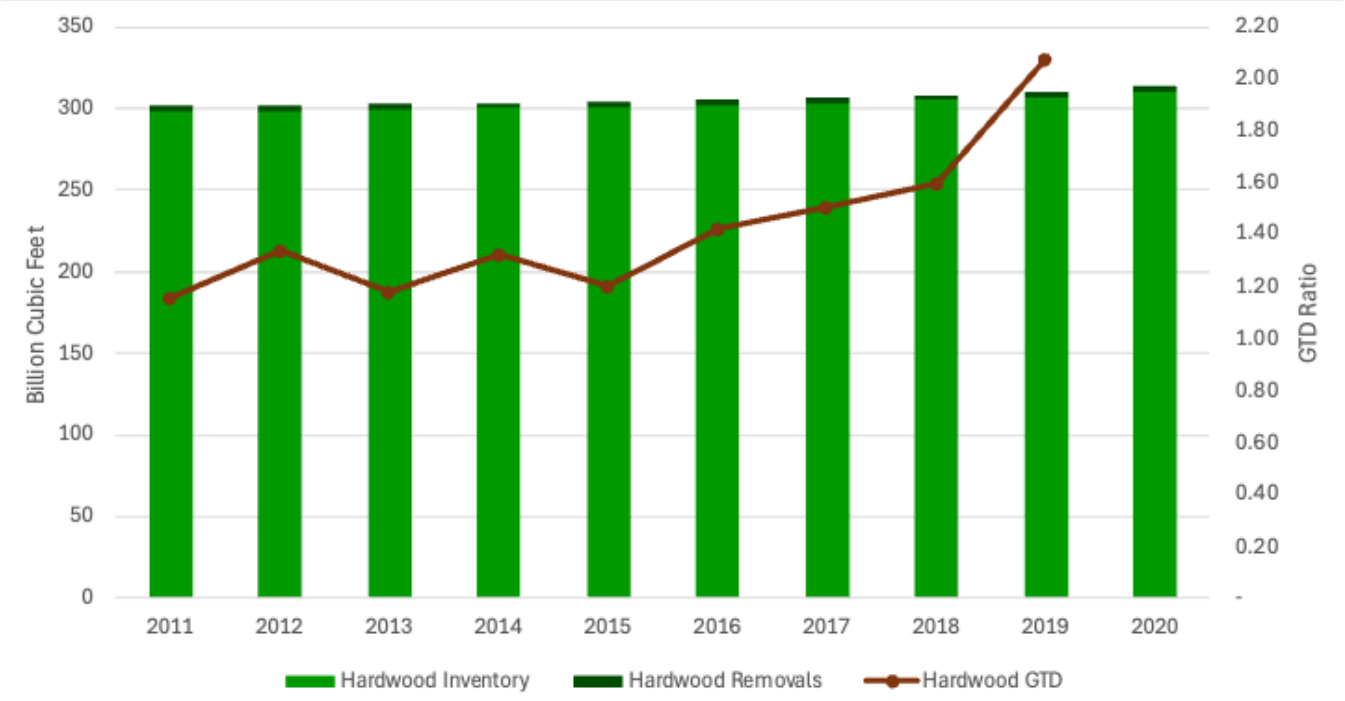
- Total hardwood inventory in the U.S. increased 4.1%, from 297.6 BCF in 2011 to 310.3 BCF in 2020.
- Total hardwood removals declined by 14.4%, from 3.7 BCF in 2011 to 3.2 BCF in 2020.
- Total hardwood growth increased by 37.2%, from 4.2 BCF to 6.7 BCF.
- Between 2011 and 2019, total U.S. hardwoods had a GTD ratio of 1.42, meaning approximately 42% more hardwood was grown than harvested.
- In 2019, U.S. hardwood GTD was 2.08 (Figures 6 and 7).

Figure 6. U.S. Hardwood Summary Data, 2011-2020

	2011	2020	% Change
Total Inventory	297.6 BCF	310.3 BCF	4.1%
Total Growth*	4.2 BCF	6.7 BCF	37.2%
Total Removals	3.7 BCF	3.2 BCF	-14.4%
Growth to Drain: 2011-2019	1.42		
Growth to Drain: 2018-2019	2.08		

Total Inventory: net volume of growing-stock trees at least 5" DBH on timberland.
*Total Growth: annual change in volume of trees between inventories net of removals and mortality. The most recent estimate for growth in the table is 2019.
Total Removals: net volume of growing-stock trees removed from the inventory by harvesting, land clearing, or changes in land use.
Growth to Drain: ratio of total growth versus total removals for a given time period.
BCF: Billion cubic feet.

Figure 7. Total Hardwood Inventory vs Total Removals, All Regions



Source: U.S. Forest Service FIA

REGIONAL TRENDS: SOUTH

Based on data from 2000 to 2020:

