Catchment Area Analysis of Forest Management and Market Trends:

Arkansas Bioenergy, LLC – Leola
Arkansas Bioenergy, LLC – Russellville
Highland Pellets, LLC

Prepared for:

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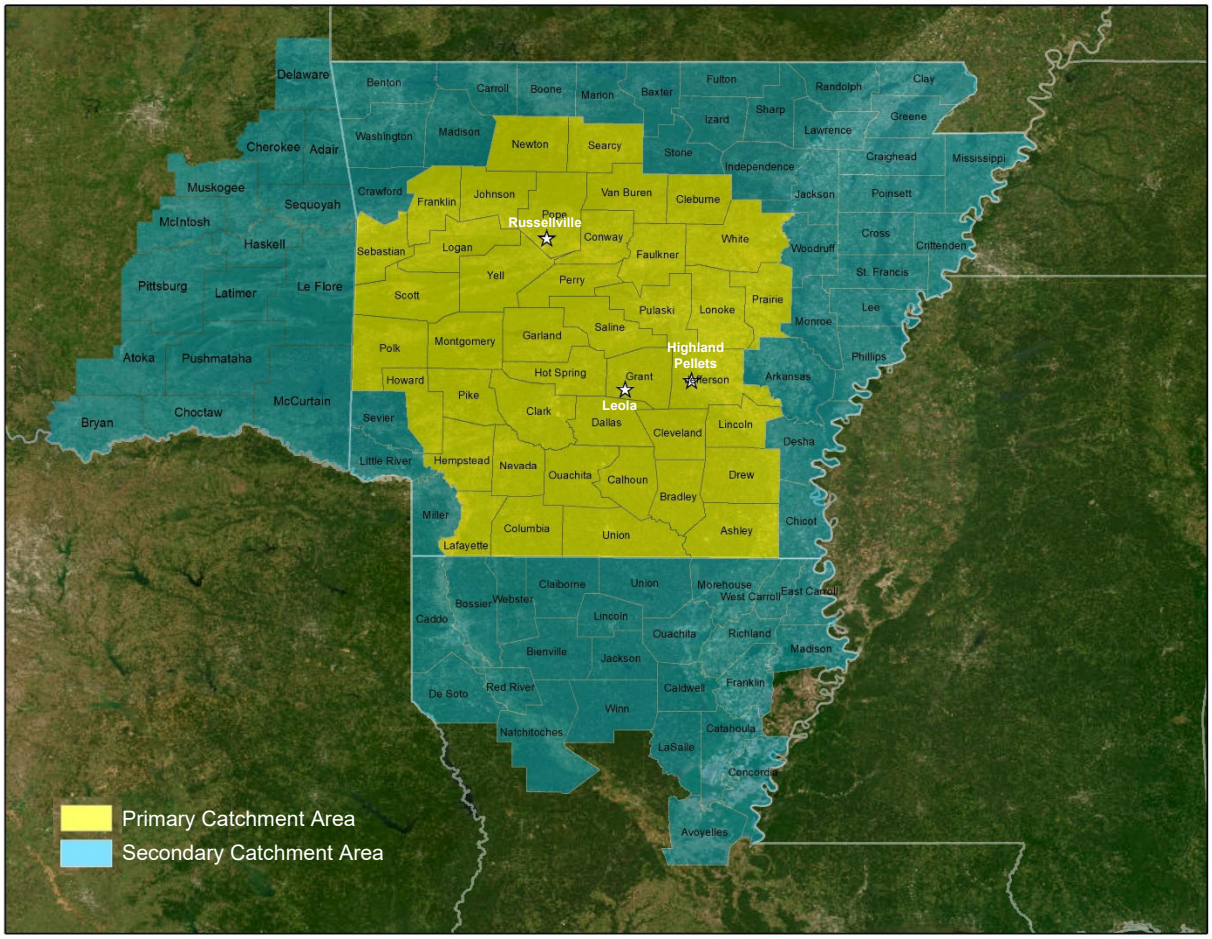
Executive Summary

In accordance with Drax's commitment to monitor forest management and timber market trends across its supply chain, the following report was conducted to examine the fiber catchment area in Arkansas, Louisiana, and east Oklahoma that supports the Arkansas Bioenergy, LLC-Leola and Arkansas Bioenergy, LLC-Russellville satellite pellet plants as well as the Highland Pellets LLC plant in Pine Bluff, Arkansas. Specifically, the primary catchment area for these mills includes 41 counties in Arkansas and covers more than 75,000 square kilometers (≈7.6 million hectares) in size. The secondary catchment area includes an additional 34 counties in Arkansas, 24 parishes in Louisiana, and 15 counties in Oklahoma. Together, the primary and secondary catchment area cover an area nearly 210,000 square kilometers (≈20.8 million hectares).

The Leola and Russellville satellite pellet mills were both commissioned by Drax in 2022. Both Drax plants have an annual production capacity of 40,000 metric tons of pellets and consume sawmill residuals only for wood pellet production. Highland Pellets was commissioned in late-2016 and has an annual production capacity of 675,000 metric tons of pellets. Highland Pellets utilizes both roundwood and sawmill residuals for wood pellet production.

Arkansas Cluster Catchment Area



Forest Area, Timber Inventory, Growth-to-Drain, & Annual Wood Demand

Forest Area. According to US Forest Service (USFS) data, the AR Cluster catchment area contains an estimated 5.33 million hectares of forestland, constituting 70% of the catchment area's total land area. Specifically, 98% of total forestland (5.24 million hectares) is classified as timberland, or forestland that is capable of commercial timber production. Also note that 80% of total timberland area is privately owned versus 20% public.

The total area of timberland in the catchment area increased 2.4% from approximately 5,114,640 hectares in 2005 to roughly 5,236,900 hectares in 2021. However, much of this increase occurred in the late-2000s and early-2010s, with total timberland stabilizing and averaging roughly 5,240,000 hectares since 2016.

Timberland Area by Forest Type (2021)

Forest Type	Hectares	% of Total
Planted Pine	1,326,082	25%
Natural Pine	1,049,714	20%
Planted Hardwood	67,840	1%
Natural Hardwood	2,256,519	43%
Mixed Pine-Hardwood	536,746	10%
Total	5,236,902	100%

Inventory. Total growing stock inventory on timberland totaled an estimated 707 million m^3 in the AR Cluster catchment area in 2021, of which approximately 54% is softwood (pine) species and 46% is hardwood species. In terms of major timber product, approximately 31% of total growing stock inventory is classified as pine sawtimber, compared to 12% pine chip-n-saw, 10% pine pulpwood, 32% hardwood sawtimber, and 14% hardwood pulpwood.

Total growing stock inventory on timberland in the AR Cluster catchment area increased an average of 1.8% per year (+32% total) from 535 million m^3 in 2005 to 707 million m^3 in 2021. However, note that the rate at which inventory levels have increased has accelerated since 2010. Specifically, total growing stock inventory increased an average of 1.2% per year from 2005-2010, compared to 2.0% per year since 2010.

Timber Inventory by Major Product (2021)

Timber Product	Inventory (million m^3)	% of Total
Pine Sawtimber	221.8	31%
Pine Chip-n-saw	85.7	12%
Pine Pulpwood	71.3	10%
Hardwood Sawtimber	227.1	32%
Hardwood Pulpwood	100.8	14%
Total	706.7	100%

Growth-to-Drain.

Grow-to-removals analysis compares annual timber growth to annual harvests and provides a measure of market demand relative to supply. A growth-to-removals ratio of 1.0 indicates a balanced market where growth equals removals. A value of >1 indicates growth exceeds removals, signifying sustainable harvest levels (as well as oversupply). A value of <1 indicates removals (or harvest levels) exceed growth, signifying more highly competitive market conditions and harvest levels that are unsustainable over the long term.

According to US Forest Service data, total growth-to-removals (G:R) for all timber in the catchment area has remained well-above 1.0, increasing from 1.33 in 2009 to 1.75 in 2021, the latest available. In particular, the G:R ratio for pine pulpwood, the primary bioenergy roundwood feedstock in this catchment area, also remained well-above 1.0 in the catchment area from 2009-2021, indicating that harvest levels remained below the sustainable yield capacity of the forest area over this period. Specifically, the G:R ratio for pine pulpwood increased from 2.27 in 2009 to 3.05 in 2021.

The overall increase in the pine pulpwood G:R ratio from 2009 to 2021 can ultimately be linked to increased growth attributed to increases in pine timberland. Note that the pine pulpwood G:R ratio has also been impacted by increases in softwood lumber production. According to USDA-TPO data, softwood lumber production increased an estimated 38% in the catchment area from 2011-2021. This increase in lumber production resulted in the increased production of sawmill residuals, a lower-cost substitute whose increased utilization replaced a portion of the market demand for pine pulpwood.

Timber Growth-to-Removals Ratios by Major Product (2021)

Timber Product	Growth-to-Removals Ratio
Pine Sawlogs*	1.31
Pine Pulpwood	3.05
Hardwood Sawtimber	1.84
Hardwood Pulpwood	3.36
Total	1.75

*Pine sawlogs includes pine sawtimber and pine chip-n-saw.

Forest Carbon.

Forest carbon in the AR Cluster catchment area totals an estimated 666 million metric tons, of which 296 million metric tons (45%) is aboveground carbon, 61 million metric tons (9%) is belowground carbon, 42 million metric tons (6%) is dead wood carbon, 47 million metric tons (7%) is litter carbon, and 221 million metric tons (33%) is soil carbon.

According to the US Forest Service, total forest carbon in the AR Cluster catchment area experienced a net increase of 91 million metric tons (+16%) from 2000 to 2021, increasing from 575 to 666 million metric tons over this period. In particular, aboveground carbon increased 65 million metric tons (+28%) and belowground carbon increased 14 million metric tons (+30%) from 2000-2021. Over this same period, dead wood carbon increased 4 million metric tons (+11%), litter carbon increased 5 million metric tons (+11%), and soil carbon increased 3 million metric tons (+1%).

Forest Carbon Inventory (2021)

Category	Carbon (Metric Tons)	% of Total
Aboveground Carbon	295.6	45%
Belowground Carbon	60.9	9%
Dead Wood Carbon	42.0	6%
Litter Carbon	46.9	7%
Soil Carbon	220.9	33%
Total	666.2	100%

Total Wood Demand.

As of December 2023, there were nearly 125 major wood-consuming mills operating in the AR Cluster primary and secondary catchment areas. However, not all wood consumed by these mills is procured from within the catchment area. Based on the relative location of these mills to the primary catchment area, total annual wood demand allocated to the AR Cluster catchment area by these mills is estimated at approximately 22.0 million metric tons of roundwood. Specifically, demand for pine and hardwood pulpwood – the predominant roundwood products consumed by the bioenergy industry for wood pellet production – totals a combined 9.0 million metric tons in 2022 and represented 41% of total catchment area wood demand.

Of the 9.0 million metric tons of total pulpwood demand in the catchment area in 2023, an estimated 86% was attributed to non-bioenergy-related sources (i.e. predominantly pulp/paper); 14% was attributed to the bioenergy sector[1]. Bioenergy-related pulpwood demand totaled an estimated 1,223,240 metric tons, of which approximately 96% was softwood (pine) pulpwood and 4% was hardwood pulpwood.

Catchment Area Wood Demand by Major Product (2023)

Product	Metric Tons	% of Total
Softwood Sawlogs	11,313,616	51%
Softwood Pulpwood	6,959,791	32%
Hardwood Sawlogs	1,651,145	8%
Hardwood Pulpwood	2,080,260	9%
Total	22,004,812	100%

Catchment Area Pulpwood Demand (2023)

Product	Metric Tons	% of Total
Biomass Demand:		
Softwood Biomass	1,171,186	13%
Hardwood Biomass	52,054	1%
Total Biomass	1,223,240	14%
Other Pulpwood Demand:		
Other Softwood Pulpwood	5,788,604	64%
Other Hardwood Pulpwood	2,028,206	22%
Total Other Pulpwood	7,816,811	86%
Total Pulpwood Demand:		
Softwood Pulpwood	6,959,791	77%
Hardwood Pulpwood	2,080,260	23%
Pulpwood Total	9,040,051	100%

[1] Drax's satellite pellet plants in Leola and Russellville consume sawmill residuals only. Bioenergy-related pulpwood demand in the Arkansas Cluster catchment area is primarily from Highland Pellets as well as from Morehouse BioEnergy in Louisiana.

Bioenergy Fiber Demand.

Total bioenergy-related fiber demand (i.e. roundwood and sawmill residuals) associated with the AR Cluster primary catchment area totaled an estimated 1.75 million metric tons in 2023. Specifically, roundwood demand associated with the bioenergy industry totaled an estimated 1.22 million metric tons and accounted for approximately 70% of total bioenergy-related fiber demand. Sawmill residual demand associated with the bioenergy industry totaled an estimated 530,380 metric tons and accounted for the remaining 30% of total fiber demand. Moreover, note that softwood roundwood and softwood sawmill residuals accounted for approximately 97% of total bioenergy-related fiber demand in the catchment area in 2023, compared to 3% for hardwood roundwood and hardwood sawmill residuals.

Catchment Area Bioenergy Fiber Demand (2023)

Product	Metric Tons	% of Total
Biomass Roundwood Demand:		
Softwood Roundwood	1,171,186	67%
Hardwood Roundwood	52,054	3%
Total Biomass Roundwood	1,223,240	68%
Biomass Residual Demand:		
Softwood Residuals	525,306	30%
Hardwood Residuals	5,074	-
Total Biomass Residuals	586,187	30%
Total Biomass Fiber Demand:		
Softwood Fiber	1,696,492	97%
Hardwood Fiber	57,127	3%
Total Biomass Fiber	1,753,619	100%

Summary of Analysis Findings

The following report provides a detailed assessment of the AR Cluster catchment area, including examination and identification of trends in forest area, timber inventory, growth, removals, wood demand, raw material prices, and harvest activities and management practices since 2000. In addition, this report also includes an assessment of long-term market sustainability and provides a market outlook through 2025.

Key report findings are highlighted and summarized in the table below and on the following pages.

Is there any evidence that bioenergy demand has caused the following:	Analysis Findings
Deforestation?	**No.** US Forest Service (USFS) data shows that total timberland in the AR Cluster catchment area increased approximately 143,800 hectares (+2.8%) from 2005 to 2014 – the year of bioenergy's entrance into this market. Total timberland declined slightly the two years that followed but since 2016 has held steady and averaged 5.24 million hectares in the catchment area. Also, planted pine timberland (the predominant source of roundwood utilized by the bioenergy industry for wood pellet production) has increased more than 177,000 hectares (+15%) in the catchment area since bioenergy's entrance into this market in 2014. However, note that this increase in planted pine timberland was due to the conversion of natural pine, hardwood, and mixed pine-hardwood forests, which decreased a combined 194,000 hectares from 2014-2021.
A change in management practices (rotation lengths, thinnings, conversion from hardwood to pine)?	**Inconclusive.** Changes in management practices have occurred in the catchment area over the last two decades. However, it is inconclusive as to whether increased demand attributed to bioenergy has caused or is responsible for those changes. Clearcuts and thinnings are the two major types of harvests that occur in this region, both of which are long-standing, widely used methods of harvesting timber. TimberMart-South (TMS) data shows that the prevalence of thinnings increased in the AR Cluster market beginning in the late-2000s due to the weakening of pine sawtimber markets following the Great Recession. Specifically, challenging market conditions saw pine sawtimber stumpages prices decline from nearly $47 per metric ton in 2007 to less than $24 per metric ton in 2012, or a roughly 50% decrease over this four-year period. This led many landowners to refrain from clearcutting (a type of harvest which typically removes large quantities of pine sawtimber), as they waited for pine sawtimber prices to improve. However, pine sawtimber stumpage prices never fully recovered and have held between roughly $25 and $30 per metric ton since 2013. Management/harvest practices have yet to return to pre-2007 trends, with thinnings currently accounting for roughly 40% of total harvest area, versus roughly 20% from 2000-2007. The catchment area has also experienced some conversion. Specifically, from 2005-2021, planted pine timberland increased more than 400,000 hectares while natural hardwood, mixed pine-hardwood, and natural pine timberland decreased a combined 260,000 hectares. Also, agricultural land decreased more than 140,000 hectares from 2005-2021. Note that the increase in planted pine timberland and decrease in natural hardwood, mixed pine-hardwood, and natural pine timberland over this period were both gradual and occurred simultaneously. This suggests a management trend in which natural timber stands have been and are converted to plantation pine

Is there any evidence that bioenergy demand has caused the following:	Analysis Findings
	following final harvest. It's also important to note that there is little evidence that links these changes to increased demand from bioenergy, as this conversion trend begun years prior to the entrance of the bioenergy industry into this market.
Diversion from other markets?	**No.** Since bioenergy's entrance into this market in 2014, demand for softwood (pine) sawlogs has increased an estimated 43% in the catchment area. Also, there is no evidence that increased demand from bioenergy has caused a diversion from other pulpwood markets (i.e. pulp/paper), as pulpwood demand not attributed to bioenergy increased 11% in the catchment area from 2014-2021.
An unexpected or abnormal increase in wood prices?	**No.** In the AR Cluster catchment area, wood demand attributed to bioenergy increased from less than 14,000 metric tons in 2014 to more than 872,000 metric tons in 2019, and this nearly 860,000-metric ton increase in demand coincided with 2-6% decrease in delivered pine pulpwood (PPW) and pine chip prices. Furthermore, bioenergy-related wood demand increased an estimated 415,000 metric tons (+48%) from 2019-2022, with delivered PPW and pine sawmill chip prices decreasing 2% and 6%, respectively, over this period. Ultimately, statistical analysis identified no relationship between biomass demand and both delivered PPW and pine chip prices. Additionally, correlation analysis found no meaningful relationship between non-biomass-related softwood pulpwood demand (which accounts for more than 80% of total catchment area softwood pulpwood demand) and both delivered PPW price and pine chip prices. Typically, we'd expect a positive relationship between demand and price. However, delivered PPW prices have not been impacted by changes in demand due to a general oversupply of pine pulpwood in this catchment area. Also, increased lumber production in this market has resulted in greater pine sawmill chip availability, which has led to decreases in pine sawmill chip prices, despite non-bioenergy-related softwood pulpwood demand increasing in the catchment area the last several years. Ultimately, there is no evidence that biomass demand has resulted in an unexpected or abnormal increase in wood prices in the catchment area.
A reduction in growing stock timber?	**No.** From 2014 (the year of bioenergy's entrance into this market) to 2021, total growing stock inventory increased 16% in the AR Cluster catchment area. Specifically, total pine inventory increased 22%, with inventories of pine sawtimber, pine chip-n-saw, and pine pulpwood increasing 25%, 19%, and 17%, respectively, over this period.
A reduction in the sequestration rate of carbon?	**No.** US Forest Service (USFS) data shows the average annual growth rate of total growing stock timber in the AR Cluster catchment area increased from 4.3% in 2014 to 4.8% in 2021, suggesting that the sequestration rate of carbon increased slightly over this period. Additionally, total forest carbon inventory levels increased 7% over this same period. Note that the increase in overall growth rate (and therefore increase in the sequestration rate of carbon) can be linked to gains in pine timberland and associated changes with the catchment area forest. Specifically, growth rates decline as timber ages, so the influx of new pine timberland (due to the conversion of both cropland and pastureland as well as natural forests) has resulted in just the opposite, with the average age of softwood (pine) growing stock inventory decreasing in the catchment area since 2005.

Is there any evidence that bioenergy demand has caused the following:	Analysis Findings
An increase in harvesting above the sustainable yield capacity of the forest area?	**No.** Growth-to-removals (G:R) ratios, which compare annual timber growth to annual timber removals, provides a measure of market demand relative to supply as well as a gauge of market sustainability. In 2021, the latest available, the G:R ratio for pine pulpwood (PPW), the predominant roundwood timber product utilized by the bioenergy sector, equaled 3.05 (recall that a value greater than 1.0 indicates sustainable harvest levels). The G:R ratio for all timber products equaled 1.75 in 2021. Moreover, note that the PPW G:R ratio has increased in the catchment area since 2016, despite a nearly 615,000-metric ton increase in PPW demand from bioenergy from 2016-2021.

Impact of bioenergy demand on:	Analysis Findings
Timber growing stock inventory	**Neutral.** According to USFS data, inventories of pine pulpwood (PPW) increased 17% in the catchment area from 2014-2021, and this increase in PPW inventory can be linked to both increases in pine timberland and harvest levels below the sustainable yield capacity of the forest area. Specifically, pine timberland (both planted and natural combined) increased more than 107,000 hectares (+5%) in the catchment area from 2014-2021. Also, over this same period, annual harvests of PPW totaled only ~30% of maximum sustainable harvest levels, meaning PPW harvest levels could have increased more than 3x without adversely affecting long-term resource sustainability.
Timber growth rates	**Neutral.** Average annual growth rate of total growing stock timber increased from 4.3% in 2014 to 4.8% in 2021 in the AR Cluster catchment area, with PPW growth rates, specifically, increasing from 12.0% to 12.5% over this period. However, there is no statistical evidence linking the increase in PPW growth rates to changes in softwood biomass demand.
Forest area	**Neutral/Positive.** In the AR Cluster catchment area, forest area (timberland) totaled 5.26 million hectares in 2014 before declining and stabilizing at an average of 5.24 million hectares from 2016-2021. However, over this same period, pine timberland – the predominant source of roundwood utilized by the bioenergy industry for wood pellet production – increased more than 107,000 hectares. While statistical analysis identified a moderately strong positive relationship between pine timberland and softwood biomass demand from 2014-2021, the increase in pine timberland over this period can be linked to other factors as well, including conversion (from hardwood/mixed pine-hardwood forests and pastureland) as well as strengthening pine sawtimber markets. Specifically, the more than 107,000-hectare increase in pine timberland from 2014-2021 coincided with a roughly 124,000-hectare decrease in natural hardwood/mixed pine-hardwood timberland and a more than 12,000-hectare decrease in pastureland over this period. Furthermore, statistical analysis confirmed these inverse relationships, identifying strong negative correlations between pine timberland and both hardwood/mixed pine-hardwood timberland and pastureland in the catchment area from 2014-2021.
Wood prices	**Neutral.** Softwood pulpwood demand attributed to bioenergy increased from less than 14,000 metric tons in 2014 (the year of bioenergy's entrance into this market) to more than 1.2 million metric tons in 2022 (the year biomass demand reached peak levels in this catchment area). However, this roughly 1.2-million metric ton increase in softwood biomass demand coincided with an 8% decrease in delivered pine pulpwood (PPW) price – which averaged $31.72 per metric ton in 2014 and $29.30 per metric ton in 2022. Interestingly, non-biomass related softwood pulpwood demand increased approximately 860,000 metric tons from 2014-2022, resulting in a nearly 2.1-million metric ton increase in total softwood pulpwood demand over this period. However, due to conversion of both agricultural land and natural hardwood/mixed pine-hardwood forests to plantation pine timberland beginning in the-2000s, the catchment area experienced an estimated 11.6-million metric ton increase in PPW inventory from 2014-2022. This allowed the imbalance of supply and demand to persist (and PPW prices to decline), despite increased demand from both bioenergy and non-bioenergy sources. Statistical analysis did identify a negative relationship between softwood biomass demand and delivered PPW price. However, the relationship between delivered PPW price and PPW inventory, which was also negative, was found to be stronger. Ultimately, the findings provide evidence that PPW price movements in the AR Cluster catchment area have been impacted more substantially by a supply/demand imbalance in this market.

Impact of bioenergy demand on:	Analysis Findings
Markets for solid wood products	**Positive.** In the AR Cluster catchment area, demand for softwood sawlogs used to produce lumber and other solid wood products has increased more than 45% since 2014, and this increase in softwood lumber production has consequentially resulted in the increased production of sawmill residuals (i.e. chips, sawdust, and shavings) – by-products of the sawmilling process and materials utilized by both Drax satellite pellet plants as well as Highland Pellets to produce wood pellets. While the two Drax satellite pellet plants consume sawmill residuals only, Highland Pellets consumes a combination of both sawmill residuals and roundwood. The increased availability of sawmill residuals and lower relative cost compared to roundwood (after chipping and other processing costs are considered) has led Highland Pellets to consume an increasing amount of sawmill residuals. This benefits Highland Pellets because sawmill residuals are a lower-cost fiber (compared to roundwood, which requires processing). Lumber producers in the catchment area have also benefited, as Highland Pellets has become an additional outlet for these producers and their by-products.

1. Report Background

Drax Group is a British electrical power generation and supply company that runs Europe's biggest biomass-fueled power station, supplying 11% of the country's electricity needs. Drax is also among the world's largest single-point consumers of wood and is committed to sourcing that wood responsibly.

In accordance with Drax's commitment to monitor forest management and timber market trends across its supply chain, the following report, conducted by Hood Consulting, focuses specifically on the fiber catchment area in Arkansas that supports the Arkansas Bioenergy, LLC-Leola and Arkansas Bioenergy, LLC-Russellville pellet plants. Specifically, this catchment area analysis examines and identifies trends with timber inventory, growth, removals, wood demand, raw material prices, and harvest activities and practices in the 'AR Cluster' catchment area since 2000. It also includes an assessment of long-term market sustainability and provides a market outlook through 2026.

The Leola and Russellville satellite pellet mills were both commissioned by Drax in 2022, and both have an annual production capacity of 40,000 metric tons of pellets. Highland Pellets was commissioned in late-2016 and has an annual production capacity of 675,000 metric tons of pellets.

1.1 About Hood Consulting

Hood Consulting provides professional forest industry advisory and consulting services to both private and corporate landowners and investors, forest product companies, manufacturers, natural resource firms, and state and local economic development authorities.

Dr. Harrison Hood is a Forest Economist and Principal of Hood Consulting. His experience also includes the furniture import and export business, real estate development, and land management. Dr. Hood received a B.B.A. in Finance from the University of Mississippi as well as a Masters of Forest Resources in Forest Business and a Ph.D. in Forest Economics from the University of Georgia.

2. Fiber Catchment Area

Traditionally, a catchment area is a geographically-defined area in which a single pellet mill ("nucleus mill") has directly acquired fiber from since the mill commenced operations, including any additional forest areas where future purchase contracts exist. However, in some cases, multiple pellet mills are located in close proximity to one another and their individual catchment areas overlap to form a larger, combined catchment area the encompasses multiple pellet mills. Furthermore, and in general, a pellet mill's catchment area is composed of both a primary catchment area and a secondary catchment area.

A primary catchment area typically extends 110-130 km (70-80 miles) from the catchment area center and, for a roundwood-consuming pellet mill, this includes the area from which low-grade roundwood and in-woods chips are sourced. However, for a pellet mill that consumes sawmill residuals only (i.e. Arkansas Bioenergy Leola & Russellville), the primary catchment area represents the area from which a mill of its size would likely procure fiber should it decide to utilize roundwood or in-woods chips in the future to produce wood pellets. For a mill of its size, it represents the typical procurement area based on fiber needs, sourceability, economic viability (i.e. based on market haul distances and haul costs).

A secondary catchment area generally includes those areas outside the primary catchment area from which secondary fiber (i.e., sawmill residuals) is sourced. This also includes the area from which those mills that provide secondary fiber to the pellet mill source their primary (roundwood) fiber.

For the Arkansas Bioenergy, LLC – Leola, Arkansas Bioenergy, LLC – Russellville, and Highland Pellets LLC pellet mills, the catchment areas of these three mills overlap to form a single, combined catchment area (denoted *Arkansas Cluster* catchment area hereafter). Drax's Leola and Russellville plants are co-located at West Fraser-Leola and West Fraser-Russellville, respectively. Drax's Leola and Russellville plants consume sawmill residuals only, which are byproducts produced by West Fraser Leola & Russellville (feedstock = sawlogs). For Drax Leola & Russellville, the "secondary" catchment area is based on counties reported by West Fraser to Drax based on Drax's Residual Supplier Questionnaire. Highland Pellets LLC is a wood pellet mill that sources both pulpwood and sawmill residuals for wood pellet production. Highland Pellets' primary and secondary catchment area is based on counties reported and identified in their Sustainable Biomass Program supply base reports.

Specifically, the Arkansas Cluster primary catchment area includes 41 counties in Arkansas and covers an area more than 75,000 square kilometers (≈7.6 million hectares) in size. The secondary catchment area includes an additional 34 counties in Arkansas, 24 parishes in Louisiana, and 15 counties in Oklahoma. Together, the primary and secondary catchment area cover an area nearly 210,000 square kilometers (≈20.8 million hectares). See Figure 1 below.

Note that the following report includes data and analysis associated with the primary catchment area only. However, data associated with the full catchment area (primary + secondary) is provided in Annex I.

***Figure 1**. AR Cluster – Catchment Area Boundary*

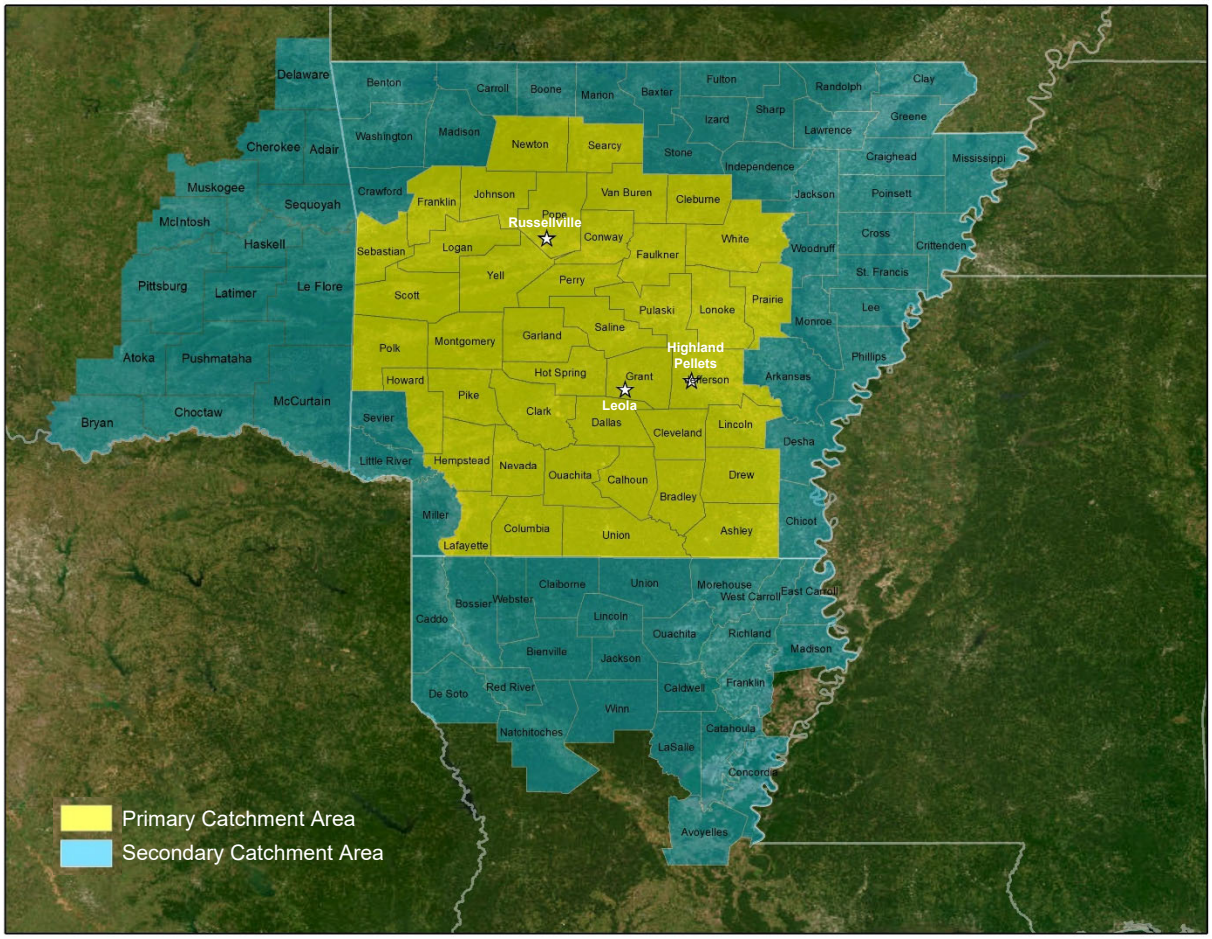


***Table 1**. AR Cluster – Catchment Area County List*

State	County	State	County	State	County
		Primary Catchment Area			
AR	Ashley	AR	Hempstead	AR	Pike
AR	Bradley	AR	Hot Spring	AR	Polk
AR	Calhoun	AR	Howard	AR	Pope
AR	Clark	AR	Jefferson	AR	Prairie
AR	Cleburne	AR	Johnson	AR	Pulaski
AR	Cleveland	AR	Lafayette	AR	Saline
AR	Columbia	AR	Lincoln	AR	Scott
AR	Conway	AR	Logan	AR	Searcy
AR	Dallas	AR	Lonoke	AR	Sebastian
AR	Drew	AR	Montgomery	AR	Union
AR	Faulkner	AR	Nevada	AR	Van Buren
AR	Franklin	AR	Newton	AR	White
AR	Garland	AR	Ouachita	AR	Yell
AR	Grant	AR	Perry		
		Secondary Catchment Area			
AR	Arkansas	AR	Phillips	LA	Natchitoches
AR	Baxter	AR	Poinsett	LA	Ouachita
AR	Benton	AR	Randolph	LA	Red River
AR	Boone	AR	Sevier	LA	Richland
AR	Carroll	AR	Sharp	LA	Union
AR	Chicot	AR	St. Francis	LA	Webster
AR	Clay	AR	Stone	LA	West Carroll
AR	Craighead	AR	Washington	LA	Winn
AR	Crawford	AR	Woodruff	OK	Adair
AR	Crittenden	LA	Avoyelles	OK	Atoka
AR	Cross	LA	Bienville	OK	Bryan
AR	Desha	LA	Bossier	OK	Cherokee
AR	Fulton	LA	Caddo	OK	Choctaw
AR	Greene	LA	Caldwell	OK	Delaware
AR	Independence	LA	Catahoula	OK	Haskell
AR	Izard	LA	Claiborne	OK	Latimer
AR	Jackson	LA	Concordia	OK	Le Flore
AR	Lawrence	LA	DeSoto	OK	McCurtain
AR	Lee	LA	East Carroll	OK	McIntosh
AR	Little River	LA	Franklin	OK	Muskogee
AR	Madison	LA	Jackson	OK	Pittsburg
AR	Marion	LA	LaSalle	OK	Pushmataha
AR	Miller	LA	Lincoln	OK	Sequoyah
AR	Mississippi	LA	Madison		
AR	Monroe	LA	Morehouse		

3. Forest Resource Assessment

The following section provides a current market profile of the AR Satellite Plant catchment area, including details regarding land area and use, forest area, timber inventory, growth, and removals. Note that all data was provided by the US Department of Agriculture (USDA) and the US Forest Service - Forest Inventory & Analysis (FIA) program.

3.1 Land Area & Use

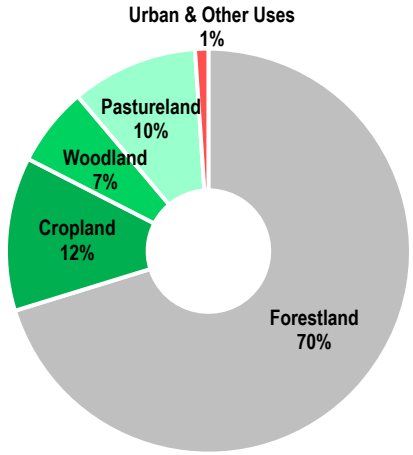
According to the US Department of Agriculture (USDA), the AR Cluster catchment area totals approximately 7,598,946 hectares in size. Approximately 70% (5,333,659 hectares) of the total land area is classified as forestland, 29% (2,182,769 hectares) is farmland, and 1% (82,518 hectares) is urban areas or land that is classified as having other uses.

***Table 2**. AR Cluster Catchment Area - Land Area by Land Classification & Use (2021)*

Land Classification / Use	Hectares	% of Total
Forestland	5,333,659	70%
Farmland:		
Cropland	935,245	12%
Woodland	480,949	7%
Pastureland	766,575	10%
Total Farmland	2,182,769	29%
Urban & Other Uses	82,518	1%
Total	**7,598,946**	**100%**

Source: USDA – US Forest Service; USDA Census of Agriculture

***Figure 2**. AR Cluster Catchment Area - Area Distribution by Land Classification & Use (2021)*



Notable changes in land use occurred in the AR Cluster catchment area from 2005-2021, including a 2.3% increase in forestland and a 6.3% decrease in land in farms (i.e. cropland, woodland, and pastureland).

According to the USDA, total catchment area forestland increased more than 120,000 hectares (+2.3%) from roughly 5,213,100 hectares in 2005 to roughly 5,333,700 hectares in 2021. (Note that while some of this increase was a genuine increase, a portion was due to the reclassification of land categories (i.e. land formerly classified as having *other uses* was reclassified as forestland)). Over this same period, total land in farms decreased 146,446 hectares (-6.3%) in the catchment area. In particular, cropland decreased an estimated 120,254 hectares (-11.4%) and pastureland decreased an estimated 63,394 hectares (-7.6%) from 2005-2021. Woodland increased an estimated 37,202 hectares (+8.4%) from 2005-2021. See Table 3 for details.

***Table 3**. AR Cluster Catchment Area – Land Area by Land Classification & Use (2005-2021)*

	Forestland			*Land in Farms*				Urban & Other Land Uses	Total Land Area
Year	Timberland	Other Forestland	Total	Cropland	Woodland	Pastureland	Total		
					(Hectares)				
2005	5,114,641	98,419	5,213,061	1,055,499	443,748	829,968	2,329,215	56,671	7,598,946
2006	5,138,578	95,821	5,234,399	1,042,044	442,463	822,339	2,306,846	57,701	7,598,946
2007	5,167,915	99,043	5,266,958	1,015,134	439,893	807,081	2,262,108	69,880	7,598,946
2008	5,164,063	101,186	5,265,249	989,132	443,607	802,496	2,235,235	98,463	7,598,946
2009	5,178,783	103,222	5,282,005	963,130	447,320	797,911	2,208,361	108,580	7,598,946
2010	5,187,717	98,225	5,285,942	937,128	451,034	793,326	2,181,488	131,516	7,598,946
2011	5,184,750	100,426	5,285,176	911,126	454,747	788,741	2,154,614	159,156	7,598,946
2012	5,222,001	102,333	5,324,334	885,124	458,461	784,156	2,127,741	146,872	7,598,946
2013	5,226,008	100,068	5,326,076	892,549	461,792	781,551	2,135,893	136,977	7,598,946
2014	5,258,474	102,626	5,361,100	899,975	465,124	778,947	2,144,045	93,800	7,598,946
2015	5,256,202	105,488	5,361,690	907,400	468,456	776,342	2,152,198	85,059	7,598,946
2016	5,245,588	109,370	5,354,957	914,825	471,787	773,737	2,160,350	83,639	7,598,946
2017	5,240,913	106,891	5,347,804	922,251	475,119	771,133	2,168,502	82,640	7,598,946
2018	5,239,205	106,936	5,346,140	925,963	476,785	769,830	2,172,578	80,227	7,598,946
2019	5,244,249	103,360	5,347,609	929,676	478,450	768,528	2,176,655	74,682	7,598,946
2020	5,236,979	100,530	5,337,510	933,389	480,116	767,226	2,180,731	80,706	7,598,946
2021	5,236,902	96,758	5,333,659	935,245	480,949	766,575	2,182,769	82,518	7,598,946

Source: USDA – US Forest Service; USDA Census of Agriculture

3.1.1 *Forestland*

Forestland, defined by the USDA as land at least 10% stock with trees of any kind, totals approximately 5,333,659 hectares and constitutes 70% of the catchment area's total land area.

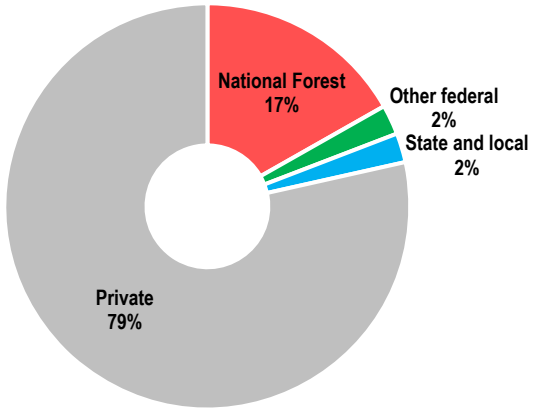
Ownership of forestland in the AR Cluster catchment area is predominantly privately owned. According to US Forest Service - Forest Inventory and Analysis (FIA) data from 2021, the latest available, privately-owned forestland constitutes 79% of total forestland and totals approximately 4,187,915 hectares. Public forestland constitutes 21% of total forestland in the catchment area, with National Forests totaling 896,191 hectares (17%), other federal forestland totaling 125,241 hectares (2%), and forestland owned by state and local authorities totaling 124,312 hectares (2%).

***Table 4**. AR Cluster Catchment Area - Forestland Area by Ownership Group (2021)*

Ownership Group	Hectares	% of Total
National Forest	896,191	17%
Other Federal	125,241	2%
State and Local	124,312	2%
Private	4,187,915	79%
Total	**5,333,659**	**100%**

Source: USDA – US Forest Service

***Figure 3**. AR Cluster Catchment Area - Distribution of Forestland Area by Ownership Group (2021)*



3.1.1.1 *Timberland*

Not all forestland is capable of commercial timber production. However, the USDA provides an alternative designation for forestland that can be commercially productive. Timberland is defined by the USDA as forestland that is capable of producing at least 1.4 m^3 of industrial wood per hectare per year.

In the AR Cluster catchment area, timberland constitutes 98% of total forestland and totals approximately 5,236,902 hectares. *Note that this report will focus specifically on timberland, and all data provided hereafter regarding timber inventory, growth, and removals will be from timberland only.*

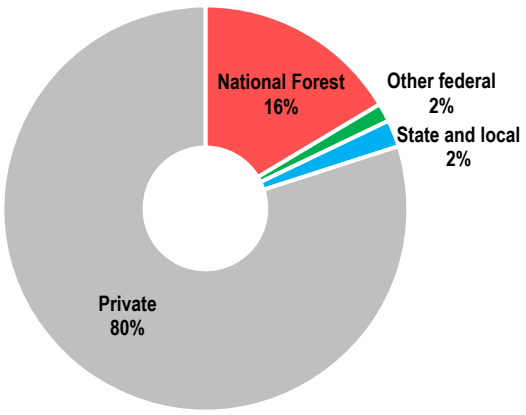
Ownership of timberland in the AR Cluster catchment area is nearly identical to that of forestland, with 80% (4,185,267 hectares) of total timberland privately owned, compared to 16% (861,072 hectares) National Forests, 2% (77,961 hectares) other federal, and 2% (112,601 hectares) owned by state and local authorities.

***Table 5**. AR Cluster Catchment Area - Timberland Area by Ownership Group (2021)*

Ownership Group	Hectares	% of Total
National Forest	861,072	16%
Other Federal	77,961	2%
State and Local	112,601	2%
Private	4,185,267	80%
Total	**5,236,902**	**100%**

Source: USDA – US Forest Service

***Figure 4**. AR Cluster Catchment Area - Distribution of Timberland Area by Ownership Group (2021)*



3.1.1.1.1 Timberland by Stand Origin

The US Forest Service provides two classifications for stand origin: 1) naturally regenerated and 2) planted. The USFS defines a *naturally regenerated* timber stand as one that has been established naturally. A *planted* timber stand is defined as an artificially regenerated stand established by planting or artificial seeding.

According to the most current USFS estimates, approximately 73% (3,842,979 hectares) of total catchment area timberland is classified as naturally regenerated forests, compared to 27% (1,393,923 hectares) planted forests. However, stand origin area distribution varies widely by major forest type.

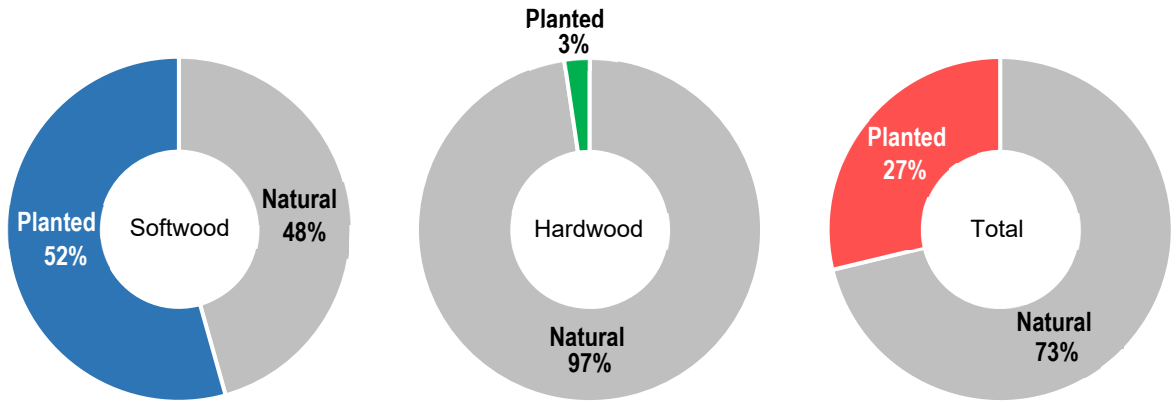
US Forest Service data shows 48% (1,220,128 hectares) of softwood timberland is naturally regenerated versus 52% (1,326,082 hectares) planted. In contrast, 97% (2,622,851 hectares) of hardwood timberland is naturally regenerated versus 3% (67,840 hectares) planted.