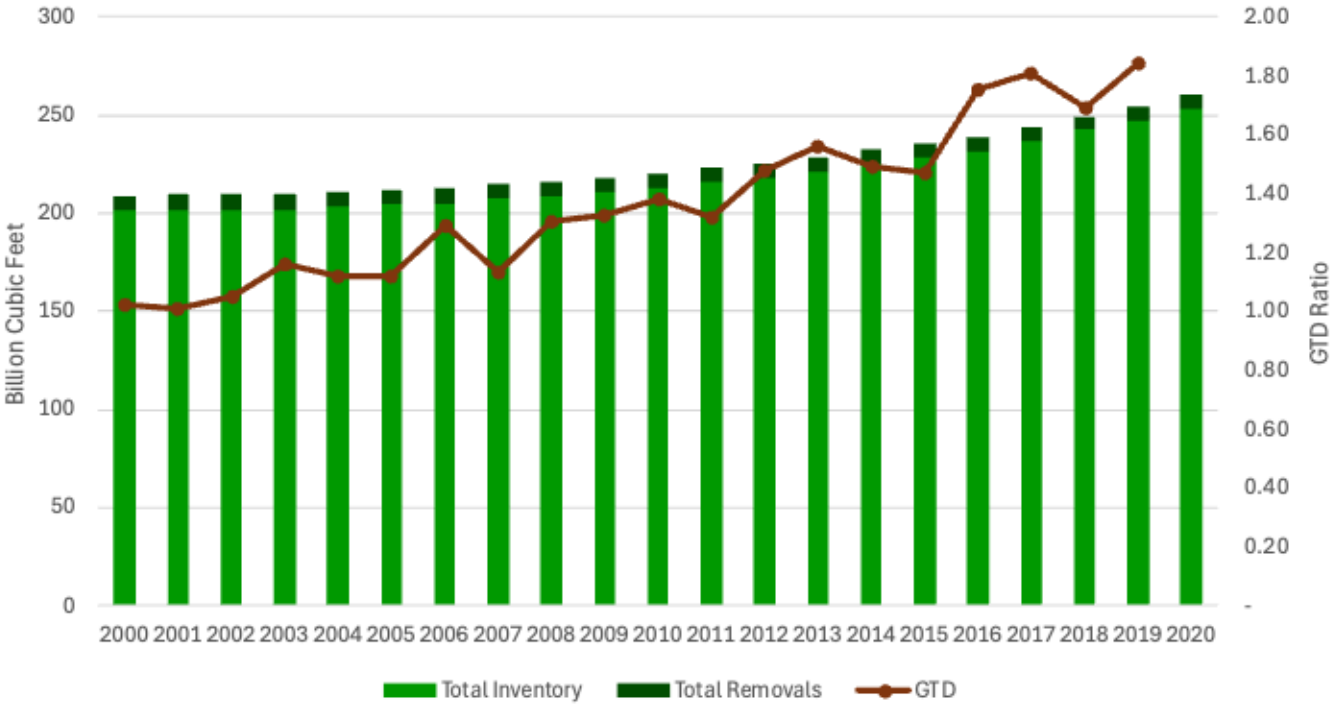
- Total inventory in the South increased 20.5% from 201.3 BCF in 2000 to 253.3 BCF in 2020.
- Total removals declined by 12.0% from 8.0 BCF to 7.1 BCF.
- Total growth increased by 37.1% from 8.1 BCF to 12.9 BCF.
- Between 2000 and 2019, the U.S. South had a total GTD ratio of 1.35, indicating that growth exceeded removals by 35% in the South between 2000 and 2019.
- In 2019 the GTD ratio was 1.84. (Figures 8 and 9).

Figure 8. U.S. South Summary Data, 2000-2020

	2000	2020	% Change
Total Inventory	201.3 BCF	253.3 BCF	20.5%
Total Growth*	8.1 BCF	12.9 BCF	37.1%
Total Removals	8.0 BCF	7.1 BCF	-12.0%
Growth to Drain: 2000-2019	1.35		
Growth to Drain: 2018-2019	1.84		

Total Inventory: net volume of growing-stock trees at least 5" DBH on timberland.
*Total Growth: annual change in volume of trees between inventories net of removals and mortality. The most recent estimate for growth in the table is 2019.
Total Removals: net volume of growing-stock trees removed from the inventory by harvesting, land clearing, or changes in land use.
Growth to Drain: ratio of total growth versus total removals for a given time period.
BCF: Billion cubic feet.

Figure 9. Total Inventory vs Total Removals, South



Source: U.S. Forest Service FIA

SOUTH SOFTWOOD

Based on data from 2000 to 2020:

- Total softwood inventory in the South increased 32.2% from 88.3 BCF in 2000 to 130.2 BCF in 2020.
- Total softwood removals increased slightly, by 1.8%, from 5.5 BCF to 5.6 BCF during this same period.
- Total softwood growth increased by 43.4% from 5.4 BCF to 9.6 BCF.
- Total softwoods had a GTD ratio of 1.39 for the South from 2000 to 2019, or growth exceeding removals by 39%.
- In 2019, the GTD ratio for softwoods in the South was 1.76 (Figures 10 and 11).

Figure 10. U.S. South Softwood Summary Data, 2000-2020

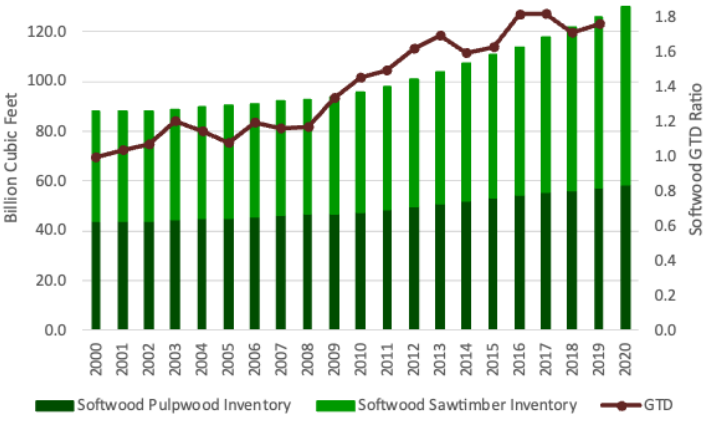
	2000	2020	% Change
Total Inventory	88.3 BCF	130.2 BCF	32.2%
Total Growth*	5.4 BCF	9.6 BCF	43.4%
Total Removals	5.5 BCF	5.6 BCF	1.8%
Growth to Drain: 2000-2019	1.39		
Growth to Drain: 2018-2019	1.76		

Total Inventory: net volume of growing-stock trees at least 5" DBH on timberland.
*Total Growth: annual change in volume of trees between inventories net of removals and mortality. The most recent estimate for growth in the table is 2019.
Total Removals: net volume of growing-stock trees removed from the inventory by harvesting, land clearing, or changes in land use.
Growth to Drain: ratio of total growth versus total removals for a given time period.
BCF: Billion cubic feet.

At the product class level, for **softwood sawtimber**:

- Softwood sawtimber inventories increased 38.5% from 44.1 BCF to 71.7 BCF between 2000 and 2020.
- Softwood sawtimber growth increased 50.5% from 2.8 BCF in 2000 to 5.6 BCF in 2019.
- Sawtimber removals remained relatively flat, increasing only 1.3% during the same period.
- The total growth relative to the total removals results in a total GTD of 1.53 for softwood sawtimber between 2000-2019.
- In 2019, the GTD ratio for softwood sawtimber was 2.07.

Figure 11. Softwood Inventory by Product, South



Source: U.S. Forest Service FIA

For **softwood pulpwood**:

- Softwood pulpwood inventory in the South increased 24.6% from 44.2 BCF in 2000 to 58.6 BCF in 2020.
- Softwood pulpwood removals increased slightly, by 2.4%, from 2.7 BCF to 2.8 BCF.
- Softwood pulpwood growth increased 33.5% from 2.7 BCF to 4.0 BCF.
- This results in a total GTD ratio of 1.26 for softwood pulpwood between 2000 and 2019.
- In 2019, the GTD ratio for softwood pulpwood was 1.45.

SOUTH HARDWOOD

Based on data from 2000 to 2020:

- Total hardwood inventory in the South increased 8.2% from 113.1 BCF in 2000 to 123.1 BCF in 2020.
- Total hardwood removals decreased significantly, by 61.2%, from 2.5 BCF to 1.6 BCF during this same period.
- Total hardwood growth increased by 18.8%, from 2.7 BCF in 2000 to 3.3 BCF in 2019.
- This results in a total hardwood GTD ratio of 1.25 for the South from 2000 to 2019, or growth exceeding removals by 25%.
- In 2019, the hardwood GTD ratio was 2.14.

Figure 12. Total South Hardwood Summary Data, 2000-2020

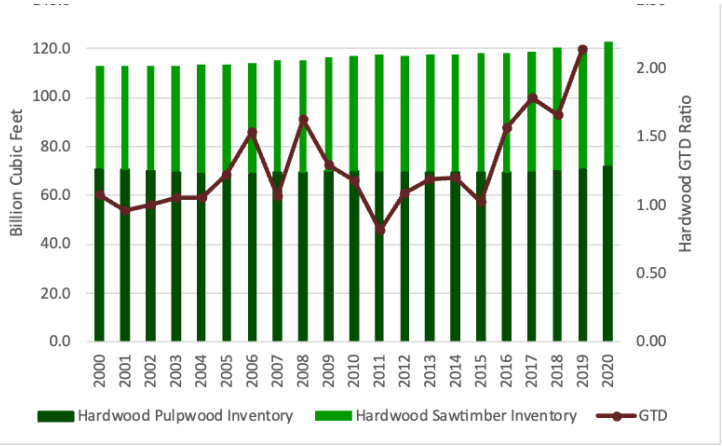
	2000	2020	% Change
Total Inventory	113.1 BCF	123.1 BCF	8.2%
Total Growth*	2.7 BCF	3.3 BCF	18.8%
Total Removals	2.5 BCF	1.6 BCF	-61.2%
Growth to Drain: 2000-2019	1.25		
Growth to Drain: 2018-2019	2.14		

Total Inventory: net volume of growing-stock trees at least 5" DBH on timberland.
*Total Growth: annual change in volume of trees between inventories net of removals and mortality. The most recent estimate for growth in the table is 2019.
Total Removals: net volume of growing-stock trees removed from the inventory by harvesting, land clearing, or changes in land use.
Growth to Drain: ratio of total growth versus total removals for a given time period.
BCF: Billion cubic feet.

At the product class level, for **hardwood sawtimber**:

- Hardwood sawtimber inventories increased 17.4% from 42.2 BCF to 51.1 BCF between 2000 and 2020.
- Sawtimber removals fell significantly, by 49.4%, during the same period from 1.0 BCF to 0.6 BCF.
- Hardwood sawtimber growth increased by 4.6% from 1.3 BCF in 2000 to 1.4 BCF in 2019.
- Hardwood sawtimber had a total GTD ratio of 1.56 between 2000 and 2019.
- In 2019, the GTD ratio was 2.18.

Figure 13. Hardwood Inventory by Product, South



Source: U.S. Forest Service FIA

For **hardwood pulpwood**:

- Hardwood pulpwood inventory in the South increased 1.6% from 70.9 BCF in 2000 to 72.0 BCF in 2020.
- During that same period hardwood pulpwood removals decreased significantly, by 69.3%, from 1.6 BCF to 0.9 BCF.
- Hardwood pulpwood growth increased 28.8% from 1.4 BCF to 1.9 BCF. However, hardwood pulpwood growth fluctuated between 2000 and 2019, ranging from 0.8 BCF to 1.9 BCF.
- Hardwood pulpwood had a total GTD ratio of 1.05 between 2000 and 2019.
- In 2019, the GTD ratio was 2.11.

REGIONAL TRENDS:
NORTH

Based on data from 2008 to 2020:

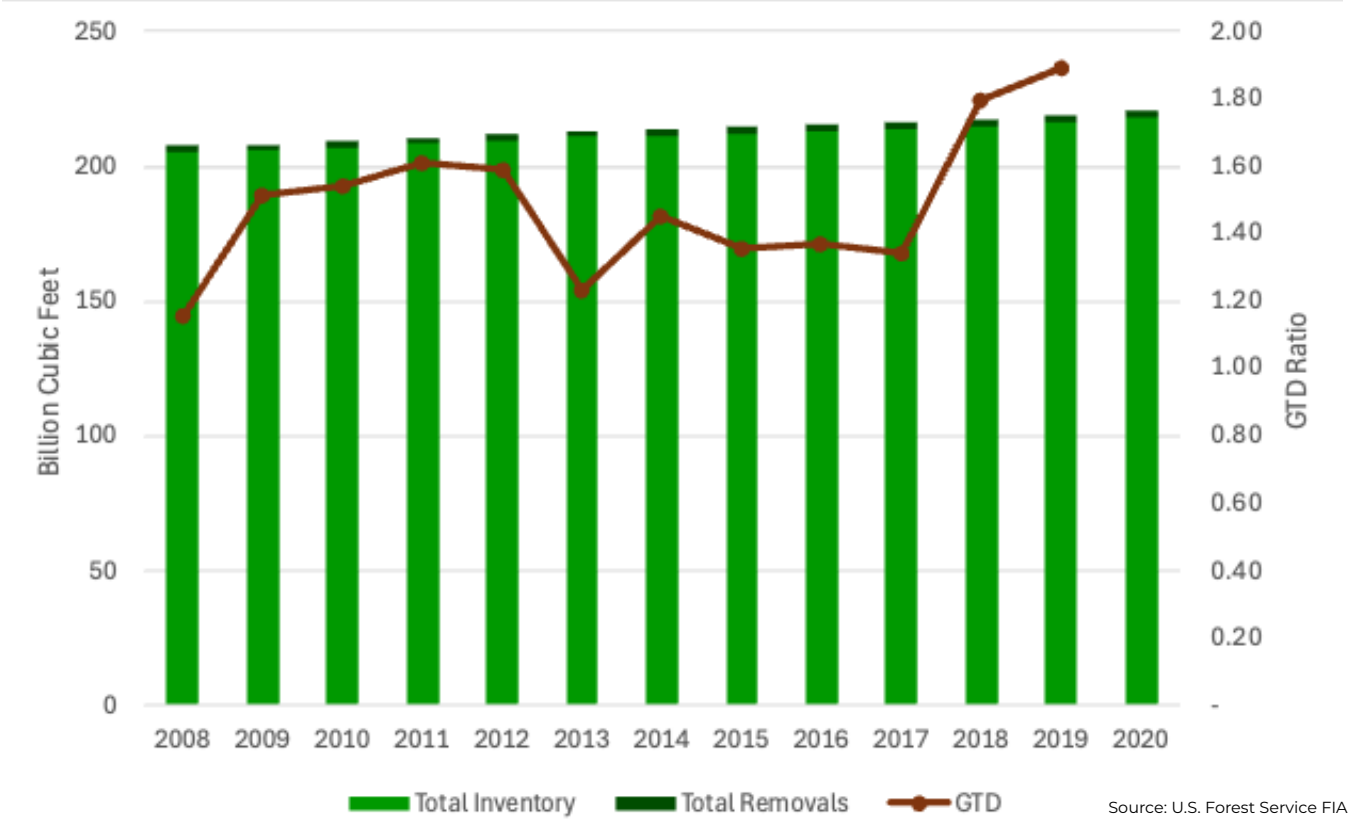
- Total inventory in the North increased 6.0% from 205.3 BCF in 2008 to 218.4 BCF in 2020.
- Total removals declined by 15.8% from 2.4 BCF to 2.1 BCF during this same period.
- Total growth increased by 31.5% from 2.8 BCF to 4.1 BCF from 2008 to 2019.
- Between 2008 and 2019, the North had a total GTD ratio of 1.49. The total GTD ratio of 1.49 indicates that growth exceeded removals by 49% in the North between 2008 and 2019 (Figure 14).
- In 2019, the GTD ratio was 1.89.

Figure 14. U.S. North Summary Data, 2008-2020

	2008	2020	% Change
Total Inventory	201.3 BCF	253.3 BCF	20.5%
Total Growth*	8.1 BCF	12.9 BCF	37.1%
Total Removals	8.0 BCF	7.1 BCF	-12.0%
Growth to Drain: 2008-2019	1.49		
Growth to Drain: 2018-2019	1.89		

Total Inventory: net volume of growing-stock trees at least 5" DBH on timberland.
*Total Growth: annual change in volume of trees between inventories net of removals and mortality. The most recent estimate for growth in the table is 2019.
Total Removals: net volume of growing-stock trees removed from the inventory by harvesting, land clearing, or changes in land use.
Growth to Drain: ratio of total growth versus total removals for a given time period.
BCF: Billion cubic feet.

Figure 15. Total Inventory vs Total Removals, North



Source: U.S. Forest Service FIA

NORTH SOFTWOOD

Based on data from 2008 to 2020:

- Total softwood inventory in the North increased 10.1% from 39.1 BCF in 2008 to 43.5 BCF in 2020.
- Total softwood removals decreased by 13.2% from 0.6 BCF to 0.5 BCF during this period.
- Total softwood growth decreased by 24.8% from 0.9 BCF to 0.7 BCF from 2008 to 2019. Growth fluctuated over time, averaging 0.9 BCF per year and ranging from 0.7 BCF to 1.3 BCF.
- This results in a total softwood GTD ratio of 1.67 for the North from 2008 to 2019, or growth exceeding removals by 67%. Lower softwood removals increased GTD in 2018; higher removals in 2019 brought GTD back to similar levels as in previous years. Lower removals corresponded with multiple conversion projects where pulp/paper mills changed from producing printing/writing papers to packaging products, which has stronger demand. Sawlog removals also declined in Maine in 2018 to recover in 2019; Maine has the largest softwood harvest volume of the Northern states and influenced the regional trend.
- In 2019, the softwood GTD ratio was 1.43 (Figures 16 and 17).

At the product class level, based on data from 2008 to 2020 for **softwood sawtimber**:

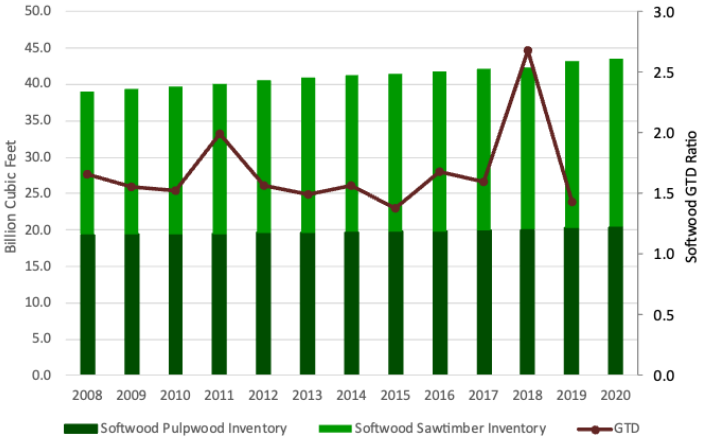
- Softwood sawtimber inventories in the North increased 14.6% from 19.7 BCF to 23.0 BCF between 2008 and 2020.
- Softwood sawtimber growth has fluctuated over time, averaging 0.6 BCF per year and ranging from 0.4 BCF to 0.8 BCF.
- Sawtimber removals have declined by 7.8% from 0.27 BCF to 0.25 BCF.
- Softwood sawtimber has a total GTD ratio of 2.03 between 2008 and 2019.
- In 2019, the sawtimber GTD was 1.62.