***Table 6**. AR Cluster Catchment Area - Timberland Area by Stand Origin & Major Forest Type (2021)*

	Softwood		*Hardwood*		*Total*	
Stand Origin	Hectares	Distribution	Hectares	Distribution	Hectares	Distribution
Naturally Regenerated	1,220,128	48%	2,622,851	97%	3,842,979	73%
Planted	1,326,082	52%	67,840	3%	1,393,923	27%
Total	**2,546,210**	**100%**	**2,690,691**	**100%**	**5,236,902**	**100%**

Source: USDA - US Forest Service

***Figure 5**. AR Cluster Catchment Area - Distribution of Timberland Area by Stand Origin & Major Forest Type (2021)*



According to the US Forest Service, total timberland in the AR Cluster catchment area experienced a net increase of 122,260 hectares (+2.4%) from 2005-2021, increasing from 5,114,642 to 5,236,902 hectares over this 16-year period. However, note that much of this increase occurred in the late 2000s and early 2010s, with total timberland stabilizing and averaging roughly 5,240,000 hectares since 2017.

In particular, planted pine timberland (the predominant supplier of pine sawtimber consumed by the lumber industry as well as pine pulpwood consumed by the pulp/paper and bioenergy industries in this market) increased approximately 406,342 hectares (+44%) from 2005 to 2021. Note that this increase coincided with a nearly 128,000-hectare decrease in natural hardwood timberland, a more than 56,000-hectare decrease in mixed pine-hardwood timberland, and a more than 75,000-hectare decrease in natural pine timberland.

***Table 7**. AR Cluster Catchment Area - Timberland Area by Stand Origin (2005-2021)*

	Planted		*Naturally Regenerated*			
Year	Pine	Hardwood	Pine	Hardwood	Mixed Pine-Hardwood	Total
			(Hectares)			
2005	919,740	92,817	1,124,859	2,384,156	593,070	5,114,642
2006	960,530	95,258	1,108,061	2,380,848	593,880	5,138,577
2007	994,072	105,809	1,083,858	2,408,051	576,124	5,167,913
2008	1,026,241	58,932	1,086,334	2,398,469	594,087	5,164,063
2009	1,044,403	65,680	1,054,597	2,389,708	624,397	5,178,784
2010	1,045,285	63,559	1,083,832	2,370,162	624,878	5,187,715
2011	1,066,116	91,412	1,068,459	2,362,740	596,024	5,184,751
2012	1,103,566	76,999	1,080,783	2,367,142	593,512	5,222,001
2013	1,088,365	66,512	1,137,086	2,353,345	580,699	5,226,008
2014	1,148,792	72,839	1,119,876	2,376,637	540,333	5,258,476
2015	1,180,669	77,633	1,093,895	2,374,611	529,396	5,256,203
2016	1,160,424	70,681	1,124,954	2,351,744	537,784	5,245,587
2017	1,167,368	67,458	1,141,198	2,317,752	547,137	5,240,912
2018	1,224,785	69,198	1,094,683	2,303,645	546,895	5,239,205
2019	1,262,024	58,580	1,086,050	2,280,807	556,788	5,244,250
2020	1,295,262	54,398	1,087,251	2,257,397	542,672	5,236,980
2021	1,326,082	67,840	1,049,714	2,256,519	536,746	5,236,902

Source: USDA-US Forest Service

***Figure 6**. AR Cluster Catchment Area - Timberland Area by Year (2005-2021)*

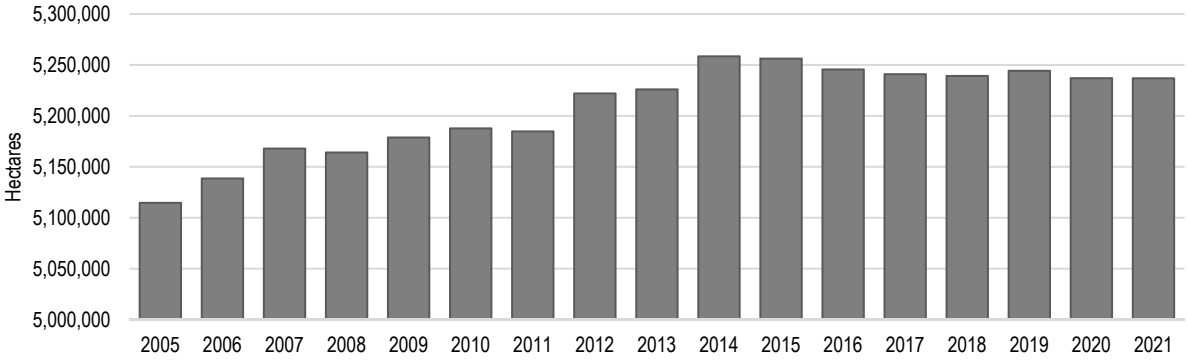
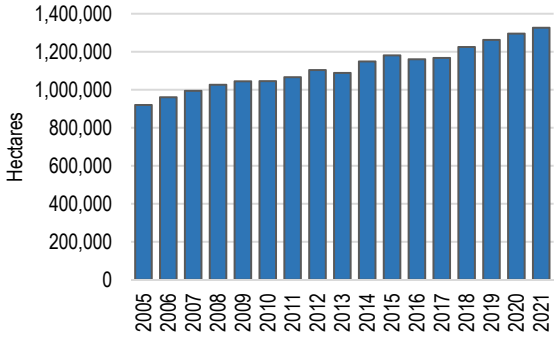
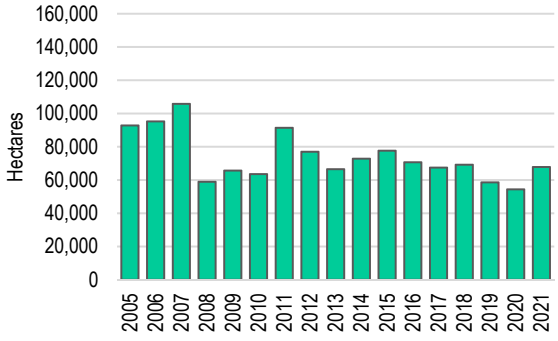


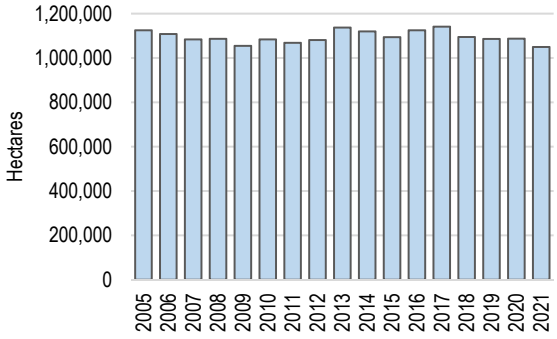
***Figure 7**. AR Cluster Catchment Area – Timberland Area by Stand Origin (2005-2021)*



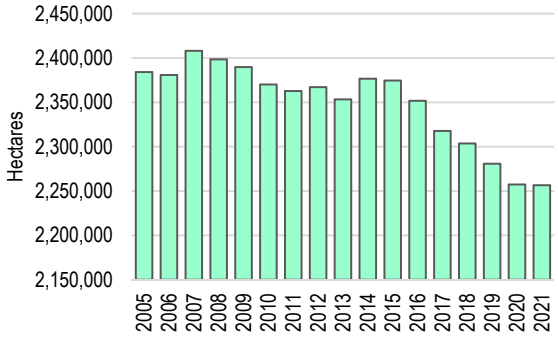
(a) Planted Pine



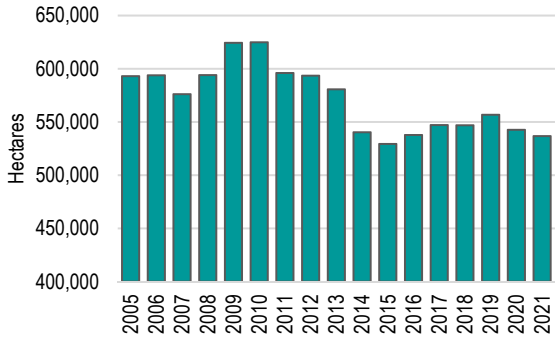
(b) Planted Hardwood



(c) Naturally Regenerated Pine



(d) Naturally Regenerated Hardwood



(e) Naturally Regenerated Mixed Pine-Hardwood

3.1.1.1.2 Timberland by Age Class Distribution

According to US Forest Service data, of the 5,236,902 hectares of timberland in the catchment area, approximately 45% (2,376,093 hectares) is classified as softwood timberland, 43% (2,268,348 hectares) is classified as hardwood timberland, and 11% (592,460 hectares) is classified as mixed pine-hardwood timberland.

Distribution of timberland area by age class varies by forest type. Specifically, 77% of softwood timberland is 50 years of age or younger, with the average age of softwood timberland (based on area) estimated at 32.4 years of age. In comparison, hardwood timberland has an average age of 55.7 years, with 69% of hardwood timberland 46-90 years of age.

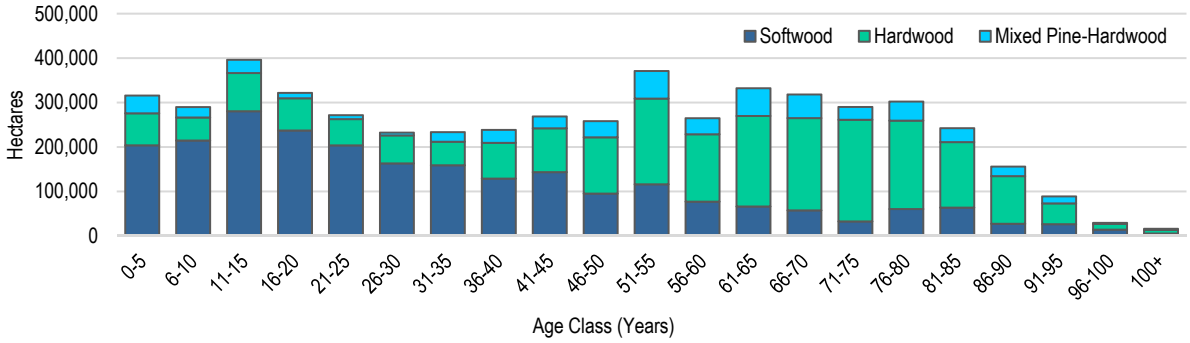
The distribution of mixed pine-hardwood timberland by age class is similar to that of hardwood timberland. Specifically, 68% of mixed pine-hardwood timberland is 41-90 years of age, with the average age of mixed pine-hardwood timberland estimated at 51.5 years of age.

***Table 8**. AR Cluster Catchment Area - Distribution of Timberland Area by Age Class & Forest Type (2021)*

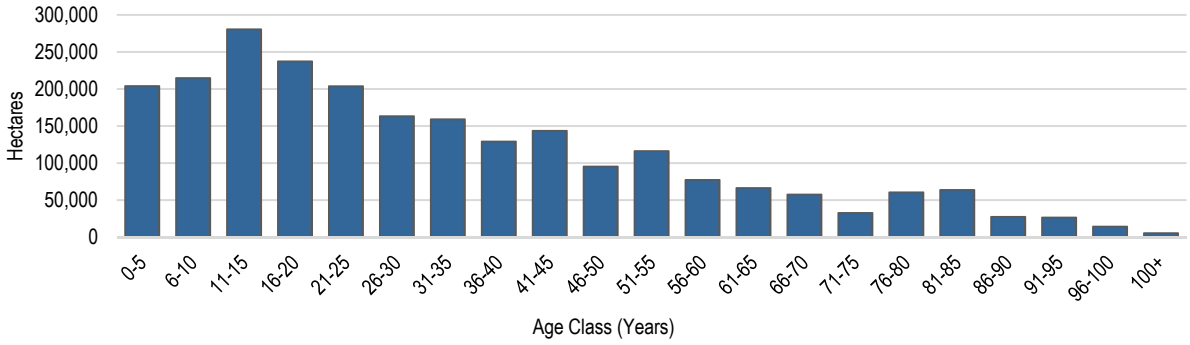
Age Class (Years)	*Softwood*		*Hardwood*		*Mixed Pine-Hardwood*		*Total*	
	Hectares	Distribution	Hectares	Distribution	Hectares	Distribution	Hectares	Distribution
0-5	203,808	9%	72,005	3%	39,913	7%	315,726	6%
6-10	214,607	9%	51,816	2%	23,351	4%	289,774	6%
11-15	280,424	12%	86,006	4%	29,650	5%	396,080	8%
16-20	237,184	10%	72,412	3%	12,144	2%	321,740	6%
21-25	203,635	9%	59,122	3%	8,780	1%	271,537	5%
26-30	163,176	7%	62,970	3%	6,221	1%	232,367	4%
31-35	158,979	7%	52,887	2%	21,630	4%	233,496	4%
36-40	128,985	5%	80,305	4%	29,246	5%	238,537	5%
41-45	143,452	6%	98,641	4%	26,587	4%	268,680	5%
46-50	95,222	4%	126,638	6%	36,298	6%	258,158	5%
51-55	116,072	5%	192,790	8%	62,124	10%	370,985	7%
56-60	77,134	3%	151,499	7%	36,169	6%	264,803	5%
61-65	66,197	3%	203,628	9%	62,333	11%	332,157	6%
66-70	57,443	2%	207,535	9%	53,156	9%	318,134	6%
71-75	32,594	1%	228,717	10%	28,808	5%	290,118	6%
76-80	60,402	3%	198,945	9%	42,890	7%	302,237	6%
81-85	63,623	3%	147,394	6%	31,273	5%	242,291	5%
86-90	27,324	1%	107,102	5%	21,510	4%	155,936	3%
91-95	26,361	1%	46,775	2%	15,675	3%	88,811	2%
96-100	14,160	1%	12,926	1%	2,236	0%	29,322	1%
100+	5,310	0%	8,235	0%	2,466	0%	16,012	0%
Total	**2,376,093**	**100%**	**2,268,348**	**100%**	**592,460**	**100%**	**5,236,902**	**100%**

Source: USDA - US Forest Service

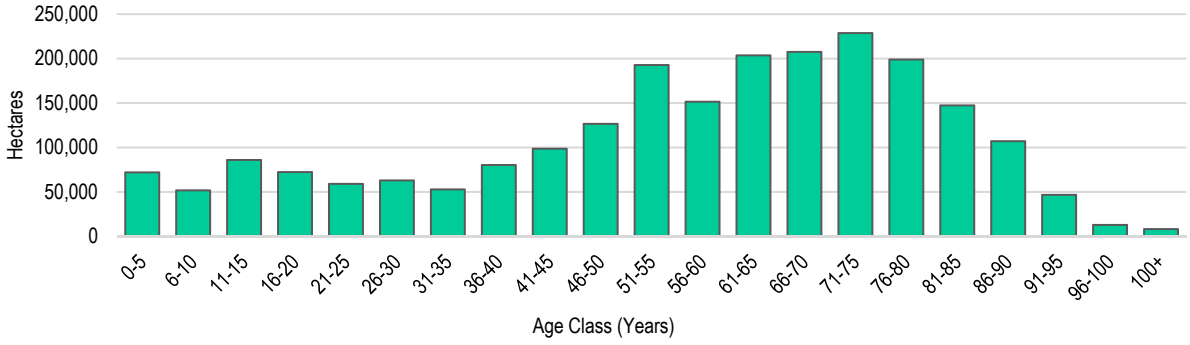
***Figure 8**. AR Cluster Catchment Area - Distribution of Timberland Area by Age Class & Forest Type (2021)*



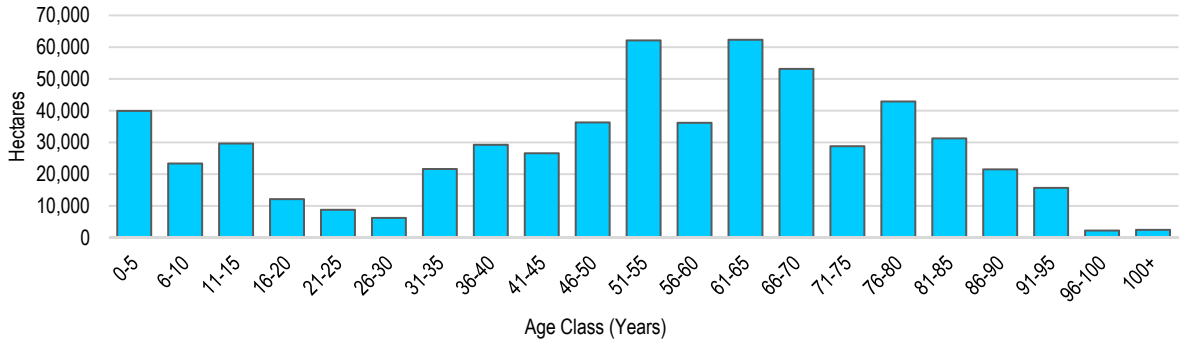
(a) Total Timberland



(b) Softwood Timberland



(c) Hardwood Timberland



(d) Mixed Pine-Hardwood Timberland

3.2 Timber Inventory, Growth, & Removals

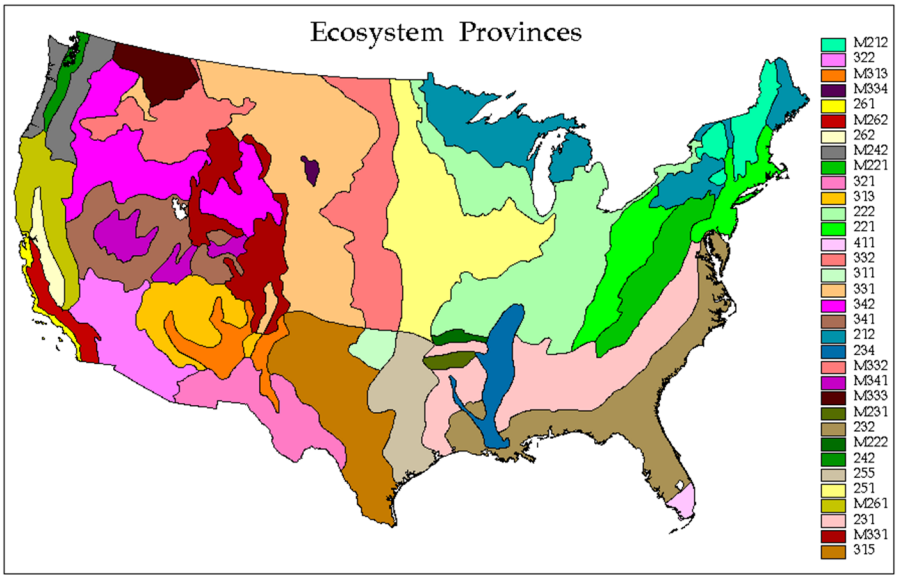
The following section profiles timber inventory, growth, and removal details as of 2021, the most current available, as well as historical trends since 2000. Timber inventory data for the AR Cluster catchment area is provided by the US Forest Service - Forest Inventory & Analysis (FIA) program. FIA data utilizes approximately 50-60 sample plots per county to calculate inventory estimates, with sampling errors of 10-25%.

Note that the USFS FIA program released a new modeling system in September 2023 to estimate tree volume and carbon. In October 2023, the USFS updated the FIA database to reflect their updated methodology. These new datasets provide a consistent methodology for estimating inventory volumes across different regions of the U.S., in contrast to previous methods which relied on alternative techniques in different regions. This update not only changes future inventory, growth, and removal estimates across the U.S. South, but it also changes historical trends in these measurements.

Specifically, the new FIA inventory and carbon model separates the US South into the following five zones for equation calculation purposes:

- Eastern-Central Broadleaf (221)
- Central Appalachians (M221)
- Lower Mississippi Riverine (234)
- Southeastern Mixed (231)
- Outer Coastal Plain (232)

The Arkansas Satellite Plants catchment area includes the Lower Mississippi Riverine and Southeastern Mixed. Under the new calculation method (and for future inventory, growth, and removals data associated with the AR Cluster catchment area), softwood volumes are expected to be 0.5-1.0% higher and hardwood volumes 1.5-4.0% higher compared to the previous calculation method. While pine volume, overall, will not see large changes under this new calculation method, diameter distributions will shift from smaller to larger diameters.



3.2.1 *Timber Inventory*

3.2.1.1 Timber Inventory by Ownership Group

Growing stock inventory on timberland in the AR Cluster catchment area in 2021, the latest available, totaled an estimated 707 million m^3, of which approximately 75% (532 million m^3) is privately owned, 19% (137 million m^3) is National Forest, 4% (25 million m^3) is owned by state and local authorities, and 2% (13 million m^3) is owned by other federal authorities.

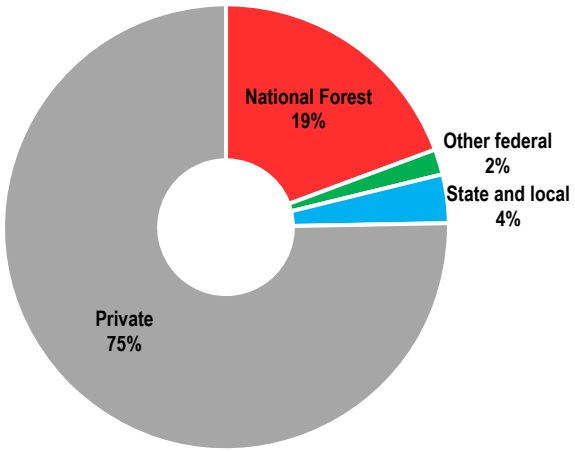
Note that the distributions of both softwood and hardwood growing stock inventory by ownership group are very similar to that of total growing stock inventory. However, there are some minor differences. Specifically, timberland owned by state and local authorities contains approximately 4% of total softwood inventory but 3% of hardwood inventory. Also, privately-owned timberland represents 75% of total softwood inventory but 77% of total hardwood inventory. See Table 9 for details.

***Table 9**. AR Cluster Catchment Area - Growing Stock Volume on Timberland by Ownership Group and Major Species (2021)*

Ownership Group	Softwood Inventory	Hardwood Inventory	Total Inventory
		(Million Cubic Meters)	
National Forest	72.5	64.2	136.7
Other Federal	4.0	9.0	13.0
State and Local	9.9	15.1	24.9
Private	292.4	239.7	532.1
Total	**378.8**	**327.9**	**706.7**

Source: USDA - US Forest Service

***Figure 9**. AR Cluster Catchment Area - Distribution of Total Timber Inventory by Ownership Group (2021)*



3.2.1.2 Timber Inventory by Diameter Class Distribution

Distribution of total growing stock inventory on timberland by diameter class varies by major species group. Based on the most current US Forest Service estimates, approximately 78% (297 million m^3) of total softwood growing stock inventory is 7- 19 inches in diameter, with 95% (358 million m^3) less than 23 inches in diameter. In comparison, 66% (216 million m^3) of total hardwood growing stock inventory is 7-19 inches in diameter, with 87% (284 million m^3) less than 23 inches in diameter.

Based on these diameter class distributions, softwood growing stock inventory averages an estimated 13.8 inches in diameter, compared to 15.3 inches for hardwood growing stock inventory.

***Table 10**. AR Cluster Catchment Area - Timber Inventory by Major Species Group & Diameter Class (2021)*

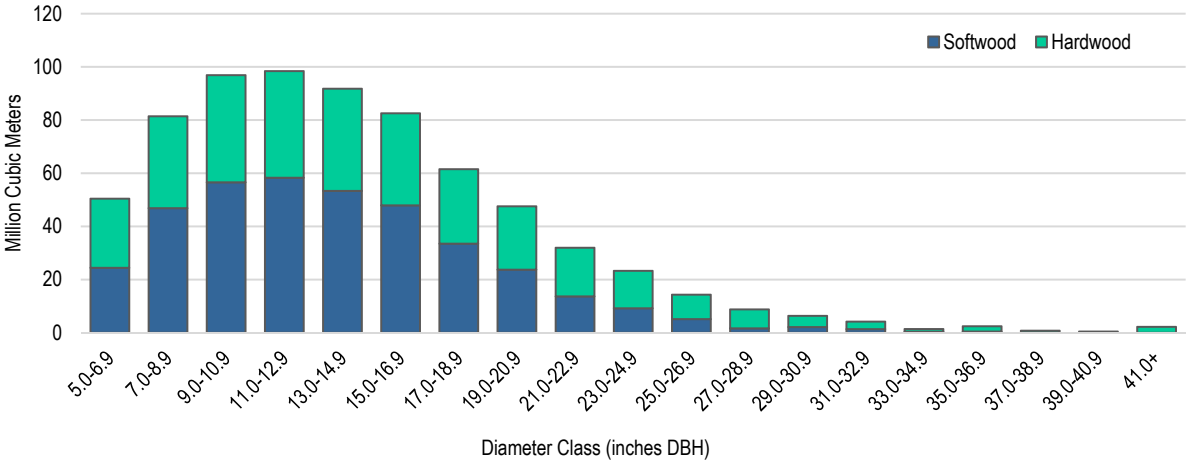
Diameter Class (inches DBH)	*Softwood*		*Hardwood*		*Total*	
	Volume (Million m^3)	Distribution	Volume (Million m^3)	Distribution	Volume (Million mt^3)	Distribution
5.0-6.9	24.4	6%	26.0	8%	50.4	7%
7.0-8.9	46.9	12%	34.5	11%	81.4	12%
9.0-10.9	56.6	15%	40.3	12%	96.9	14%
11.0-12.9	58.3	15%	40.1	12%	98.4	14%
13.0-14.9	53.3	14%	38.4	12%	91.8	13%
15.0-16.9	47.9	13%	34.6	11%	82.5	12%
17.0-18.9	33.5	9%	28.0	9%	61.5	9%
19.0-20.9	23.7	6%	23.8	7%	47.5	7%
21.0-22.9	13.7	4%	18.3	6%	32.0	5%
23.0-24.9	9.2	2%	14.1	4%	23.3	3%
25.0-26.9	5.1	1%	9.2	3%	14.3	2%
27.0-28.9	1.7	0%	7.1	2%	8.8	1%
29.0-30.9	2.1	1%	4.2	1%	6.4	1%
31.0-32.9	1.4	0%	2.8	1%	4.2	1%
33.0-34.9	0.4	0%	1.0	0%	1.4	0%
35.0-36.9	0.5	0%	2.0	1%	2.5	0%
37.0-38.9	0.0	0%	0.8	0%	0.8	0%
39.0-40.9	0.0	0%	0.5	0%	0.5	0%
41.0+	0.0	0%	2.2	1%	2.2	0%
Total	**378.8**	**100%**	**327.9**	**100%**	**706.7**	**100%**

Source: USDA - US Forest Service

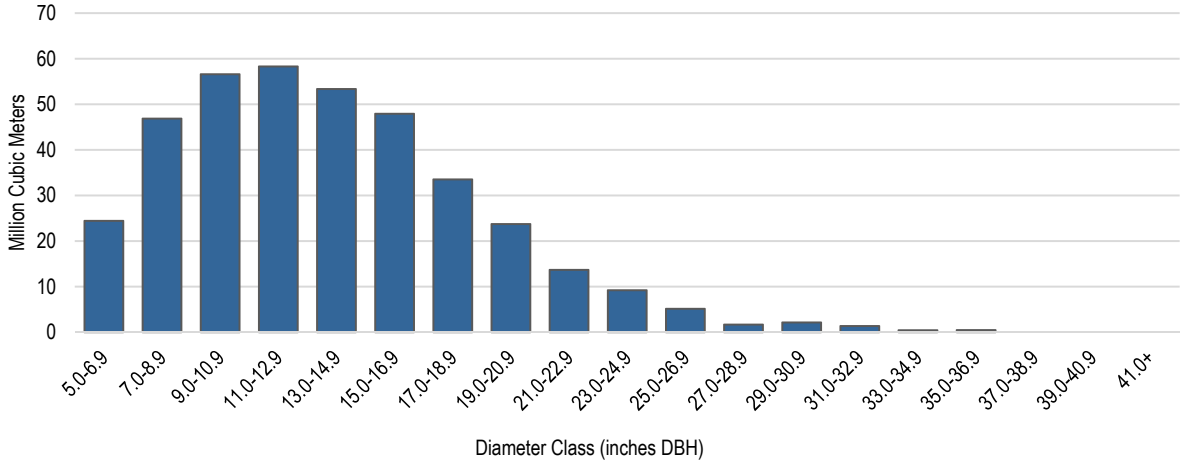
Pine Pulpwood Pine Chip-n-saw Pine Sawtimber Hardwood Pulpwood Hardwood Sawtimber

***Note:** In the US South, tree diameter at breast height (DBH) is measured and reported in inches. The metric conversion is 1 inch=2.54 cm.*

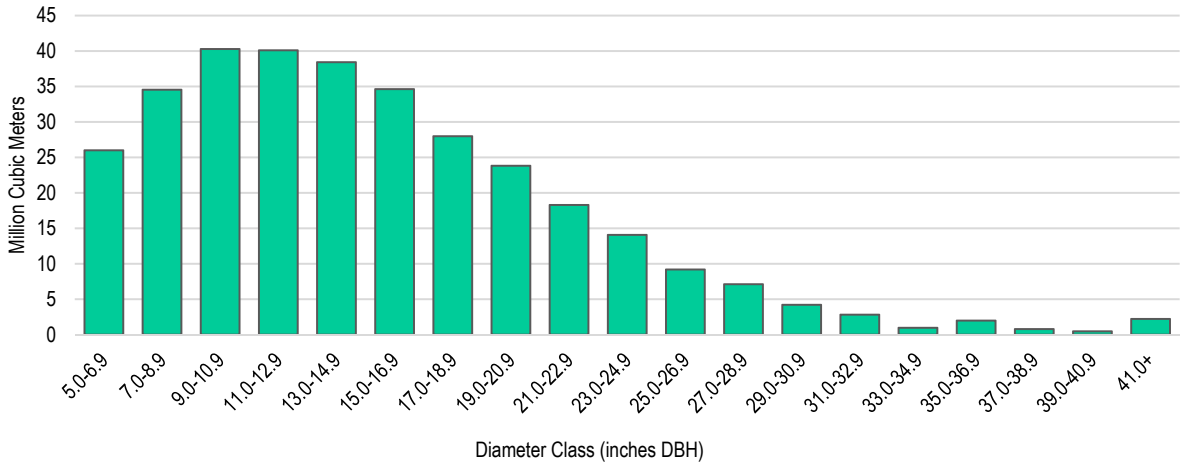
***Figure 10**. AR Cluster Catchment Area - Distribution of Growing Stock Volume on Timberland by Diameter Class (2021)*



(a) Total Growing Stock Inventory



(b) Softwood Growing Stock Inventory



(c) Hardwood Growing Stock Inventory

Total growing stock inventory on timberland increased from 535 million m^3 in 2005 to 707 million m^3 in 2021, or a net increase of 172 million m^3 (+32%) over this period. In addition to the overall increase in inventory level, there were also changes in the distribution of growing stock inventory by diameter class.

Table 11 below provides a comparison of growing stock inventory estimates in the catchment area by major species group and diameter class in 2005 and 2021. Specifically, USFS data shows that in 2005, approximately 35% of softwood growing stock inventory was less than 11 inches in diameter (i.e. pulpwood classification), versus 34% within these parameters in 2021. In terms of average diameter size, softwood inventory averaged 13.5 inches in diameter in 2005 and 13.8 inches in diameter in 2021.

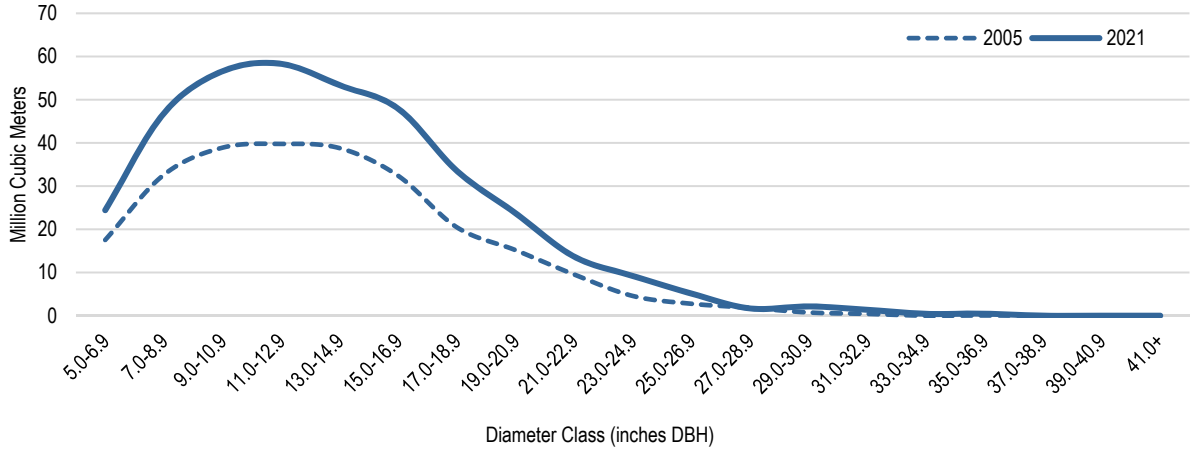
The historic distributions of hardwood growing stock inventory by diameter class show 51% of hardwood inventory was 13 inches in diameter or greater (i.e. sawtimber classification) in 2005, increasing to 57% within these same parameters in 2021. Hardwood growing stock inventory averaged an estimated 14.3 inches in diameter in 2005, compared to 15.3 inches in 2021.

***Table 11**. AR Cluster Catchment Area - Timber Inventory by Major Species Group & Diameter Class (2005 & 2021)*

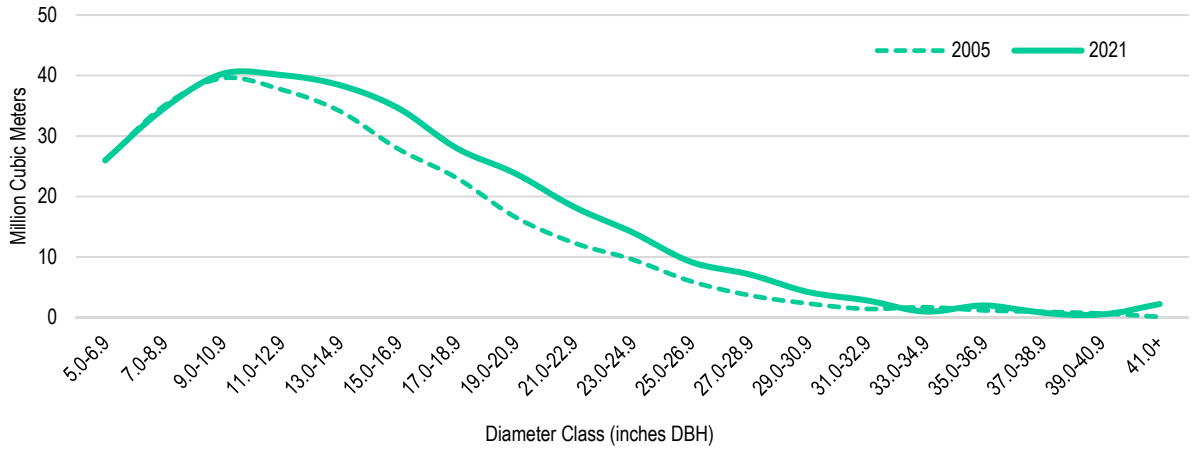
Diameter Class (inches DBH)	*Softwood*		*Hardwood*		*Total*	
	2005	2021	2005	2021	2005	2021
	(Million Cubic Meters)					
5.0-6.9	17.5	24.4	25.9	26.0	43.4	50.4
7.0-8.9	32.6	46.9	35.0	34.5	67.6	81.4
9.0-10.9	38.9	56.6	39.6	40.3	78.5	96.9
11.0-12.9	39.8	58.3	37.7	40.1	77.5	98.4
13.0-14.9	38.8	53.3	34.1	38.4	72.9	91.8
15.0-16.9	32.4	47.9	27.9	34.6	60.2	82.5
17.0-18.9	20.5	33.5	23.1	28.0	43.5	61.5
19.0-20.9	15.2	23.7	16.6	23.8	31.8	47.5
21.0-22.9	9.5	13.7	12.3	18.3	21.9	32.0
23.0-24.9	4.6	9.2	9.6	14.1	14.2	23.3
25.0-26.9	2.8	5.1	6.0	9.2	8.7	14.3
27.0-28.9	1.8	1.7	3.7	7.1	5.5	8.8
29.0-30.9	0.7	2.1	2.3	4.2	3.0	6.4
31.0-32.9	0.4	1.4	1.4	2.8	1.8	4.2
33.0-34.9	0.0	0.4	1.7	1.0	1.7	1.4
35.0-36.9	0.1	0.5	1.2	2.0	1.2	2.5
37.0-38.9	0.0	0.0	0.9	0.8	0.9	0.8
39.0-40.9	0.0	0.0	0.7	0.5	0.7	0.5
41.0+	0.0	0.0	0.1	2.2	0.1	2.2
Total	**255.5**	**378.8**	**279.7**	**327.9**	**535.2**	**706.7**

Source: USDA - US Forest Service

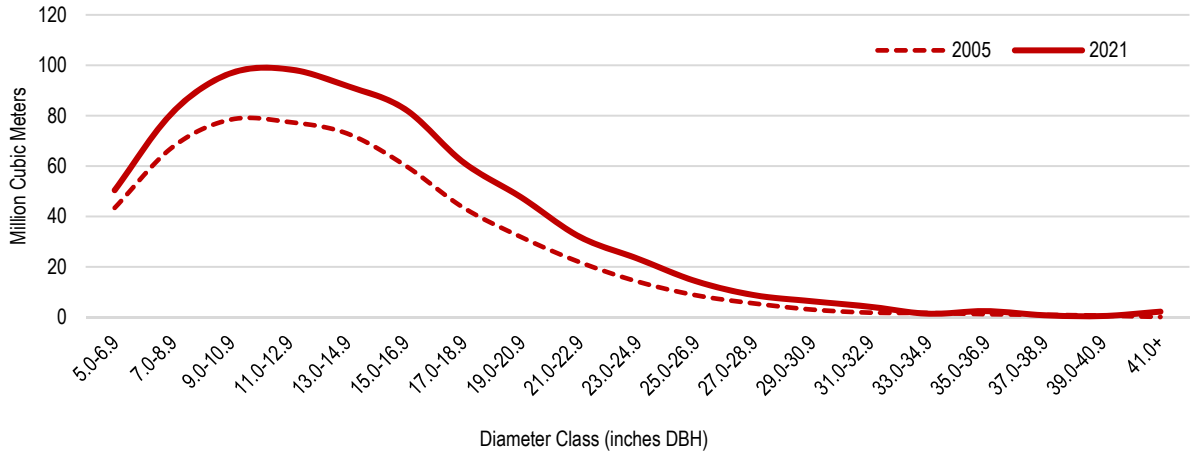
***Figure 11**. AR Cluster Catchment Area - Timber Inventory by Major Species Group & Diameter Class (2005 & 2021)*



(a) Softwood Growing Stock Inventory



(b) Hardwood Growing Stock Inventory



(c) Total Growing Stock Inventory

3.2.1.3 Timber Inventory by Major Timber Product

In addition, FIA estimates of diameter class distribution by major species group allow us to break down volume estimates according to major timber product. Also note that *softwood* and *pine* are used interchangeably, as pine constitutes more than 98% of total softwood inventory in the catchment area (according to FIA data). Individual product specifications are defined as follows:

Major Product	DBH (inches)	DBH (cm)
Pine Sawtimber	12.0+	30.5+
Pine Chip-n-saw	9.0 - 11.9	22.9 - 30.4
Pine Pulpwood	5.0 - 8.9	12.7 - 22.8
Hardwood Sawtimber	12.0+	30.5+
Hardwood Pulpwood	5.0 - 11.9	12.7 - 30.4

Based on these product specifications, approximately 222 million m^3 (31%) of total growing stock inventory is classified as pine sawtimber, compared to 86 million m^3 (12%) of pine chip-n-saw, 71 million m^3 (10%) of pine pulpwood, 227 million m^3 (32%) of hardwood sawtimber, and 101 million m^3 (14%) of hardwood pulpwood.

***Table 12**. AR Cluster Catchment Area - Distribution of Total Growing Stock Volume by Major Timber Product (2021)*

Product	Volume (Million m^3)	Distribution
Pine Sawtimber	221.8	31%
Pine Chip-n-saw	85.7	12%
Pine Pulpwood	71.3	10%
Hardwood Sawtimber	227.1	32%
Hardwood Pulpwood	100.8	14%
Total	**706.7**	**100%**

Source: USDA - US Forest Service

Timber inventory data for the AR Cluster catchment area was provided by the US Forest Service - Forest Inventory & Analysis (FIA) program from 2005 through 2021, the most current available. According to FIA estimates, total growing stock inventory on timberland in the AR Cluster catchment area increased an average of 1.8% per year (+32% total) from 535 million m^3 in 2005 to 707 million m^3 in 2021. However, note that the rate at which inventory levels have increased has accelerated since 2010. Specifically, total growing stock inventory increased an average of 1.2% per year from 2005-2010, compared to 2.0% per year since 2010.

Table 13 below (as well as Figures 12 and 13 on the following page) provides a breakdown of timber inventory in the catchment area by major timber product from 2005-2021. Note that inventories increased for all five major products over this period, with the exception of hardwood pulpwood, which was essentially unchanged for this period.

***Table 13**. AR Cluster Catchment Area - Timber Inventory by Major Timber Product (2000-2021)*

	Softwood			*Hardwood*		
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
			(Million Cubic Meters)			
2005	147	59	50	179	100	535
2006	147	60	51	184	100	540
2007	148	60	51	186	100	546
2008	151	61	52	188	100	551
2009	151	62	51	194	98	556
2010	157	64	52	197	98	568
2011	162	65	56	200	99	581
2012	168	67	58	204	100	597
2013	174	69	61	203	99	607
2014	178	72	61	204	98	612
2015	181	73	62	206	98	620
2016	188	76	63	207	98	632
2017	192	78	65	210	98	643
2018	199	81	67	213	99	659
2019	208	83	70	219	100	679
2020	214	83	71	224	100	692
2021	222	86	71	227	101	707

Source: USDA - US Forest Service

***Figure 12**. AR Cluster Catchment Area - Timber Inventory by Year (2005-2021)*

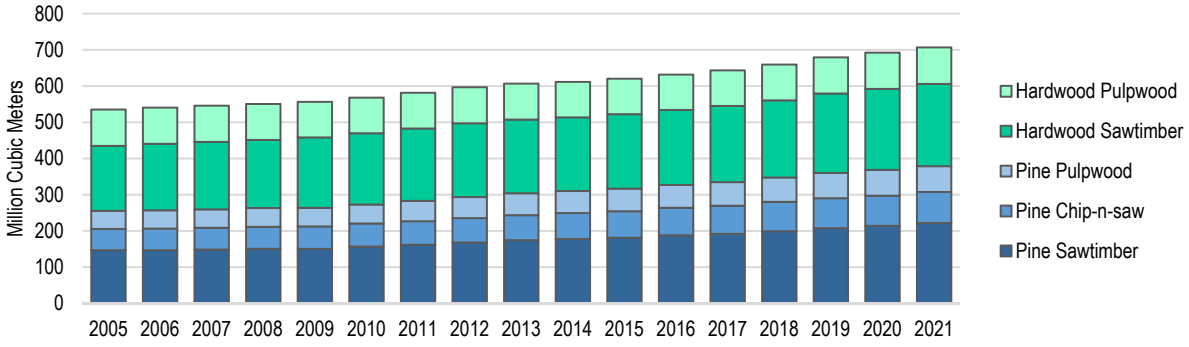
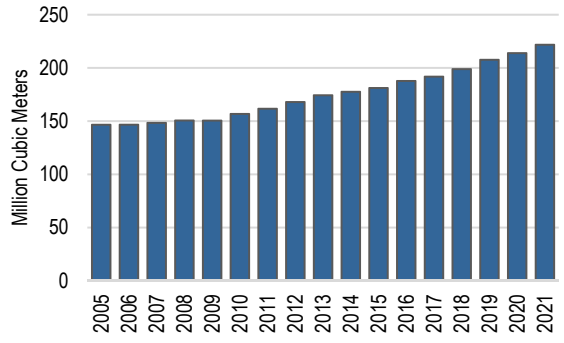
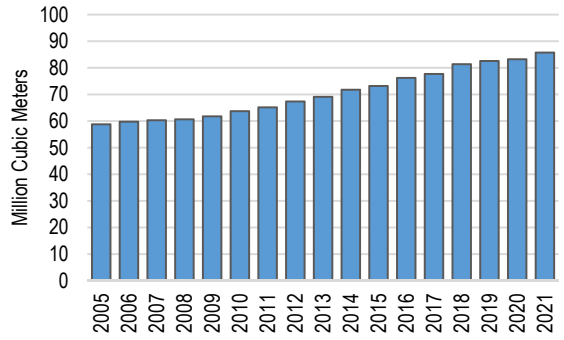


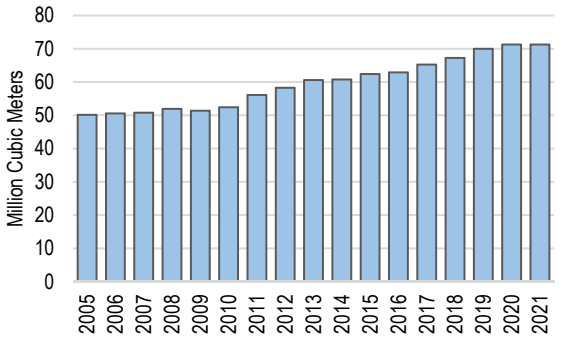
***Figure 13**. AR Cluster Catchment Area - Timber Inventory by Major Timber Product (2005-2021)*



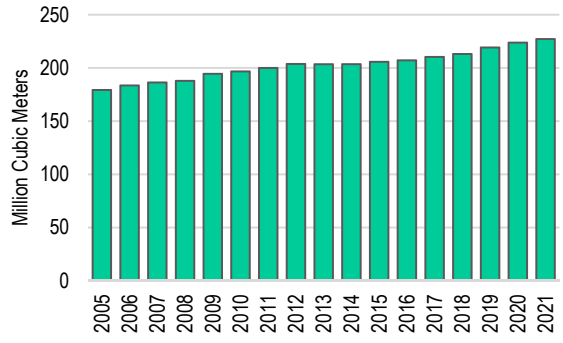
(a) Pine Sawtimber



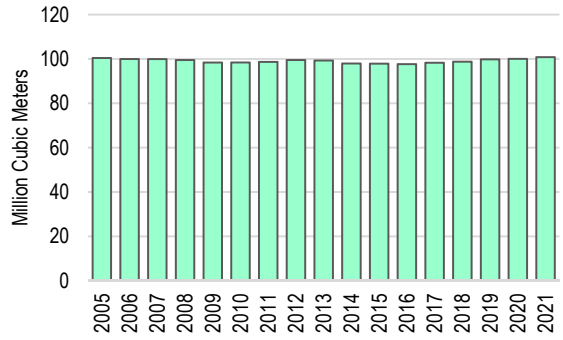
(b) Pine Chip-n-saw



(c) Pine Pulpwood



(d) Hardwood Sawtimber



(e) Hardwood Pulpwood

3.2.1.4 Timber Inventory by Age Class Distribution

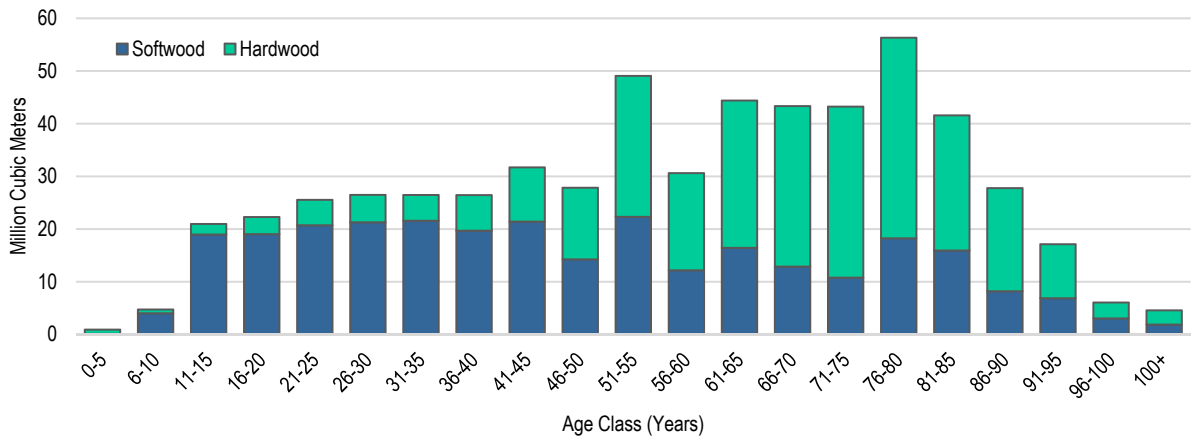
The distribution of total growing stock volume on timberland by age class shows that 71% of total inventory is 21-85 years of age (see Figure 14 on the following page). Specifically, according to USFS estimates, softwood growing stock inventory averages an estimated 44.5 years of age, with 76% (289 million m^3) of total softwood inventory 11-65 years of age. In contrast, hardwood inventory averages an estimated 63.6 years of age, with 74% (244 million m^3) of hardwood inventory 51-90 years of age.