Figure 16. Total Softwood Summary Data – North, 2008-2020

	2008	2020	% Change
Total Inventory	39.1 BCF	43.5 BCF	10.1%
Total Growth*	0.9 BCF	0.7 BCF	-24.8%
Total Removals	0.6 BCF	0.5 BCF	-13.2%
Growth to Drain: 2008-2019	1.67		
Growth to Drain: 2018-2019	1.43		

Total Inventory: net volume of growing-stock trees at least 5" DBH on timberland.
*Total Growth: annual change in volume of trees between inventories net of removals and mortality. The most recent estimate for growth in the table is 2019.
Total Removals: net volume of growing-stock trees removed from the inventory by harvesting, land clearing, or changes in land use.
Growth to Drain: ratio of total growth versus total removals for a given time period.
BCF: Billion cubic feet.

Figure 17. Softwood Inventory by Product, North



Source: U.S. Forest Service FIA

For **softwood pulpwood** between 2008 to 2020:

- Softwood pulpwood inventory in the North increased 5.1% from 19.4 BCF in 2008 to 20.4 BCF in 2020.
- During that same period pulpwood removals declined by 18.6% from 0.3 BCF to 0.2 BCF.
- Pulpwood growth was largely flat, averaging 0.36 BCF per year and ranging from 0.23 BCF to 0.59 BCF.
- Softwood pulpwood had a total GTD ratio of 1.33 between 2008 and 2019.
- In 2019, the pulpwood GTD ratio was 1.23.

NORTH HARDWOOD

Based on data from 2008 to 2020:

- Total hardwood inventory in the North increased 4.9% from 166.3 BCF in 2008 to 174.9 BCF in 2020.
- Total hardwood removals decreased by 16.6%, from 1.9 BCF to 1.6 BCF during this period.
- Total hardwood growth increased by 44.0% from 1.9 BCF to 3.3 BCF between 2008 and 2019.
- This results in a hardwood total GTD ratio of 1.43 for the North from 2008 to 2019, or growth exceeding removals by 43%.
- In 2019, the hardwood GTD ratio was 2.04.

At the product class level, for **hardwood sawtimber** between 2008 and 2020:

- Hardwood sawtimber inventory increased 14.4% from 58.9 BCF to 68.8 BCF between 2008 and 2020.
- Hardwood sawtimber removals fell by 16.0%, during the same period.
- Hardwood sawtimber growth increased 20.5% from 1.5 BCF in 2008 to 1.9 BCF in 2019.
- This results in a hardwood sawtimber total GTD ratio of 2.04 between 2008 and 2019.
- In 2019, the hardwood sawtimber GTD ratio was 2.50.

For **hardwood pulpwood:**

- Hardwood pulpwood inventory in the North decreased slightly, by 1.2%, from 107.3 BCF in 2008 to 106.1 BCF in 2020.
- Hardwood pulpwood removals decreased by 17.2%, from 1.0 BCF to 0.8 BCF.
- Hardwood pulpwood growth increased significantly, by 75.9%, from 0.3 BCF in 2008 to 1.4 BCF in 2019.

Figure 18. Total Hardwood Summary Data - North, 2008-2020

	2008	2020	% Change
Total Inventory	166.3 BCF	174.9 BCF	4.9%
Total Growth*	1.9 BCF	3.3 BCF	44.0%
Total Removals	1.9 BCF	1.6 BCF	-16.6%
Growth to Drain: 2008-2019	1.43		
Growth to Drain: 2018-2019	2.04		

Total Inventory: net volume of growing-stock trees at least 5" DBH on timberland.

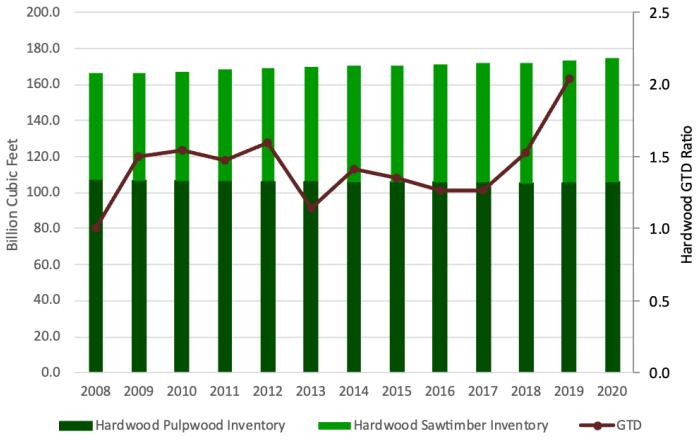
*Total Growth: annual change in volume of trees between inventories net of removals and mortality. The most recent estimate for growth in the table is 2019.

Total Removals: net volume of growing-stock trees removed from the inventory by harvesting, land clearing, or changes in land use.

Growth to Drain: ratio of total growth versus total removals for a given time period.

BCF: Billion cubic feet.

Figure 19. North Hardwood Inventory by Product, 2008-2020



Source: U.S. Forest Service FIA

- This results in a total GTD ratio of 0.89 for hardwood pulpwood between 2008 and 2019.
- The growth to drain ratio has increased significantly in recent years, growing from 0.76 in 2017 to 1.17 in 2018 and 1.64 in 2019.