***Table 14**. AR Cluster Catchment Area - Distribution of Growing Stock Volume by Age Class & Major Species (2021)*

Age Class (Years)	*Softwood* Volume (Million m^3)	*Softwood* Distribution	*Hardwood* Volume (Million m^3)	*Hardwood* Distribution	*Total* Volume (Million m^3)	*Total* Distribution
0-5	0.8	0%	1.0	0%	1.8	0%
6-10	6.1	2%	1.6	0%	7.7	1%
11-15	27.1	7%	2.7	1%	29.8	4%
16-20	31.1	8%	4.0	1%	35.1	5%
21-25	33.2	9%	5.9	2%	39.1	6%
26-30	28.1	7%	6.8	2%	34.9	5%
31-35	28.6	8%	6.5	2%	35.1	5%
36-40	25.9	7%	9.8	3%	35.7	5%
41-45	29.7	8%	13.0	4%	42.7	6%
46-50	21.0	6%	16.5	5%	37.5	5%
51-55	25.7	7%	30.6	9%	56.2	8%
56-60	17.6	5%	23.6	7%	41.2	6%
61-65	21.0	6%	33.0	10%	54.0	8%
66-70	16.7	4%	36.1	11%	52.8	7%
71-75	11.1	3%	34.1	10%	45.3	6%
76-80	18.7	5%	39.4	12%	58.0	8%
81-85	15.9	4%	26.5	8%	42.4	6%
86-90	8.3	2%	20.9	6%	29.2	4%
91-95	6.9	2%	10.3	3%	17.1	2%
96-100	3.0	1%	3.0	1%	6.1	1%
100+	2.3	1%	2.7	1%	5.0	1%
Total	**378.8**	**100%**	**327.9**	**100%**	**706.7**	**100%**

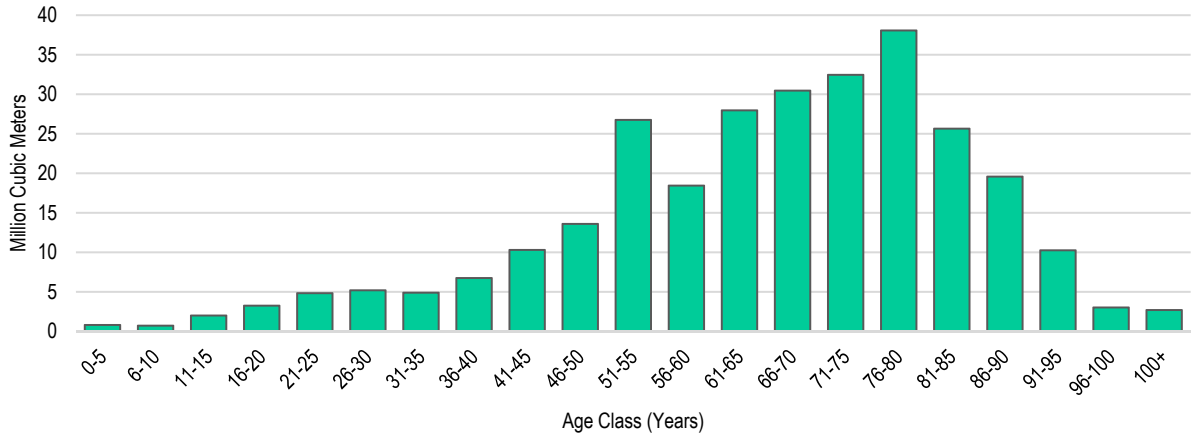
Source: USDA - US Forest Service

***Figure 14**. AR Cluster Catchment Area - Distribution of Growing Stock Volume on Timberland by Age Class (2021)*



(a) Total Growing Stock Inventory

(b) Softwood Growing Stock Inventory



(c) Hardwood Growing Stock Inventory

US Forest Service data indicates the average age of softwood growing stock inventory decreased slightly from 44.7 years old in 2005 to 44.5 years old in 2021. Conversely, the average age of hardwood growing stock inventory increased from 55.9 to 63.6 years of age over this 16-year period. In particular, the increase in the average age of hardwood growing stock inventory was reflected in changes in age class distribution, as the distribution of hardwood growing stock inventory greater than 50 years of age increased from 65% in 2005 to 79% in 2021.

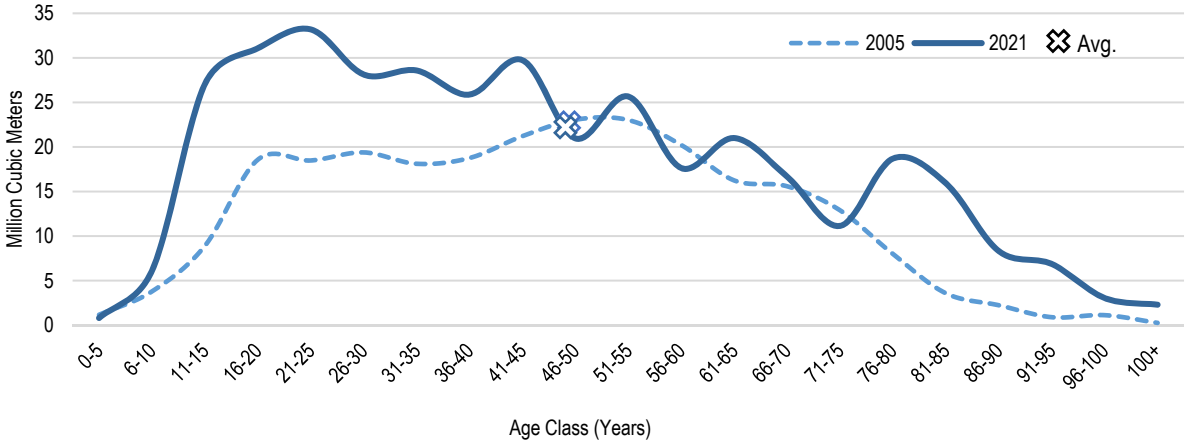
Table 15 below provides US Forest Service estimates of softwood and hardwood growing stock inventory by age class in 2005 and 2021. Corresponding values are shown graphically in Figure 15 on the following page.

***Table 15**. AR Cluster Catchment Area - Timber Inventory by Major Species Group & Age Class (2005 & 2021)*

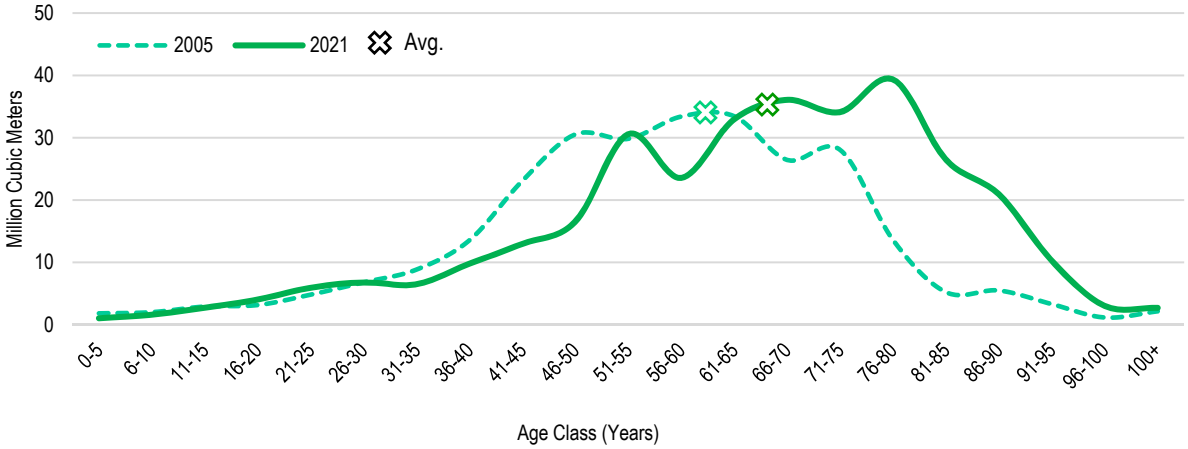
Age Class (years)	*Softwood*		*Hardwood*		*Total*	
	2005	2021	2005	2021	2005	2021
	(Million Cubic Meters)					
0-5	1.2	0.8	1.8	1.0	3.0	1.8
6-10	3.8	6.1	2.0	1.6	5.8	7.7
11-15	8.9	27.1	2.9	2.7	11.8	29.8
16-20	18.6	31.1	3.2	4.0	21.7	35.1
21-25	18.5	33.2	4.8	5.9	23.3	39.1
26-30	19.4	28.1	6.8	6.8	26.2	34.9
31-35	18.1	28.6	8.9	6.5	27.0	35.1
36-40	18.8	25.9	13.6	9.8	32.3	35.7
41-45	21.2	29.7	23.1	13.0	44.3	42.7
46-50	23.1	21.0	30.5	16.5	53.6	37.5
51-55	23.0	25.7	29.8	30.6	52.9	56.2
56-60	20.2	17.6	33.4	23.6	53.6	41.2
61-65	16.2	21.0	33.5	33.0	49.7	54.0
66-70	15.6	16.7	26.4	36.1	42.0	52.8
71-75	12.9	11.1	28.1	34.1	41.0	45.3
76-80	8.0	18.7	13.6	39.4	21.6	58.0
81-85	3.6	15.9	5.2	26.5	8.8	42.4
86-90	2.2	8.3	5.5	20.9	7.7	29.2
91-95	0.9	6.9	3.3	10.3	4.2	17.1
96-100	1.1	3.0	1.2	3.0	2.3	6.1
100+	0.3	2.3	2.2	2.7	2.4	5.0
Total	**255.5**	**378.8**	**279.7**	**327.9**	**535.2**	**706.7**

Source: USDA - US Forest Service

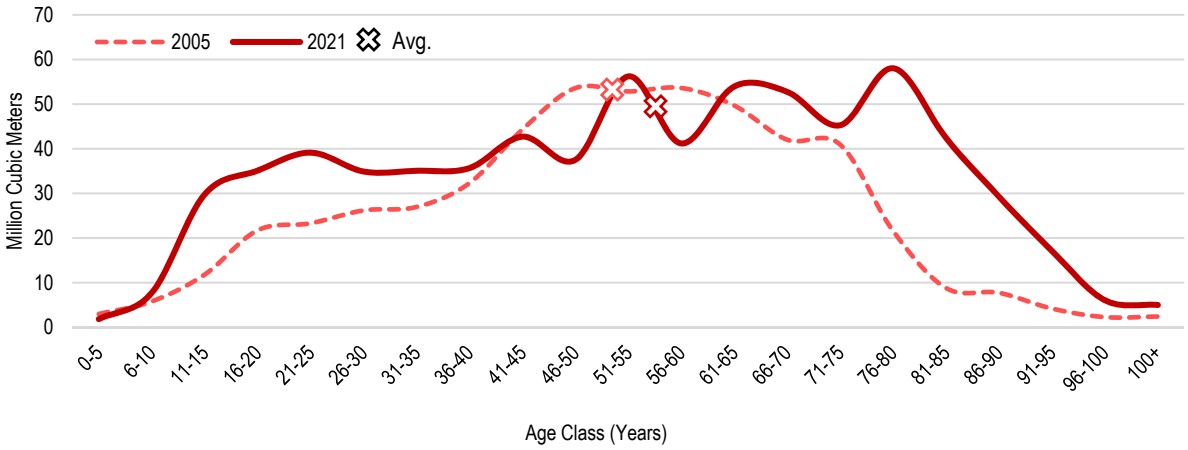
***Figure 15**. AR Cluster Catchment Area - Timber Inventory by Major Species Group & Age Class (2005 & 2021)*



(a) Softwood Growing Stock Inventory



(b) Hardwood Growing Stock Inventory



(c) Total Growing Stock Inventory

3.2.1.4 Timber Inventory by Stand Origin

US Forest Service data includes two classifications for stand origin: 1) naturally regenerated timber stands and 2) planted timber stands. Specifically, *naturally regenerated* timber stands are defined by the USFS as those that have been established naturally. A *planted* timber stand is defined as an artificially regenerated stand established by planting or artificial seedling.

Based on the most current US Forest Service FIA estimates, approximately 78% of total growing stock volume in the catchment area, or 552 million m^3, is naturally regenerated timber, compared to 22% (155 million m^3) planted. However, stand origin distribution varies widely by major species group.

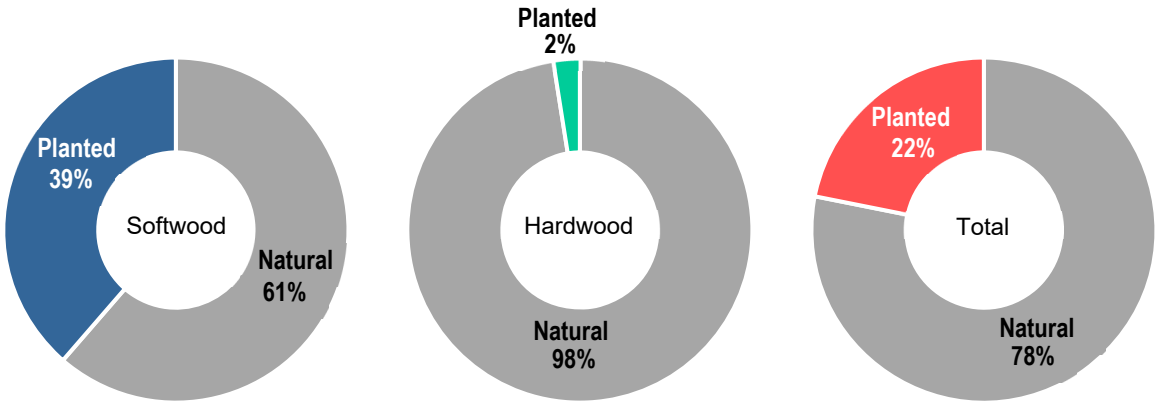
US Forest Service data shows approximately 61% (233 million m^3) of softwood growing stock inventory is naturally regenerated versus 39% (146 million m^3) planted. In contrast, approximately 98% (320 million m^3) of hardwood inventory is naturally regenerated, compared to 2% (8 million m^3) planted.

***Table 16**. AR Cluster Catchment Area - Growing Stock Volume on Timberland by Stand Origin & Major Species (2021)*

Stand Origin	*Softwood* Volume (Million m^3)	*Softwood* Distribution	*Hardwood* Volume (Million m^3)	*Hardwood* Distribution	*Total* Volume (Million m^3)	*Total* Distribution
Naturally Regenerated	232.5	61%	319.8	98%	552.2	78%
Planted	146.3	39%	8.2	2%	154.5	22%
Total	**378.8**	**100%**	**327.9**	**100%**	**706.7**	**100%**

Source: USDA - US Forest Service

***Figure 16**. AR Cluster Catchment Area - Distribution of Growing Stock Volume on Timberland by Stand Origin & Major Species (2021)*



3.2.2 *Timber Growth*

Timber growth data for the AR Satellite Plant catchment area was also provided by the US Forest Service - Forest Inventory & Analysis (FIA) program. According to US Forest Service estimates, net annual growth of growing stock timber in the catchment area totaled an estimated 33.7 million m^3 in 2021, the latest available. Specifically, 76% (25.7 million m^3) of total growth was attributed to softwood species compared to 24% (8.0 million m^3) hardwood species.

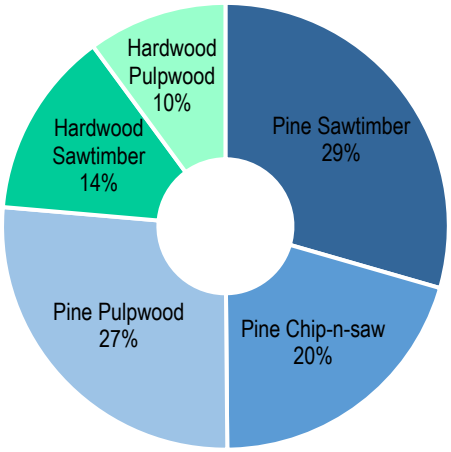
Annual growth was highest for pine sawtimber, which totaled 9.9 million m^3 and accounted for 29% of total volume growth, followed by pine pulpwood at 8.9 million m^3 (27%), pine chip-n-saw at 6.9 million m^3 (20%), hardwood sawtimber at 4.6 million m^3 (14%), and hardwood pulpwood at 3.4 million m^3 (10%).

***Table 17**. AR Cluster Catchment Area - Net Growth of Growing Stock Timber by Major Timber Product (2021)*

Product	Volume Growth (Million m^3)	% of Total Growth
Pine Sawtimber	9.9	29%
Pine Chip-n-saw	6.9	20%
Pine Pulpwood	8.9	27%
Hardwood Sawtimber	4.6	14%
Hardwood Pulpwood	3.4	10%
Total	**33.7**	**100%**

Source: USDA - US Forest Service

***Figure 17**. AR Cluster Catchment Area – Distribution of Annual Timber Growth by Major Timber Product (2021)*



According to FIA data, net annual growth of growing stock timber held relatively steady and averaged 26.1 million m^3 from 2009-2017 before increasing 29% over the four years that followed to 33.7 million m^3 in 2021, or an overall increase of 7.7 million m^3 (+30%) from 2009-2021.

Table 18 below (as well as Figures 18 and 19 on the following page) provides a breakdown of annual timber growth by major timber product from 2009 through 2021. Note that annual growth of softwood timber increased 44%, with pine sawtimber, pine chip-n-saw, and pine pulpwood increasing 40%, 51%, and 44%, respectively, from 2009-2021. Annual growth of hardwood sawtimber increased 4% over this period. However, annual growth of hardwood pulpwood decreased 8% from 2009-2021. This was due primarily to hardwood trees moving up in classification from hardwood pulpwood to hardwood sawtimber.

***Table 18**. AR Cluster Catchment Area - Annual Growth by Major Timber Product (2009-2021)*

Year	*Softwood*			*Hardwood*		Total
	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	
			(Million Cubic Meters)			
2009	7.1	4.5	6.2	4.4	3.7	25.9
2010	7.5	4.8	6.3	4.4	3.7	26.6
2011	7.7	4.9	6.9	4.0	3.5	27.1
2012	7.7	5.0	7.0	3.9	3.3	26.9
2013	7.7	5.1	7.1	3.4	3.1	26.4
2014	7.6	5.2	7.3	3.2	3.1	26.4
2015	7.2	5.2	7.4	2.7	2.9	25.3
2016	7.2	5.3	7.2	2.5	2.7	24.9
2017	7.3	5.5	7.5	2.5	2.6	25.5
2018	7.8	5.9	7.8	2.9	2.8	27.1
2019	8.4	6.2	8.2	3.4	2.9	29.1
2020	9.0	6.4	8.6	4.0	3.1	31.1
2021	9.9	6.9	8.9	4.6	3.4	33.7

Source: USDA-US Forest Service

***Figure 18**. AR Cluster Catchment Area - Net Annual Growth of Growing Stock Timber on Timberland (2009-2021)*

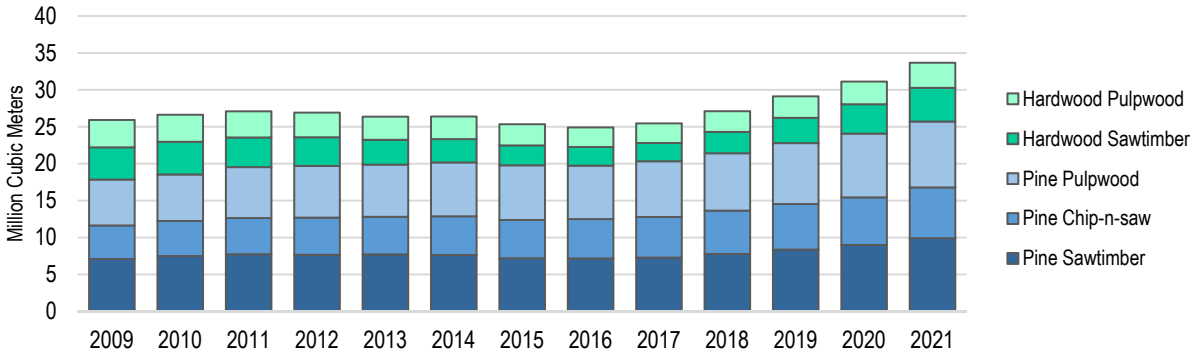
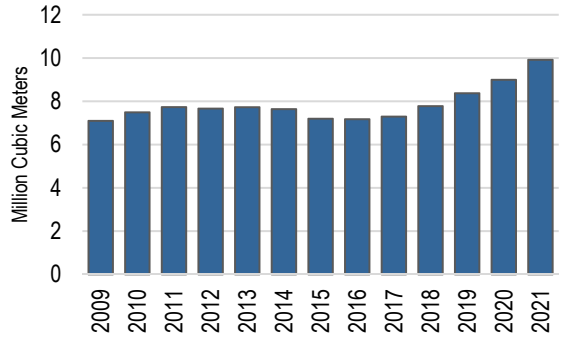
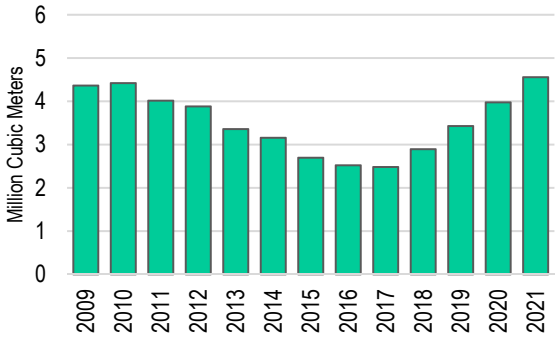


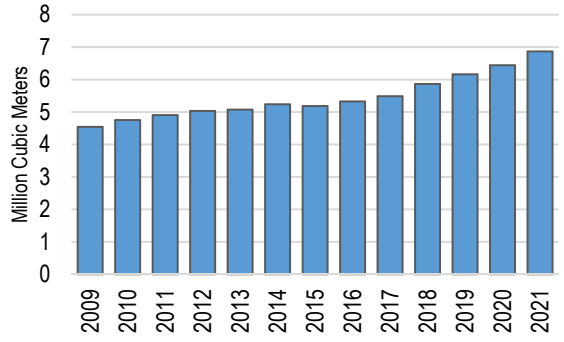
***Figure 19**. AR Cluster Catchment Area - Net Annual Growth by Major Timber Product (2009-2021)*



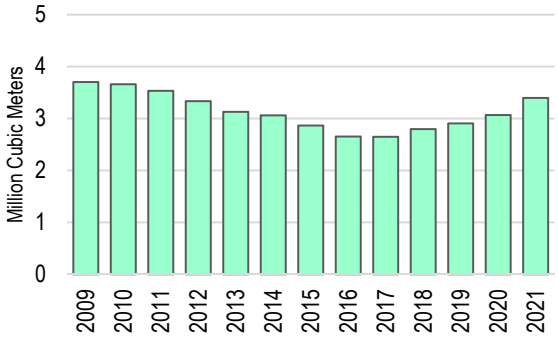
(a) Pine Sawtimber



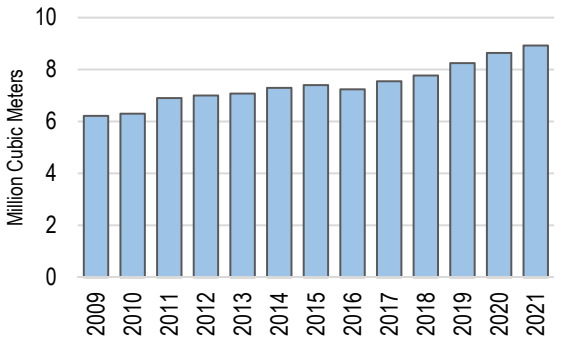
(d) Hardwood Sawtimber



(b) Pine Chip-n-saw



(e) Hardwood Pulpwood



(c) Pine Pulpwood

3.2.2.1 Annual Timber Growth Rate & Per Hectare Growth

According to USFS data, the annual growth rate of timber in the catchment area averaged 4.7% from 2009-2011 before falling to 3.9% in 2016. Since 2016, the average growth rate of timber has steady risen, increasing to 4.8% in 2021. Specifically, the average annual growth rate of pine pulpwood, the primary roundwood timber product consumed by the bioenergy sector, averaged 11.9% per year from 2009-2019 before increasing to 12.5% in 2021. See Table 19 below for details.

Furthermore, average per-hectare volume growth in the AR Cluster catchment area averaged 5.02 m^3 per year from 2009-2018. However, since 2018, average per-hectare growth has increased an average of 8% per year and to 6.43 m^3 in 2021. In terms of individual timber products, combined per-hectare growth of pine sawtimber and chip-n-saw increased 43% from 2009-2021 while pine pulpwood per-hectare growth increased 42% over this period (see Table 20 on the following page).

Ultimately, this data suggests that the catchment area forest, overall, has become more productive. However, it also shows that young softwood (pine) forests in the catchment area have recently transitioned, with each of the major pine products now in the lower range of their respective diameter class range.

***Table 19**. AR Cluster Catchment Area - Average Annual Growth Rate by Major Timber Product (2009-2021)*

	Softwood			*Hardwood*		
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
			Annual Growth Rate (%)			
2009	4.7%	7.4%	12.1%	2.2%	3.8%	4.7%
2010	4.8%	7.5%	12.0%	2.2%	3.7%	4.7%
2011	4.8%	7.5%	12.3%	2.0%	3.6%	4.7%
2012	4.6%	7.5%	12.0%	1.9%	3.4%	4.5%
2013	4.4%	7.3%	11.7%	1.7%	3.2%	4.3%
2014	4.3%	7.3%	12.0%	1.6%	3.1%	4.3%
2015	4.0%	7.1%	11.9%	1.3%	2.9%	4.1%
2016	3.8%	7.0%	11.5%	1.2%	2.7%	3.9%
2017	3.8%	7.1%	11.6%	1.2%	2.7%	4.0%
2018	3.9%	7.2%	11.6%	1.4%	2.8%	4.1%
2019	4.0%	7.5%	11.8%	1.6%	2.9%	4.3%
2020	4.2%	7.7%	12.1%	1.8%	3.1%	4.5%
2021	4.5%	8.0%	12.5%	2.0%	3.4%	4.8%

Source: USDA - US Forest Service

***Table 20**. AR Cluster Catchment Area - Average Per-Hectare Volume Growth by Major Timber Product (2009-2021)*

Year	Softwood			Hardwood		
	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
	(Cubic Meters/Hectare/Year)					
2009	1.37	0.88	1.20	0.84	0.72	5.01
2010	1.44	0.92	1.21	0.85	0.71	5.13
2011	1.49	0.95	1.33	0.77	0.68	5.22
2012	1.47	0.96	1.34	0.74	0.64	5.15
2013	1.48	0.97	1.35	0.64	0.60	5.04
2014	1.45	1.00	1.39	0.60	0.58	5.02
2015	1.37	0.99	1.41	0.51	0.55	4.82
2016	1.37	1.02	1.38	0.48	0.51	4.75
2017	1.39	1.05	1.44	0.47	0.51	4.86
2018	1.48	1.12	1.48	0.55	0.53	5.17
2019	1.60	1.18	1.57	0.65	0.55	5.55
2020	1.72	1.23	1.65	0.76	0.59	5.94
2021	1.89	1.31	1.70	0.87	0.65	6.43

Source: USDA - US Forest Service

***Figure 20**. AR Cluster Catchment Area – Average Timber Growth Rate & Total Per-Hectare Volume Growth (2009-2021)*

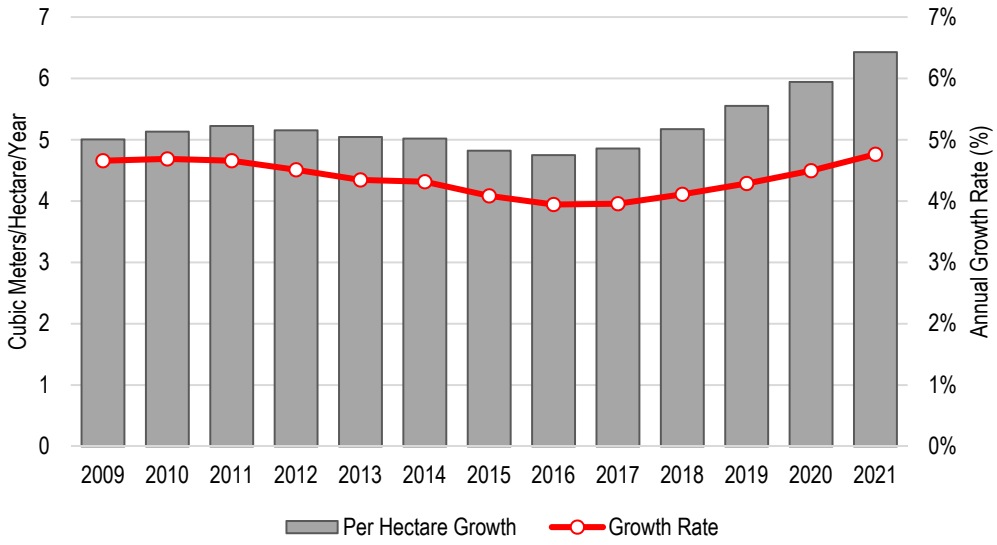
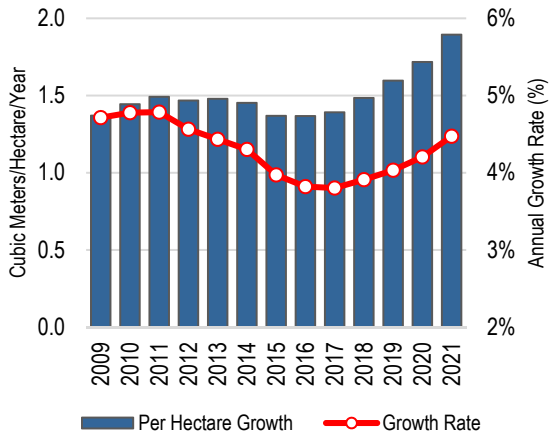
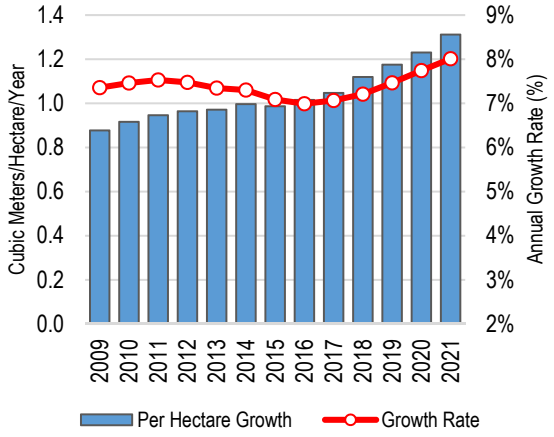


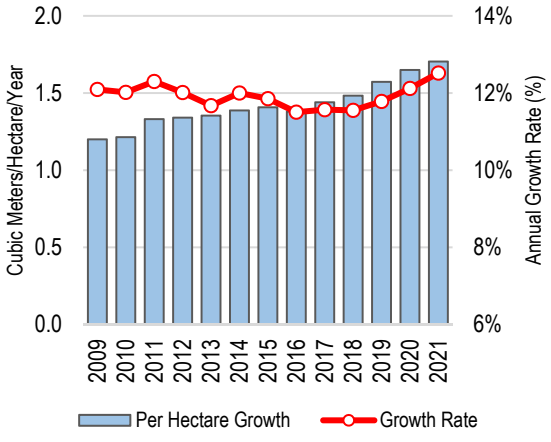
***Figure 21**. AR Cluster Catchment Area - Annual Growth Rates & Per-Hectare Growth by Major Timber Product (2009-2021)*



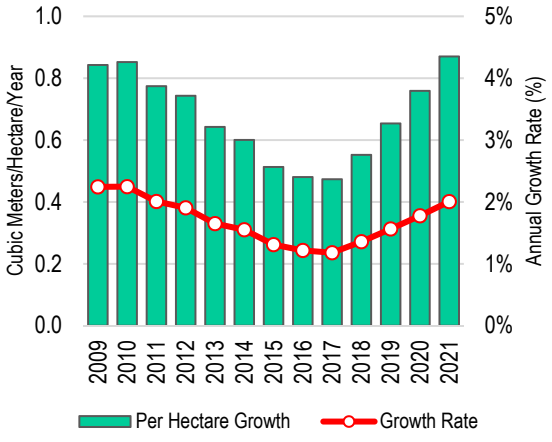
(a) Pine Sawtimber



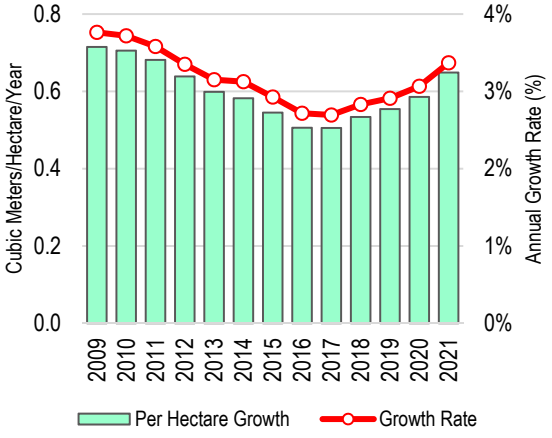
(b) Pine Chip-n-saw



(c) Pine Pulpwood



(d) Hardwood Sawtimber



(e) Hardwood Pulpwood

3.2.3 *Timber Removals*

According to the USFS, timber removals in the catchment area totaled 19.2 million m^3 in 2021, of which approximately 82% (15.7 million m^3) was softwood timber and 18% (3.5 million m^3) was hardwood timber.

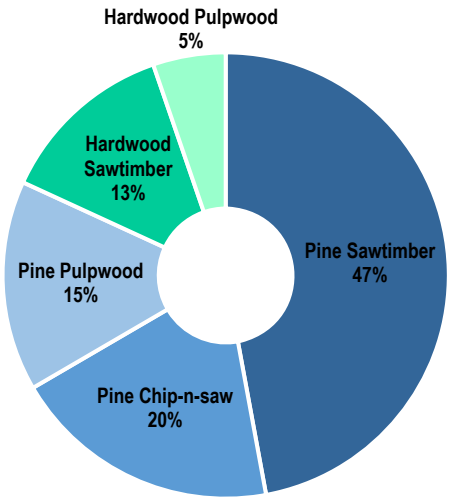
Of the five major timber products, removals were highest for pine sawtimber, which totaled 9.0 million m^3 and accounted for 47% of total removals, followed by pine chip-n-saw at 3.7 million m^3 (20%), pine pulpwood at 2.9 million m^3 (15%), hardwood sawtimber at 2.5 million m^3 (13%), and hardwood pulpwood at 1.0 million m^3 (5%).

***Table 21**. AR Cluster Catchment Area - Timber Removals by Major Timber Product (2021)*

Product	Removals (Million m^3)	% of Total Removals
Pine Sawtimber	9.0	47%
Pine Chip-n-saw	3.7	20%
Pine Pulpwood	2.9	15%
Hardwood Sawtimber	2.5	13%
Hardwood Pulpwood	1.0	5%
Total	**19.2**	**100%**

Source: USDA - US Forest Service

***Figure 22**. AR Cluster Catchment Area – Distribution of Timber Removals by Major Timber Product (2021)*



According to the US Forest Service, annual removals of growing stock timber averaged 19.6million m^3 per year from 2005-2010 before declining to 15.2 million m^3 in 2015. However, total removals steadily increased over the six years that followed and to 19.2 million m^3 in 2021, which was down 4% compared to 2005 levels.

Table 22 below provides a breakdown of annual removal estimates by major timber product in the AR Cluster catchment area from 2005 through 2021. Combined annual removals of pine sawtimber and pine chip-n-saw (i.e. softwood sawlogs) averaged 11.5 million m^3 per year from 2005-2011 before declining to 9.5 million m^3 in 2014. Softwood sawlog removals have steadily increased since, increasing 35% and to 12.8 million m^3 in 2021.

Annual removals of pine pulpwood (the primary roundwood timber product consumed by the bioenergy sector) declined from 3.0 million m^3 in 2005 to less than 2.1 million m^3 in 2014. However, pine pulpwood removals have increased 40% since and to 2.9 million m^3 in 2021.

***Table 22**. AR Cluster Catchment Area - Annual Removals by Major Timber Product (2005-2021)*

Year	*Softwood*			*Hardwood*		Total
	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	
			(Million Cubic Meters)			
2005	8.2	3.1	3.0	3.7	2.0	19.9
2006	8.3	3.1	2.9	3.6	2.0	19.8
2007	8.5	3.1	2.9	3.4	2.1	19.7
2008	8.6	3.1	2.8	3.2	2.1	19.6
2009	8.7	3.1	2.7	3.1	2.2	19.4
2010	8.3	3.0	2.6	3.4	2.1	19.3
2011	8.0	3.1	2.5	3.2	2.0	18.5
2012	7.6	3.0	2.3	3.2	1.7	17.8
2013	7.1	2.8	2.1	2.8	1.5	15.7
2014	6.9	2.6	2.1	3.0	1.5	15.9
2015	7.0	2.7	2.2	2.5	1.4	15.2
2016	6.9	2.8	2.4	2.6	1.2	15.9
2017	7.6	3.0	2.5	2.4	1.2	16.3
2018	8.3	3.0	2.5	2.6	1.2	17.5
2019	7.9	3.2	2.4	2.0	1.0	16.1
2020	8.1	3.5	2.8	2.2	0.9	17.5
2021	9.0	3.7	2.9	2.5	1.0	19.2

Source: USDA - US Forest Service

***Figure 23**. AR Cluster Catchment Area - Annual Removals by Year (2005-2021)*

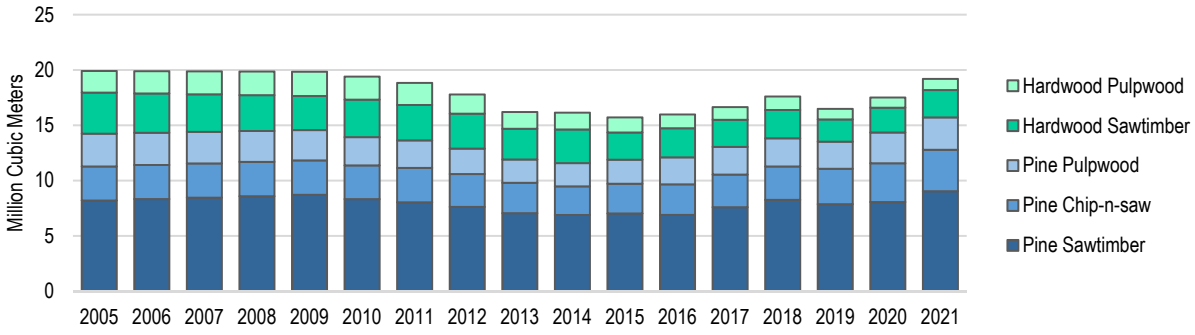
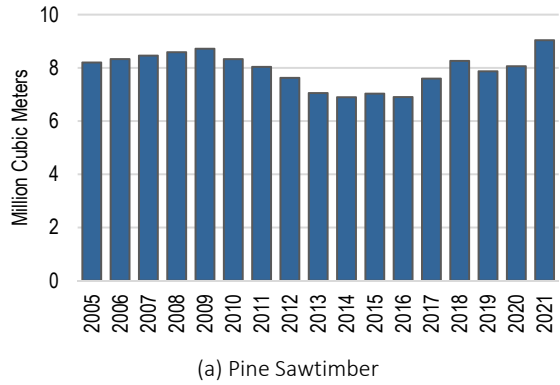
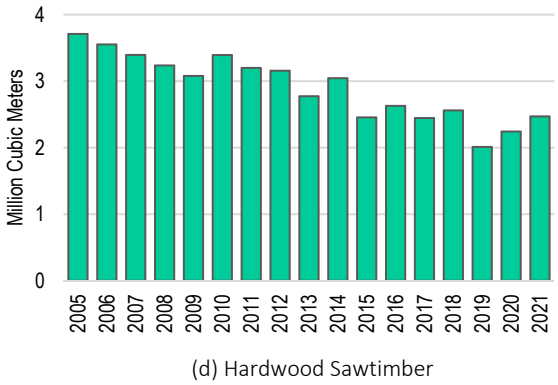


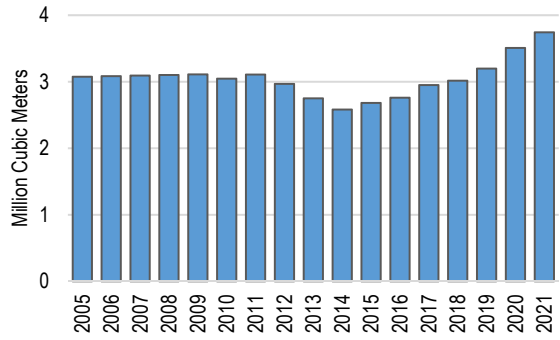
***Figure 24**. AR Cluster Catchment Area - Annual Removals by Major Timber Product (2005-2021)*



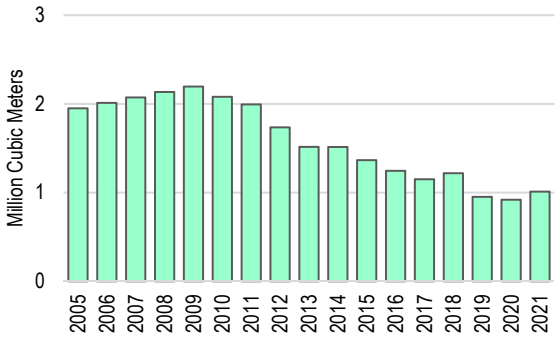
(a) Pine Sawtimber



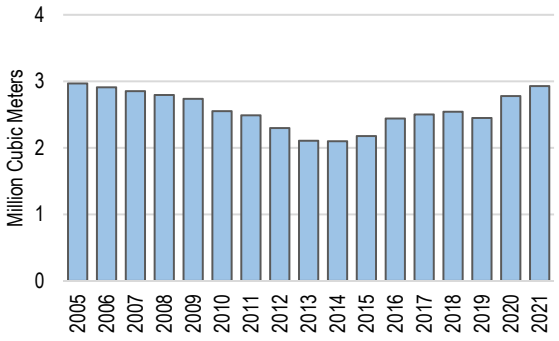
(d) Hardwood Sawtimber



(b) Pine Chip-n-saw



(e) Hardwood Pulpwood



(c) Pine Pulpwood

3.3 Timber Growth-to-Drain

Growth-to-removals analysis compares annual timber growth to annual harvests and provides a measure of market demand relative to supply. A growth-to-removals ratio of 1.0 indicates a balanced market where growth equals removals. A value of >1 indicates growth exceeds removals, signifying sustainable harvest levels (as well as oversupply). A value of <1 indicates removals (or harvest levels) exceed growth, signifying more highly competitive market conditions and harvest levels that are unsustainable over the long term.