REGIONAL TRENDS:
PACIFIC COAST/NORTHWEST (WEST)

Based on data from 2011 to 2020:

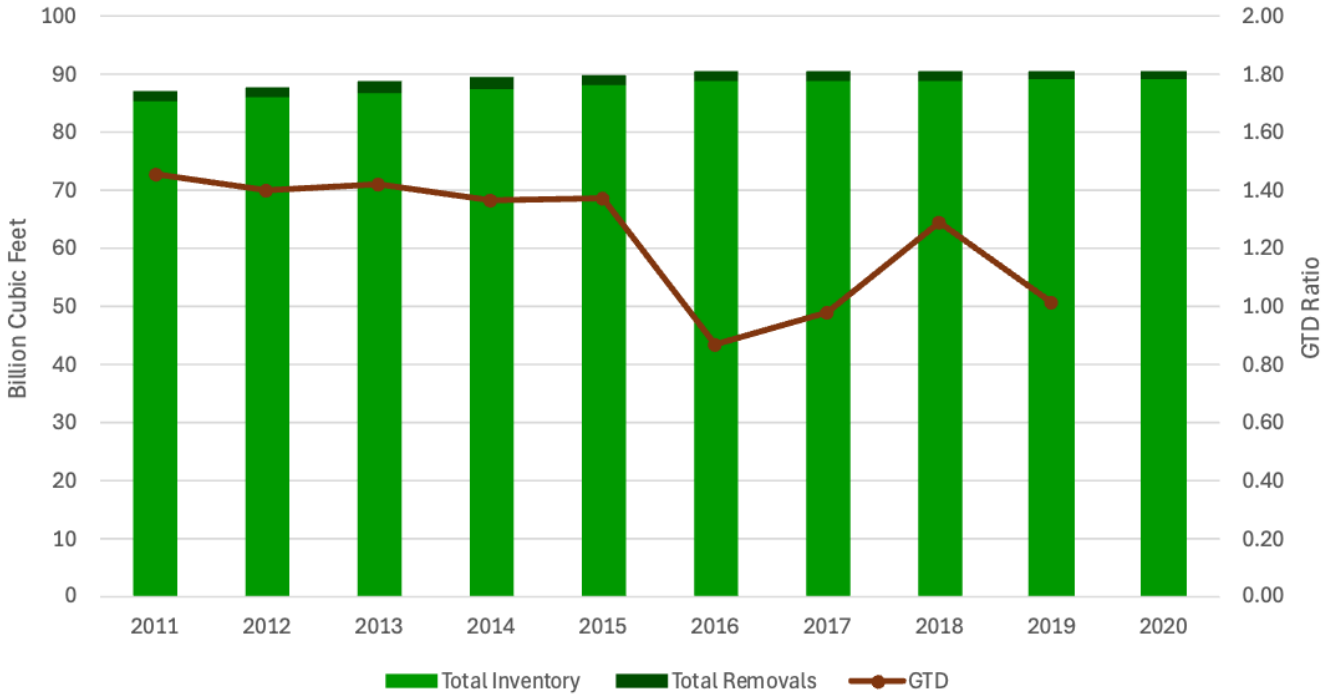
- Total inventory in the West increased 4.3% from 85.4 BCF in 2011 to 89.3 BCF in 2020.
- Total removals decreased by 7.6% from 1.6 BCF to 1.5 BCF during this same period.
- Total growth decreased by 52.9%, from 2.3 BCF to 1.5 BCF, reducing GTD. The U.S. Forest Service changed sampling frequency in 2016 from periodic (every 10 years) to annual (1/10 of each state measured each year). This likely contributed to differences in the estimated growth and reduced GTD. Also, wildfires likely lowered estimated growth and inventories (and GTD) in Washington and Oregon. Washington's 2015 wildfire season and Oregon's 2020 wildfire season impacted private timberlands .
- Between 2011 and 2019, the West had a total GTD ratio of 1.25, indicating that growth exceeded removals by 25% in the West between 2011 and 2019 (Figure 20).
- In 2019 the GTD ratio was 1.02 (Figures 20 and 21).

Figure 20. U.S. Pacific Coast/Northwest Data, 2011-2020

	2011	2020	% Change
Total Inventory	85.4 BCF	89.3 BCF	4.3%
Total Growth*	2.3 BCF	1.5 BCF	-52.9%
Total Removals	1.6 BCF	1.5 BCF	-7.6%
Growth to Drain: 2011-2019	1.25		
Growth to Drain: 2018-2019	1.02		

Total Inventory: net volume of growing-stock trees at least 5" DBH on timberland.
*Total Growth: annual change in volume of trees between inventories net of removals and mortality. The most recent estimate for growth in the table is 2019.
Total Removals: net volume of growing-stock trees removed from the inventory by harvesting, land clearing, or changes in land use.
Growth to Drain: ratio of total growth versus total removals for a given time period.
BCF: Billion cubic feet.

Figure 21. Total West Inventory vs Total Removals, 2011-2020



Source: U.S. Forest Service FIA

[10] Short, Karen C. 2022. Spatial wildfire occurrence data for the United States, 1992-2020 [FPA_FOD_20221014]. 6th Edition. Fort Collins, CO: Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2013-0009.6

WEST SOFTWOOD

Based on data from 2011 to 2020:

- Total softwood inventory in the West increased 4.3% from 73.6 BCF in 2011 to 77.0 BCF in 2020.
- Total softwood removals decreased by 7.4%, from 1.6 BCF to 1.5 BCF during this period.
- Total softwood growth has fluctuated between 2011 and 2019, averaging 2.0 BCF per year and ranging from 1.4 BCF to 2.6 BCF per year. Changes in the sampling frequency by the U.S. Forest service could have contributed to lower growth estimates and lower GTD. Also, wildfires likely contributed to lower growth and inventories (and GTD) in Washington and Oregon. This results in a softwood total GTD ratio of 1.22 for the West from 2011 to 2019, or growth exceeding removals by 22%.
- In 2019, the total softwood GTD was 1.00.

At the product class level, for **softwood sawtimber:**

- Softwood sawtimber inventories in the West increased 5.4% from 61.7 BCF to 65.2 BCF between 2011 and 2020.
- Softwood sawtimber growth averaged 1.7 BCF per year between 2011 and 2019, ranging from 1.3 BCF to 2.2 BCF per year.
- Softwood sawtimber removals have declined by 8.1% from 1.3 BCF to 1.2 BCF.
- The total growth relative to the total removals between 2011 and 2019 results in a growth to drain ratio of 1.29 for softwood sawtimber.
- In 2019, softwood sawtimber had a GTD ratio of 1.10.