According to US Forest Service data from 2021, the latest available, overall inventory growth totaled 33.7 million m^3, compared to total removals of 19.2 million m^3, or a growth-to-removals ratio of 1.75. The growth-to-removal ratio for softwood species was 1.64 versus 2.28 for hardwood species.

Growth-to-removals ratios by species and individual timber product in 2021 were as follows: pine sawtimber=1.10, pine chip-n-saw=1.83, pine pulpwood=3.05, hardwood sawtimber=1.84, and hardwood pulpwood=3.36. Note that growth-to-removals ratios for all five major products were above 1.0, indicating sustainable market conditions as well as oversupply.

***Table 23**. AR Cluster Catchment Area - Annual Growth, Removals, & Growth-to-Removal Ratios by Major Timber Product (2021)*

Softwood (Pine)	Growth (million m^3)	Removals (million m^3)	G:R Ratio
Pine Sawtimber	9.9	9.0	1.10
Pine Chip-n-saw	6.9	3.7	1.83
Pine Pulpwood	8.9	2.9	3.05
Softwood (Pine) Total	**25.7**	**15.7**	**1.64**

Hardwood	Growth (million m^3)	Removals (million m^3)	G:R Ratio
Hardwood Sawtimber	4.6	2.5	1.84
Hardwood Pulpwood	3.4	1.0	3.36
Hardwood Total	**8.0**	**3.5**	**2.28**

Product	Growth (million m^3)	Removals (million m^3)	G:R Ratio
Sawtimber	21.3	15.3	1.40
Pulpwood	12.3	3.9	3.13
Total	**33.7**	**19.2**	**1.75**

Source: USDA - US Forest Service

In terms of historical context, according to US Forest Service data, the growth-to-removals (G:R) ratio for pine pulpwood, the primary bioenergy feedstock, remained well above 1.0 in the catchment area from 2009-2021, indicating that harvest levels remained below the sustainable yield capacity of the forest area over this period. Specifically, pine pulpwood G:R ratio increased from 2.27 in 2009 to 3.05 in 2021.

Note that unsustainable harvest levels persisted in the catchment area for pine sawtimber from 2009-2011 and again from 2017-2018. However, this apparent unsustainability is due to product classification. When you consider combined pine sawtimber and chip-n-saw (i.e. pine sawlogs), the G:R ratio has remained above 1.0 since 2010 and totaled 1.31 in 2021.

***Table 24**. AR Cluster Catchment Area – Growth-to-Removals Ratios (2009-2021)*

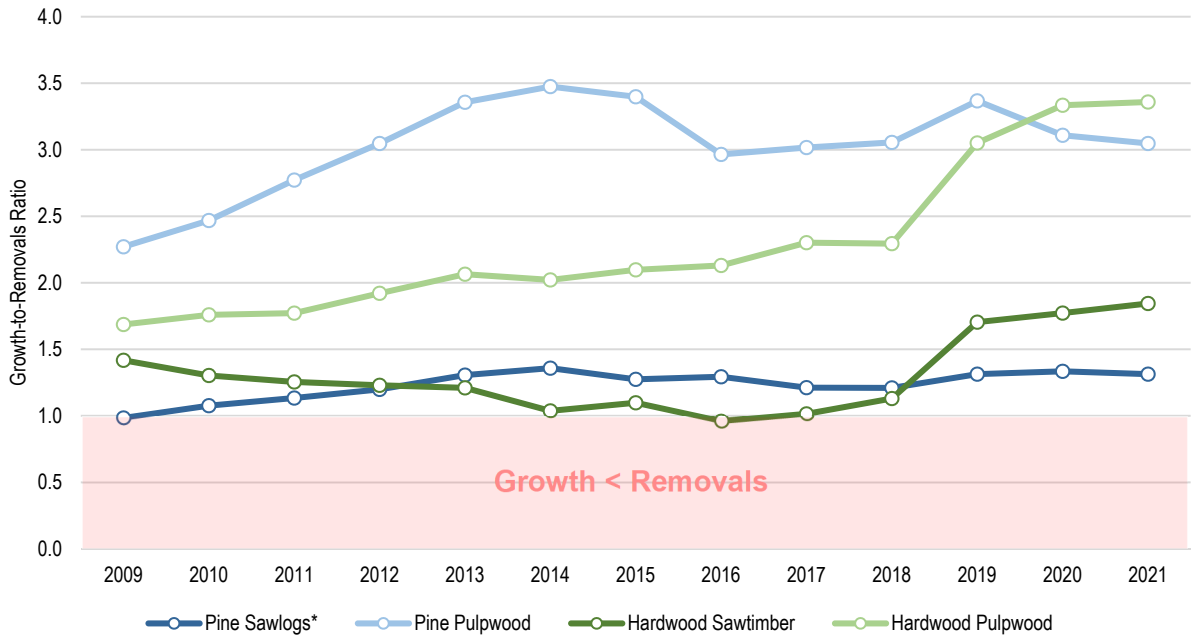
	Softwood			*Hardwood*		
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
			(Growth-to-Removals Ratio)			
2009	0.81	1.46	2.27	1.42	1.69	1.33
2010	0.90	1.56	2.47	1.30	1.76	1.38
2011	0.96	1.58	2.77	1.25	1.77	1.46
2012	1.01	1.70	3.05	1.23	1.92	1.52
2013	1.10	1.85	3.36	1.21	2.06	1.67
2014	1.11	2.03	3.47	1.04	2.02	1.66
2015	1.02	1.93	3.40	1.10	2.10	1.67
2016	1.04	1.93	2.97	0.96	2.13	1.57
2017	0.96	1.86	3.02	1.01	2.30	1.57
2018	0.94	1.94	3.06	1.13	2.29	1.55
2019	1.06	1.93	3.37	1.70	3.05	1.81
2020	1.12	1.84	3.11	1.77	3.33	1.78
2021	1.10	1.83	3.05	1.84	3.36	1.75

Source: USDA - US Forest Service

Figure 25 below shows growth-to-removals ratios in the catchment area for the major timber products from 2009-2021. As this figure shows (and was noted on the previous page), the pine pulpwood G:R ratio increase from 2.27 in 2009 to 3.05 in 2021. Note that the overall increase in the pine pulpwood G:R ratio from 2009 to 2021 can ultimately be linked to increased growth attributed to increases in pine timberland.

Also note that increases in the pine pulpwood G:R ratio since the mid-2010s is also due in part to increases in softwood lumber production. Specifically, according to USDA-TPO data, softwood lumber production increased roughly 40% in the catchment area from 2015-2021. This increase in production resulted in an increase in sawmill residual production, and, as a result, pine pulpwood removals have also decreased – leading to an increase in the pine pulpwood G:R ratio.

***Figure 25**. AR Cluster Catchment Area – Growth-to-Removals Ratios by Major Timber Product (2009-2021)*



*Pine sawlogs includes pine sawtimber and pine chip-n-saw.

3.4 Certified Forests

The primary forest certification organizations used by landowners in Arkansas include the Forest Stewardship Council (FSC), the Sustainable Forestry Initiative (SFI), and the American Tree Farm System (ATFS). County-level property records, FSC and SFI-certified landowner lists, and ATFS-enrollment data was examined to quantify the total amount of certified forest located within the AR Cluster catchment area.

According to Hood Consulting research, the total area of certified forest in the AR Cluster catchment area was estimated at 1,440,000 to 1,480,000 hectares as of 2nd Quarter 2023. This represents approximately 27-28% of total catchment area timberland and approximately 34-35% of privately-owned timberland in the catchment area.

Timberland	Hectares	% of Total
Certified forest	1,461,886	28%
Non-certified forest	3,775,016	72%
Total	5,236,902	100%

3.5 Federal Cost-Share Program Enrollment

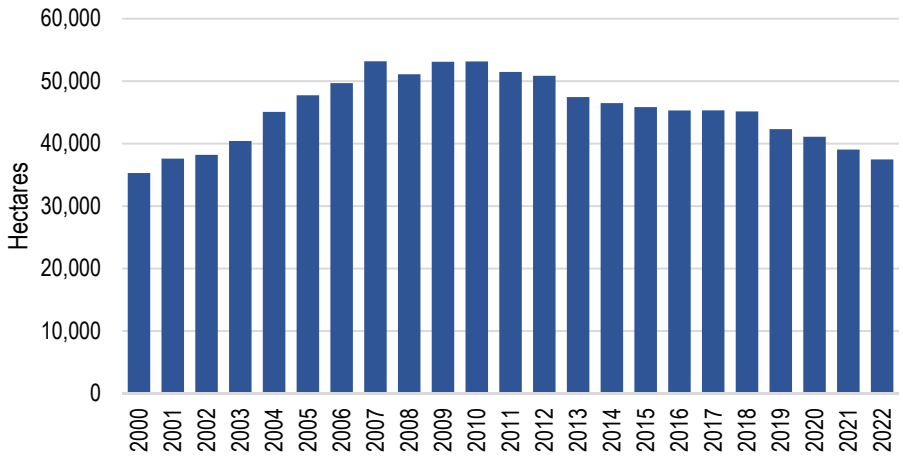
Federal cost-share programs offered to landowners in the US and applicable to forestland ownership include the Conservation Reserve Program (CRP), the Wetland Reserve Program (WRP), and the Environmental Quality Incentives Program (EQIP).

- The Conservation Reserve Program (CRP) is a voluntary program for agricultural landowners. Through CRP, you can receive annual rental payments and cost-share assistance to establish long-term, resource conserving covers on eligible farmland. The Commodity Credit Corporation (CCC) makes annual rental payments based on the agriculture rental value of the land, and it provides cost-share assistance for up to 50% of the participant's costs in establishing approved conservation practices. Participants enroll in CRP contracts for 10 to 15 years. CRP protects millions of hectares of American topsoil from erosion and is designed to safeguard the Nation's natural resources. By reducing water runoff and sedimentation, CRP protects groundwater and helps improve the condition of lakes, rivers, ponds, and streams. Land enrolled in the CRP is planted to resource-conserving vegetative covers, making the program a major contributor to increased wildlife populations in many parts of the country.
- The Wetland Reserve Program (WRP) is a voluntary program that provides technical and financial assistance to eligible landowners to address wetland, wildlife habitat, soil, water, and related natural resource concerns on private lands. The program provides an opportunity for landowners to receive financial incentives to enhance wetlands in exchange for retiring marginal land from agriculture.
- The Environmental Quality Incentives Program (EQIP) is a voluntary conservation program that offers farmers and ranchers financial cost-share and technical assistance to implement

conservation practices on working agricultural land. EQIP participants install or implement structural, vegetative, and management practices – like improving irrigation efficiency, restoring pasture, or nutrient and pest management – on eligible agricultural land and nonindustrial private forestland. In return, USDA's Natural Resources Conservation Service (NRCS) provides financial cost-share assistance and technical assistance through a contractual agreement.

The figure below detail CRP enrollment for the AR Cluster catchment area since 2000 (WRP and EQIP enrollment data is not available at the county level). According to the USDA, catchment area enrollment in CRP totaled approximately 35,300 hectares in 2000, increasing to 53,180 hectares in 2007. Since 2007, the total number of hectares enrolled in CRP has steadily declined, falling to 37,470 hectares in 2022. Over this 22-year period, CRP enrollment in the catchment area averaged 45,320 hectares annually.

***Figure 26**. AR Cluster Catchment Area – CRP Enrollment (2000-2022)*



4. Forest Carbon, Forest Health, & Forest Threats

The following section provides details related to forest carbon and forest certification. Specifically, this section utilizes data provided by the US Forest Service to detail current and historic forest carbon levels as well as provide a high-carbon forest assessment. Additionally, this section includes a summary of forest health and threats identified by the Arkansas Forestry Commission in its most current Forest Action Plan.

4.1 Forest Carbon Inventory

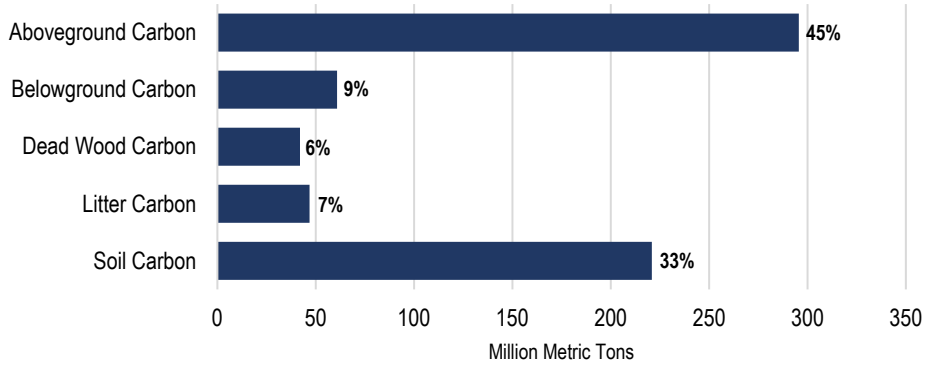
According to the USFS, forest carbon in the AR Cluster catchment area totals an estimated 666 million metric tons, of which 296 million metric tons (45%) is aboveground carbon, 61 million metric tons (9%) is belowground carbon, 42 million metric tons (6%) is dead wood carbon, 47 million metric tons (7%) is litter carbon, and 221 million metric tons (33%) is soil carbon.

***Table 25**. AR Cluster Catchment Area – Forest Carbon Inventory by Category (2021)*

Category	Carbon (Metric Tons)	% of Total
Aboveground Carbon:		
Live Trees	281,119,695	42%
Live Seedlings, Shrubs & Brushes	14,487,157	2%
Aboveground Carbon Total	295,606,852	45%
Belowground Carbon:		
Live Trees	59,240,921	9%
Live Seedlings, Shrubs & Brushes	1,609,688	0%
Belowground Carbon Total	60,850,609	9%
Dead Wood Carbon	41,999,675	6%
Litter Carbon	46,854,178	7%
Soil Carbon	220,876,823	33%
Total Carbon	**666,188,138**	**100%**

Source: USDA - US Forest Service

***Figure 27**. AR Cluster Catchment Area –Forest Carbon Inventory by Category (2021)*



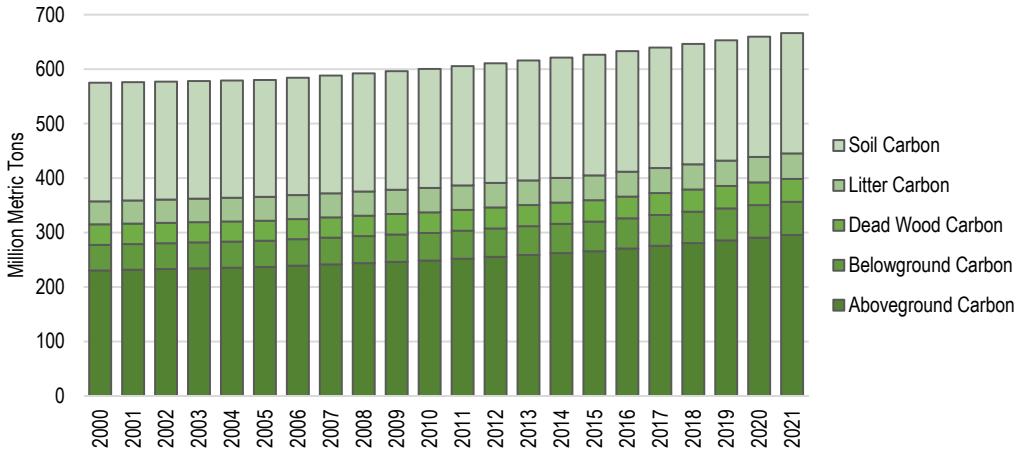
According to the US Forest Service, total forest carbon in the AR Cluster catchment area experienced a net increase of 91 million metric tons (+16%) from 2000 to 2021, increasing from 575 to 666 million metric tons over this period. In particular, aboveground carbon increased 65 million metric tons (+28%) and belowground carbon increased 14 million metric tons (+30%) from 2000-2021. Over this same period, dead wood carbon increased 4 million metric tons (+11%), litter carbon increased 5 million metric tons (+11%), and soil carbon increased 3 million metric tons (+1%).

***Table 26**. AR Cluster Catchment Area – Forest Carbon Inventory (2000-2021)*

Year	Aboveground Carbon	Belowground Carbon	Dead Wood Carbon	Litter Carbon	Soil Carbon	Total Carbon
			(Million Metric Tons)			
2000	230.4	46.9	37.8	42.1	217.8	575.1
2001	231.7	47.2	37.6	42.5	217.2	576.1
2002	233.0	47.4	37.4	42.8	216.5	577.1
2003	234.3	47.7	37.2	43.2	215.9	578.1
2004	235.6	47.9	36.9	43.5	215.2	579.1
2005	236.8	48.2	36.7	43.9	214.6	580.2
2006	239.2	48.6	37.0	44.0	215.4	584.2
2007	241.5	49.1	37.2	44.2	216.1	588.2
2008	243.9	49.6	37.5	44.4	216.9	592.3
2009	246.2	50.1	37.7	44.6	217.7	596.3
2010	248.6	50.6	38.0	44.8	218.4	600.4
2011	252.0	51.4	38.2	44.9	219.0	605.6
2012	255.4	52.1	38.5	45.0	219.7	610.8
2013	258.9	52.9	38.8	45.2	220.3	616.0
2014	262.3	53.6	39.1	45.3	220.9	621.2
2015	265.7	54.4	39.3	45.5	221.5	626.4
2016	270.7	55.5	39.8	45.7	221.4	633.1
2017	275.7	56.6	40.3	46.0	221.2	639.7
2018	280.7	57.6	40.8	46.2	221.0	646.3
2019	285.6	58.7	41.3	46.5	220.9	653.0
2020	290.6	59.8	41.7	46.7	220.7	659.6
2021	295.6	60.9	42.0	46.9	220.9	666.2

Source: USDA - US Forest Service

***Figure 28**. AR Cluster Catchment Area – Forest Carbon by Category (2000-2021)*



4.2 High-Carbon Forest Assessment

Forest carbon levels were examined further to identify whether any specific counties within the AR Cluster catchment area are considered to have "high-carbon" forests. Specifically, the table below identifies average per-hectare forest carbon volume for each catchment area county as well as each county's catchment area rank (percentile based on a comparison of AR Cluster catchment area counties only), state rank (percentile based on a comparison of Arkansas counties only), and South-wide rank (percentile based on a comparison of all US South counties). Note that, with this assessment, those counties with a South-wide Rank of 0.90 and higher are identified as having "high carbon" forests.

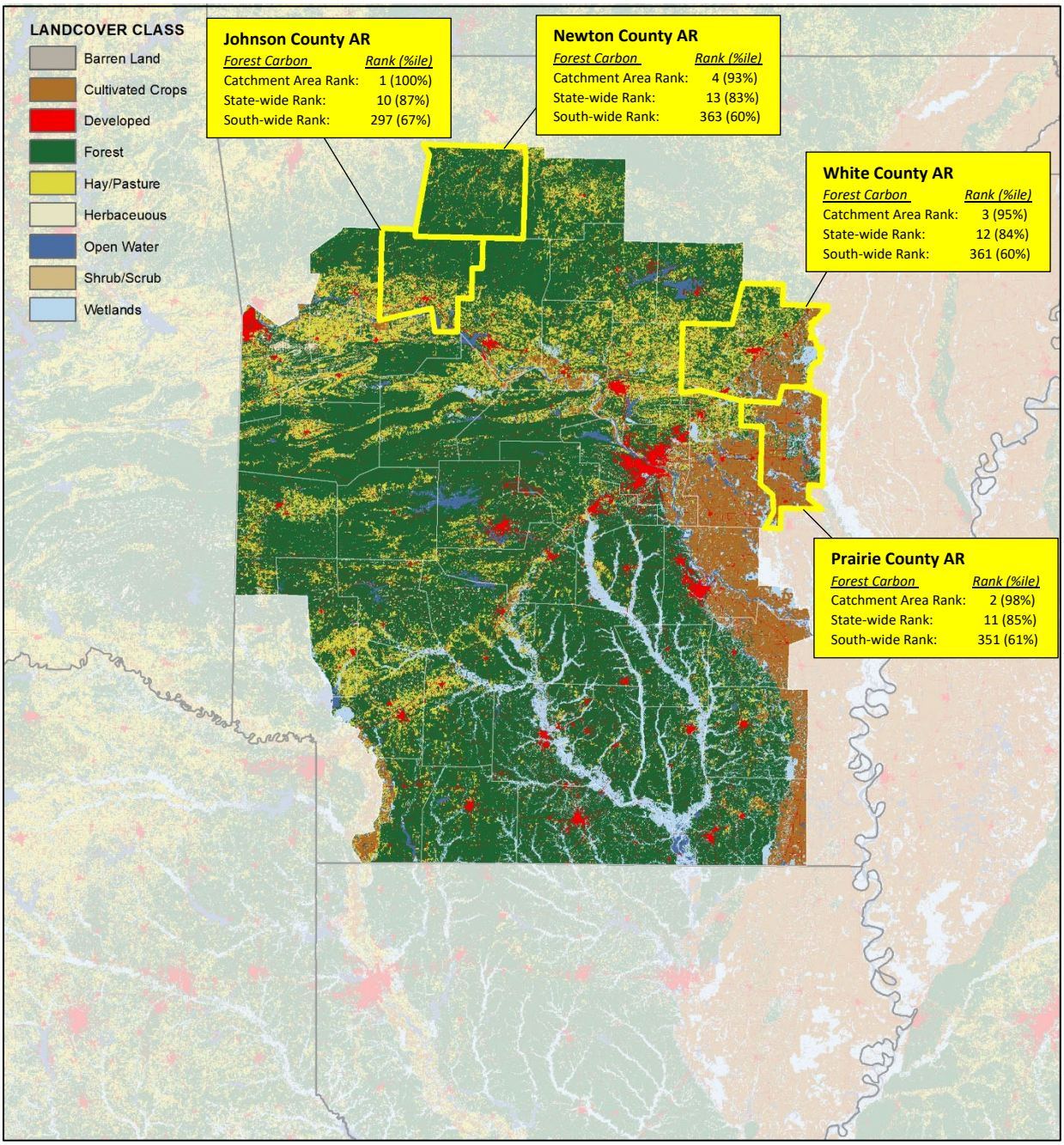
In the Arkansas Cluster catchment area, no counties were identified as having "high carbon" forests. However, Johnson, Newton, Prairie, and White Counties are the highest-ranking counties in the catchment area (see Figure 29). All four of these counties are ranked in the 60th percentile or higher on a South-wide basis and in the 80th percentile or higher on a state-wide basis.

***Table 27**. AR Cluster Catchment Area – High-Carbon Forest Rank by County*

State	County	Forest Carbon (Metric Tons/Hectare)	Catchment Area Rank (Percentile)	State Rank (Percentile)	South-wide Rank (Percentile)
AR	Ashley	152.7	7%	4%	13%
AR	Bradley	152.1	5%	3%	12%
AR	Calhoun	172.8	61%	49%	38%
AR	Clark	161.5	24%	16%	22%
AR	Cleburne	175.6	68%	56%	42%
AR	Cleveland	166.7	41%	30%	29%
AR	Columbia	157.5	20%	12%	18%
AR	Conway	156.9	17%	10%	17%
AR	Dallas	162.6	29%	19%	24%
AR	Drew	158.5	22%	14%	19%
AR	Faulkner	166.8	44%	32%	29%
AR	Franklin	187.7	85%	77%	57%
AR	Garland	177.2	73%	62%	44%
AR	Grant	167.1	46%	33%	30%
AR	Hempstead	168.4	54%	38%	32%
AR	Hot Spring	162.7	32%	22%	24%
AR	Howard	149.1	0%	0%	9%
AR	Jefferson	161.7	27%	18%	23%
AR	Johnson	196.2	98%	86%	67%
AR	Lafayette	169.2	56%	40%	33%
AR	Lincoln	164.8	39%	26%	26%
AR	Logan	167.7	51%	36%	31%
AR	Lonoke	183.3	83%	70%	51%
AR	Montgomery	188.2	88%	79%	58%
AR	Nevada	164.5	37%	25%	26%
AR	Newton	190.3	90%	82%	60%
AR	Ouachita	175.6	68%	55%	42%
AR	Perry	153.1	10%	5%	13%
AR	Pike	151.3	2%	1%	11%
AR	Polk	177.0	71%	59%	43%
AR	Pope	179.1	78%	64%	46%
AR	Prairie	190.7	95%	85%	61%
AR	Pulaski	179.1	78%	63%	46%
AR	Saline	171.7	59%	44%	36%
AR	Scott	181.0	80%	67%	49%
AR	Searcy	163.0	34%	23%	25%
AR	Sebastian	154.2	12%	7%	15%
AR	Union	156.5	15%	8%	17%
AR	Van Buren	167.6	49%	34%	30%
AR	White	190.6	93%	84%	60%
AR	Yell	175.3	63%	53%	41%

Source: USDA - US Forest Service

***Figure 29**. AR Cluster Catchment Area – Land Cover & Use*



Note: Catchment Area Rank is a given county's numerical and percentile rank based on average forest carbon volume per hectare for all 41 counties in the Arkansas Cluster catchment area. State-wide Rank is a given county's numerical and percentile based on average forest carbon volume per hectare for all 75 counties in Arkansas. South-wide Rank is a given county's numerical and percentile rank based on average forest carbon volume per hectare for 930 US South counties.

In Johnson, Newton, Prairie, and White Counties, forest carbon levels are high due to a combination of soil productivity levels and species composition. Specifically, hardwood forests account for 70-98% of total forests in each of these four respective counties.

4.3 Forest Health & Threats

The following subsection highlights forest health and threats identified by Arkansas's Forest Action Plan. The most current Forest Action Plan (FAP) was published in 2020, following in the footsteps of each state's original 2010 plan, which originated from the 2008 Farm Bill. The Farm Bill encouraged State Foresters to complete statewide assessments of their state's forest resource at 10-year intervals.

In the most recent Arkansas FAP, the state identified seven threats or issues facing its forest resources. Those threats/issues are highlighted and detailed below and on the following page.

4.3.1 *Arkansas's Forest Action Plan: Highlights*

Arkansas's Forest Action Plan examines current conditions, trends, threats, and strategies for the Arkansas Department of Agriculture's Forestry Division to use as a guide to ensure healthy Arkansas forests into the future. The most current plan, published in 2020, identifies conditions and trends of Arkansas's forest resource and threats to Arkansas's forest resource.

- Conditions and Trends of Forest Resources in Arkansas

  Currently, 67% of forestland is non-industrial private ownership and 14% is industry owned. The remaining 19% is protected by federal and state agencies.

  Approximately 7.6 million hectares of the state of Arkansas is forested, amounting to 56% of the state's land area. Since 1978, forestland has increased by roughly 650,000 hectares. Forest type composition by area is 40% oak-hickory, 32% pine, 16% bottomland hardwood, 10% oak-pine, and 2% cedar. The state features many distinct landcover types, which align with Arkansas's geology.

- Threats to Forested Lands and Resources in Arkansas

  There are seven major threats identified in Arkansas's Forest Action Plan:

  1. Urbanization – Urbanization is expected to cause forest losses, increased carbon emissions, and stress to the other resources like wildlife and drinking water.
  2. Unmanaged Forest Property – In rural areas of the state, absentee ownership, transfer of ownership to heirs, second home development, and delay of forest management practices are all considered ongoing threats to healthy forests. The recent pandemic seems be increasing the trend. Many of the newer landowners do not have the information or background that would make them consider forest management necessary or desirable.
  3. Water Supply Forest Conservation – A concern for increasing populations is water stress, i.e., the ratio of water demand to water supply. The problem is exacerbated with issues arising from variable weather patterns and climatic changes, such as the frequency and severity of drought. Furthermore, growth of population will increase water demand and cause the parcelization and reduction of forests, which may degrade water quality. Public drinking water systems are mindful of the role that forested watersheds provide. Federal and state agencies play a substantial role in fostering sustainable management of these forested watersheds.

4. Climate Challenges – Climate change, in the context of Arkansas forests, can be described as conditions that are more volatile and extreme than the forests of Arkansas are adapted to. More intense rain events, longer drought periods, and warmer winters can cause changes in forest resiliency. Lower resiliency creates openings for catastrophic wildfires, insect and disease outbreaks, and increased storm damage. Direct climate driven changes, such as extended spring and autumn fire seasons, may lead to hotter and larger wildfire events.
5. Community Wildfire Protection – Fire as a natural disturbance has been an integral part of Arkansas' forests for thousands of years. Many of the forest types in Arkansas need to receive fire periodically in order to remain healthy. At the same time, timber resources and rural populations need to be protected from wildfire.
6. Forest Pest Issues – Native insects and diseases are natural part of forest systems. However, damaging outbreaks occur more frequently and are more serious due to unhealthy forest conditions. Diseases and insect vectors generally attack weakened trees. Predisposing and inciting factors like drought, overcrowding, advanced age, and carbon starvation may cause decline events. Also, there is an ever-increasing set of non-native invasive species that negatively impact forest ecosystems. Non-native invasive species can eliminate tree species from the forest, change fire regimes, impact wildlife populations, and generally decrease forest health.
7. Urban Forestry – The quality of life in urban centers is directly influenced by the presence of urban trees and natural areas. Researchers have determined that time spent outside and more connected with nature can improve personal health. Retention and restoration of the urban forest canopy is difficult and requires community involvement, therefore community planning efforts need to include elements related to trees. The urban and community trees are relatively more susceptible to mortality pressures, such as disease, invasive species, carbon starvation, storm damage, and mechanical damage. Public outreach and tree care professional development are needed to mitigate tree health concerns.

5. Timber Market & Wood Demand

5.1 Mill Types, Locations, & Capacities

According to TimberMart-South's mill database, as of December 2023, there were nearly 125 wood-consuming mills operating in the AR Cluster primary and secondary catchment areas (within roughly 250-300 km of the catchment area center). This includes 76 lumber mills, 12 pulp/paper mills, 13 panel (plywood/OSB) mills, 14 chip mills, and 9 pellet mills.

Total production capacity associated with these nearly 125 mills translates to nearly 62 million metric tons of roundwood per year. However, not all wood consumed by these mills is procured from within the catchment area. Based on the relative location of these mills to the primary catchment area, total annual wood demand allocated to the AR Cluster primary catchment area is estimated at approximately 23.3 million metric tons of roundwood.

***Table 28**. AR Cluster Catchment Area - Number of Mills, Total Mill Capacity, & Catchment Area Allocated Mill Capacity (2023)*

Mill Type	No. Mills	Total Capacity[1] (Metric Tons)	Catchment Area Allocation[2] (Metric Tons)
Lumber	76	18,141,200	10,425,360
Panels[3]	13	9,490,767	5,457,080
Pulp/Paper	12	28,703,711	5,574,618
Chip	14	2,667,877	1,009,982
Pellet	9	2,921,960	774,955
Total	**124**	**61,925,515**	**23,241,995**

[1] Roundwood equivalent volume associated with production capacity.
[2] Actual roundwood demand attributed to the catchment area.
[3] Includes plywood, OSB, and other panel mills.
Source: TimberMart-South; Hood Consulting

***Table 29**. AR Cluster Catchment Area - Mill List (2023)*

Company	City	County	State	Mill Type	Capacity	Units
		Softwood Lumber				
Almond Bros. Lumber	Coushatta	Red River	LA	lumber	19	MM Bf
Anthony Timberlands	Malvern	Hot Spring	AR	lumber	115	MM Bf
Anthony Timberlands	Bearden	Ouachita	AR	lumber	175	MM Bf
Ashcraft Wood Products	Warren	Bradley	AR	lumber	26	MM Bf
Canfor	Urbana	Union	AR	lumber	150	MM Bf
Georgia-Pacific	Gurdon	Clark	AR	lumber	187	MM Bf
Green Bay Packaging	Plumerville	Conway	AR	lumber	58	MM Bf
H.G. Toler & Son	Leola	Grant	AR	lumber	30	MM Bf
Hunt FP/Tolko	Urania	La Salle	LA	lumber	320	MM Bf
Interfor	Monticello	Drew	AR	lumber	160	MM Bf
Kitchen Bros. Manufacturing	Monroe	Ouachita	LA	lumber	13	MM Bf
PBS Lumber Mfg.	Winnfield	Winn	LA	lumber	38	MM Bf
PotlatchDeltic	Ola	Yell	AR	lumber	165	MM Bf
PotlatchDeltic	Warren	Bradley	AR	lumber	240	MM Bf
PotlatchDeltic	Waldo	Columbia	AR	lumber	285	MM Bf
Ray White Lumber Co	Sparkman	Dallas	AR	lumber	33	MM Bf
Resolute Forest Products	Glenwood	Pike	AR	lumber	185	MM Bf
Resolute Forest Products	El Dorado	Union	AR	lumber	250	MM Bf
Warren Timbers Company	Warren	Bradley	AR	lumber	30	MM Bf
West Fraser	Mansfield	Scott	AR	lumber	92	MM Bf
West Fraser	Leola	Grant	AR	lumber	121	MM Bf
West Fraser	Huttig	Union	AR	lumber	136	MM Bf
West Fraser	Russellville	Pope	AR	lumber	159	MM Bf
West Fraser	Joyce	Winn	LA	lumber	200	MM Bf
Weyerhaeuser	Idabel	McCurtain	OK	lumber	220	MM Bf
Weyerhaeuser	Dierks	Howard	AR	lumber	310	MM Bf
Weyerhaeuser	Dodson	Winn	LA	lumber	205	MM Bf
Wood Lumber	Idabel	McCurtain	OK	lumber	12	MM Bf
		Hardwood Lumber				
Anthony Timberlands	Mount Holly	Union	AR	lumber	12	MM Bf
Anthony Timberlands	Beirne	Clark	AR	lumber	55	MM Bf
Arkansas Wood Solutions	Knoxville	Johnson	AR	lumber	40	MM Bf
Barnes Hardwood Inc.	Simsboro	Lincoln	LA	lumber	12	MM Bf
Gene Brazeale Lumber	Sparkman	Dallas	AR	lumber	10	MM Bf
Hunt Forest Products	Olla	La Salle	LA	lumber	11	MM Bf
T & S Sawmill, Inc.	Clarendon	Monroe	AR	lumber	12	MM Bf
Willhite Forest Products	Saint Paul	Madison	AR	lumber	10	MM Bf
WLS Sawmill	Haskell	Saline	AR	lumber	12	MM Bf
		Panels				
Arauco	Malvern	Hot Spring	AR	Panel	320	MM SqFt
Huber	Broken Bow	McCurtain	OK	Panel-OSB	716	MM SqFt
Georgia-Pacific	Gurdon	Clark	AR	Panel-Plywood	335	MM SqFt
PotlatchDeltic	El Dorado	Union	AR	Panel	150	MM SqFt
Roseburg Forest Products	Simsboro	Lincoln	LA	Panel	200	MM SqFt
Weyerhaeuser	Emerson	Columbia	AR	Panel-Plywood	440	MM SqFt
Weyerhaeuser	Simsboro	Lincoln	LA	Panel-OSB	425	MM SqFt
		Pulp/Paper				
Clearwater Paper	McGehee	Desha	AR	pulp/paper	287	M tons
Domtar	Ashdown	Little River	AR	pulp/paper	472	M tons

Company	City	County	State	Mill Type	Capacity	Units
Evergreen Packaging	Pine Bluff	Jefferson	AR	pulp/paper	539	M tons
Georgia-Pacific	Muskogee	Muskogee	OK	pulp/paper	324	M tons
Georgia-Pacific	Crossett	Ashley	AR	pulp/paper	621	M tons
Graphic Packaging	West Monroe	Ouachita	LA	pulp/paper	1,200	M tons
Green Bay Packaging	Morrilton	Conway	AR	pulp/paper	408	M tons
International Paper	Campti	Natchitoches	LA	pulp/paper	970	M tons
International Paper	Mansfield	De Soto	LA	pulp/paper	980	M tons
International Paper	Valliant	McCurtain	OK	pulp/paper	1,597	M tons
Mondi USA	Pine Bluff	Jefferson	AR	pulp/paper	163	M tons
WestRock	Hodge	Jackson	LA	pulp/paper	800	M tons
		Chips				
Clearwater Paper	Warren	Bradley	AR	chip	272	M tonnes
Corbit Manufacturing	Monroe	Ouachita	LA	chip	-	M tonnes
Cypress Bend Chips	Arkansas City	Desha	AR	chip	-	M tonnes
Evergreen Packaging	Pine Bluff	Jefferson	AR	chip	272	M tonnes
Evergreen Packaging	Menifee	Conway	AR	chip	363	M tonnes
Georgia-Pacific	Bernice	Union	LA	chip	-	M tonnes
Kisatchie Chips	Campti	Natchitoches	LA	chip	-	M tonnes
LTM Chips Inc.	Mount Holly	Union	AR	chip	-	M tonnes
Robert Floyd Sawmill	Star City	Lincoln	AR	chip	-	M tonnes
Southern Chips Inc.	Perry	Perry	AR	chip	-	M tonnes
Valliant Chips Inc.	Valliant	McCurtain	OK	chip	-	M tonnes
West Monroe Fiber Processing	West Monroe	Union	LA	chip	1,100	M tonnes
Winn Timber Products	Winnfield	Winn	LA	chip	-	M tonnes
		Pellets				
BioWood LLC	Monticello	Drew	AR	pellet	40	M tonnes
Drax	Leola	Grant	AR	pellet	40	M tonnes
Drax	Russellville	Pope	AR	pellet	40	M tonnes
Drax	Urania	La Salle	LA	pellet	600	M tonnes
Drax	Bastrop	Morehouse	LA	pellet	700	M tonnes
Fiber Energy Products	Mountain View	Stone	AR	pellet	40	M tonnes
Fiber Resources	Pine Bluff	Jefferson	AR	pellet	150	M tonnes
Gulf Coast Renewable Energy	West Monroe	Ouachita	LA	pellet	120	M tonnes
Highland Pellets	Pine Bluff	Jefferson	AR	pellet	675	M tonnes

Note: Table includes all major mills located within the AR Cluster primary and secondary catchment area. Also, only sawmills with annual production capacity of 10 million board feet or greater are included in this list.

***Figure 30**. AR Cluster Catchment Area - Mill Map (2023)*

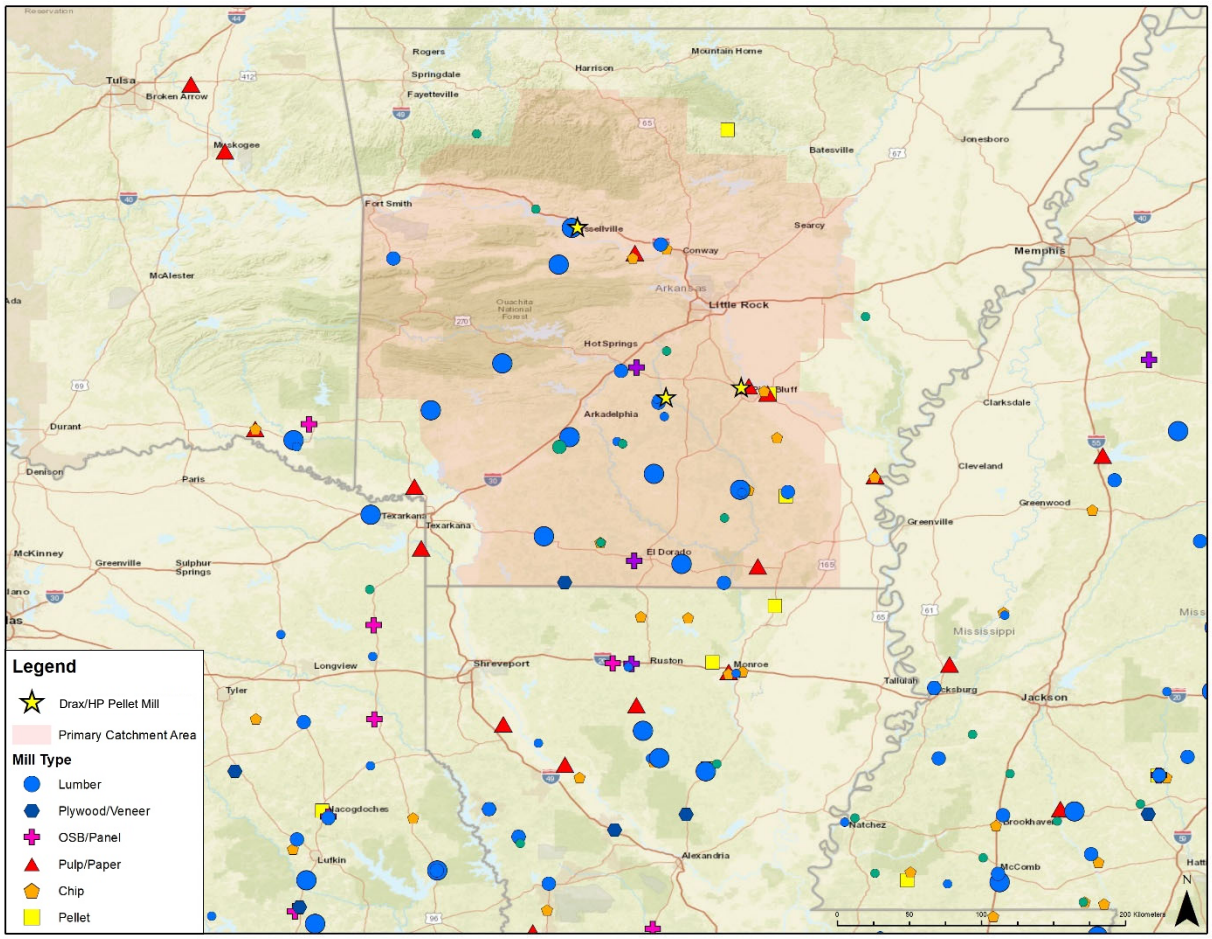


***Figure 31**. AR Cluster Catchment Area - Lumber Mills (2023)*

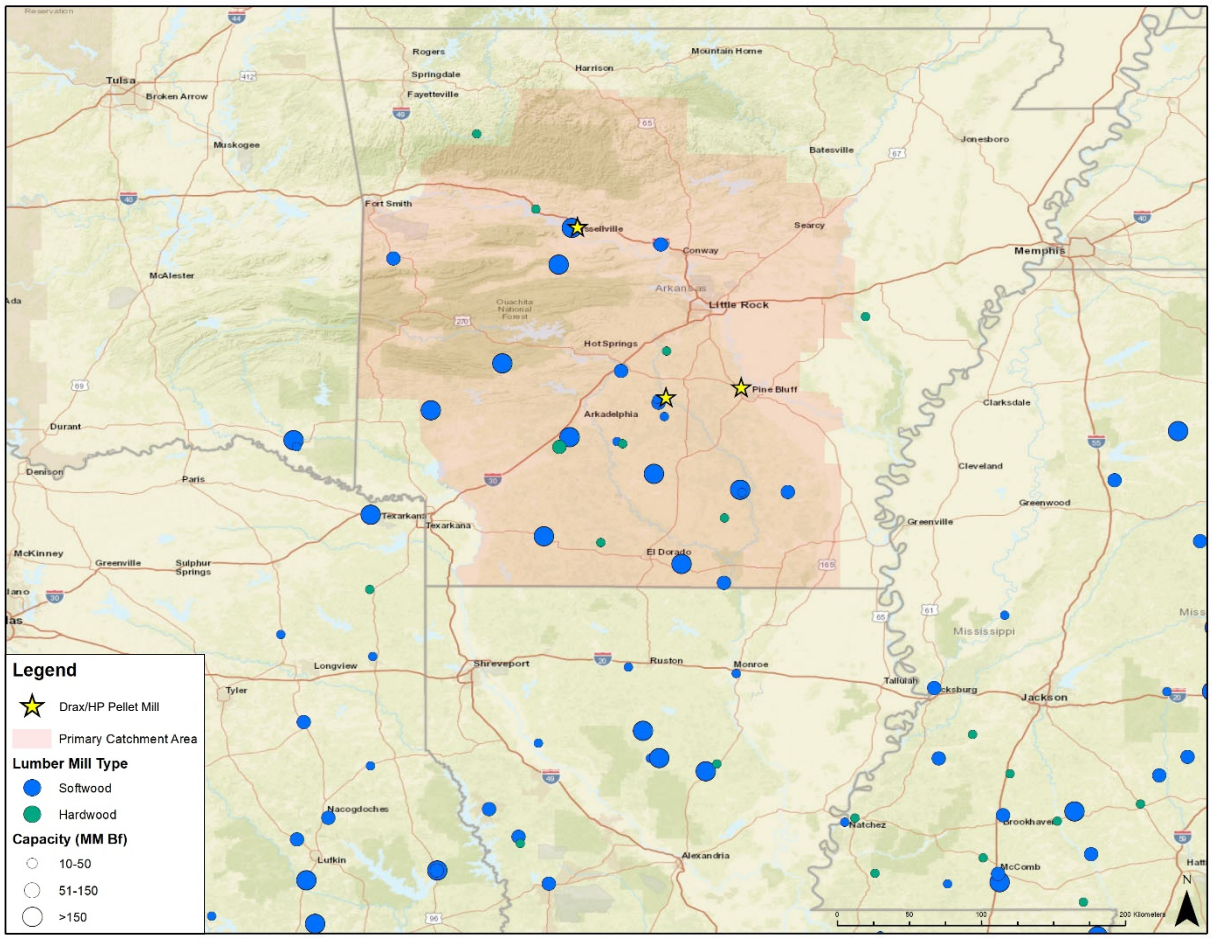


***Figure 32**. AR Cluster Catchment Area - Panel Mills (2023)*

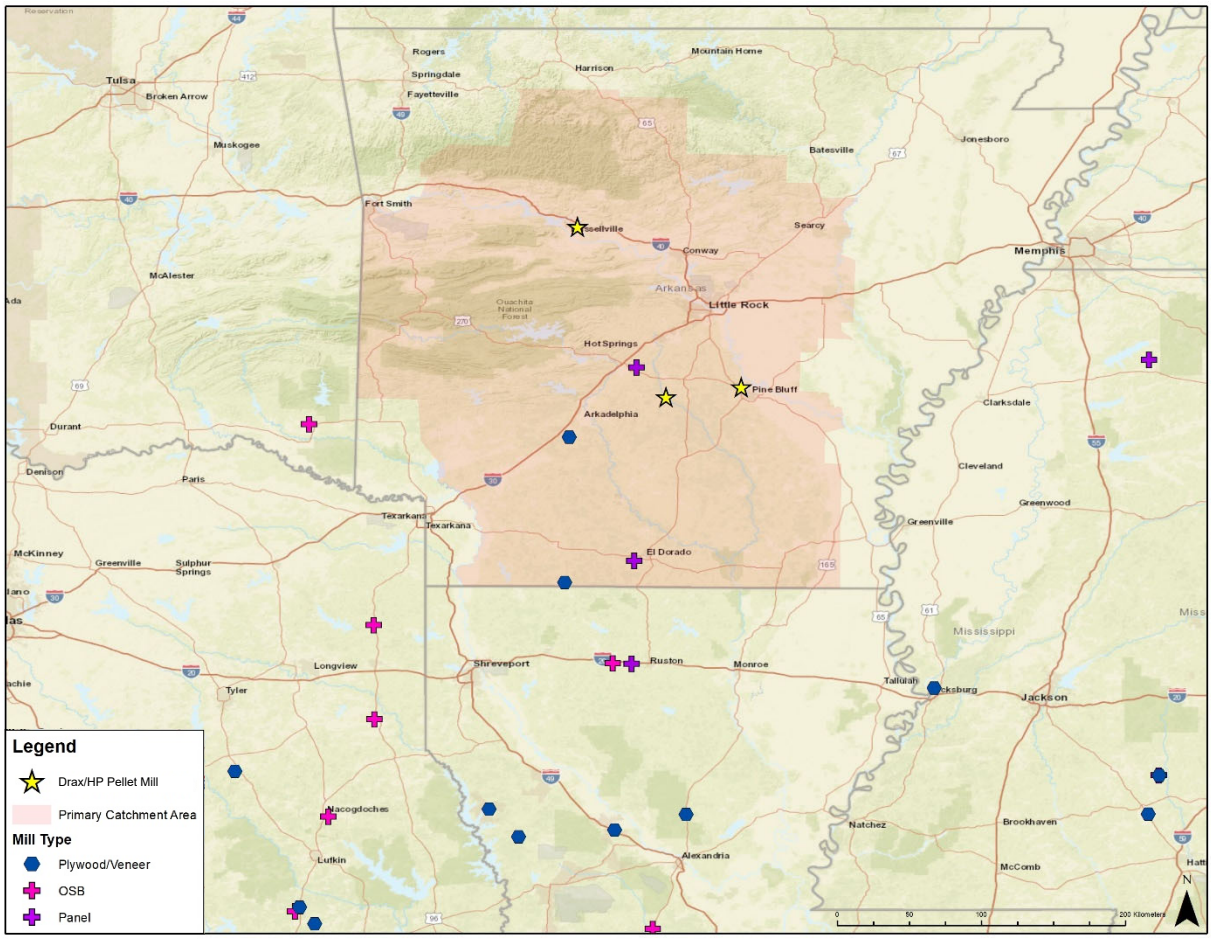
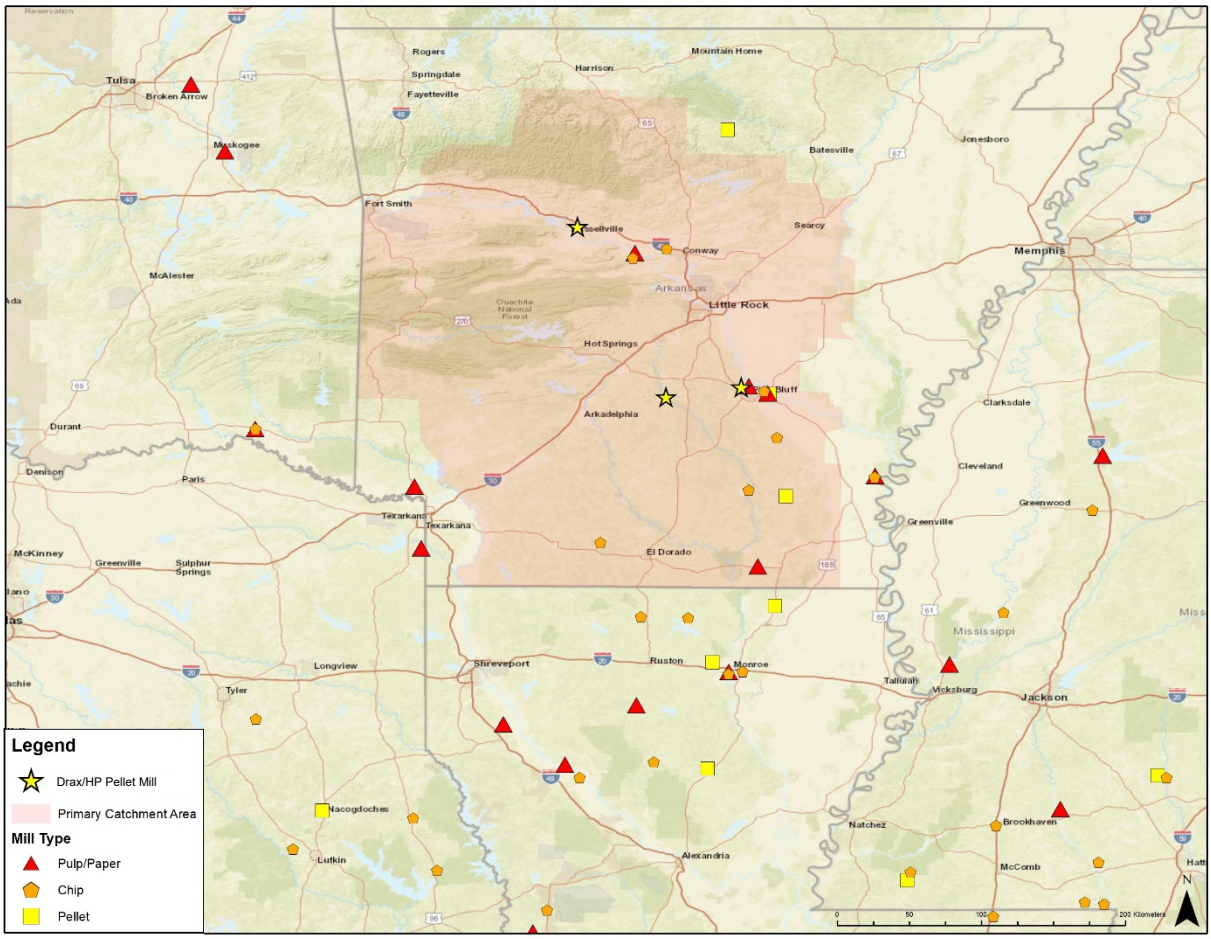