For **softwood pulpwood:**

- Softwood pulpwood inventory in the West declined by 1.5% from 12.0 BCF in 2011 to 11.8 BCF in 2020.
- Softwood pulpwood removals decreased 4.7% from 0.30 BCF in 2011 to 0.28 BCF in 2020.
- Pulpwood growth has varied over time, averaging 0.3 BCF per year between 2011 and 2019.
- Softwood pulpwood had a total GTD ratio of 0.94 between 2011 and 2019.
- In 2019, the softwood pulpwood GTD ratio was 0.60. Softwood pulpwood GTD fluctuated between 0.33 to 1.24 between 2011 and 2019. The GTD of softwood pulpwood in the West varies because pulpwood is a marginal forest product in the region (low volumes). Regional timber management and markets are driven by sawtimber. Pulp producing mills primarily rely on residuals from lumber manufacturers as a source of supply rather than pulpwood from timberlands. As such, the low volumes of pulpwood are difficult to consistently measure with GTD (and less relevant to the regional market). Also, changes in sampling methodology and wildfires likely contributed to lower GTD ratios in recent years.

Figure 22. Total West Softwood Summary Data, 2011-2020

	2008	2020	% Change
Total Inventory	73.6 BCF	77.0 BCF	4.3%
Total Growth*	2.2 BCF	1.5 BCF	-50.7%
Total Removals	1.6 BCF	1.5 BCF	-7.4%
Growth to Drain: 2008-2019	1.22		
Growth to Drain: 2018-2019	1.00		

Total Inventory: net volume of growing-stock trees at least 5" DBH on timberland.

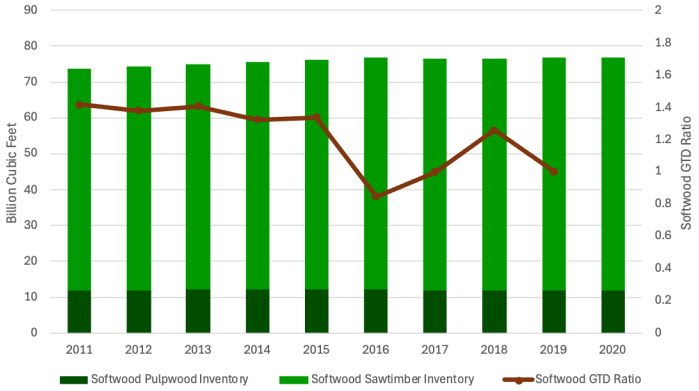
*Total Growth: annual change in volume of trees between inventories net of removals and mortality. The most recent estimate for growth in the table is 2019.

Total Removals: net volume of growing-stock trees removed from the inventory by harvesting, land clearing, or changes in land use.

Growth to Drain: ratio of total growth versus total removals for a given time period.

BCF: Billion cubic feet.

Figure 23. West Softwood Inventory by Product, 2011-2020



Source: U.S. Forest Service FIA

WEST HARDWOOD

Based on data from 2011 to 2020:

- Total hardwood inventory in the West increased 3.9% from 11.8 BCF in 2011 to 12.3 BCF in 2020.
- Total hardwood removals have declined 10.7%, from 0.6 BCF to 0.5 BCF.
- Total hardwood growth has decreased significantly from 0.14 BCF in 2011 to 0.07 BCF in 2019. Hardwood accounts for only 14% of the total timber inventory on private lands in the West. As such, the sample size of hardwood data is lower than that of softwoods. In addition, sampling changes and wildfires likely contributed to lower recent growth estimates.
- This results in a total hardwood GTD ratio of 1.89 for the West from 2011 to 2019. GTD dipped below 1.0 in 2017, and then increased the following year due to inventory declines in Oregon and increases in Washington. Hardwood inventory in Oregon peaked in 2017 then declined 1% per year from 2017 to 2020. Steady increases in hardwood inventory in Washington caused GTD to recover for hardwoods.
- In 2019, the total hardwood GTD ratio was 1.43.

At the product class level, for **hardwood sawtimber:**

- Hardwood sawtimber inventories increased 5.9% from 7.0 BCF to 7.4 BCF between 2011 and 2020.
- Hardwood sawtimber growth decreased 15.0% from 0.1 BCF in 2011 to 0.09 BCF in 2019. Lower sample sizes of hardwood in the West coupled with sampling changes and wildfires likely contributed to lower recent growth estimates.
- Hardwood sawlog removals decreased 12.4% during the same period.
- The total growth relative to the total removals results in a total GTD ratio of 2.38 for hardwood sawtimber between 2011 and 2019.
- In 2019, the hardwood sawtimber GTD ratio was 3.13.

For **hardwood pulpwood:**

- Hardwood pulpwood inventory in the West was flat, increasing 0.8% to 4.9 BCF from 2011 to 2020.
- During that same period pulpwood removals decreased by 8.2% from 0.23 BCF to 0.21 BCF.
- Hardwood pulpwood growth has fluctuated over the years, averaging 0.29 BCF and ranging from -0.2 BCF to 0.6 BCF between 2011 and 2019.

Figure 24. Total Hardwood Summary Data - West, 2011-2020

	2008	2020	% Change
Total Inventory	11.8 BCF	12.3 BCF	3.9%
Total Growth*	0.14 BCF	0.07 BCF	-98%
Total Removals	0.6 BCF	0.5 BCF	10.7%
Growth to Drain: 2008-2019	1.89		
Growth to Drain: 2018-2019	1.43		

Total Inventory: net volume of growing-stock trees at least 5" DBH on timberland.

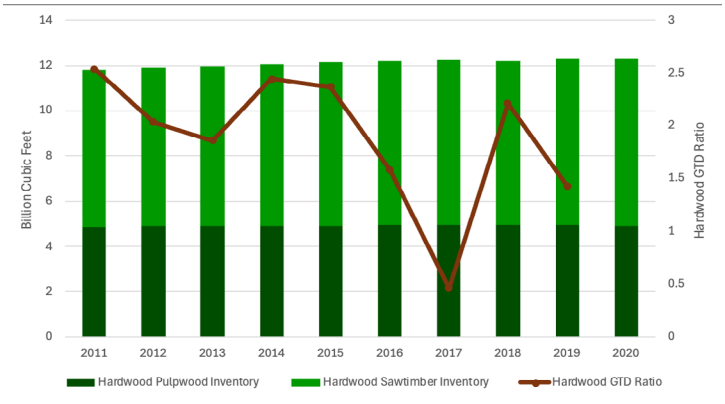
*Total Growth: annual change in volume of trees between inventories net of removals and mortality. The most recent estimate for growth in the table is 2019.