***Figure 33**. AR Cluster Catchment Area - Pulp/Paper, Pellet, & Chip Mills (2023)*



5.1.1 Identification of Certified Mills

The table below identifies all forest product mills located within the AR satellite plant primary and secondary catchment area that are certified under Sustainable Forestry Initiative (SFI) with an SFI Fiber Sourcing certificate.

***Table 30**. Sustainable Forestry Initiative (SFI) Certified Mill List*

Certified Organization	City	State	Org Type	Certificate Type	Certificate	Cert Expiry Date
Canfor	Urbana	AR	Sawmill	SFI Fiber Sourcing	NSF-SFI-FS-C0079539	8/9/2024
Clearwater Paper Corporation	Arkansas City	AR	Pulp/Paper	SFI Fiber Sourcing	NSF-SFI-FS-C0035688	12/4/2025
Domtar Paper Company	Ashdown	AR	Pulp/Paper	SFI Fiber Sourcing	SAI-SFIFS-026944	12/30/2024
Drax	Bastrop	LA	Bioenergy	SFI Fiber Sourcing	SCS-SFI-FS-007444	12/18/2024
Drax	Urania	LA	Bioenergy	SFI Fiber Sourcing	SCS-SFI-FS-007444	12/18/2024
Evergreen Packaging	Menifee	AR	Pulp/Paper	SFI Fiber Sourcing	NSF-SFI-FS-6U691	12/31/2023
Evergreen Packaging	Pine Bluff	AR	Pulp/Paper	SFI Fiber Sourcing	NSF-SFI-FS-6U691	12/31/2023
Georgia-Pacific	Crossett	AR	Pulp/Paper	SFI Fiber Sourcing	SCS-SFI/FS-007263	7/26/2026
Georgia-Pacific	Fordyce	AR	Panel-OSB	SFI Fiber Sourcing	SCS-SFI/FS-007263	7/26/2026
Georgia-Pacific	Gurdon	AR	Sawmill	SFI Fiber Sourcing	SCS-SFI/FS-007263	7/26/2026
Georgia-Pacific	Gurdon	AR	Panel-Plywood	SFI Fiber Sourcing	SCS-SFI/FS-007263	7/26/2026
Georgia-Pacific	Muskogee	OK	Pulp/Paper	SFI Fiber Sourcing	SCS-SFI/FS-007263	7/26/2026
Graphic Packaging	West Monroe	LA	Pulp/Paper	SFI Fiber Sourcing	SCS-SFI/FS-008742	11/7/2025
Green Bay Packaging	Morrilton	AR	Pulp/Paper	SFI Fiber Sourcing	NSF-SFI-FS-6U121	8/30/2025
Green Bay Packaging	Plumerville	AR	Pulp/Paper	SFI Fiber Sourcing	NSF-SFI-FS-6U121	8/30/2025
Highland Pellets	Pine Bluff	AR	Pellet/Bioenergy	SFI Fiber Sourcing	SCS-SFI/FS-007525	12/6/2027
Huber Engineered Woods	Broken Bow	OK	Panel-OSB	SFI Fiber Sourcing	NSF-SFI-FS-4Z968	12/31/2023
Interfor US, Inc.	Monticello	AR	Sawmill	SFI Fiber Sourcing	NSF-SFI-FS-C0088953	7/26/2026
International Paper	Valliant	OK	Pulp/Paper	SFI Fiber Sourcing	BVC-SFIFS-004424-1	9/9/2027
International Paper Company	Campti	LA	Pulp/Paper	SFI Fiber Sourcing	BVC-SFIFS-004424-1	9/9/2027
International Paper Company	Mansfield	LA	Pulp/Paper	SFI Fiber Sourcing	BVC-SFIFS-004424-1	9/9/2027
LaSalle Lumber Company LLC	Olla	LA	Sawmill	SFI Fiber Sourcing	NSF-SFI-FS-C0480634	12/31/2023
PotlatchDeltic	Ola	AR	Sawmill	SFI Fiber Sourcing	BV-SFIS-009808-1	1/17/2027
PotlatchDeltic	Waldo	AR	Sawmill	SFI Fiber Sourcing	BV-SFIS-009808-1	1/17/2027
PotlatchDeltic	Warren	AR	Sawmill	SFI Fiber Sourcing	BV-SFIS-009808-1	1/17/2027
Resolute Forest Products	El Dorado	AR	Sawmill	SFI Fiber Sourcing	NSF-SFI-FS-C0486857	4/27/2026
Resolute Forest Products	Glenwood	AR	Sawmill	SFI Fiber Sourcing	NSF-SFI-FS-C0486857	4/27/2026
Twin Rivers Paper Company	Pine Bluff	AR	Pulp/Paper	SFI Fiber Sourcing	NSF-SFI-FS-C0418865	12/31/2023
West Fraser	Huttig	AR	Sawmill	SFI Fiber Sourcing	NSF-SFI-FS-C0750561	6/23/2027
West Fraser	Leola	AR	Sawmill	SFI Fiber Sourcing	NSF-SFI-FS-C0750561	6/23/2027
West Fraser	Mansfield	AR	Sawmill	SFI Fiber Sourcing	NSF-SFI-FS-C0750561	6/23/2027
West Fraser	Russellville	AR	Sawmill	SFI Fiber Sourcing	NSF-SFI-FS-C0750561	6/23/2027
West Fraser Mills Ltd.	Joyce	LA	Sawmill	SFI Fiber Sourcing	NSF-SFI-FS-C0750561	6/23/2027
WestRock Company	Hodge	LA	Pulp/Paper	SFI Fiber Sourcing	NSF-SFI-FS-6S751	12/31/2023
Weyerhaeuser	Dierks	AR	Sawmill	SFI Fiber Sourcing	BV-SFIS-US011612	12/10/2026
Weyerhaeuser	Emerson	AR	Sawmill	SFI Fiber Sourcing	BV-SFIS-US011612	12/10/2026
Weyerhaeuser	Idabel	OK	Sawmill	SFI Fiber Sourcing	BV-SFIS-US011612	12/10/2026
Weyerhaeuser	Dodson	LA	Sawmill	SFI Fiber Sourcing	BV-SFIS-US011612	12/10/2026
Weyerhaeuser	Simsboro	LA	Sawmill	SFI Fiber Sourcing	BV-SFIS-US011612	12/10/2026

5.1.2 Mill Openings, Closings, & Other News

There have been several announcements related to mill openings and closings in and around the AR Cluster catchment area that stand to impact this market moving forward. These include:

- Camden Timbers, a subsidiary of Astara Capital Partners, reopened the former Victory Lumber southern yellow pine sawmill in Camden, Arkansas, in February 2023. The group invested about $20 million to upgrade the facility to produce small-log timbers and dimensional lumber with 50 mmbf of annual lumber capacity. However, the company experienced difficulties operating the mill and subsequently shut down in December 2023. While the future of this mill is unknown, should it start back up, this mill would increase roundwood demand attributed to the AR Cluster catchment area by an estimated 130,000-170,000 metric tons annually at full production.
- Canfor announced plans to invest $130 million in its sawmill in Urbana, Arkansas. The project will upgrade facilities and expand capacity by about 115 mmbf, from 150 to 265 mmbf per year. Upgrades include major improvements to the planer, sawmill, and log yard. Construction began in the 3rd Quarter of 2022 and is expected to take approximately 18 months, with completion in 2024. The facility will continue to operate during the project. The project is expected to increase roundwood demand attributed to the AR Cluster catchment area by an estimated 100,000-200,000 metric tons in 2024 and by an additional 175,000-275,000 metric tons annually in 2025 and thereafter.
- Idaho Timber announced in 2022 plans to rebuild its sawmill in Carthage, Arkansas, which was partially destroyed by a fire in early-2022. The rebuilt mill is expected to have annual production capacity of 80 mmbf (up from 40 mmbf before the fire). A construction schedule or expected startup of the rebuilt mill has not been disclosed. The project is expected to increase roundwood demand attributed to the AR Cluster catchment area by an estimated 100,000-130,000 metric tons annually once running at full production capacity.
- Pactiv Evergreen announced in early-2023 that it continues to explore strategic alternatives for its pulp and paper mill in Pine Bluff, Arkansas. The company idled one of the paper machines at its mill in Canton, North Carolina, in February 2023 due to challenging market conditions. The Pine Bluff mill, like the Canton NC mill, supports the company's Beverage Merchandizing and Food Merchandizing businesses.
- PotlatchDeltic announced in 1Q 2023 the restart of its rebuilt sawmill in Ola, Arkansas. The rebuilt sawmill has annual lumber capacity of 150 mmbf. The project is expected to increase roundwood demand attributed to the AR Cluster catchment area by an estimated 50,000-70,000 metric tons annually beginning in 2023.
- PotlatchDeltic announced in 2022 plans to invest $131 million to expand and modernize its sawmill in Waldo, Arkansas. The company estimates the project will increase annual lumber capacity at the mill from 190 mmbf to roughly 275 mmbf. Activity is currently focused on site preparation with most of the equipment delivery and installation to come in 2024. The existing sawmill will continue to operate during the project. The company expects completion by the end of 2024. The project is expected to increase roundwood demand attributed to the AR Cluster catchment area by an estimated 200,000-275,000 metric tons annually beginning in 2025.
- Warren Timbers Company announced planned investments at its southern yellow pine timbers mill in Warren, Arkansas. The expansion project will increase annual production capacity from 25 to 75 mmbf annually. Project completion is expected in early-2025. The project is expected to increase roundwood demand attributed to the AR Cluster catchment area by an estimated 125,000-175,000 metric tons annually beginning in 2025.

5.2 Catchment Area Wood Demand

Note that total capacity is not the same as actual demand, but rather the maximum potential demand associated with mills running at full production capacity. While total capacity is estimated at approximately 61.9 million metric tons annually, actual wood demand[2] in the AR Cluster catchment area in 2021, the latest available, was estimated at 21.4 million metric tons.

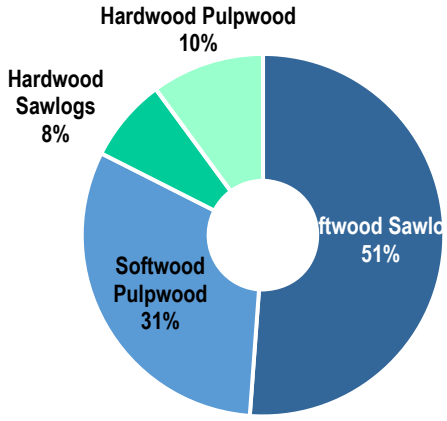
Distribution of total wood demand by major species in 2021 included 82% (17.7 million metric tons) softwood versus 18% (3.8 million metric tons) hardwood. Specifically, 38% of total softwood demand was attributed to softwood pulpwood compared to 62% softwood sawlogs. In terms of total hardwood demand, 57% was attributed to hardwood pulpwood versus 43% hardwood sawlogs.

***Table 31**. AR Cluster Catchment Area - Wood Demand (2021)*

Major Species / Product	Demand (Metric Tons)	% of Total
Softwood:		
Sawlogs	10,972,676	51%
Pulpwood	6,710,436	31%
Softwood Total	*17,683,113*	*82%*
Hardwood:		
Sawlogs	1,602,704	7%
Pulpwood	2,159,869	10%
Hardwood Total	*3,762,573*	*18%*
Total	**21,445,685**	**100%**

Source: USDA US Forest Service-TPO; TimberMart-South

***Figure 34**. AR Cluster Catchment Area - Distribution of Wood Demand by Major Species & Product (2021)*



[2] Wood demand estimates for the AR Cluster catchment area are based on both USDA Forest Service data and TimberMart-South wood demand data.

Biomass demand, defined in this analysis as softwood and hardwood pulpwood (roundwood) consumed by pellet or other bioenergy facilities, totaled an estimated 909,470 metric tons in 2021, the latest available, accounting for approximately 10% of total pulpwood demand (and 5% of total wood demand) in the catchment area. The predominant source of biomass demand in the catchment area is Highland Pellets, with Drax's Morehouse BioEnergy also a minor contributor.

Note that not all wood consumed by a pellet mill or other bioenergy facility is encompassed in biomass demand. Wood consumption (demand) at pellet and other bioenergy facilities generally includes a combination of roundwood, wood chips, and sawmill residuals. However, sawmill residuals are a by-product of the sawmilling process – from the processing of sawlogs, not pulpwood. As such, sawmill residuals consumed by biomass facilities are not included in this calculation of biomass demand. Furthermore, note that Drax's satellite pellet plants in Leola and Russellville both consume sawmill residuals only, so these two plants have zero contribution of biomass demand.

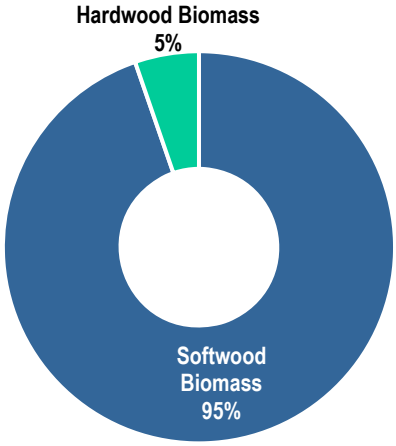
Non-bioenergy related pulpwood demand, almost entirely attributed to the pulp/paper industry, accounted for approximately 88% of total pulpwood demand in the catchment area.

***Table 32**. AR Cluster Catchment Area - Biomass Demand & Total Pulpwood Demand (2021)*

Product	Demand (Metric Tons)	% of Total
Softwood Pulpwood:		
Biomass	861,436	10%
Other Pulpwood	5,849,001	66%
Softwood Pulpwood Total	*6,710,436*	*76%*
Hardwood Pulpwood:		
Biomass	48,034	1%
Other Pulpwood	2,111,835	23%
Hardwood Pulpwood Total	*2,159,869*	*24%*
Total Pulpwood	**8,870,305**	**100%**

Source: USDA US Forest Service–TPO; TimberMart-South; Drax

***Figure 35**. AR Cluster Catchment Area - Distribution of Biomass Demand by Major Species (2021)*



5.2.1 *Annual Wood Demand by Product*

Annual wood demand[3] in the AR Cluster catchment area averaged 21.7 million metric tons per year in the mid-2000s before declining and ultimately stabilizing at an average of 17.8 million metric tons per year from 2009-2015. Note that the decrease in total wood demand was due in large part to reduced demand from the lumber/solid wood products industry. However, total wood demand rebounded over the next several years and since 2018 has averaged 21.1 million metric tons per year in the catchment area, up 19% compared to 2009-2015 average levels.

***Table 33**. AR Cluster Catchment Area - Annual Wood Demand (2000-2021)*

Year	Softwood Sawlogs	Softwood Pulpwood	Hardwood Sawlogs	Hardwood Pulpwood	Total Wood Demand
			(Metric Tons)		
2005	10,924,324	4,743,016	3,536,653	2,449,489	21,653,482
2006	11,071,489	4,691,870	3,533,926	2,446,205	21,743,491
2007	9,569,402	4,866,732	3,531,200	2,442,922	20,410,256
2008	8,628,252	4,803,150	3,113,089	2,348,213	18,892,704
2009	7,687,102	4,591,983	2,656,123	2,253,503	17,188,711
2010	8,049,296	4,348,768	2,861,396	2,294,760	17,554,220
2011	8,464,915	4,965,557	2,905,671	2,398,749	18,734,893
2012	8,040,937	4,946,485	2,810,201	2,348,800	18,146,423
2013	7,926,972	4,918,552	2,606,685	2,310,763	17,762,972
2014	7,690,860	4,969,341	2,704,604	2,240,924	17,605,730
2015	7,947,166	5,078,811	2,529,213	2,124,300	17,679,489
2016	8,427,340	5,577,508	2,741,618	2,125,120	18,871,586
2017	9,792,099	6,028,183	1,864,887	2,134,072	19,819,241
2018	10,272,360	6,398,762	2,272,537	2,110,986	21,054,645
2019	10,452,477	6,742,413	2,469,274	1,981,707	21,645,870
2020	10,584,496	6,180,436	2,223,428	1,334,460	20,322,820
2021	10,972,676	6,710,436	1,602,704	2,159,869	21,445,685

Source: USDA US Forest Service-TPO; TimberMart-South

[3] Wood demand estimates for the AR Cluster catchment area are based on USDA Forest Service FIA & Timber Products Output (TPO) data as well as TimberMart-South wood demand data.

***Figure 36**. AR Cluster Catchment Area – Total Annual Wood Demand (2005-2021)*

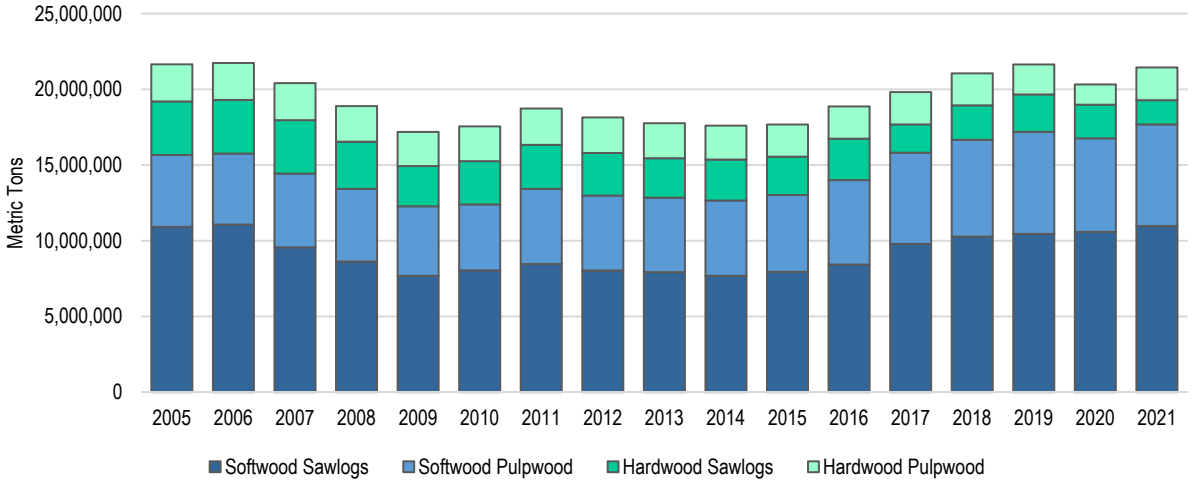
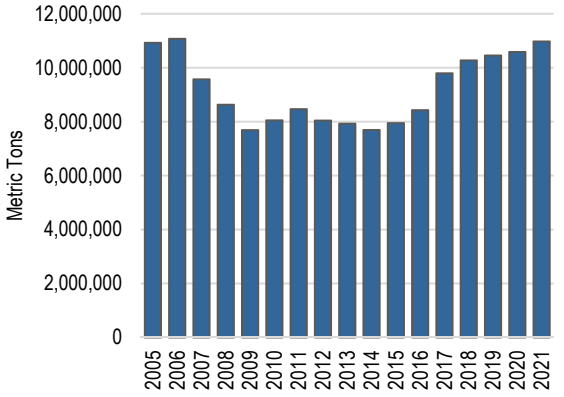
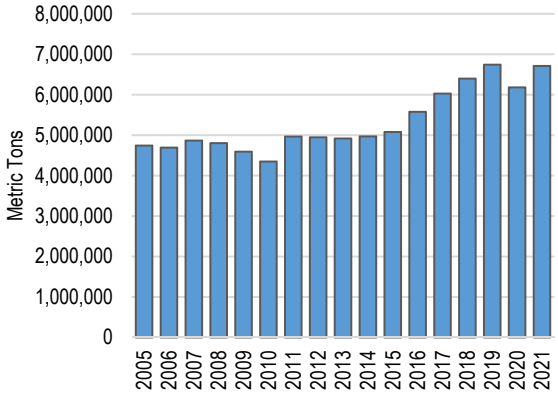


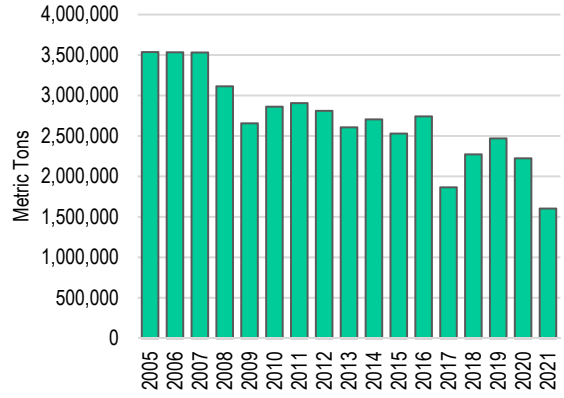
***Figure 37**. AR Cluster Catchment Area – Annual Wood Demand by Major Species & Product (2005-2021)*



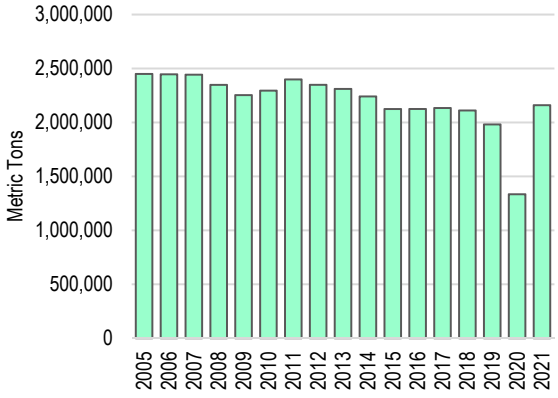
(a) Softwood Sawlogs



(b) Softwood Pulpwood



(c) Hardwood Sawlogs



(d) Hardwood Pulpwood

5.2.1.1 Biomass Demand & Total Pulpwood Demand

Biomass demand is defined as softwood and hardwood pulpwood (roundwood) consumed by pellet or other bioenergy facilities. Presently, the two Drax satellite pellet plants, Highland Pellets, and Fiber Resources are the only major wood pellet mills operating within the catchment area. However, the two Drax mills and Fiber Resources utilize sawmill residuals only for wood pellet production. Only Highland Pellets and several other pellet mills located outside the catchment area but procure some level of roundwood from within the AR Cluster catchment area contribute to biomass-related roundwood demand.

Total biomass demand in the catchment area remained below 110,000 metric tons per year through 2015 before increasing to more than 810,000 metric tons in 2018. Excluding the year 2020, when Highland Pellets was temporarily shut down, total biomass demand averaged 864,000 metric tons per year from 2018-2021.

Note that biomass demand is predominantly softwood (pine), with softwood biomass demand accounting for 94% of total biomass demand in the catchment area since 2014 (compared to 6% hardwood biomass demand). Since 2018, biomass-related pulpwood demand has accounted for 9% of total pulpwood demand in the catchment area. For a detailed breakdown of biomass and non-biomass-related pulpwood demand in the catchment area since 2005, see Table 34 below.

***Table 34**. AR Cluster Catchment Area - Biomass Demand & Total Pulpwood Demand (2005-2021)*

	Biomass Demand			*Other Pulpwood Demand*			*Total Pulpwood Demand*		
Year	Softwood	Hardwood	Total	Softwood	Hardwood	Total	Softwood	Hardwood	Total
					(Metric Tons)				
2005	0	0	0	4,743,016	2,449,489	7,192,504	4,743,016	2,449,489	7,192,504
2006	0	0	0	4,691,870	2,446,205	7,138,075	4,691,870	2,446,205	7,138,075
2007	0	0	0	4,866,732	2,442,922	7,309,654	4,866,732	2,442,922	7,309,654
2008	0	0	0	4,803,150	2,348,213	7,151,362	4,803,150	2,348,213	7,151,362
2009	0	0	0	4,591,983	2,253,503	6,845,486	4,591,983	2,253,503	6,845,486
2010	0	0	0	4,348,768	2,294,760	6,643,529	4,348,768	2,294,760	6,643,529
2011	0	0	0	4,965,557	2,398,749	7,364,306	4,965,557	2,398,749	7,364,306
2012	0	0	0	4,946,485	2,348,800	7,295,285	4,946,485	2,348,800	7,295,285
2013	0	0	0	4,918,552	2,310,763	7,229,315	4,918,552	2,310,763	7,229,315
2014	13,872	0	13,872	4,955,470	2,240,924	7,196,394	4,969,341	2,240,924	7,210,266
2015	109,454	0	109,454	4,969,357	2,124,300	7,093,657	5,078,811	2,124,300	7,203,111
2016	247,412	0	247,412	5,330,096	2,125,120	7,455,216	5,577,508	2,125,120	7,702,628
2017	593,633	66,065	659,698	5,434,550	2,068,007	7,502,557	6,028,183	2,134,072	8,162,255
2018	747,596	62,910	810,506	5,651,166	2,048,076	7,699,242	6,398,762	2,110,986	8,509,748
2019	809,652	61,906	871,558	5,932,761	1,919,801	7,852,561	6,742,413	1,981,707	8,724,119
2020	297,951	19,395	317,346	5,882,486	1,315,065	7,197,551	6,180,436	1,334,460	7,514,896
2021	861,436	48,034	909,470	5,849,001	2,111,835	7,960,836	6,710,436	2,159,869	8,870,305

Source: USDA-US Forest Service; TimberMart-South; Drax; Hood Consulting research

Figure 38. AR Cluster Catchment Area – Softwood Pulpwood Demand (2005-2021)

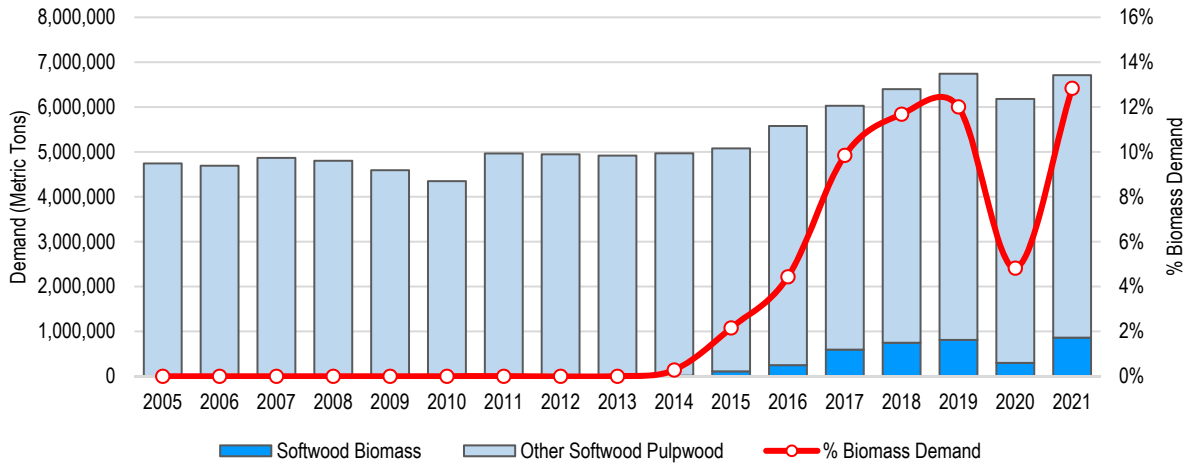


Figure 39. AR Cluster Catchment Area – Hardwood Pulpwood Demand (2005-2021)

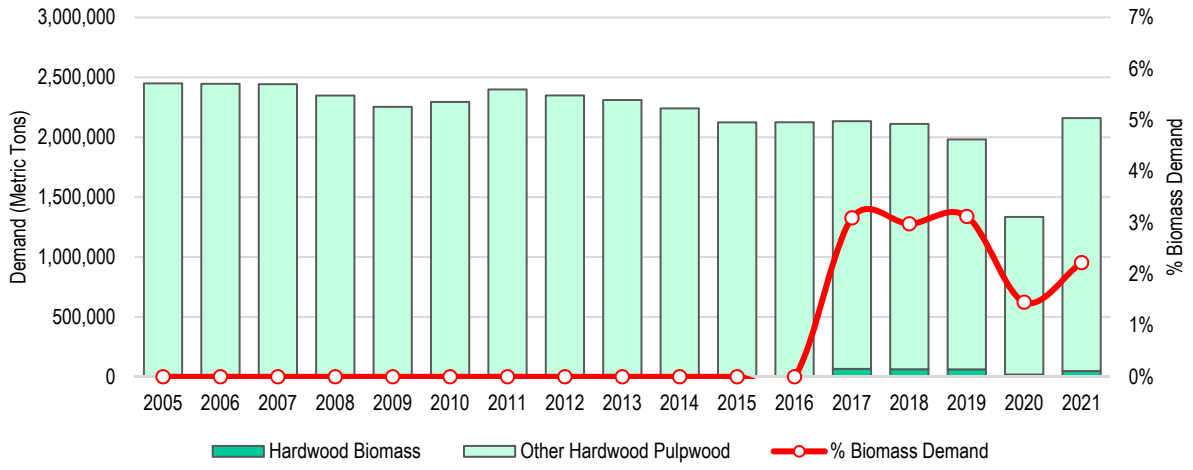
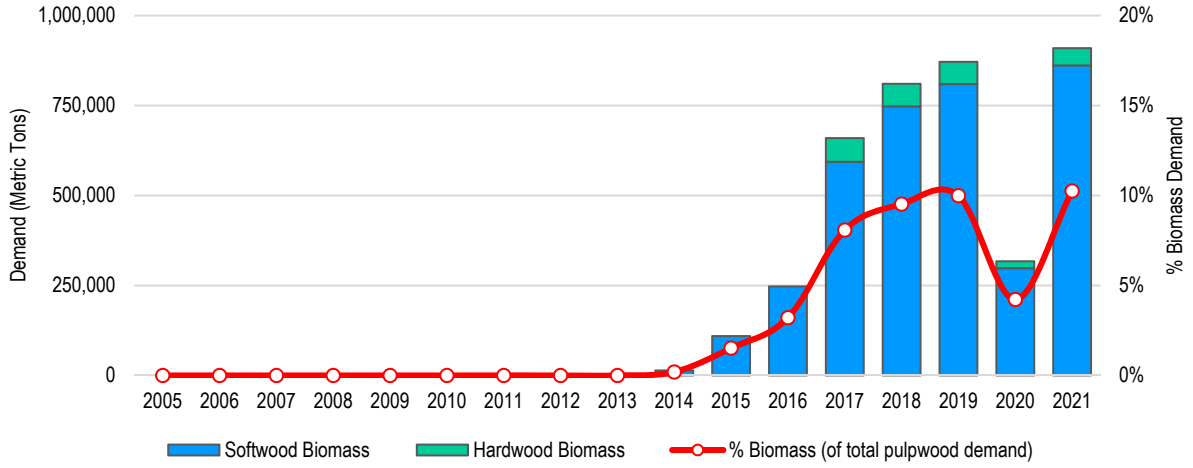


Figure 40. AR Cluster Catchment Area – Total Biomass Demand (2005-2021)



5.2.1.2 Biomass-Related Demand for Residuals

In the Arkansas Cluster catchment area, sawmill residual consumption by the bioenergy industry averaged an estimated 167,400 metric tons per year from 2005-2015 but proceeded to increase to an estimated 412,200 metric tons in 2021, representing a nearly 150% increase compared to 2005-2015 average levels. In terms of demand by residual type, sawmill chips have accounted for anywhere from 53-58% of total annual sawmill residual demand in the catchment area since 2005, compared to 26-34% for shavings and 10-20% for sawdust.

Overall, total bioenergy fiber demand (i.e. roundwood and sawmill residuals) in the catchment area increased from an average of 167,400 metric tons per year from 2005-2013 to an estimated 1.3 million metric tons in 2021, or a nearly 7x increase in total fiber demand from 2013-2021. In terms of demand distribution by fiber type, sawmill residuals accounted for 100% of total bioenergy fiber demand from 2005-2013, falling to as low as 25% in 2017 but steadily increasing thereafter to an estimated 31% in 2021.

In terms of sawmill residual demand by major species type, softwood (pine) sawmill residuals account for an estimated 98-99% of total bioenergy residual demand, versus 1-2% hardwood sawmill residuals.

***Table 35**. AR Cluster Catchment Area – Biomass-Related Sawmill Residual Demand (2005-2021)*

Year	Roundwood Demand	*Sawmill Residual Demand*				Total Fiber Demand	% Residual Demand
		Sawmill Chips	Shavings	Sawdust	Total		
				(Metric Tons)			
2005	-	93,757	45,204	28,462	167,423	167,423	100%
2006	-	93,757	45,204	28,462	167,423	167,423	100%
2007	-	93,757	45,204	28,462	167,423	167,423	100%
2008	-	93,757	45,204	28,462	167,423	167,423	100%
2009	-	93,757	45,204	28,462	167,423	167,423	100%
2010	-	93,757	45,204	28,462	167,423	167,423	100%
2011	-	93,757	45,204	28,462	167,423	167,423	100%
2012	-	93,757	45,204	28,462	167,423	167,423	100%
2013	-	93,757	45,204	28,462	167,423	167,423	100%
2014	13,872	93,757	45,204	28,462	167,423	181,294	92%
2015	109,454	93,765	45,204	28,462	167,431	276,885	60%
2016	247,412	98,965	45,212	30,053	174,230	421,642	41%
2017	659,698	117,744	59,575	43,325	220,644	880,342	25%
2018	810,506	181,406	89,456	61,641	332,503	1,143,009	29%
2019	871,558	177,959	102,256	35,582	315,797	1,187,355	27%
2020	317,346	165,643	101,531	29,665	296,840	614,185	48%
2021	909,470	239,671	128,786	43,762	412,219	1,321,689	31%

Source: USDA-USFS; TimberMart-South; Drax; Sustainable Biomass Program; Hood Consulting research

5.2.2 *Wood Demand Outlook*

Based on the announcements highlighted in Section 5.1.1 as well as other anticipated production changes, total wood demand in the AR Cluster catchment area is projected to increase an estimated 6% from 2021 to 2025. In particular, biomass demand is projected to increase from roughly 910,000 metric tons in 2021 to an average of 1,222,000 metric tons per year from 2022-2025, or a 34% increase compared to 2021 levels. Note that this expected increase is due to the anticipated increase in pellet production at Highland Pellets.

***Table 36**. AR Cluster Catchment Area - Projected Wood Demand (2021-2025)*

Product	2021	2022	2023	2024	2025
	Catchment Area – Annual Wood Demand (Metric Tons)				
Sawlogs:					
Softwood	10,972,676	11,135,825	11,313,616	11,765,412	12,187,926
Hardwood	1,602,704	1,626,744	1,651,145	1,675,913	1,701,051
Total Sawlogs	12,575,380	12,762,570	12,964,761	13,441,325	13,888,977
Pulpwood:					
Softwood	6,710,436	7,052,642	6,962,883	6,869,769	6,776,794
Hardwood	2,159,869	2,126,074	2,080,260	2,039,175	1,998,907
Total Pulpwood	8,870,305	9,178,716	9,043,143	8,908,944	8,775,701
Total	**21,445,685**	**21,941,285**	**22,007,904**	**22,350,269**	**22,664,679**

**projected*

***Table 37**. AR Cluster Catchment Area – Projected Biomass & Total Pulpwood Demand (2021-2025)*

Product	2021	2022	2023	2024	2025
	Catchment Area – Pulpwood Demand (Metric Tons)				
Biomass Demand:					
Softwood Biomass	861,436	1,230,015	1,171,186	1,144,457	1,130,617
Hardwood Biomass	48,034	56,475	52,054	51,533	51,018
Total Biomass	**909,470**	**1,286,491**	**1,223,240**	**1,195,990**	**1,181,634**
Other Pulpwood Demand:					
Other Softwood Pulpwood	5,849,001	5,816,057	5,788,604	5,722,717	5,645,849
Other Hardwood Pulpwood	2,111,835	2,069,598	2,028,206	1,987,642	1,947,889
Total Other Pulpwood	**7,960,836**	**7,885,655**	**7,816,811**	**7,710,359**	**7,593,738**
Total Pulpwood Demand:					
Total Softwood Pulpwood	6,710,436	7,046,073	6,959,791	6,867,175	6,776,466
Total Hardwood Pulpwood	2,159,869	2,126,074	2,080,260	2,039,175	1,998,907
Total Pulpwood	**8,870,305**	**9,172,146**	**9,040,051**	**8,906,350**	**8,775,373**

**projected*

***Figure 41**. AR Cluster Catchment Area - Projected Wood Demand (2021 – 2025)*

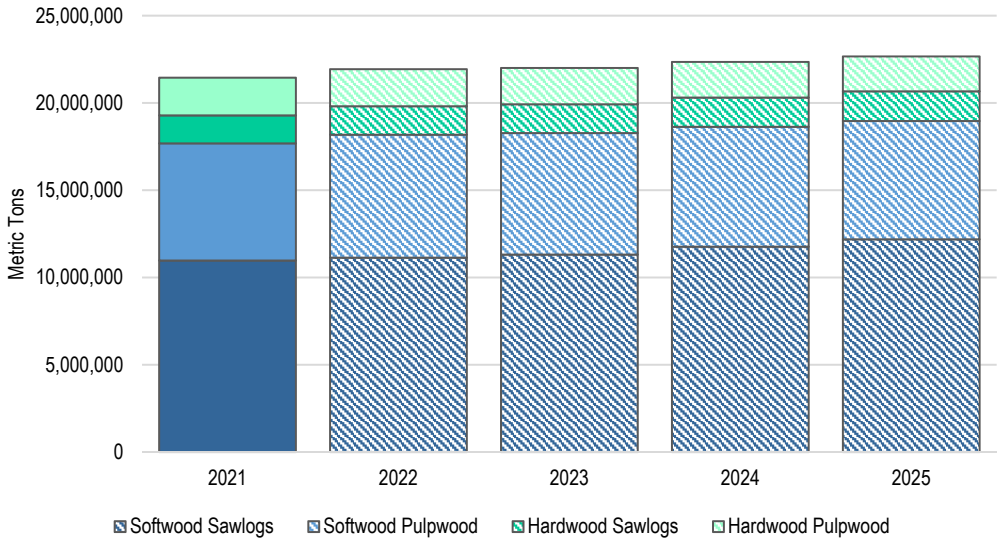
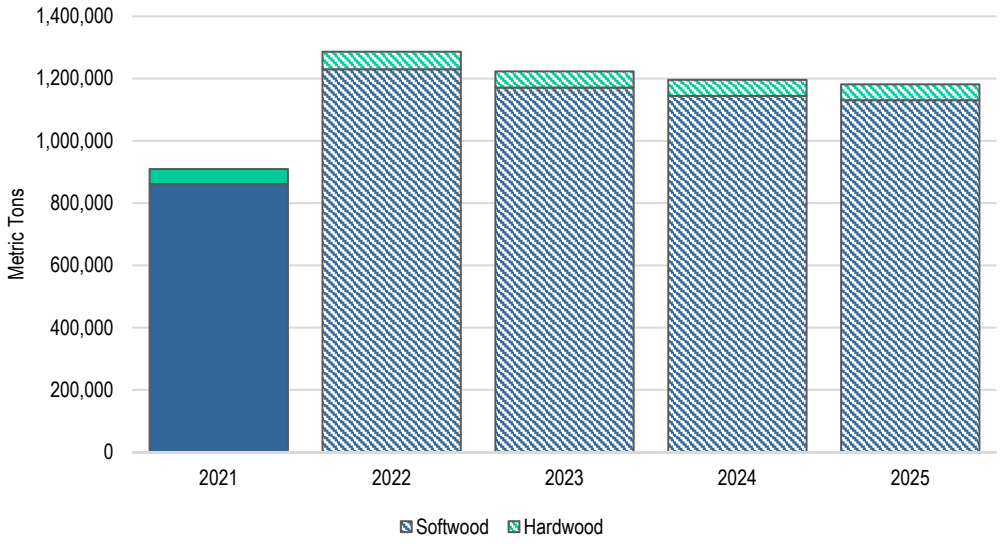


***Figure 42**. AR Cluster Catchment Area - Projected Biomass Demand (2021 – 2025)*



5.2.2.1 Biomass-Related Residual Demand Outlook

In the Arkansas Cluster catchment area, sawmill residual consumption by the bioenergy industry averaged an estimated 167,400 metric tons per year from 2005-2015 but proceeded to increase to an estimated 412,200 metric tons in 2021, representing a nearly 150% increase compared to 2005-2015 average levels. In terms of demand by residual type, sawmill chips have accounted for anywhere from 53-58% of total annual sawmill residual demand in the catchment area since 2005, compared to 26-34% for shavings and 10-20% for sawdust.

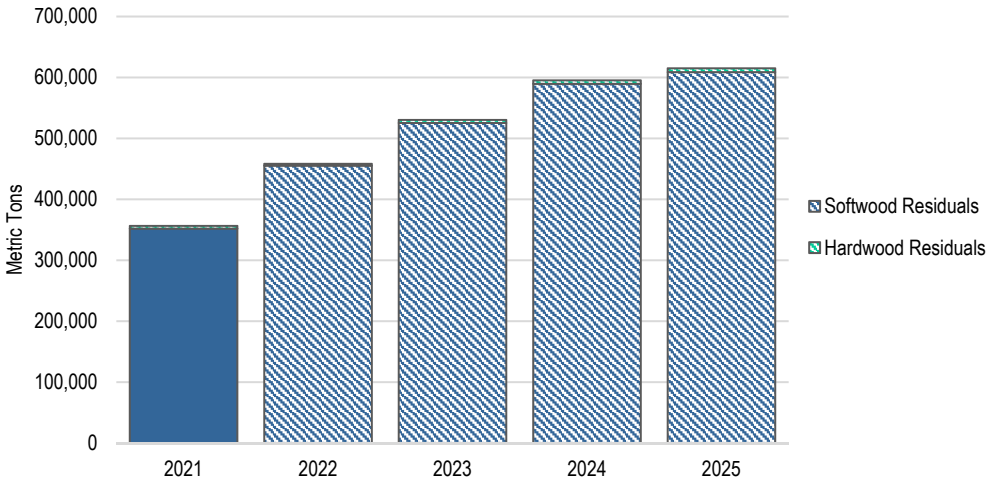
Overall, total bioenergy fiber demand (i.e. roundwood and sawmill residuals) in the catchment area increased from an average of 167,400 metric tons per year from 2005-2013 to an estimated 1.3 million metric tons in 2021, or a nearly 7x increase in total bioenergy-related fiber demand from 2013-2021. In terms of demand distribution by fiber type, sawmill residuals accounted for 100% of total bioenergy fiber demand from 2005-2013, falling to as low as 25% in 2017 but increasing to an estimated 31% in 2021.

***Table 38**. AR Cluster Catchment Area – Projected Biomass Fiber Demand (2021-2025)*

Product	2021	2022	2023	2024	2025
	Catchment Area – Biomass Fiber Demand (Metric Tons)				
Biomass Roundwood Demand:					
Softwood Roundwood	861,436	1,230,015	1,171,186	1,144,457	1,130,617
Hardwood Roundwood	48,034	56,475	52,054	51,533	51,018
Total Biomass Roundwood	**909,470**	**1,286,491**	**1,223,240**	**1,195,990**	**1,181,634**
Biomass Residuals Demand:					
Softwood Residuals	407,789	511,125	581,113	589,569	608,794
Hardwood Residuals	4,430	2,969	5,074	5,726	6,306
Total Biomass Residuals	**412,219**	**514,095**	**586,187**	**595,295**	**615,099**
Total Biomass Fiber Demand:					
Softwood Fiber	1,269,225	1,741,141	1,752,300	1,734,026	1,739,410
Hardwood Fiber	52,464	59,445	57,127	57,259	57,323
Total Biomass Fiber	**1,321,689**	**1,800,586**	**1,809,427**	**1,791,285**	**1,796,733**

**projected*

***Figure 43**. AR Cluster Catchment Area - Projected Biomass-Related Sawmill Residual Demand (2021 – 2025)*



5.3 Raw Material Costs

Current and historic prices for both stumpage and delivered timber as well as pulp quality chips have been provided by TimberMart-South (TMS). Note that these prices are specific to the AR Cluster catchment area and are average market prices calculated from actual timber sales reported to TMS. Also, historic quarterly raw material prices are provided in tabular form in Appendix A.

5.3.1 *Stumpage (Standing Timber) Prices*

Stumpage price is the value of timber as it stands uncut on the stump and is what landowners are paid by loggers and other wood buyers for their standing timber.

Table 39 below provides annual average (nominal) stumpage prices in the AR Cluster catchment area for each of the five major timber products since 2000.

***Table 39**. AR Cluster Catchment Area – Annual Stumpage Prices ($/Metric Ton)*

Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
			($/Metric Ton)		
2000	$42.03	$23.82	$5.81	$17.86	$4.03
2001	$36.57	$20.62	$4.91	$20.77	$5.66
2002	$38.47	$21.69	$5.22	$18.68	$5.59
2003	$38.43	$22.82	$5.97	$19.92	$6.06
2004	$41.78	$25.29	$6.18	$20.16	$6.01
2005	$47.52	$23.94	$8.58	$29.10	$9.27
2006	$45.47	$22.04	$7.23	$24.92	$7.17
2007	$46.66	$22.53	$10.99	$30.52	$10.71
2008	$34.28	$22.88	$12.26	$26.43	$12.54
2009	$29.56	$20.41	$10.56	$25.55	$12.90
2010	$30.43	$19.82	$12.08	$29.88	$15.11
2011	$24.92	$16.34	$8.39	$25.96	$9.91
2012	$23.40	$15.64	$8.82	$28.42	$11.41
2013	$24.50	$16.67	$9.28	$31.19	$11.96
2014	$25.87	$17.26	$9.09	$34.31	$16.93
2015	$26.81	$18.02	$8.53	$36.39	$17.12
2016	$25.73	$17.13	$7.70	$43.35	$13.69
2017	$24.59	$16.52	$6.97	$38.25	$12.04
2018	$25.11	$16.13	$7.50	$40.67	$13.73
2019	$27.10	$16.51	$7.98	$44.00	$16.42
2020	$26.24	$14.92	$6.36	$38.75	$8.66
2021	$30.34	$18.62	$5.84	$42.05	$8.97
2022	$29.59	$18.94	$6.12	$46.96	$12.00
2023	$28.39	$15.94	$5.53	$44.57	$11.50

Source: TimberMart-South

Trends/changes with nominal stumpage prices in the catchment area since 2000 are as follows:

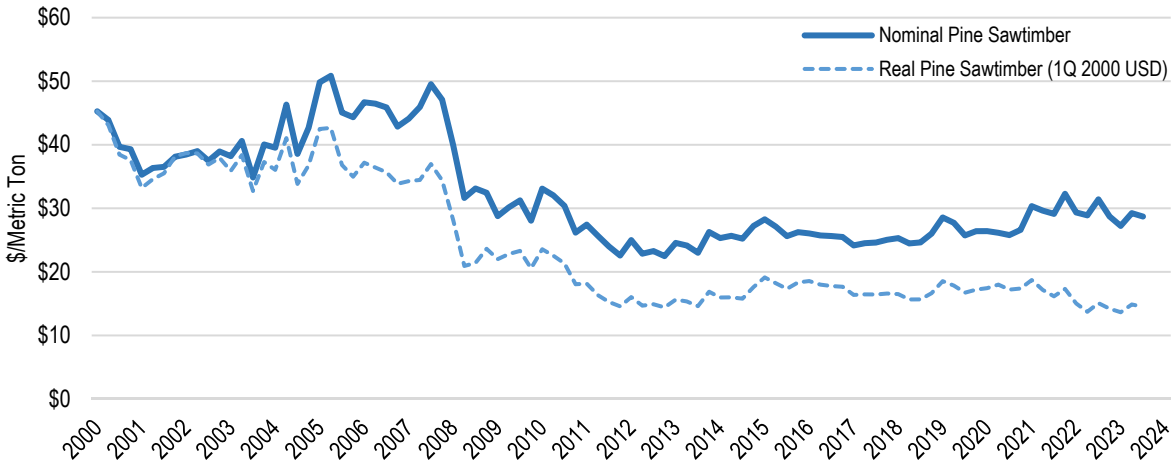
- Pine Sawtimber Stumpage. Pine sawtimber (PST) stumpage prices held between roughly $40 and $50 per metric ton in the catchment area from 2000 through 2007 before falling to roughly $23 per metric ton in 2012, or a 50% decrease compared to 2007 average levels. Prices improved modestly over the two years that followed but have held more-or-less flat and averaged approximately $27 per metric ton since 2014.
- Pine Chip-n-saw Stumpage. Pine chip-n-saw (CNS) stumpage prices in the AR Satellite Plant catchment area were a bit volatile through the early and mid-2000s but overall averaged $22.85 per metric ton average from 2000-2008. Prices subsequently declined more than 30% to less than $15 per metric ton in 2Q 2012 and since 2013 have averaged roughly $17 per metric ton in the catchment area.
- Pine Pulpwood Stumpage. Pine pulpwood (PPW) stumpage prices increased from an average of $5.81 per metric ton in 2000 to $12.26 per metric ton in 2008. However, since 2008, PPW prices have declined an average of 5.2% per year (-55% total) and to $5.53 per metric ton in 2023.
- Hardwood Sawtimber Stumpage. Hardwood sawtimber (HST) stumpage prices trended upwards from less than $18 per metric ton in 2000 to more than $43 per metric ton in 2016. Since 2016, HST prices have held relatively steady and averaged more than $42 per metric ton in the AR Satellite Plant catchment area.
- Hardwood Pulpwood Stumpage. Hardwood pulpwood (HPW) stumpage prices, although somewhat volatile, trended upwards from an average of $4.03 per metric ton in 2000 to $17.12 per metric ton in 2015. However, HPW prices have declined an average of 4.9% per year since and to $11.50 per metric ton in 2023.

Additionally, we'd like to highlight several notable trends and observations:

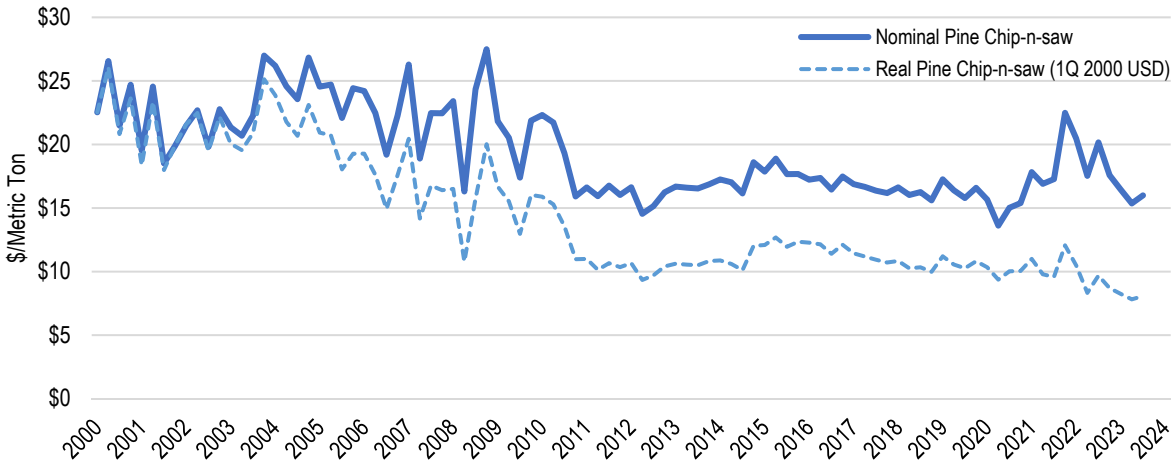
- PST stumpage prices were already on the decline prior to the Great Recession (which officially lasted from December 2007 through June 2009), with prices peaking at $50.85 per metric ton in 2Q 2005. From the peak of $50.85 per metric ton in 2Q 2005 to the post-recession low of $22.49 per metric ton in 4Q 2012, PST stumpage prices declined 56%.
- From 2000 up until the beginning of the Great Recession, PST stumpage prices held an average premium of more than 90% of HST stumpages prices. A reversal occurred in the late-2000s and early-2010s, and since 2015, HST stumpage prices have averaged a nearly 55% premium over PST stumpage prices.

See Figures 44 and 45 for nominal and real quarterly average stumpage prices in the AR Cluster catchment area for the five major timber products from 1Q 2000 – 3Q 2023. Corresponding prices are provided in tabular form in Appendix A.

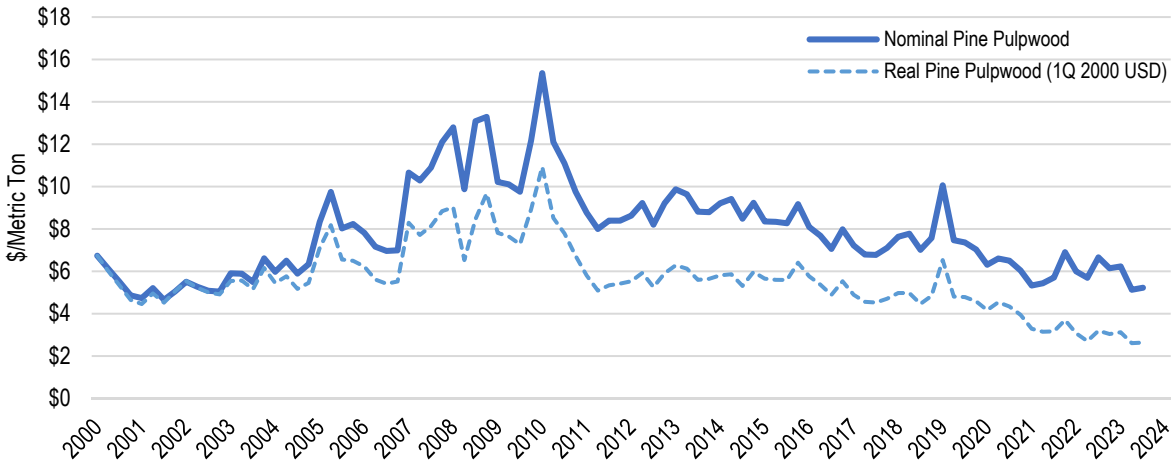
***Figure 44**. AR Cluster Catchment Area – Nominal & Real Quarterly Pine Stumpage Prices ($/Metric Ton)*



(a) Pine Sawtimber Stumpage

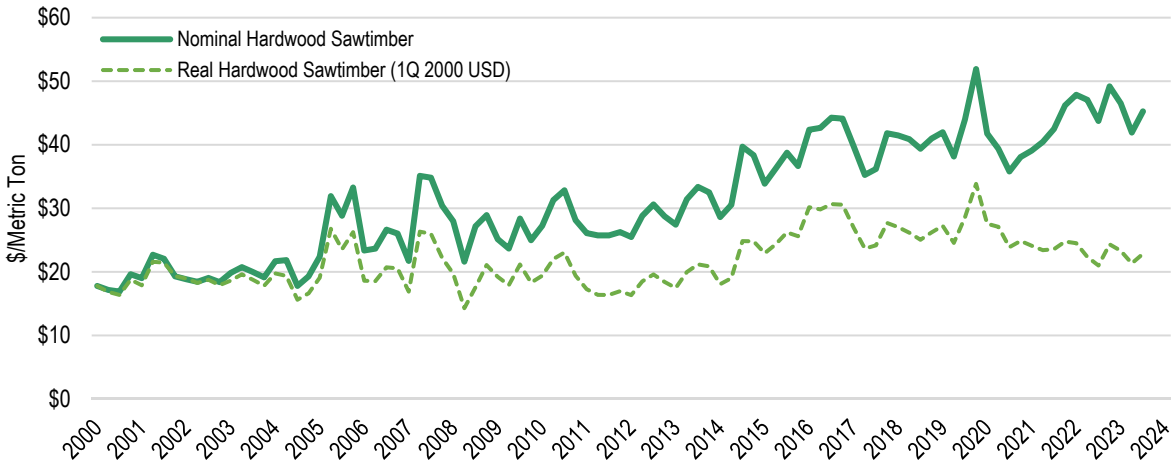


(b) Pine Chip-n-saw Stumpage

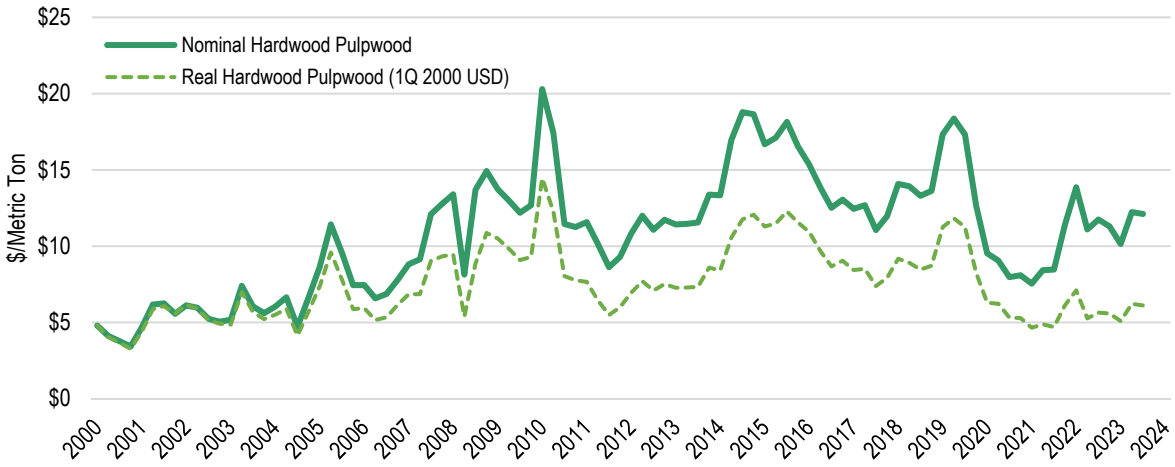


(c) Pine Pulpwood Stumpage

***Figure 45**. AR Cluster Catchment Area – Nominal & Real Quarterly Hardwood Stumpage Prices ($/Metric Ton)*



(a) Hardwood Sawtimber Stumpage



(b) Hardwood Pulpwood Stumpage

5.3.2 *Delivered Timber Prices*

Delivered prices are those paid for timber delivered to the mill. These prices include stumpage (standing timber) price plus any costs associated with cutting, loading, and hauling timber to the mill.

Table 40 below provides annual average (nominal) delivered timber prices in the AR Cluster catchment area for each of the five major timber products since 2000.

***Table 40**. AR Cluster Catchment Area – Annual Delivered Timber Prices ($/Metric Ton)*

Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
			($/Metric Ton)		
2000	$61.57	$42.44	$21.77	$34.69	$20.32
2001	$53.51	$38.72	$21.77	$37.11	$23.61
2002	$54.75	$37.31	$23.23	$37.38	$24.29
2003	$55.58	$38.35	$24.15	$36.14	$24.29
2004	$57.21	$40.68	$23.36	$35.32	$24.11
2005	$57.52	$38.94	$30.10	$37.09	$29.36
2006	$56.56	$35.82	$26.00	$39.88	$24.42
2007	$57.11	$37.57	$33.04	$41.83	$29.33
2008	$54.83	$39.11	$34.04	$43.92	$33.25
2009	$43.47	$35.56	$29.91	$44.24	$32.50
2010	$48.96	$38.58	$32.32	$46.57	$34.74
2011	$43.98	$35.31	$28.86	$46.29	$29.79
2012	$43.39	$35.48	$30.76	$53.97	$33.41
2013	$44.23	$38.01	$30.88	$57.00	$34.25
2014	$47.12	$38.55	$31.72	$61.36	$39.34
2015	$48.56	$39.62	$30.94	$64.37	$40.28
2016	$47.98	$38.59	$30.21	$70.01	$37.06
2017	$46.45	$37.36	$30.48	$64.02	$34.66
2018	$46.38	$37.58	$30.58	$64.35	$34.82
2019	$48.02	$37.83	$29.95	$66.34	$38.97
2020	$47.85	$37.02	$28.32	$64.23	$31.33
2021	$51.95	$42.45	$28.06	$66.54	$33.73
2022	$53.50	$43.84	$29.30	$72.97	$35.86
2023	$53.21	$43.94	$29.74	$72.87	$38.28

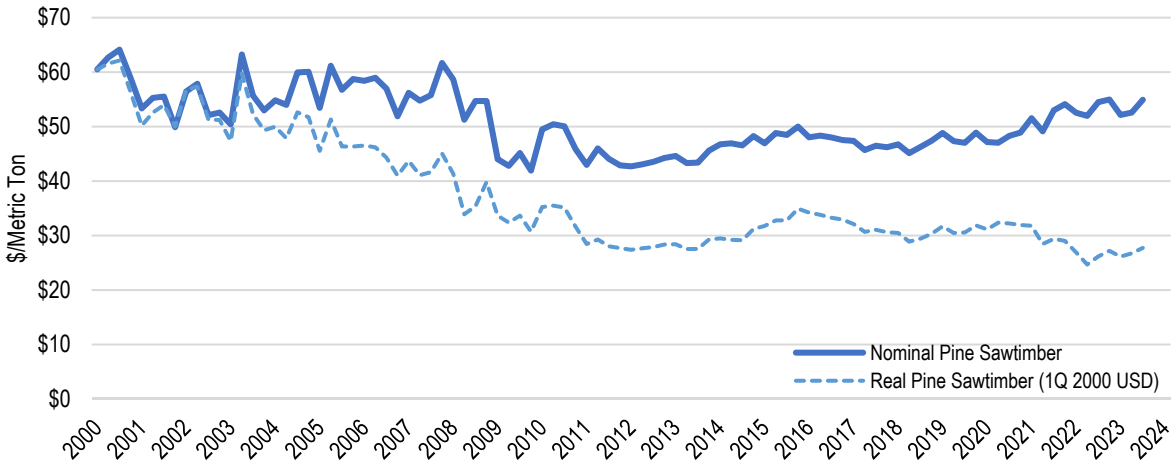
Source: TimberMart-South

Trends/changes with nominal delivered timber prices in the catchment area since 2000 are as follows:

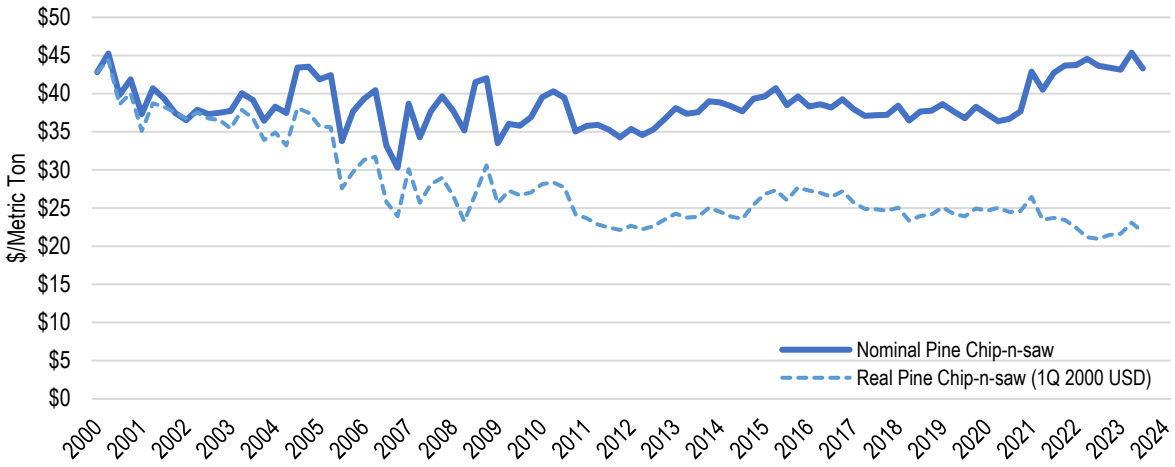
- Delivered Pine Sawtimber. Delivered pine sawtimber (PST) prices averaged $56.72 per metric ton from 2000-2007 before declining to less than $44 per metric ton in 2012. Delivered PST prices rebounded a bit and held steady at roughly $47 per metric ton from 2014-2020. However, prices have increased more than 10% since and to more than $53 per metric ton in 2023.
- Delivered Pine Chip-n-saw. Delivered pine chip-n-saw (CNS) prices trended overall flat through the 2000s and 2010s, averaging roughly $38 per metric ton from 2000-2020. However, delivered CNS prices increased 15% in 2021 and have since held steady and averaged more than $43 per metric ton in the AR Satellite Plant catchment area.
- Delivered Pine Pulpwood. Delivered pine pulpwood (PPW) prices trended upwards and increased an average 4.0% per year (+48% total) from $21.77 per metric ton in 2000 to $32.32 per metric ton in 2010. Delivered PPW prices declined slightly in 2011 but since 2012 have held steady and averaged approximately $30 per metric ton in the AR Cluster catchment area.
- Delivered Hardwood Sawtimber. Delivered hardwood sawtimber (HST) prices held steady and averaged roughly $36 per metric ton from 2000-2004 before increasing an average of 5.9% per year to approximately $70 per metric ton in 2015. Since 2015, prices have held steady and averaged nearly $68 per metric ton in the catchment area.
- Delivered Hardwood Pulpwood. Delivered hardwood pulpwood (HPW) prices increased at an average rate of 4.7% per year (+98% total) from $20.32 per metric ton in 2000 to $40.28 per metric ton in 2015. Prices have declined slightly since, averaging nearly $36 per metric ton since 2016.

See Figures 46 and 47 for nominal and real quarterly average delivered prices in the AR Cluster catchment area for the five major timber products from 1Q 2000 – 3Q 2023. Corresponding prices are provided in tabular form in Appendix A.

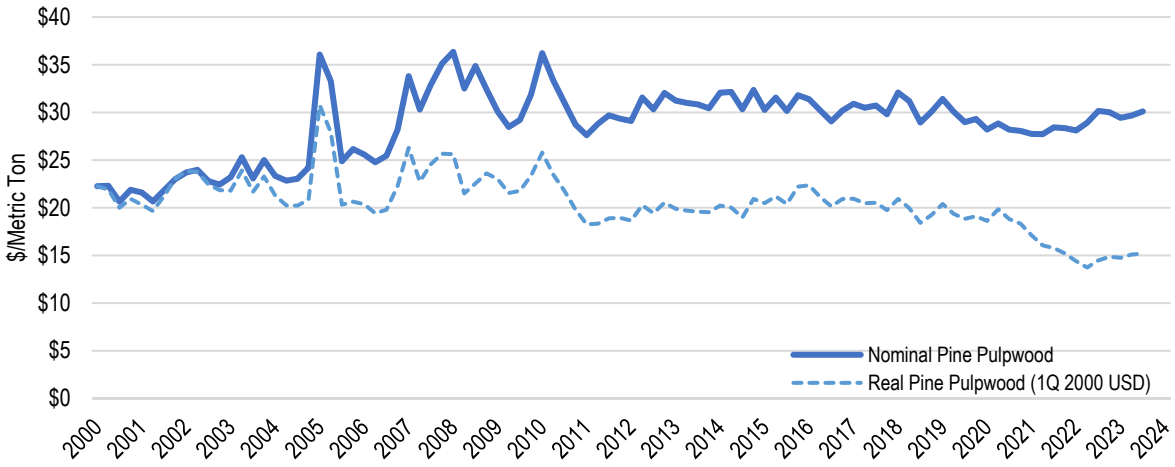
***Figure 46**. AR Cluster Catchment Area - Nominal & Real Quarterly Delivered Pine Prices ($/Metric Ton)*



(a) Delivered Pine Sawtimber

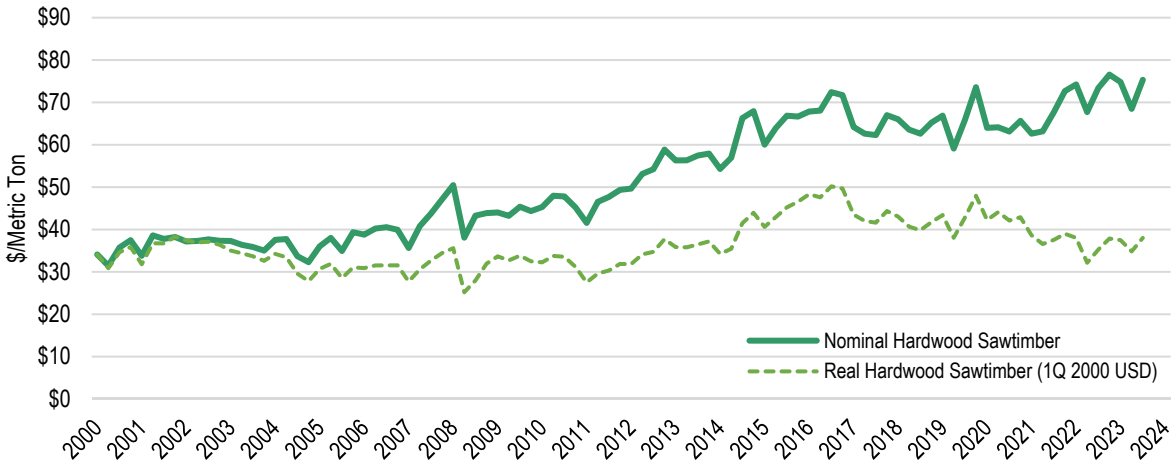


(b) Delivered Pine Chip-n-saw

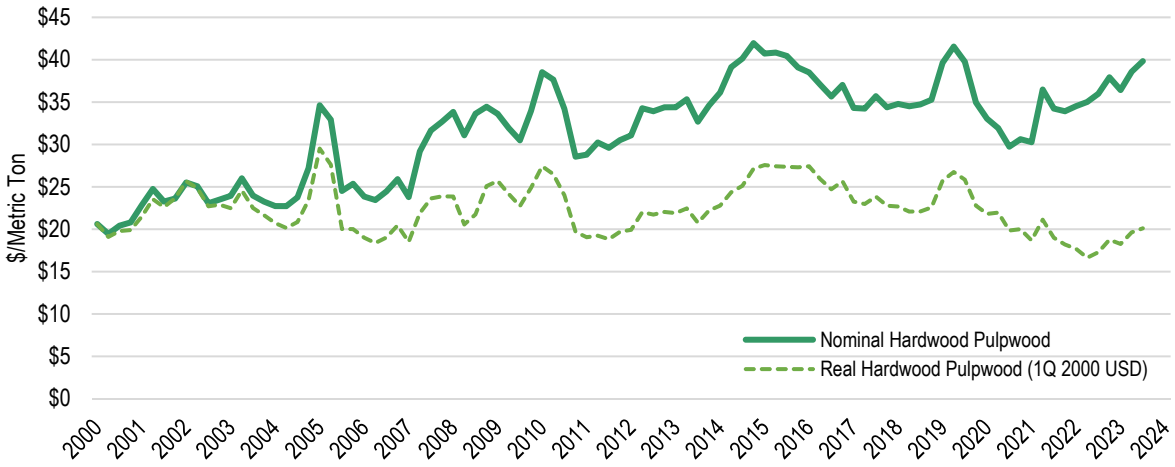


(c) Delivered Pine Pulpwood

***Figure 47**. AR Cluster Catchment Area - Nominal & Real Quarterly Delivered Hardwood Prices ($/Metric Ton)*



(a) Delivered Hardwood Sawtimber



(b) Delivered Hardwood Pulpwood

5.3.3 *Pulp Quality Chip & Planer Shaving Prices*

Pulpwood quality chips (FOB point of production) include both pine and hardwood sawmill chips (sawmill residuals) and pine and hardwood chip mill chips.

Table 41 below provides annual average (nominal) pulp quality chip and planer shaving prices in the AR Cluster catchment area since 2000. Prices are also shown graphically in Figures 48 and 49.

***Table 41**. AR Cluster Catchment Area – Annual Pulp Quality Chip & Planer Shaving Prices ($/Metric Ton)*

Year	Pine Sawmill Chips	Hardwood Sawmill Chips	Pine Chip Mill Chips	Hardwood Chip Mill Chips	Pine Planer Shavings*
			($/Metric Ton – FOB point of production)		
2000	$24.56	$27.83	$30.95	$29.17	-
2001	$24.18	$24.59	$32.27	$30.72	-
2002	$23.51	$24.38	$31.95	$30.55	-
2003	$22.72	$24.12	$31.51	$33.27	-
2004	$23.09	$22.04	$29.20	$31.27	-
2005	$24.31	$23.14	$29.07	$31.82	-
2006	$24.93	$24.52	$32.85	$31.85	-
2007	$27.64	$24.69	$36.78	$36.37	-
2008	$32.21	$26.52	$45.74	$36.99	-
2009	$31.55	$25.67	$43.20	$38.19	-
2010	$30.28	$25.36	$44.49	$42.94	$36.24
2011	$28.49	$25.72	$39.89	$39.96	$31.43
2012	$28.27	$26.39	$39.22	$41.35	$30.56
2013	$29.35	$28.59	$39.78	$41.56	$27.97
2014	$29.52	$31.84	$40.22	$44.32	$31.97
2015	$31.05	$35.01	$40.68	$45.85	$34.37
2016	$29.08	$30.75	$38.54	$45.33	$35.10
2017	$28.43	$31.98	$39.27	$41.44	$35.93
2018	$28.89	$31.44	$39.39	$42.13	$36.47
2019	$29.08	$34.30	$38.85	$44.77	$37.91
2020	$28.58	$32.96	$38.25	$41.03	$38.39
2021	$27.78	$34.14	$38.62	$42.28	$44.49
2022	$27.27	$33.60	$39.88	$44.36	$53.68
2023	$23.77	$33.22	$39.32	$43.90	$51.36

***Planer shaving prices are South-wide average prices. State or catchment area-level pricing is unavailable for this product.
Source: TimberMart-South

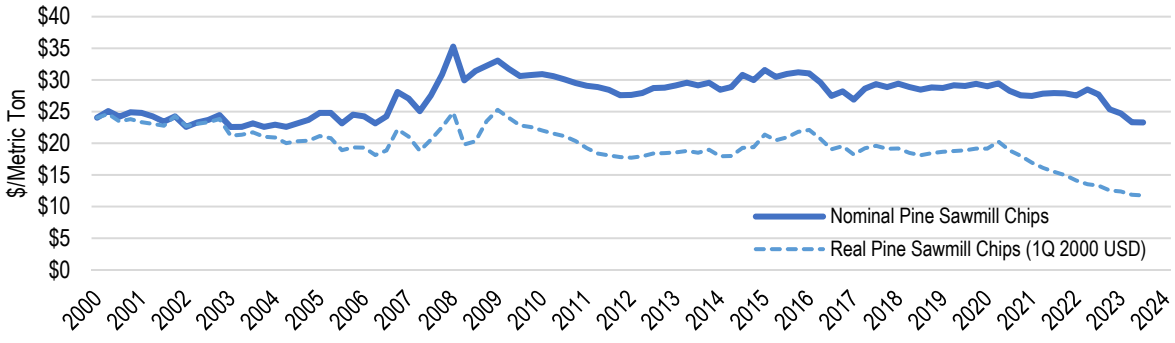
Pulpwood quality chips (FOB point of production) include both pine and hardwood sawmill chips (sawmill residuals) and pine and hardwood chip mill chips. Trends/changes with nominal chip, sawmill residual, and planer shaving prices since 2000 are as follows:

- Pine Sawmill Chips (Sawmill Residuals). Pine sawmill chip prices trended flat and averaged nearly $24 per metric ton from 2000-2006 before increasing more than 30% and to $32.21 per metric ton in 2008. Prices stabilized and averaged approximately $29 per metric ton from 2009 through 2022 before falling to less than $24 per metric ton in 2023.
- Pine Chip Mill Chips. Pine chip mill chip prices have trended similarly to pine sawmill chip prices, averaging roughly $32 per metric ton from 2000-2007 but increasing and stabilizing at around $40 per metric ton since 2008.
- Hardwood Sawmill Chips (Sawmill Residuals). Prices for hardwood sawmill chips averaged approximately $25 per metric ton from 2000 through 2011 before increasing to $35 per metric ton in 2015. Prices has held steady since and averaged nearly $33 per metric ton in the catchment area.
- Hardwood Chip Mill Chips. Hardwood chip mill chip prices increased steadily from roughly $29 per metric ton in 2000 to nearly $46 per metric ton in 2015. Prices have stabilized since, averaging more than $43 per metric ton since 2016.

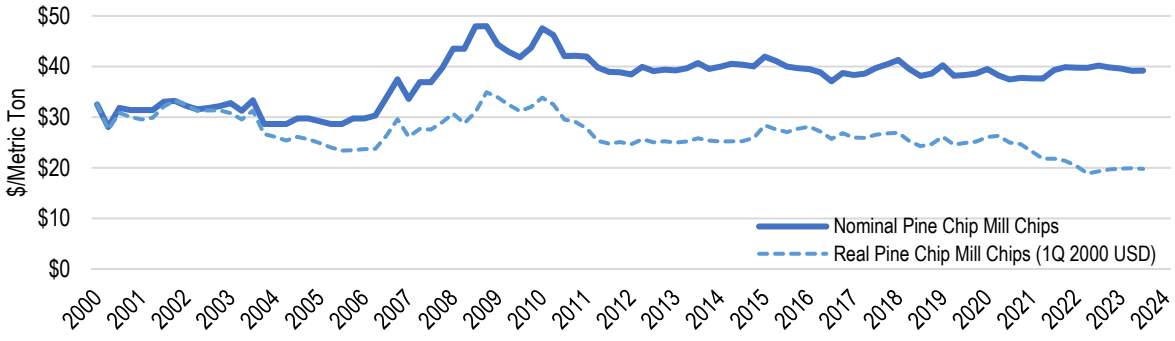
  In addition, we'd like to note that chip mill chip prices have historically remained above sawmill chip prices, with pine and hardwood chip mill chip prices averaging a 37% over pine and hardwood sawmill chip prices since 2000.
- Pine Planer Shavings. Pine planer shaving prices declined from $36.24 per metric ton in 2010 to just below $28 per metric ton in 2013 before steadily increasing to $38.39 per metric ton in 2020. However, prices proceeded to increase 40% to $53.68 per metric ton in 2022 before decreasing slightly to $51.36 per metric ton in 2023.

See Figure 48 for nominal and real quarterly average prices for pine sawmill chips, pine chip mill chips, hardwood sawmill chips, and hardwood chip mill chips in the AR Cluster catchment area from 1Q 2000 – 3Q 2023. See Figure 49 for nominal and real quarterly average prices for pine planer shavings in the AR Cluster catchment area from 1Q 2010 – 3Q 2023. Corresponding prices are provided in tabular form in Appendix A.

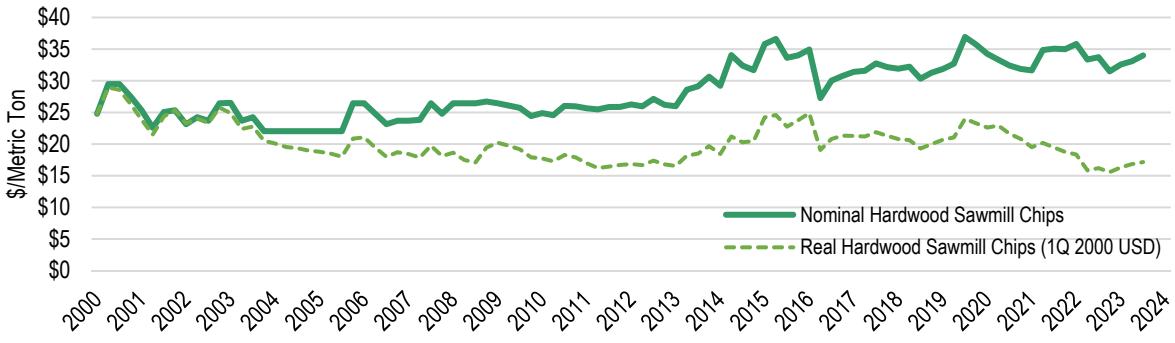
***Figure 48**. AR Cluster Catchment Area - Nominal & Real Quarterly Pulp Quality Chip Prices ($/Metric Ton)*



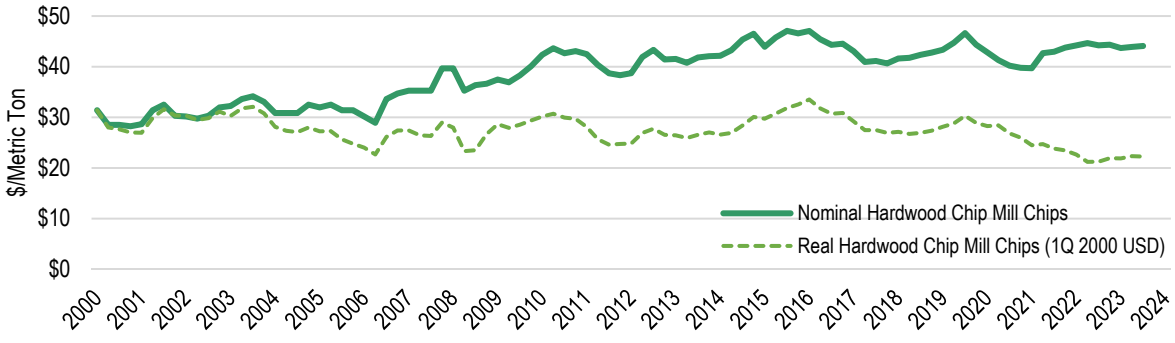
(a) Pine Sawmill Chips



(b) Pine Chip Mill Chips

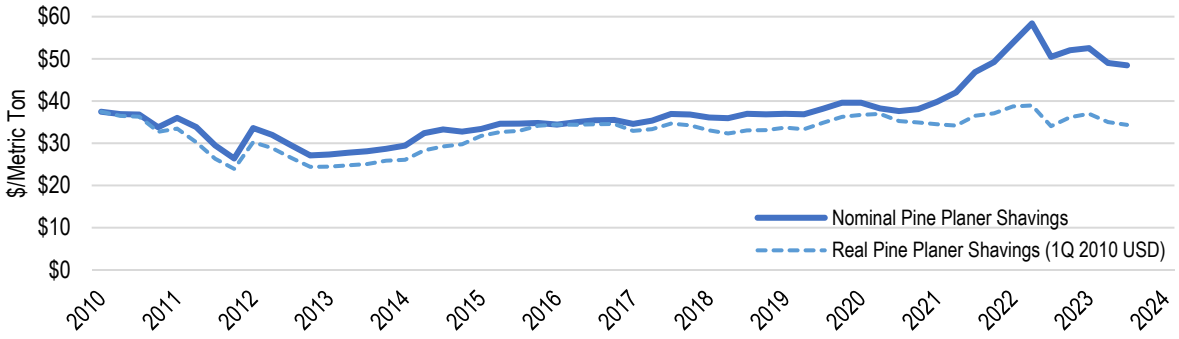


(c) Hardwood Sawmill Chips



(d) Hardwood Chip Mill Chips

***Figure 49**. US South - Nominal & Real Quarterly Pine Planer Shaving Prices ($/Metric Ton)*



Note: Planer shaving prices are unavailable at the state or catchment area level. Historic South-wide average planer shaving prices are only available back to 2010.

5.3.4 *Raw Material Price Outlook*

Historically, raw material purchases for pellet mills operating in and around the AR Cluster catchment area have included a mix of pine pulpwood (roundwood), pine chips, and other pine sawmill residuals. Specifically, over the last five years, pine pulpwood and pine sawmill residuals have accounted for over 95% of total raw material purchases by the bioenergy sector in this catchment area, with pine sawmill residuals, specifically, accounting for 33-35% of total purchases. Hardwood pulpwood, hardwood chips, and secondary hardwood residuals have accounted for the remaining 5% of raw material purchases.

Given that pine pulpwood, pine sawmill chips, and pine planer shavings constitute an overwhelming majority of the raw materials purchased by the bioenergy industry in this catchment area, and that these specific raw materials are expected to account for a majority of the raw materials purchased by these mills over the next several years, our price forecasts focus specifically on these pine products.

Delivered pine pulpwood, pine sawmill chips, and pine planer shaving price forecasts are as follows:

- Delivered Pine Pulpwood. Based on our analysis of raw material prices in the catchment area, including anticipated changes in biomass demand and total softwood pulpwood demand moving forward, we forecast a modest 2% increase in delivered pine pulpwood (PPW) price from 2023 through 2026. Specifically, delivered PPW prices are forecasted to average $30.15 per metric ton from 2024-2026.
- Pine Sawmill Chips. Pine sawmill chip prices are forecasted to rebound to approximately $27.50 per metric ton in 2024, a 16% increase from 2023 levels, after which prices are projected to hold steady and average approximately $27.75 per metric ton from 2025-2026.
- Pine Planer Shavings. Pine planer shaving prices are forecasted to decline slightly from an average of $51.36 per metric ton in 2023 to $49.85 per metric ton in 2026. Overall, pine planer shaving prices are forecasted to average $50.25 per metric ton from 2024-2026, down 2% from 2023 average levels.