Total Removals: net volume of growing-stock trees removed from the inventory by harvesting, land clearing, or changes in land use.

Growth to Drain: ratio of total growth versus total removals for a given time period.

BCF: Billion cubic feet.

Figure 25. West Hardwood Inventory by Product, 2011-2020



Source: U.S. Forest Service FIA

- Hardwood pulpwood had a total GTD ratio of 1.18 between 2011 and 2019.
- In 2019, the hardwood pulpwood GTD ratio was -0.94. Negative GTD indicates that growth was negative. This means that the inventory dropped more than what was harvested from the forest. This could be from more mortality, possibly due to wildfires or natural disasters. It also could be a function of limited sample size from a marginal pulpwood forest product (low volumes) for a small portion of the forest inventory (hardwood pulpwood is 6% of the inventory in the West).

APPENDIX 1: GLOSSARY

BBFT: Billion board feet. One board foot is 12 inches x 12 inches x 1 inch. A standard 8-foot long 2"x4" piece of lumber contains 5.34 board feet.

BCF: Billion cubic feet. One cubic foot is 12 inches x 12 inches x 12 inches. One billion cubic feet represents the volume of approximately 100,000 average-sized trees harvested for lumber. For context, Americans consume 10 to 15 BCF of wood and paper products per year in the U.S.

Bole: Trunk or main stem of a tree.

DBH: Diameter at breast height; the diameter of a tree measured at 4.5 feet above the ground.

FIA: Forest Inventory and Analysis. A program of the USDA Forest Service Research and Development branch that "collects, processes, analyzes, and reports on data necessary for assessing the extent and condition of forest resources in the United States"[11]

Growing-stock: The U.S. Forest Service defines growing-stock trees as all live trees of commercial species that meet minimum merchantability standards. In general, these trees have at least one solid 8-foot section and have no defects. Growing-stock volume is measured from the main part of a living tree between a stump height of one foot and the growing stock top. The growing stock top is defined as the point where the main stem branches out, or a minimum diameter of 4.0 inches outside bark.

Growth: A measure of the annual change in volume of trees between inventories net of removals and mortality. For this report, growth was calculated as: GrowthT1 = InventoryT2 – InventoryT1 + RemovalsT1, where T1 equals Year 1 and T2 equals Year 2.

Growth-to-Drain: A measure of growth of a forest relative to harvests or removals from the same forest over a given time period.

Hardwood: Broad-leafed tree species including oaks, maples, ash, and others.

Inventory: The quantity of trees growing across a given land area.

Merchantable: Defined by the U.S. Forest service as a pulpwood or sawlog section that meets pulpwood or sawlog specifications, respectively.

Metric Ton: A metric ton equals 1,000 kilograms, or 2,204 pounds.

OSB: Oriented strand board; a type of engineered wood formed by adding adhesives and compressing layers of wood strands in specific orientations.

Pulpwood: Timber product from small diameter (6-9 inches) and/or low quality trees used for fuel, paper, or panel production.

Removals: The net volume of sound (growing-stock) trees removed from the inventory by harvesting or other cultural operations (such as timber-stand improvement), by land clearing, or by changes in land use (such as Wilderness designation)."[12]

Residuals: Residuals include forestry residuals and mill residuals. Forestry residuals are the branches, stumps, treetops, and other materials resulting from harvest activities. Mill residuals include bark, sawdust, and wood chips.

Sawtimber: Timber product from large diameter trees (12-14 inches and up) of good quality used to make lumber and large panels.

Short ton: A short ton equals 2,000 pounds.

Softwood: Needle-leafed tree species including pines, spruces, and firs.

Timberland: Defined by the U.S. Forest service as forest land that is producing or capable of producing 20 cubic feet of wood per acre annually from trees classified as timber species and not withdrawn from timber utilization by statute or administrative regulation.

Wood pellet: a type of fuel that is burned to produce heat; is produced from sawdust or dried woody material that is ground into fine particles and compressed into a small cylinder, generally about 1/4 inch in diameter and less than 1.5 inches in length.

[11] U.S. Forest Service
[12] USFS Forest Inventory and Analysis Glossary

APPENDIX 2: PRODUCT SPECIFICATIONS

South

Softwood Pulpwood: 6-8 inch DBH classes + cull from softwood sawtimber

Softwood Sawtimber includes the following products:

- Chip-n-Saw: 10 inch class (65% cull)
- Medium Sawtimber: 12 inch class (25% cull)
- Sawtimber: 12-16 inch DBH classes (15% cull)
- Large Sawtimber: 18-21" DBH classes (15% cull)

Hardwood Pulpwood: 6-12 inch DBH classes + cull from hardwood sawtimber

Hardwood Sawtimber: 14-21 inch DBH classes (25% cull)

North

Softwood Pulpwood: 6-8 inch DBH classes + cull from softwood sawtimber

Softwood Sawtimber includes the following products:

- Chip-n-Saw: 10 inch class (65% cull)
- Medium Sawtimber: 12 inch class (25% cull)
- Sawtimber: 12-16 inch DBH classes (15% cull)
- Large Sawtimber: 18-21" DBH classes (15% cull)

Hardwood Pulpwood: 6-12 inch DBH classes + cull from hardwood sawtimber

Hardwood Sawtimber: 14-21 inch DBH classes (25% cull)

West

Softwood Pulpwood: Calculated as the difference in net merchantable bole wood volume of growing-stock trees minus sawlog volume.

Softwood Sawtimber: U.S. Forest Service estimates of net sawlog wood volume of sawtimber trees.

Hardwood Pulpwood: Calculated as the difference in net merchantable bole wood volume of growing-stock trees minus sawlog volume.

Hardwood Sawtimber: U.S. Forest Service estimates of net sawlog wood volume of sawtimber trees.

[12] USFS Forest Inventory and Analysis Glossary