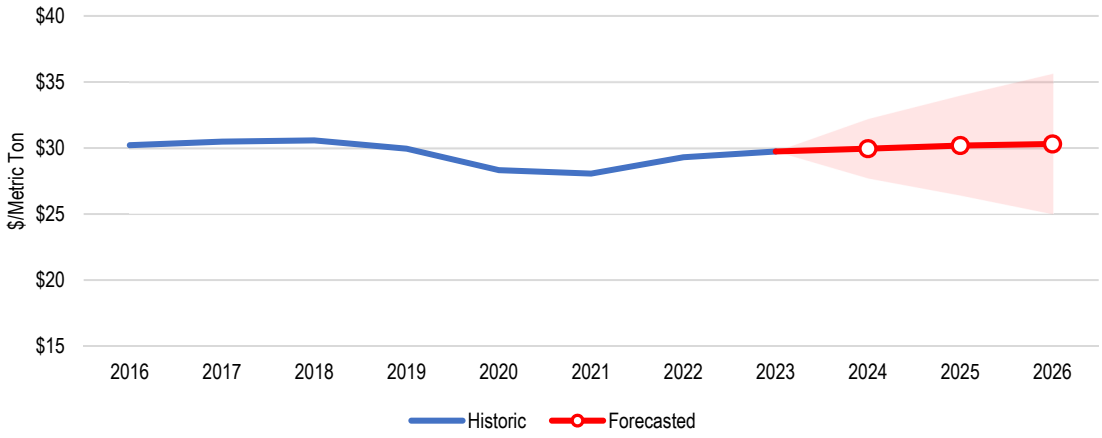
***Table 42**. AR Cluster Catchment Area - Forecasted Delivered Pine Pulpwood, Pine Sawmill Chips, & Pine Planer Shaving Prices (2024-2026)*

Year	Delivered Pine Pulpwood	Pine Sawmill Chips	Pine Planer Shavings
		($/Metric Ton)	
2000	$21.77	$24.56	-
2001	$21.77	$24.18	-
2002	$23.23	$23.51	-
2003	$24.15	$22.72	-
2004	$23.36	$23.09	-
2005	$30.10	$24.31	-
2006	$26.00	$24.93	-
2007	$33.04	$27.64	-
2008	$34.04	$32.21	-
2009	$29.91	$31.55	-
2010	$32.32	$30.28	$36.24
2011	$28.86	$28.49	$31.43
2012	$30.76	$28.27	$30.56
2013	$30.88	$29.35	$27.97
2014	$31.72	$29.52	$31.97
2015	$30.94	$31.05	$34.37
2016	$30.21	$29.08	$35.10
2017	$30.48	$28.43	$35.93
2018	$30.58	$28.89	$36.47
2019	$29.95	$29.08	$37.91
2020	$28.32	$28.58	$38.39
2021	$28.06	$27.78	$44.49
2022	$29.30	$27.27	$53.68
2023	$29.74	$23.77	$51.36
2024	$29.95	$27.52	$50.75
2025	$30.19	$27.71	$50.15
2026	$30.31	$27.80	$49.85

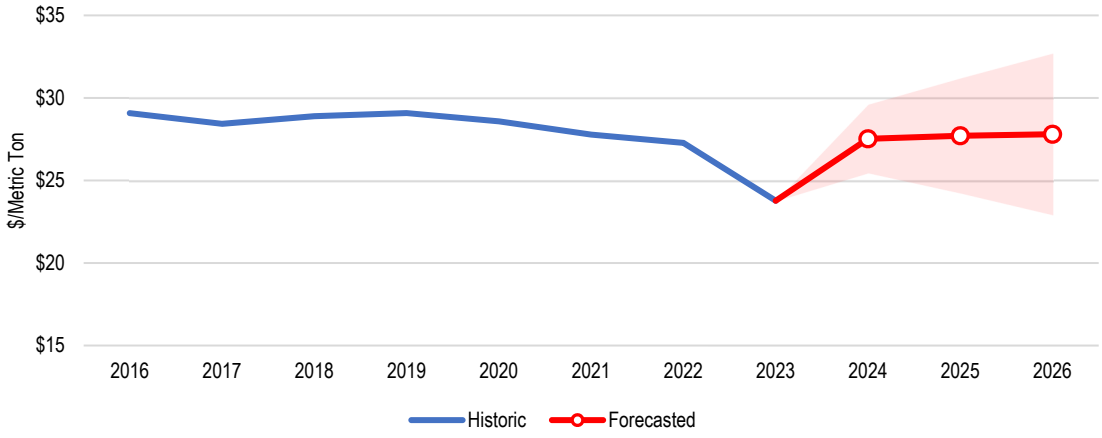
**Forecasted values*

Note that forecasted values are based on Hood Consulting's assessment of historical prices as well as assumptions regarding future wood demand in the AR Cluster catchment area.

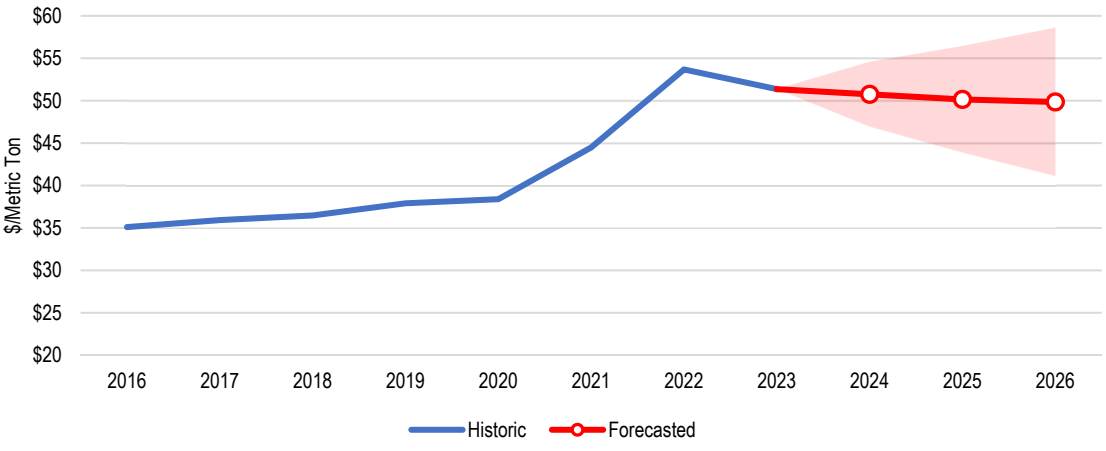
***Figure 50**. AR Cluster Catchment Area Price Forecasts: Delivered Pine Pulpwood, Pine Sawmill Chips, Pine Chip Mill Chips, & Planer Shavings (2024-2026)*



(a) Delivered Pine Pulpwood



(b) Pine Sawmill Chips



(c) Pine Planer Shavings

Table 43 provides a cost index (2020=100) of historic and forecasted per-unit pine raw material costs for the wood pellet mills in the AR Cluster catchment area from 2016 through 2026. These index values are based on the historic distributions and prices of pine pulpwood, pine sawmill chips, and pine planer shavings purchases by the pellet mills in the catchment area. These index values are intended to show how average per-unit raw material costs have changed and are projected to change for bioenergy mills over the next several years. Note that these index calculations are not based on actual raw material costs incurred by either of Drax's satellite pellet plants or any other facility but rather based on average market prices in the AR Cluster catchment area.

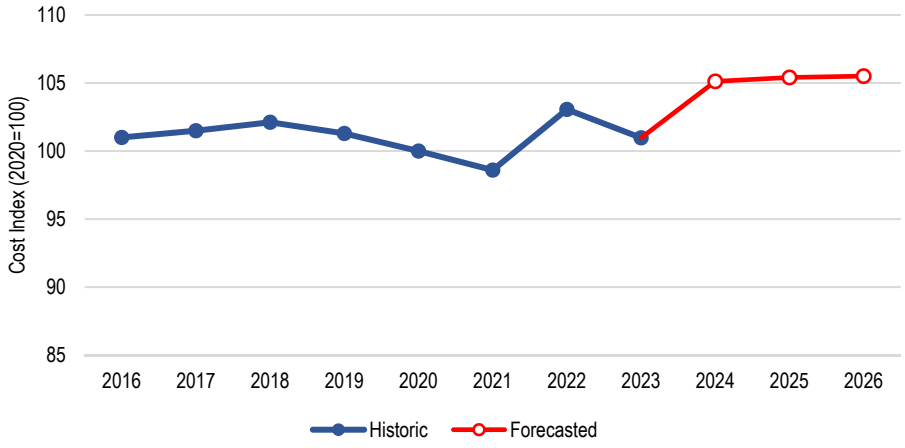
Average per-unit pine costs for a pellet mill in the catchment area increased 2% from 2016-2022 before decreasing 2% in 2023. However, based on our forecasts and anticipated changes in product mix consumption, average per-unit pine raw material costs are projected to increase 4% in 2024 but hold steady and increase only marginally in 2025 and 2026.

***Table 43**. AR Cluster Catchment Area – Pine Raw Material Per-Unit Cost Index (2020=100)*

Year	Pine Raw Material Cost Index (2020 = 100)
2016	101
2017	101
2018	102
2019	101
2020	100
2021	99
2022	103
2023	101
2024	105
2025	105
2026	105

**Forecasted*

***Figure 51**. Historic & Projected Raw Material Per Unit Index Cost (2020=100)*



6. Forest Management Practices Assessment

Historic timber sales reported to TimberMart-South were examined to help assess how forest management practices in the AR Cluster catchment area and surrounding market has changed since 2000. Specifically, we examined trends related to total sale volume, hectares, and harvest type to identify how this area responds to various market conditions. Study details and key findings are detailed below and on the following pages.

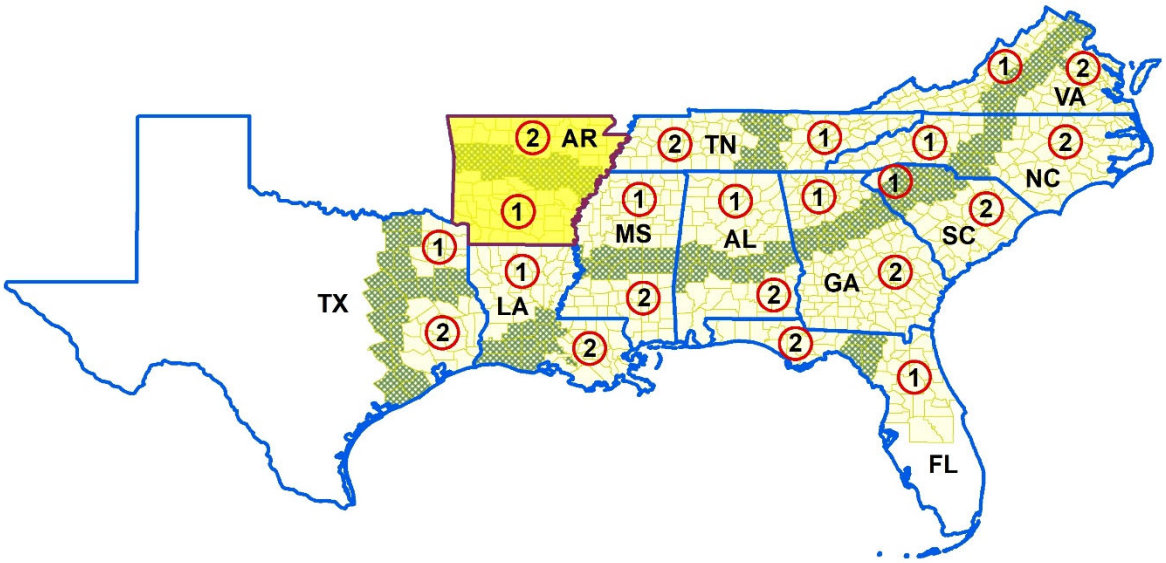
6.1 TimberMart-South Harvest Trends

The TimberMart-South (TMS) sales database includes over 120,000 unique timber sales that have occurred throughout the TMS 11-state region since 2000. In addition to providing details regarding timber prices (by product), these reported sales include information regarding date of sale, location, sale volume, sale size (hectares), sale type (final harvest/clearcut vs. thinning), and other unique sale characteristics. The data provided in the following section contains some of these stumpage characteristic details, particularly those related to trends in sale type and harvesting activities.

The AR Cluster catchment area is located in two different TMS regions: Arkansas Region 1 and Arkansas Region 2 (see highlighted portion in Figure 52 below). Data and trends for this multi-region area (denoted 'AR Satellite Plant market' in this section) have been provided by TimberMart-South and are intended to be representative of the catchment area.

Note that TMS database sales utilized for this portion of the assessment only includes those reported sales with total sale volumes between 500 and 50,000 metric tons. Sales that fell outside these parameters were excluded to ensure consistency and to mitigate potential bias from major outliers.

***Figure 52**. TimberMart-South Region Map*



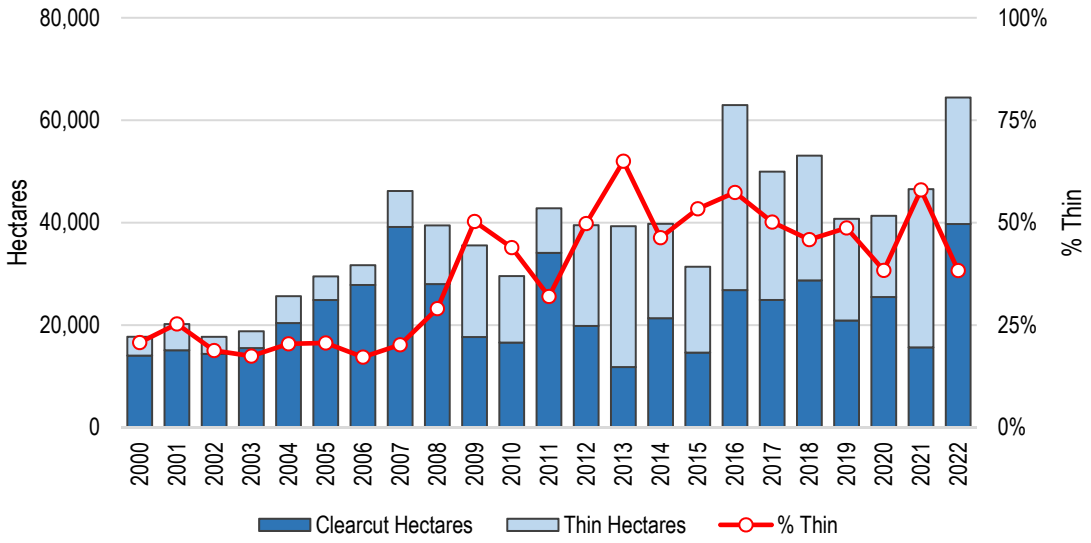
6.1.1 *Total Sale Hectares*

In the AR Cluster market, the total area of all timber sales reported to TMS has averaged roughly 37,600 hectares per year since 2000 (see Figure 53). However, TMS data shows a shift in the distribution of reported sale area by harvest type (clearcut vs. thinning) in examining trends throughout this period.

Clearcuts and thinnings are the two major types of harvests that occur in the region, both of which are long-standing, widely used methods of harvesting timber. In the AR Cluster market, thinnings accounted for approximately 20% of the total reported harvest area from 2000-2007. However, since 2008, thinnings have accounted for nearly 50% of total reported harvest area.

Note that this shift coincided with the bursting of the US housing bubble and Great Recession that followed. During this period, pine sawtimber markets weakened substantially, with pine sawtimber stumpage prices decreasing 50% in the catchment area from 2007-2012. The data suggests that landowners refrained from clear cutting during this period – waiting for the price of pine sawtimber (a higher-value product) to recover. However, a full pine sawtimber recovery never occurred and prices have stabilized below pre-recession levels.

***Figure 53**. Total Reported Sale Hectares by Harvest Type (2000-2022)*



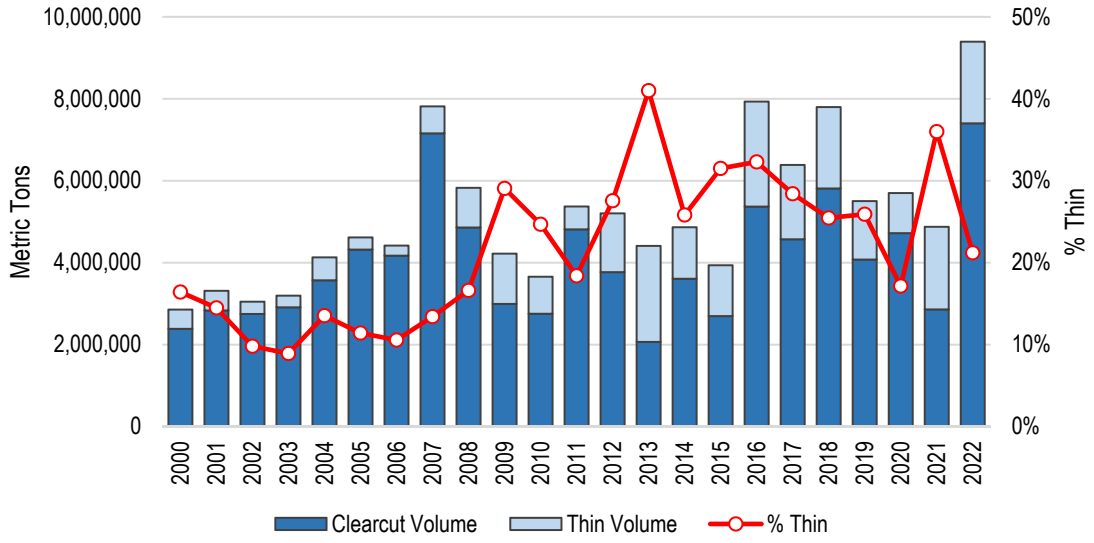
**Please note that these values do not represent the total hectares of all timber harvested in this market, but rather the total number of acres reported to TimberMart-South by its contributing reporters.*

6.1.2 *Total Sale Volume*

In the AR Cluster market, the total volume of all timber sales reported to TMS has averaged nearly 5.2 million metric tons per year since 2000 (see Figure 54). However, as with reported sale area, the distribution of harvest volume by specific harvest type has also experienced a shift over the last two decades.

Examination of total sale volume reported to TMS by harvest type shows the proportion of total volume attributed to thinnings increased from an average of 13% per year from 2000-2008 to an average of 27% per year since 2009. Note that the increased distribution of volume thinned (relative to volume clearcut) beginning in the late-2000s coincided with the weakening of sawtimber markets. However, as pine sawtimber stumpage have stabilized, so too has the distribution of total harvest volume by harvest type.

***Figure 54**. Total Reported Sale Volume by Harvest Type (2000-2022)*



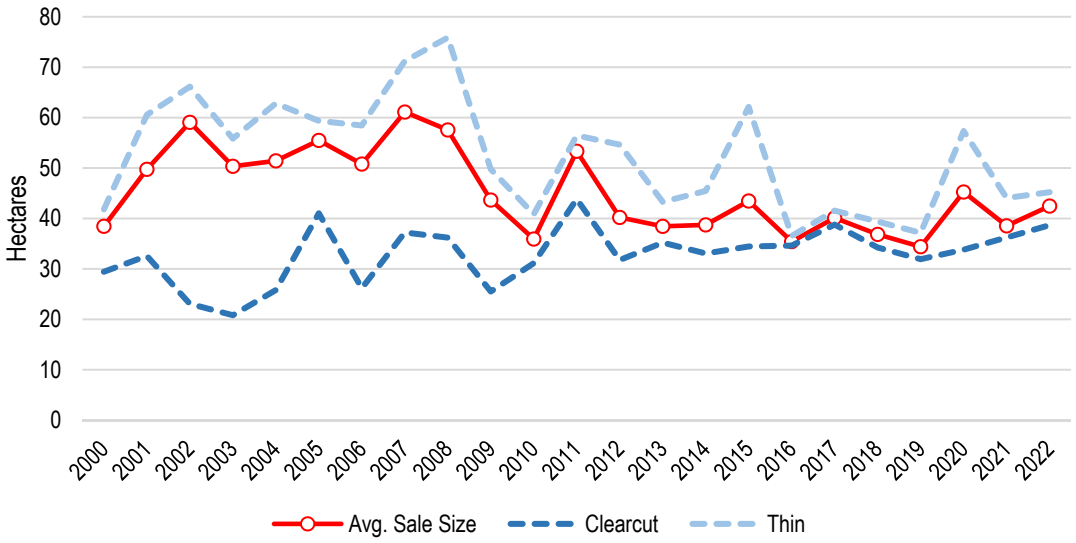
**Please note that these values do not represent the actual volume of all timber harvested in this market, but rather the total volume of harvested timber reported to TimberMart-South by its contributing reporters.*

6.1.3 *Average Sale Size*

The average size of timber sales reported to TMS in the AR Cluster market averaged approximately 45 hectares from 2000-2022. TimberMart-South data also shows that thinnings have averaged 60% larger (+19 hectares) than clearcuts since 2000, with thinnings averaging 52 hectares in size compared to 33 hectares for clearcuts.

In general, clearcuts tend to be smaller than thinnings in size due to capital requirements for the logger/wood buyer. To elaborate, clearcuts typically remove more timber volume per hectare (and higher-value timber products) compared to thinnings. So, for example, given the same amount of capital, a wood buyer/logger can purchase a 40-hectare tract to be clearcut or a 60-hectare tract to be thinned. Also, loggers/wood buyers typically prefer larger tracts for thinning because it allows them to take advantage of economies of scale. Furthermore, timberland owners and managers that adhere to Sustainable Forestry Initiative (SFI) standards must limit the size of cleacuts to an average of approximately 50 hectares or smaller in size.

***Figure 55**. Average Reported Sale Size by Harvest Type (2000-2022)*



7. Market Trends & Correlation Analysis

The following section provides an examination and assessment of forest market trends in the AR Cluster catchment area since 2005. Specifically, correlation analysis was used to identify any relationships between biomass demand and key variables, including timberland, inventory, fiber prices.

Correlation analysis is a statistical method used to measure the direction and strength of the linear relationship between two variables. The correlation coefficient is measured on a scale that ranges from -1 to +1. A perfect positive correlation has a value of 1.0, whereas a perfect negative correlation has a value of -1.0. A value of zero (0) indicates no identifiable relationship.

Within this assessment, relationships are defined as follows based on correlation coefficient values:

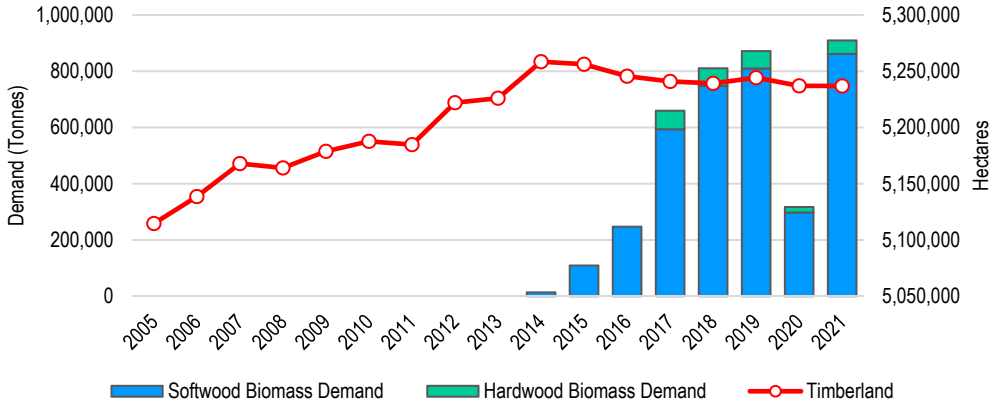
Relationship	Correlation Coefficient
Perfect positive	1.00
Strong positive	0.80 to 0.99
Moderate positive	0.60 to 0.79
Weak positive	0.35 to 0.59
None	-0.34 to 0.34
Weak negative	-0.35 to -0.59
Moderate negative	-0.60 to -0.79
Strong negative	-0.80 to -0.99
Perfect negative	-1.00

7.1 Biomass Demand vs. Timberland

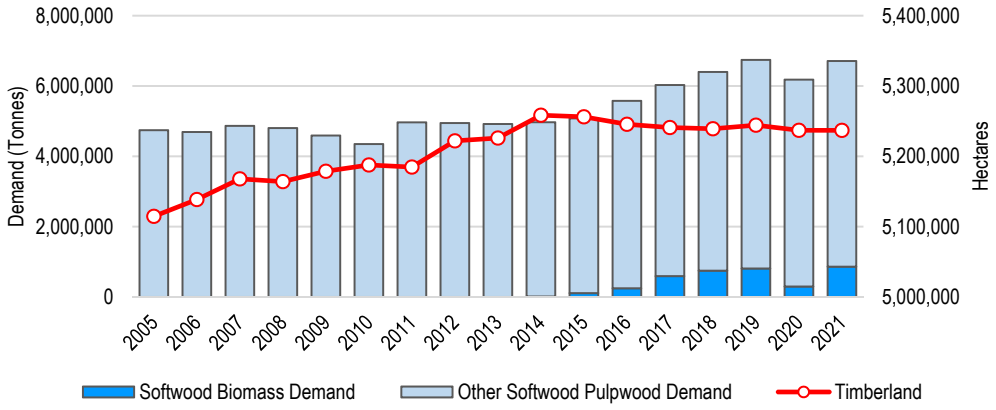
Figure 56 provides a side-by-side comparison of both biomass demand and softwood pulpwood demand versus timberland hectares in the catchment area from 2005-2021. In comparing changes in biomass demand to changes in timberland hectares, no discernable relationship appears evident. Specifically, total biomass demand increased from nearly 250,000 metric tons in 2016 to an average of roughly 970,000 metric tons per year from 2018-2021 (excluding 2020, when Highland Pellets was temporarily shut down). However, this increase in biomass demand coincided with only a marginal change in timberland hectares.

Correlation analysis did identify a weak positive correlation (correlation coefficient=0.52) between total biomass demand and timberland hectares from 2005-2021. However, this relationship appears to be more coincidental in nature and does not provide sufficient evidence to suggest causation. Furthermore, the overall increase in timberland since the mid-2000s appears to more closely linked to changes in farmland, as farmland (i.e. cropland and pastureland) and timberland were found to have a strong negative relationship (correlation coefficient=-0.91).

***Figure 56**. AR Cluster Catchment Area – Biomass Demand & Total Softwood Pulpwood Demand vs. Timberland Hectares (2005-2021)*



(a) Biomass Demand vs. Timberland Acres



(b) Softwood Pulpwood Demand vs. Timberland Acres

***Table 44**. Correlation Analysis –Biomass Demand, Pulpwood Demand & Timberland Hectares (2005-2021)*

	Softwood Biomass Demand	*Other Softwood Pulpwood Demand*	*Total Softwood Pulpwood Demand*	*Pine Timberland*	*Total Timberland*
Softwood Biomass Demand	1				
Other Softwood Pulpwood Demand	0.87	1			
Total Softwood Pulpwood Demand	0.95	0.98	1		
Pine Timberland	0.77	0.87	0.86	1	
Total Timberland	0.53	0.62	0.60	0.89	1

	Hardwood Biomass Demand	*Other Hardwood Pulpwood Demand*	*Total Hardwood Pulpwood Demand*	*Hardwood Timberland*	*Total Timberland*
Hardwood Biomass Demand	1				
Other Hardwood Pulpwood Demand	-0.48	1			
Total Hardwood Pulpwood Demand	-0.40	0.99	1		
Hardwood Timberland	-0.74	0.82	0.79	1	
Total Timberland	0.45	-0.58	-0.56	-0.62	1

	Softwood Biomass Demand	*Hardwood Biomass Demand*	*Total Biomass Demand*	*Total Timberland*
Softwood Biomass Demand	1			
Hardwood Biomass Demand	0.94	1		
Total Biomass Demand	0.99	0.95	1	
Total Timberland	0.53	0.45	0.52	1

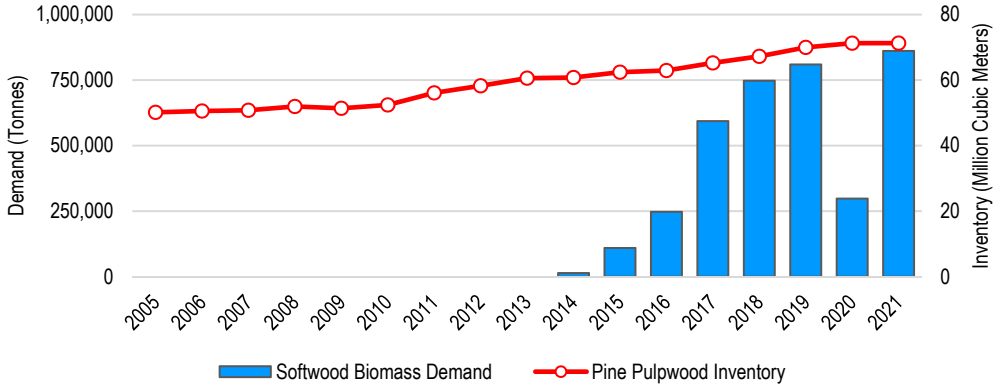
7.2 Biomass Demand vs. Timber Inventory

US Forest Service data shows that total timber inventory increased 32% in the AR Cluster catchment area from 2005-2021. Intuitively, timber inventories can increase one of two ways: 1) through additional timberland gains or 2) through an environment in which annual growth outpaces annual removals. In this catchment area, both occurred over this period.

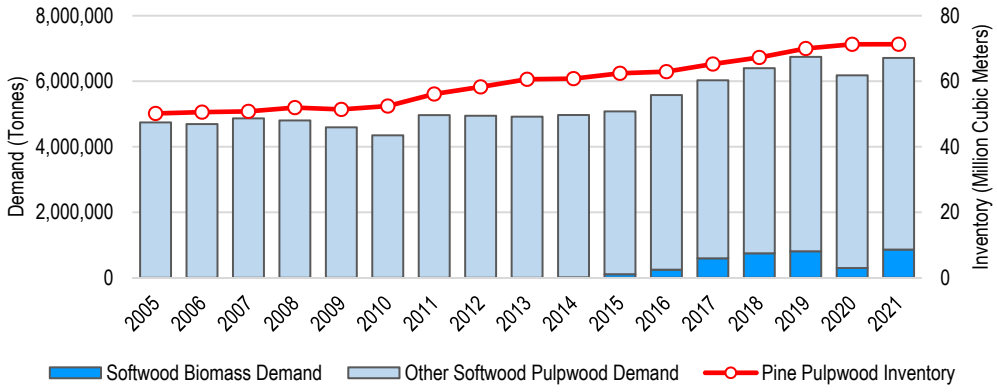
In particular, inventories of pine pulpwood – the predominant timber product utilized by the bioenergy industry for pellet production – held flat from 2005-2010 but have since increased at an average rate of 2.8% per year (+36% total) in the catchment area.

Ultimately, correlation analysis identified a strong positive relationship between pine pulpwood inventory and pine pulpwood demand (correlation coefficient=0.91) from 2005-2021. While a strong positive relationship (correlation coefficient=0.81) was also found between pine pulpwood inventory and softwood biomass demand, the increase in pine pulpwood inventory over this period was not due to increased softwood pulpwood demand from bioenergy. Rather, the increase in inventory level can be more closely linked to both increases in timberland and increased pine sawlog harvest levels in the early and mid-2000s.

***Figure 57**. AR Cluster Catchment Area – Softwood Pulpwood Demand vs. Pine Pulpwood Inventory (2005-2021)*



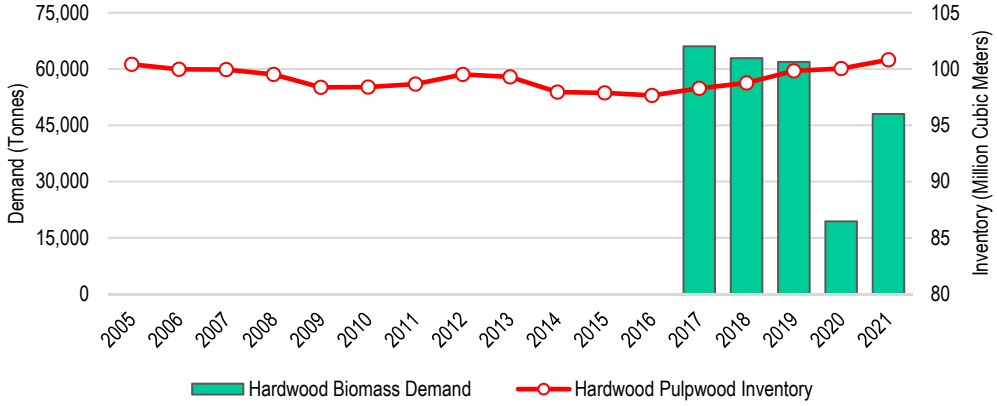
(a) Softwood Biomass Demand vs. Pine Pulpwood Inventory



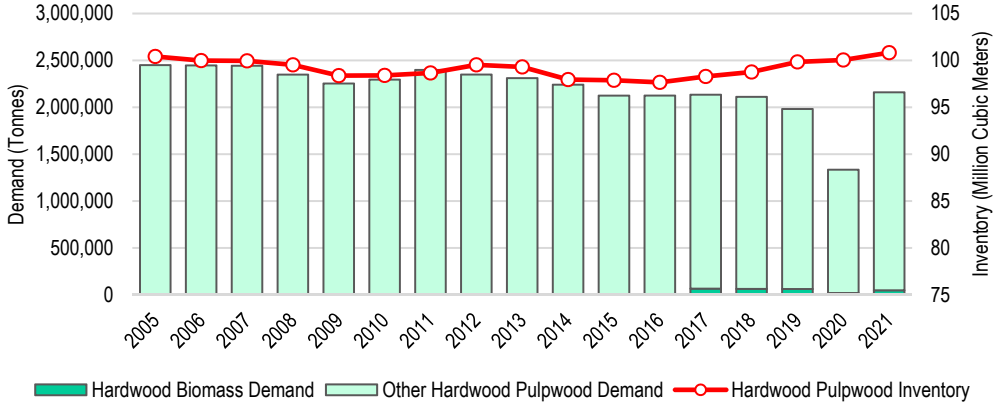
(b) Softwood Pulpwood Demand vs. Softwood Pulpwood Inventory

Hardwood pulpwood inventory was also examined alongside hardwood pulpwood demand, and correlation analysis identified no relationship between these two variables. No identifiable relationship was found between hardwood pulpwood inventory and hardwood biomass demand in the catchment area.

***Figure 58**. AR Cluster Catchment Area – Hardwood Pulpwood Demand vs. Hardwood Pulpwood Inventory (2005-2021)*



(a) Hardwood Biomass Demand vs. Hardwood Pulpwood Inventory



(b) Hardwood Pulpwood Demand vs. Hardwood Pulpwood Inventory

***Table 45**. Correlation Analysis –Biomass Demand, Pulpwood Demand & Timber Inventory (2005-2021)*

	Softwood Biomass Demand	*Other Softwood Pulpwood Demand*	*Total Softwood Pulpwood Demand*	*Pine Pulpwood Inventory*	*Total Pine Inventory*
Softwood Biomass Demand	1				
Other Softwood Pulpwood Demand	0.87	1			
Total Softwood Pulpwood Demand	0.95	0.98	1		
Pine Pulpwood Inventory	0.81	0.92	0.91	1	
Total Pine Inventory	0.84	0.93	0.92	0.99	1

	Hardwood Biomass Demand	*Other Hardwood Pulpwood Demand*	*Total Hardwood Pulpwood Demand*	*Hardwood Pulpwood Inventory*	*Total Hardwood Inventory*
Hardwood Biomass Demand	1				
Other Hardwood Pulpwood Demand	-0.48	1			
Total Hardwood Pulpwood Demand	-0.40	0.99	1		
Hardwood Pulpwood Inventory	0.15	-0.04	-0.03	1	
Total Hardwood Inventory	0.67	-0.77	-0.74	0.06	1

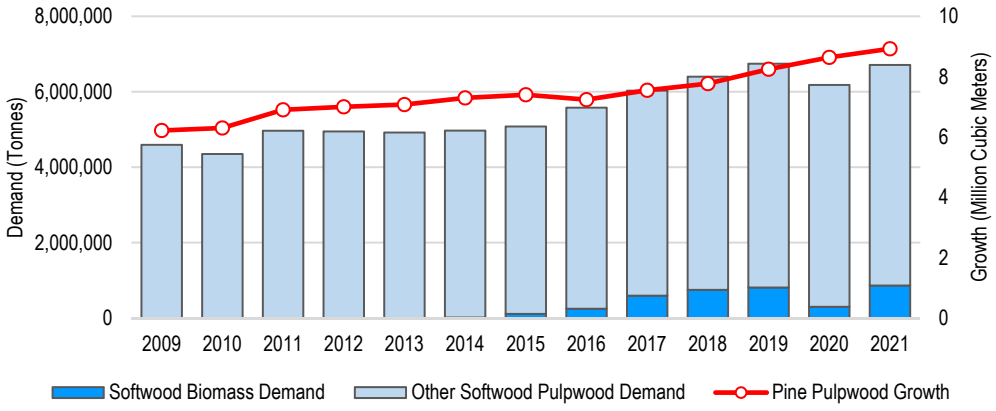
	Softwood Biomass Demand	*Hardwood Biomass Demand*	*Total Biomass Demand*	*Total Pulpwood Inventory*	*Total Inventory*
Softwood Biomass Demand	1				
Hardwood Biomass Demand	0.94	1			
Total Biomass Demand	0.99	0.95	1		
Total Pulpwood Inventory	0.83	0.73	0.82	1	
Total Inventory	0.83	0.72	0.82	0.99	1

7.3 Biomass Demand vs. Timber Growth

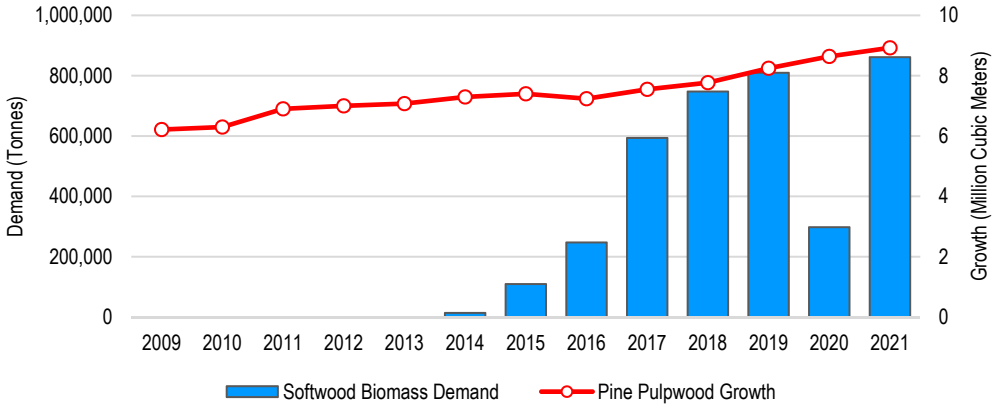
Figure 59 provides a side-by-side comparison of softwood pulpwood demand (including biomass demand) and annual pine pulpwood growth in the catchment area from 2009-2021. In particular, Figure 59(a) shows total softwood pulpwood demand holding steady before increasing beginning in the mid-2010s, with pine pulpwood growth exhibiting a similar trend. Statistical analysis ultimately identified a strong positive correlation (correlation coefficient=0.90) between these two variables from 2009-2021.

Similarly, Figure 59(b) shows that softwood biomass demand, in particular, has generally tracked softwood pulpwood growth in the catchment area since 2009 (correlation coefficient=0.77). However, this moderately strong positive correlation does not link increases in softwood pulpwood growth to increased demand from bioenergy, as this positive relationship is more coincidental in nature. In the AR Cluster catchment area, the increase in softwood pulpwood growth can be more closely linked to increases in planted pine timberland, which has translated into increased inventory and ultimately increased growth.

***Figure 59**. AR Cluster Catchment Area – Softwood Pulpwood Demand vs. Annual Pine Pulpwood Growth (2009-2021)*



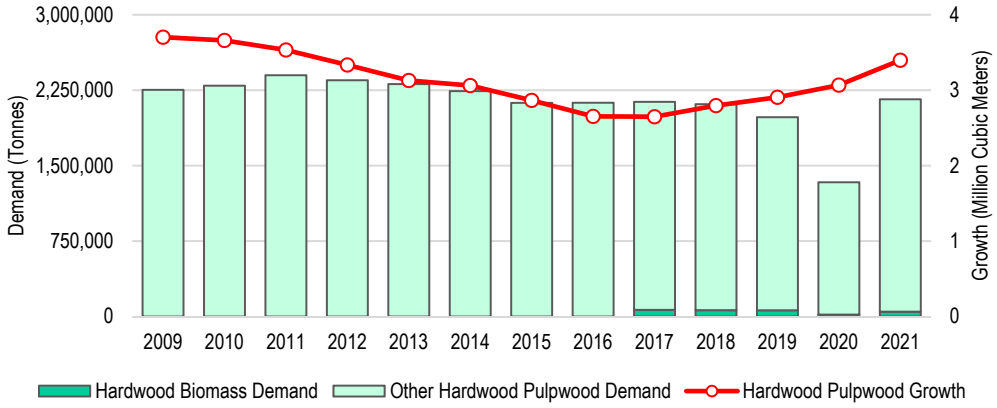
(a) Softwood Pulpwood Demand vs. Pine Pulpwood Growth



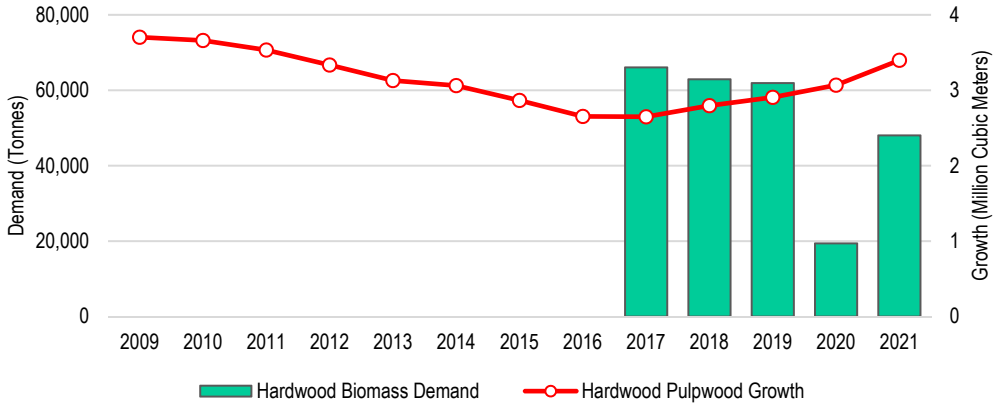
(b) Softwood Biomass Demand vs. Pine Pulpwood Growth

Looking at Figure 60, no discernable relationship appears evident between hardwood pulpwood demand and hardwood pulpwood growth from 2009-2021. This lack of relationship was confirmed with statistical analysis (correlation coefficient=0.34). The overall decrease in hardwood pulpwood growth since 2009 can be more closely linked to the roughly 130,000-hectare decrease in hardwood timberland (on account of conversion to pine) that occurred from 2009-2021 as well as reduced hardwood harvest levels since 2009.

***Figure 60**. AR Cluster Catchment Area – Hardwood Pulpwood Demand vs. Annual Hardwood Pulpwood Growth (2009-2021)*



(a) Hardwood Pulpwood Demand vs. Hardwood Pulpwood Growth



(b) Hardwood Biomass Demand vs. Hardwood Pulpwood Growth

***Table 46**. Correlation Analysis –Biomass Demand, Pulpwood Demand & Annual Timber Growth (2009-2021)*

	Softwood Biomass Demand	*Other Softwood Pulpwood Demand*	*Total Softwood Pulpwood Demand*	*Pine Pulpwood Growth*	*Total Pine Growth*
Softwood Biomass Demand	1				
Other Softwood Pulpwood Demand	0.85	1			
Total Softwood Pulpwood Demand	0.94	0.97	1		
Pine Pulpwood Growth	0.77	0.93	0.90	1	
Total Pine Growth	0.74	0.87	0.85	0.97	1

	Hardwood Biomass Demand	*Other Hardwood Pulpwood Demand*	*Total Hardwood Pulpwood Demand*	*Hardwood Pulpwood Growth*	*Total Hardwood Growth*
Hardwood Biomass Demand	1				
Other Hardwood Pulpwood Demand	-0.38	1			
Total Hardwood Pulpwood Demand	-0.29	0.99	1		
Hardwood Pulpwood Growth	-0.45	0.38	0.34	1	
Total Hardwood Growth	0.48	-0.58	-0.55	0.02	1

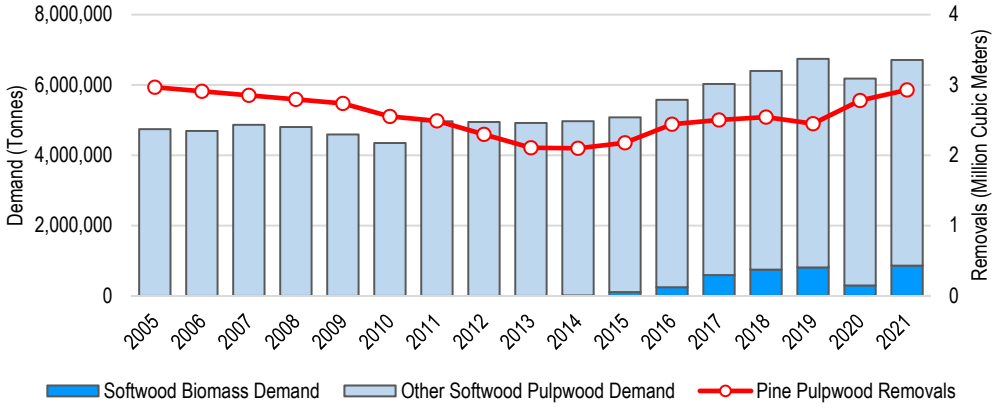
	Softwood Biomass Demand	*Hardwood Biomass Demand*	*Total Biomass Demand*	*Total Pulpwood Growth*	*Total Growth*
Softwood Biomass Demand	1				
Hardwood Biomass Demand	0.94	1			
Total Biomass Demand	0.99	0.95	1		
Total Pulpwood Growth	0.63	0.48	0.62	1	
Total Growth	0.72	0.57	0.71	0.98	1

7.4 Biomass Demand vs. Timber Removals

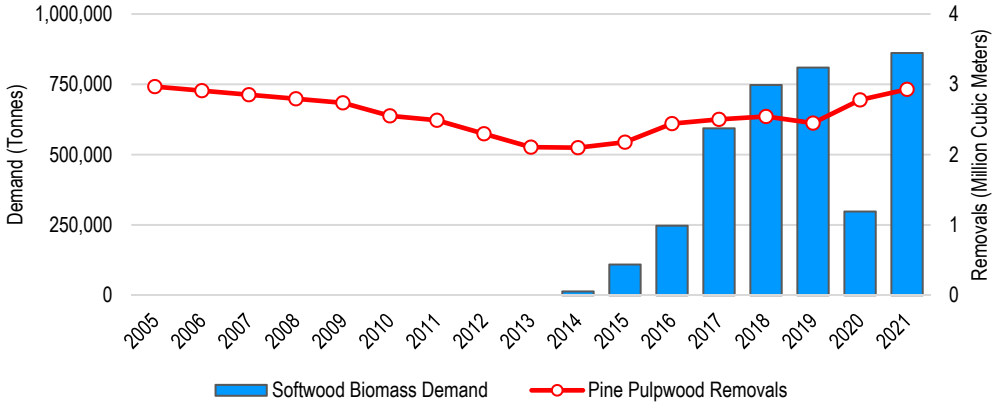
Figure 61 provides a side-by-side comparison of softwood biomass demand and total softwood pulpwood demand versus pine pulpwood removals in the catchment area from 2005-2021. In general, removals should be representative of pulpwood demand and we'd expect these two to be very strongly (positively) correlated, and that's generally what we see in Figure 61 (over the last decade). Statistical analysis confirms this relationship, identifying a moderately-strong positive correlation between total softwood pulpwood demand and pine pulpwood removals (correlation coefficient=0.77) from 2011-2021.

Looking specifically at Figure 61(b), it's difficult to decipher any noticeable relationship between softwood biomass demand and pine pulpwood. Statistical analysis also failed to identify any significant relationship between the two from 2005-2021 (correlation coefficient=0.10). However, note that demand from other sources (i.e. pulp/paper) is the primary driver of pine pulpwood removals in this catchment area, with demand from other sources accounting for 92% of total softwood pulpwood demand since the pellet industry's entrance into this catchment area in the mid-2010s.

***Figure 61**. AR Cluster Catchment Area – Softwood Pulpwood Demand vs. Pine Pulpwood Removals (2005-2021)*



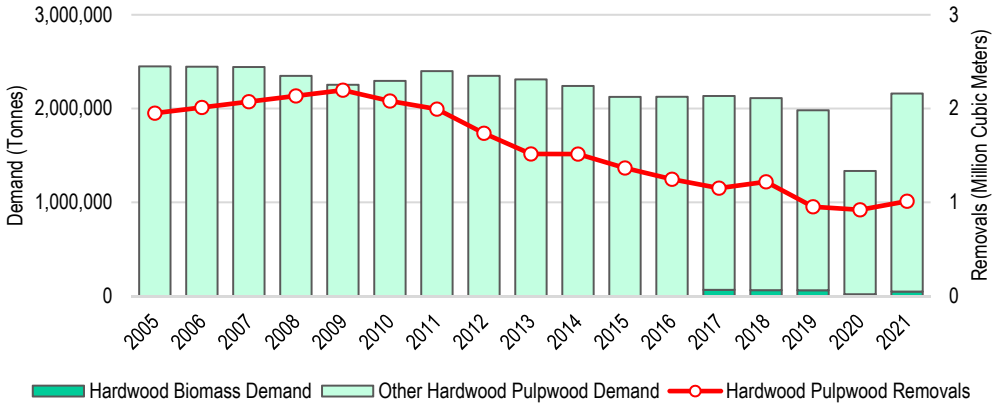
(a) Softwood Pulpwood Demand vs. Pine Pulpwood Removals



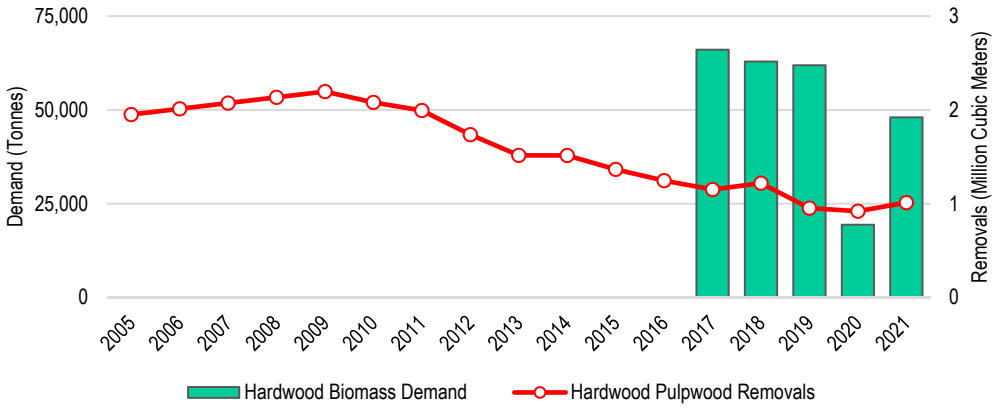
(b) Softwood Biomass Demand vs. Pine Pulpwood Removals

A moderately strong positive relationship was found between total hardwood pulpwood demand and hardwood pulpwood removals (correlation coefficient=0.73) from 2005-2021. However, note that demand from non-bioenergy-related sources, which accounts for 98-99% of total hardwood pulpwood demand, is the primary driver of hardwood pulpwood removals in the catchment area. Statistical analysis identified a moderately strong negative relationship between hardwood biomass demand and hardwood pulpwood removals from 2005-2021 (correlation coefficient=-0.70).

***Figure 62**. AR Cluster Catchment Area –Pulpwood Demand vs. Annual Pulpwood Removals (2005-2021)*



(a) Hardwood Pulpwood Demand vs. Hardwood Pulpwood Removals



(b) Hardwood Biomass Demand vs. Hardwood Pulpwood Removals

***Table 47**. Correlation Analysis –Biomass Demand, Pulpwood Demand & Annual Timber Removals (2005-2021)*

	Softwood Biomass Demand	*Other Softwood Pulpwood Demand*	*Total Softwood Pulpwood Demand*	*Pine Pulpwood Removals*	*Total Pine Removals*
Softwood Biomass Demand	1				
Other Softwood Pulpwood Demand	0.87	1			
Total Softwood Pulpwood Demand	0.95	0.98	1		
Pine Pulpwood Removals	0.10	0.02	0.05	1	
Total Pine Removals	0.23	0.10	0.16	0.91	1

	Hardwood Biomass Demand	*Other Hardwood Pulpwood Demand*	*Total Hardwood Pulpwood Demand*	*Hardwood Pulpwood Removals*	*Total Hardwood Removals*
Hardwood Biomass Demand	1				
Other Hardwood Pulpwood Demand	-0.48	1			
Total Hardwood Pulpwood Demand	-0.40	0.99	1		
Hardwood Pulpwood Removals	-0.70	0.77	0.73	1	
Total Hardwood Removals	-0.71	0.80	0.76	0.97	1

	Softwood Biomass Demand	*Hardwood Biomass Demand*	*Total Biomass Demand*	*Total Pulpwood Removals*	*Total Removals*
Softwood Biomass Demand	1				
Hardwood Biomass Demand	0.94	1			
Total Biomass Demand	0.99	0.95	1		
Total Pulpwood Removals	-0.56	-0.50	-0.56	1	
Total Removals	-0.29	-0.26	-0.29	0.93	1

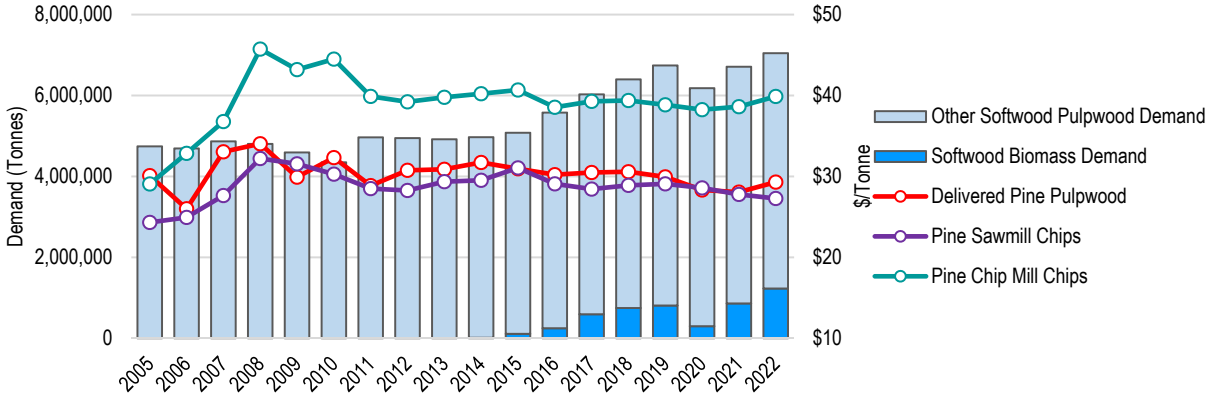
7.5 Biomass Demand vs. Raw Material Costs

Drax's Leola and Russellville satellite pellet mills consume 100% pine sawmill residuals. However, raw material purchases by Highland Pellets as well as other pellet mills that procure fiber from within the AR Cluster catchment area include a combination of softwood pulpwood (roundwood), pine sawmill chips, and other pine sawmill residuals.

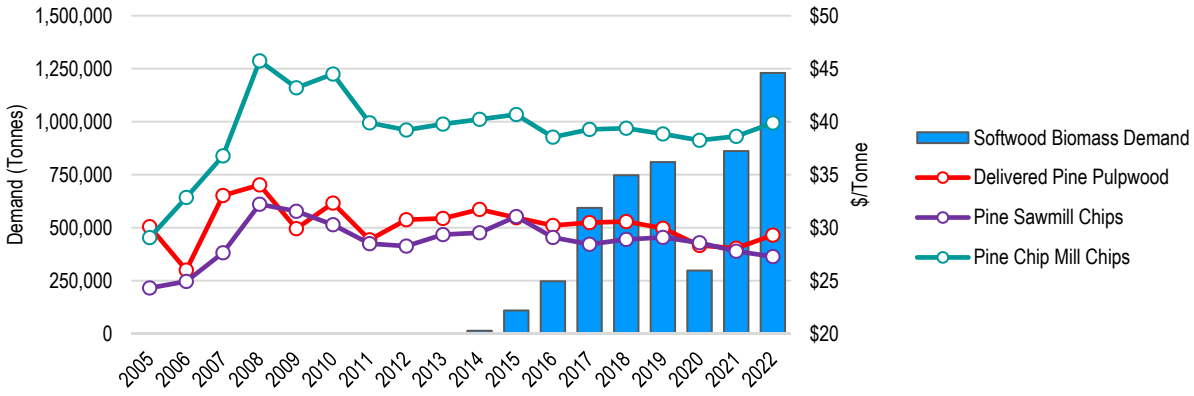
Figure 63 provides a side-by-side comparison of softwood biomass demand and total softwood pulpwood demand versus delivered pine pulpwood, pine sawmill chip, and pine chip mill chip prices in the catchment area from 2005-2022. Intuitively, we'd expect to see prices and demand moving in the same direction, but this is not what we see in this figure. Furthermore, correlation analysis identified no meaningful relationships between total softwood pulpwood demand and each of these three pine raw material prices (see Table 48 on pg. 119). No relationships were also found between softwood biomass demand and these raw material prices.

In this market, there's an imbalance in supply and demand, and the oversupply that exists has made supply no longer a true constraint. Also, as lumber production in this market has increased, sawmill residuals have increasingly replaced roundwood consumption by pulp/paper and pellet mills.

***Figure 63**. AR Cluster Catchment Area – Softwood Pulpwood Demand vs. Delivered Pine Pulpwood, Sawmill Chip, & Chip Mill Chip Prices (2005-2022)*



(a) Softwood Pulpwood Demand vs. Delivered Pine Pulpwood & Pine Chip Prices



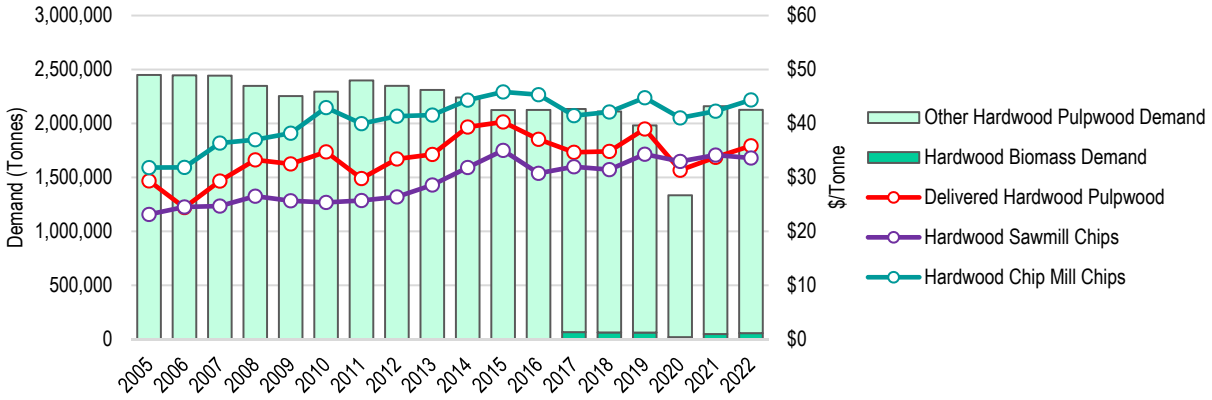
(b) Softwood Biomass Demand vs. Delivered Pine Pulpwood & Pine Chip Prices

Hardwood Pulpwood & Hardwood Chip Prices

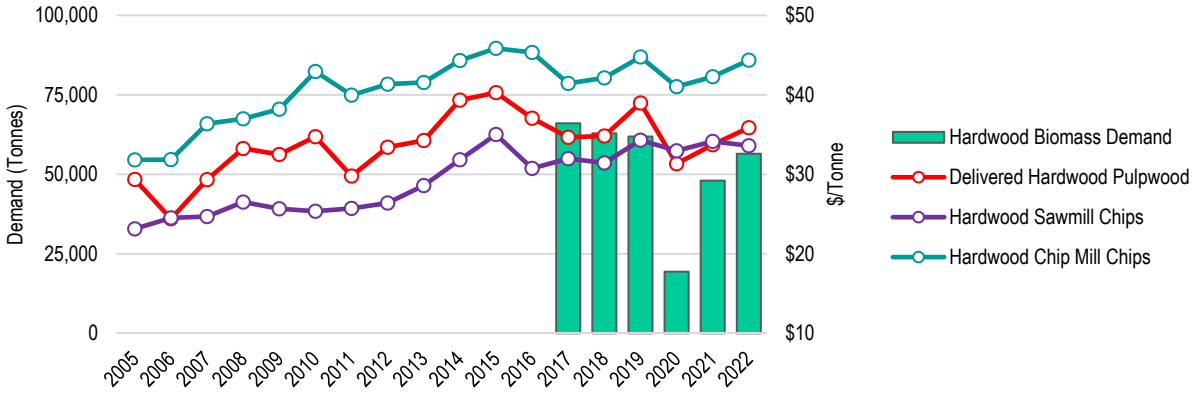
Figure 64 provides a side-by-side comparison of hardwood pulpwood demand and hardwood raw material prices in the catchment area since 2005. As this figure shows, hardwood raw material costs have steadily increased in the catchment area despite demand for hardwood pulpwood steadily decreasing since the mid-2000s. Ultimately, statistical analysis identified weak *negative* correlations between hardwood pulpwood demand and hardwood raw material prices from 2005-2021 (see Table 49 on pg. 119). However, weak to moderately-strong positive correlations were found between hardwood biomass demand and these hardwood raw material prices.

These positive correlations do not provide enough evidence to suggest that increased hardwood pulpwood demand attributed to bioenergy is responsible for increased hardwood pulpwood and hardwood chip prices in the catchment area. While it is completely plausible that increased demand attributed to bioenergy has impacted these hardwood raw material prices, ultimately, hardwood biomass demand accounts for less than 2% of total hardwood pulpwood demand in the AR Cluster catchment area. Furthermore, the increase in these hardwood raw material prices can be more closely linked to decreases in hardwood timberland and limited hardwood pulpwood supply in the catchment area.

***Figure 64**. AR Cluster Catchment Area – Hardwood Pulpwood Demand vs. Delivered Hardwood Pulpwood, Hardwood Sawmill Chip, & Hardwood Chip Mill Chip Prices (2005-2022)*



(a) Hardwood Pulpwood Demand vs. Delivered Hardwood Pulpwood & Hardwood Chip Prices



(b) Hardwood Biomass Demand vs. Delivered Hardwood Pulpwood & Hardwood Chip Prices

Sawtimber Prices

Pine and hardwood sawtimber prices were also examined to assess the impact biomass demand has had on markets for other solid wood products. Specifically, Figure 65 provides a side-by-side comparison of biomass demand versus delivered pine sawtimber, pine chip-n-saw, and hardwood sawtimber prices in the catchment area from 2005-2022.

The prices of all three of these sawtimber products have loosely followed total biomass demand since the mid-2010s. However, that these common trends are coincidental in nature and there is little evidence to suggest that increases in biomass-related wood demand has resulted in changes in sawtimber prices.

Changes in delivered pine sawlog prices, historically, have been largely driven by changes in softwood sawlog demand, and this generally appears to be the case in the catchment area from the mid-2000s through early-2010s (see Figure 66). However, a growing imbalance between supply and demand has caused this relationship to weaken substantially over the last decade. Specifically, since 2015, demand for softwood sawlogs has increased nearly 40% while delivered pine sawtimber and pine chip-n-saw prices have increased only 10%.

***Figure 65**. AR Cluster Catchment Area – Biomass Demand vs. Delivered Pine Sawtimber, Pine Chip-n-saw, & Hardwood Sawtimber Prices (2005-2022)*

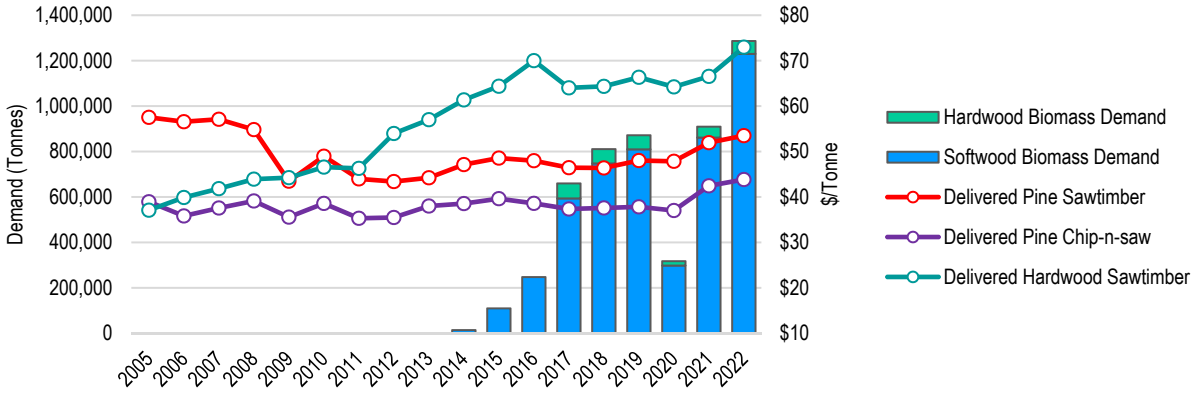


***Figure 66**. AR Cluster Catchment Area – Sawlog Demand vs. Delivered Pine Sawtimber, Pine Chip-n-saw, & Hardwood Sawtimber Prices (2005-2022)*

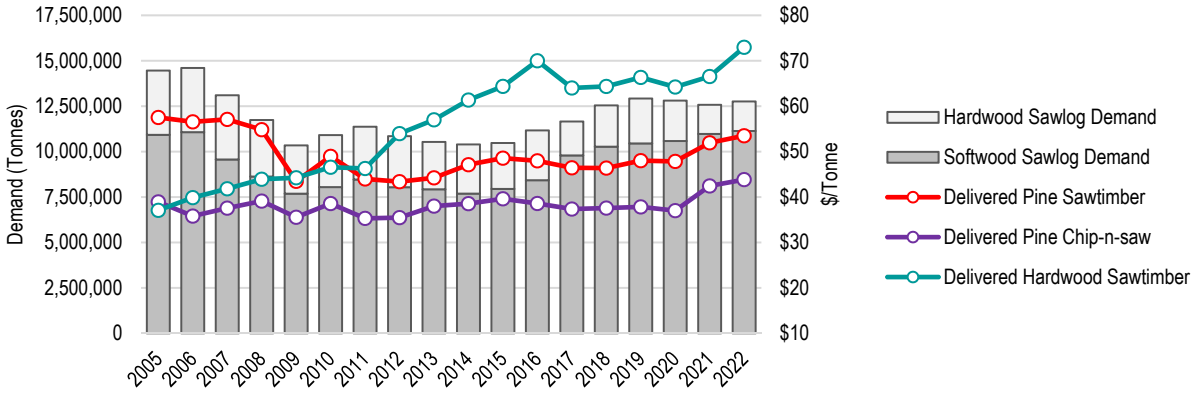


***Table 48**. Correlation Analysis – Softwood Biomass Demand, Delivered Pine Pulpwood Price, Pine Sawmill Chip Price & Pine Chip Mill Chip Price (2005-2022)*

	Softwood Biomass Demand	*Other Softwood Pulpwood Demand*	*Total Softwood Pulpwood Demand*	*Delivered Pine Pulpwood Price*	*Pine Sawmill Chip Price*	*Pine Chip Mill Chip Price*
Softwood Biomass Demand	1					
Other Softwood Pulpwood Demand	0.85	1				
Total Softwood Pulpwood Demand	0.95	0.97	1			
Delivered Pine Pulpwood Price	-0.29	-0.35	-0.34	1		
Pine Sawmill Chip Price	-0.15	-0.13	-0.14	0.57	1	
Pine Chip Mill Chip Price	0.01	-0.08	-0.04	0.51	0.92	1

***Table 49**. Correlation Analysis – Hardwood Biomass Demand, Delivered Hardwood Pulpwood Price, Hardwood Sawmill Chip Price & Hardwood Chip Mill Chip Price (2005-2022)*

	Hardwood Biomass Demand	*Other Hardwood Pulpwood Demand*	*Total Hardwood Pulpwood Demand*	*Delivered Hardwood Pulpwood Price*	*Hardwood Sawmill Chip Price*	*Hardwood Chip Mill Chip Price*
Hardwood Biomass Demand	1					
Other Hardwood Pulpwood Demand	-0.48	1				
Total Hardwood Pulpwood Demand	-0.40	0.99	1			
Delivered Hardwood Pulpwood Price	0.29	-0.31	-0.30	1		
Hardwood Sawmill Chip Price	0.64	-0.70	-0.66	0.72	1	
Hardwood Chip Mill Chip Price	0.35	-0.46	-0.45	0.88	0.78	1

***Table 50**. Correlation Analysis – Sawlog Demand & Delivered Sawtimber Prices (2005-2022)*

	Softwood Sawlog Demand	*Hardwood Sawlog Demand*	*Total Sawlog Demand*	*Delivered Pine Sawtimber*	*Delivered Pine Chip-n-saw*	*Delivered Hardwood Sawtimber*
Softwood Sawlog Demand	1					
Hardwood Sawlog Demand	-0.21	1				
Total Sawlog Demand	0.90	0.23	1			
Delivered Pine Sawtimber	0.59	0.38	0.75	1		
Delivered Pine Chip-n-saw	0.35	-0.52	0.12	0.42	1	
Delivered Hardwood Sawtimber	0.14	-0.84	-0.23	-0.35	0.49	1

8. Analysis Summary & Findings

Provided below and on the following pages is Hood Consulting's overall analysis summary, including a synopsis of key report elements and analysis findings. Please note that any conclusions drawn by Hood Consulting are based on a thorough assessment of the AR Cluster catchment area as well as our industry expertise and knowledge.

- Changes in Forest Area

  According to the US Forest Service (USFS), total timberland in the AR Cluster catchment area experienced a net increase of 122,260 hectares (+2.4%) from 2005-2021, increasing from 5,114,642 to 5,236,902 hectares over this 16-year period. However, note that much of this increase occurred in the late 2000s and early 2010s, with total timberland stabilizing and averaging roughly 5,240,000 hectares since 2016.

  The composition of timberland in the catchment area has also undergone changes over the last two decades. Planted pine timberland (the predominant supplier of pine pulpwood consumed by the pulp/paper and bioenergy industries in this market) increased approximately 406,340 hectares (+44%) from 2005 to 2021. This increase coincided with an approximately 128,000-hectare decrease in natural hardwood timberland, a more than 56,000-hectare decrease in mixed pine-hardwood timberland, and a more than 75,000-hectare decrease in natural pine timberland. Note that the increase in planted pine timberland and decrease in natural hardwood, natural mixed pine-hardwood, and natural pine timberland occurred simultaneously beginning in the mid-2010s. This suggests a management trend in which natural timber stands were converted to plantation pine following final harvest.

  Ultimately, the total area of pine timberland (planted and natural) in this catchment area has remained at a level that is more than adequate to supply both the pulp/paper and bioenergy industries. Furthermore, the more than 330,000-hectare increase in total pine timberland since 2005 further strengthens this catchment area's ability to supply fiber to the pulp/paper and bioenergy industries in the coming years.

- Changes in Timber Inventory, Growth, & Removals

  According to USFS estimates, total growing stock inventory on timberland in the AR Cluster catchment area increased an average of 1.8% per year (+32% total) from 535 million m^3 in 2005 to 707 million m^3 in 2021. However, note that the rate at which inventory levels have increased has accelerated since 2010. Specifically, total growing stock inventory increased an average of 1.2% per year from 2005-2010, compared to 2.0% per year since 2010.

  Specifically, inventories of pine pulpwood (PPW) increased 36% in the catchment area from 2010-2021, and much of this increase can be attributed to increased harvest levels in the early and mid-2000s as well as increases in pine timberland in the catchment area. Also note that inventories of pine sawtimber and pine chip-n-saw increased 41% and 35%, respectively, from 2010-2021. These increases in pine sawtimber and pine chip-n-saw inventory levels can be linked to two key items: 1) increases in pine timberland beginning in the 1990s and 2) reduced demand

in the late-2000s and early-2010s, which allowed inventories to replenish and reach such levels that annual growth has been able to remain well-above annual removals.

The increase in total timber inventory in the catchment are reflected trends in both timber growth and removals, as total annual timber growth outpaced total annual removals every year covered by this study. Specifically, total annual growth of growing stock timber increased an average of 2.2% per year (+26% total) from 26.6 million m^3 in 2010 to 33.7 million m^3 in 2021. In comparison, total annual removals decreased 0.6% from 19.9 million m^3 in 2010 to 19.2 million m^3 in 2021.

Similarly, the increase in PPW inventory level also reflects trends in both growth and removals as well as general forest trends. Specifically, increases in pine timberland beginning in the early 2000s led to increases in PPW inventory, which in turn resulted in increases in PPW growth. Also, increased pine sawtimber (PST) harvest levels (i.e. increased clearcut levels) beginning in the early-2010s translated to increased PPW growth beginning in the late-2010s. Ultimately, annual growth of PPW has continued to exceed annual removals of PPW, leading to both increases in both PPW and total pine inventory levels in the AR Cluster catchment area.

In terms of long-term resource availability and market sustainability, the ratio of total growth to total removals has remained above 1.0 in the AR Cluster catchment area since the mid-2000s. (Recall that a value of >1 indicates growth exceeds removals, signifying oversupply and sustainable harvest levels). The growth-to-removals ratio for pine pulpwood, specifically, increased from 2.27 in 2009 to 3.47 in 2014 and has stabilized and averaged 3.09 in the catchment area since 2016. Even though total demand for PPW is projected to increase slightly over the next several years, the long-term sustainability of this market will not be placed in jeopardy in the coming years.

- Changes in Wood Demand

Total wood demand in the AR Cluster catchment area averaged 21.7 million metric tons per year in the mid-2000s before declining and ultimately stabilizing at an average of 17.9 million metric tons per year from 2010-2015. Note that the decrease in total wood demand was due in large part to reduced demand from the lumber/solid wood products industry. However, total wood demand rebounded over the next several years and since 2018 has averaged 21.1 million metric tons per year in the catchment area, up 18% compared to 2010-2015 levels but down 3% compared to mid-2000s levels.

Specifically, demand for softwood sawlogs, which historically has accounted for 50-55% of total annual wood demand in the catchment area, fell from 10.9 million metric tons in 2005 to an average of 8.0 million metric tons per year from 2009-2016. However, softwood sawlog demand has rebounded and averaged of 10.6 million metric tons per year since 2018.

Demand for softwood pulpwood, which accounts for roughly 30% of total wood demand in the catchment area annually, averaged 4.8 million metric tons per year from 2005-2015 before increasing and averaging 6.5 million metric tons per year since 2018. Note that the increase in softwood pulpwood demand is due to increased demand from both the pulp/paper industry and the bioenergy industry. Specifically, the more than 1.6 million metric ton-increase in softwood

pulpwood demand since 2015 can be attributed nearly equally to both bioenergy and other sources (i.e. pulp/paper).

In terms of the short-term outlook, demand for pine pulpwood is projected to increase only 1% in the AR Cluster catchment area from 2021-2025. Specifically, biomass-related softwood pulpwood demand is projected to increase approximately 270,000 metric tons (+29%) while non-biomass related softwood pulpwood demand is projected to decrease roughly 200,000 metric tons (-4%) from 2021-2025.

- Changes in Raw Material Prices

Raw material purchases for the Drax satellite pellet mills in Leola and Russellville consist entirely of pine sawmill residuals. However, several other pellet mills that procure fiber from within the catchment area consume a combination of both sawmill residuals and roundwood. Specifically, pine pulpwood (roundwood) demand attributed to the bioenergy sector has averaged roughly 780,000 metric tons per year since 2018, or roughly 12% of the total catchment area pine pulpwood demand. Moreover, sawmill residuals account for approximately 30-35% of total raw material purchases by these pellet mills annually.

In the AR Cluster catchment area, the price of pine sawmill chips – the raw material purchased by Drax's satellite pellet mills – held flat at approximately $29 per metric ton from 2009-2022 before falling to less than $24 per metric to in 2023. Delivered pine pulpwood (PPW) prices have held steady in the catchment area at an average of $30 per metric ton since 2012.

Ultimately, our analysis identified no meaningful relationships between softwood biomass demand and both delivered PPW price and pine sawmill chip price. In this market, there's an imbalance in supply and demand, and the oversupply that exists has made supply no longer a true constraint. Also, as lumber production in this market has increased, sawmill residuals have increasingly replaced roundwood consumption by pulp/paper and pellet mills.

In terms of the short-term outlook, pine sawmill chip prices and delivered PPW prices are projected to increase 2.0% and 3.4%, respectively, in the catchment area from 2022-2026.

- Management/Harvest Trends

As part of this market analysis, Hood Consulting examined management practices to see how harvesting activities have changed in this market since 2000. Specifically, we wanted to assess whether landowners' approach to timber management has changed and, if so, what was or has been the stimulus of those changes in this catchment area.

Clearcuts and thinnings are the two major types of harvests that occur in the region, both of which are long-standing, widely used methods of harvesting timber. TimberMart-South (TMS) data shows that a shift occurred in the distribution of hectares clearcut versus hectares thinned in the Arkansas market beginning in the late-2000s. Specifically, thinnings accounted for roughly 20% of total (annual) reported harvest area in this market from 2000-2007. However, since 2008, thinnings have accounted for nearly 50% of total reported harvest area.

The increased prevalence of thinnings beginning in the late-2000s can be linked to the bursting of the US housing bubble and Great Recession that followed. Timber management in this market is largely driven by pine sawtimber production, and from 2000-2007, pine sawtimber (PST) stumpage prices averaged more than $42 per metric ton. However, challenging market conditions resulted in PST stumpage prices falling to below $24 per metric ton in 2012 and ultimately stabilizing at roughly $27 per metric ton since 2014 (or a more than 35% decrease compared to 2000-2007 average levels).

The weakening of PST markets beginning in the late-2000s led many landowners to refrain from clear cutting (which typically removes primarily pine sawtimber, the highest-value pine product) until PST prices improved. However, PST prices have never fully recovered and the oversupply of wood in this market has led to increased rotation lengths and increased thinning of older, mature stands.

- Impact of Biomass Demand on Raw Material Prices

One of the important components of this analysis was to identify any relationships or linkages between changes in biomass demand and changes in raw material prices. Intuitively, an increase (decrease) in demand should result in an increase (decrease) in price. However, both delivered PPW and pine sawmill chip prices have held steady in the catchment area despite increases in overall demand since the mid-2010s. Ultimately, Hood Consulting's analysis found no evidence that changes in bioenergy demand have led to any price increases or decreases in the AR Cluster catchment area.

The Drax satellite pellet mills in Leola and Russellville both consume sawmill residuals only, so these two plants add no bioenergy-related roundwood demand to the catchment area. Also, other pellet mills located within or that procure fiber from within the catchment area (including Highland Pellets) consume substantial volumes of sawmill residuals as well. However, demand for sawmill residuals from the pellet industry has also not resulted in increased residual prices in the catchment area. Softwood lumber production has increased more than 40% in the catchment area since 2014, and this increase in lumber production has resulted in a likewise increase in sawmill residual production. Even though there's been an increase in demand for residuals from the bioenergy sector since the mid-2010s, increases in lumber production have more than met the increases in demand, and sawmill chip prices have remained nearly unchanged in the catchment area.

Additionally, prices of non-biomass-related timber products (i.e. pine sawtimber, pine chip-n-saw, and hardwood sawtimber) were also examined, and Hood Consulting's assessment found no identifiable relationships or links between changes in biomass demand and changes in these other raw material prices.

Appendix A. Quarterly Stumpage Prices, Delivered Timber Prices, Pulp Quality Chip Prices, & Planer Shaving Prices (1Q 2000 – 3Q 2023)

AR Cluster Catchment Area - Quarterly Stumpage Prices ($/Metric Ton)

Year	Quarter	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
2000	1	45.26	22.54	6.74	17.78	4.79
2000	2	43.90	26.56	6.12	17.15	4.11
2000	3	39.67	21.49	5.50	16.90	3.78
2000	4	39.29	24.70	4.86	19.62	3.42
2001	1	35.29	19.53	4.74	19.02	4.67
2001	2	36.35	24.55	5.21	22.69	6.17
2001	3	36.53	18.52	4.65	22.07	6.25
2001	4	38.11	19.90	5.05	19.29	5.57
2002	1	38.47	21.47	5.51	18.84	6.12
2002	2	39.00	22.68	5.27	18.44	5.96
2002	3	37.47	19.82	5.08	19.04	5.24
2002	4	38.94	22.77	5.04	18.39	5.05
2003	1	38.21	21.35	5.90	19.84	5.17
2003	2	40.60	20.69	5.89	20.75	7.40
2003	3	34.86	22.26	5.49	19.97	6.05
2003	4	40.04	26.99	6.61	19.13	5.61
2004	1	39.55	26.19	5.98	21.67	6.04
2004	2	46.31	24.58	6.50	21.85	6.65
2004	3	38.57	23.57	5.89	17.80	4.71
2004	4	42.68	26.83	6.33	19.30	6.65
2005	1	49.83	24.55	8.33	22.39	8.64
2005	2	50.85	24.71	9.74	31.92	11.43
2005	3	45.07	22.09	8.03	28.84	9.56
2005	4	44.34	24.43	8.23	33.27	7.44
2006	1	46.69	24.20	7.82	23.36	7.45
2006	2	46.47	22.47	7.16	23.66	6.58
2006	3	45.87	19.20	6.96	26.64	6.87
2006	4	42.86	22.27	6.99	26.03	7.79
2007	1	44.09	26.29	10.66	21.73	8.81
2007	2	45.94	18.90	10.29	35.11	9.14
2007	3	49.52	22.47	10.89	34.82	12.10
2007	4	47.09	22.45	12.10	30.41	12.78
2008	1	39.91	23.41	12.79	27.98	13.40
2008	2	31.64	16.31	9.88	21.61	8.14
2008	3	33.12	24.33	13.09	27.18	13.70
2008	4	32.45	27.49	13.29	28.93	14.92
2009	1	28.78	21.82	10.22	25.14	13.74
2009	2	30.15	20.53	10.10	23.68	13.00
2009	3	31.25	17.40	9.76	28.38	12.19
2009	4	28.06	21.87	12.17	24.98	12.68
2010	1	33.09	22.32	15.35	27.25	20.30
2010	2	32.03	21.73	12.10	31.29	17.43
2010	3	30.39	19.31	11.09	32.83	11.45
2010	4	26.18	15.92	9.76	28.13	11.26
2011	1	27.44	16.62	8.77	26.10	11.58
2011	2	25.68	15.94	8.00	25.74	10.15
2011	3	24.00	16.76	8.39	25.74	8.63
2011	4	22.58	16.03	8.39	26.27	9.30

Year	Quarter	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
2012	1	25.00	16.63	8.63	25.49	10.83
2012	2	22.86	14.55	9.22	28.82	11.99
2012	3	23.27	15.15	8.20	30.60	11.08
2012	4	22.49	16.23	9.21	28.74	11.73
2013	1	24.56	16.68	9.87	27.43	11.42
2013	2	24.15	16.60	9.64	31.43	11.47
2013	3	23.01	16.54	8.81	33.37	11.55
2013	4	26.27	16.87	8.79	32.51	13.38
2014	1	25.32	17.25	9.21	28.63	13.33
2014	2	25.68	17.03	9.41	30.55	16.96
2014	3	25.23	16.16	8.49	39.69	18.78
2014	4	27.24	18.60	9.23	38.36	18.65
2015	1	28.26	17.87	8.35	33.88	16.68
2015	2	27.12	18.88	8.34	36.28	17.11
2015	3	25.62	17.67	8.27	38.75	18.15
2015	4	26.26	17.68	9.17	36.66	16.53
2016	1	26.05	17.23	8.09	42.36	15.35
2016	2	25.73	17.37	7.68	42.66	13.85
2016	3	25.64	16.46	7.06	44.26	12.52
2016	4	25.49	17.48	7.98	44.11	13.05
2017	1	24.16	16.88	7.22	39.76	12.45
2017	2	24.52	16.67	6.79	35.25	12.68
2017	3	24.61	16.37	6.78	36.19	11.06
2017	4	25.05	16.18	7.11	41.81	11.96
2018	1	25.32	16.62	7.63	41.47	14.08
2018	2	24.47	16.03	7.78	40.88	13.92
2018	3	24.64	16.25	7.02	39.38	13.30
2018	4	26.02	15.61	7.57	40.97	13.63
2019	1	28.56	17.26	10.06	41.96	17.33
2019	2	27.72	16.40	7.47	38.16	18.36
2019	3	25.74	15.79	7.36	43.97	17.32
2019	4	26.40	16.59	7.03	51.91	12.68
2020	1	26.41	15.67	6.31	41.76	9.53
2020	2	26.15	13.62	6.60	39.38	9.05
2020	3	25.79	15.02	6.50	35.80	7.97
2020	4	26.60	15.39	6.04	38.07	8.09
2021	1	30.34	17.82	5.33	39.08	7.54
2021	2	29.63	16.90	5.44	40.45	8.43
2021	3	29.12	17.27	5.71	42.48	8.47
2021	4	32.28	22.49	6.90	46.20	11.43
2022	1	29.35	20.47	5.99	47.86	13.86
2022	2	28.89	17.54	5.70	47.06	11.10
2022	3	31.40	20.16	6.66	43.74	11.75
2022	4	28.72	17.59	6.14	49.19	11.30
2023	1	27.24	16.46	6.23	46.54	10.15
2023	2	29.24	15.37	5.13	41.93	12.23
2023	3	28.71	15.99	5.23	45.25	12.11

Source: TimberMart-South

AR Cluster Catchment Area - Quarterly Delivered Timber Prices ($/Metric Ton)

Year	Quarter	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
2000	1	60.51	42.82	22.26	34.11	20.61
2000	2	62.71	45.26	22.30	31.44	19.45
2000	3	64.12	39.82	20.64	35.74	20.42
2000	4	58.92	41.88	21.88	37.48	20.80
2001	1	53.34	37.32	21.60	33.80	22.83
2001	2	55.28	40.70	20.66	38.61	24.74
2001	3	55.51	39.38	21.83	37.78	23.27
2001	4	49.90	37.47	23.00	38.24	23.62
2002	1	56.45	36.53	23.70	37.18	25.51
2002	2	57.86	37.88	23.98	37.30	25.07
2002	3	52.10	37.32	22.80	37.68	23.07
2002	4	52.57	37.50	22.43	37.35	23.50
2003	1	50.41	37.73	23.21	37.29	23.94
2003	2	63.24	40.06	25.29	36.38	26.01
2003	3	55.68	39.15	23.08	35.87	23.97
2003	4	52.98	36.45	25.00	35.03	23.25
2004	1	54.82	38.29	23.34	37.57	22.73
2004	2	54.00	37.47	22.84	37.74	22.73
2004	3	59.95	43.42	23.04	33.69	23.76
2004	4	60.06	43.53	24.22	32.29	27.22
2005	1	53.45	41.88	36.07	36.04	34.62
2005	2	61.16	42.43	33.28	38.02	32.93
2005	3	56.75	33.78	24.88	34.94	24.52
2005	4	58.74	37.69	26.16	39.37	25.36
2006	1	58.41	39.34	25.58	38.79	23.85
2006	2	58.96	40.44	24.77	40.22	23.44
2006	3	56.97	33.17	25.46	40.55	24.46
2006	4	51.90	30.31	28.19	39.94	25.90
2007	1	56.20	38.68	33.80	35.65	23.79
2007	2	54.77	34.27	30.31	40.80	29.18
2007	3	55.78	37.69	32.93	43.75	31.66
2007	4	61.67	39.64	35.12	47.12	32.69
2008	1	58.67	37.74	36.35	50.47	33.84
2008	2	51.27	35.18	32.51	38.09	31.09
2008	3	54.70	41.51	34.87	43.26	33.62
2008	4	54.69	42.02	32.42	43.87	34.45
2009	1	44.01	33.50	30.08	44.03	33.61
2009	2	42.80	36.04	28.48	43.22	31.93
2009	3	45.14	35.79	29.21	45.37	30.49
2009	4	41.93	36.91	31.87	44.35	33.96
2010	1	49.48	39.53	36.22	45.31	38.53
2010	2	50.44	40.30	33.34	47.98	37.66
2010	3	50.05	39.45	31.02	47.80	34.19
2010	4	45.89	35.05	28.72	45.20	28.56
2011	1	42.98	35.77	27.61	41.57	28.80
2011	2	46.00	35.91	28.79	46.52	30.23
2011	3	44.08	35.28	29.70	47.69	29.60
2011	4	42.88	34.27	29.34	49.37	30.52
2012	1	42.71	35.36	29.10	49.65	31.08
2012	2	43.07	34.58	31.56	53.13	34.27
2012	3	43.54	35.31	30.33	54.24	33.92
2012	4	44.25	36.65	32.04	58.85	34.38

Year	Quarter	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
2013	1	44.61	38.11	31.24	56.31	34.39
2013	2	43.31	37.37	31.00	56.33	35.33
2013	3	43.40	37.57	30.84	57.46	32.70
2013	4	45.60	38.99	30.43	57.92	34.59
2014	1	46.74	38.85	32.07	54.29	36.13
2014	2	46.93	38.34	32.15	56.94	39.13
2014	3	46.56	37.68	30.33	66.30	40.14
2014	4	48.26	39.33	32.35	67.93	41.96
2015	1	46.94	39.63	30.27	60.03	40.73
2015	2	48.82	40.72	31.55	63.93	40.84
2015	3	48.48	38.50	30.15	66.85	40.45
2015	4	50.01	39.63	31.80	66.66	39.09
2016	1	48.03	38.31	31.38	67.84	38.50
2016	2	48.34	38.60	30.21	68.07	37.06
2016	3	48.01	38.19	29.06	72.42	35.66
2016	4	47.54	39.26	30.20	71.71	37.03
2017	1	47.38	37.97	30.90	64.18	34.31
2017	2	45.70	37.08	30.49	62.61	34.24
2017	3	46.49	37.17	30.73	62.29	35.70
2017	4	46.22	37.22	29.81	66.98	34.39
2018	1	46.75	38.42	32.09	66.01	34.78
2018	2	45.13	36.48	31.20	63.55	34.51
2018	3	46.26	37.66	28.95	62.62	34.73
2018	4	47.39	37.76	30.07	65.23	35.28
2019	1	48.83	38.63	31.41	66.86	39.63
2019	2	47.33	37.65	30.07	59.11	41.55
2019	3	47.03	36.78	28.98	65.80	39.76
2019	4	48.88	38.27	29.32	73.57	34.95
2020	1	47.17	37.33	28.20	64.00	33.04
2020	2	47.04	36.39	28.84	64.13	31.93
2020	3	48.30	36.69	28.19	63.12	29.74
2020	4	48.89	37.67	28.07	65.65	30.63
2021	1	51.54	42.88	27.74	62.63	30.27
2021	2	49.13	40.52	27.72	63.17	36.48
2021	3	53.00	42.73	28.43	67.69	34.23
2021	4	54.12	43.69	28.35	72.68	33.92
2022	1	52.55	43.75	28.11	74.23	34.52
2022	2	51.97	44.56	28.92	67.72	35.02
2022	3	54.49	43.66	30.15	73.38	35.99
2022	4	54.97	43.40	30.02	76.55	37.92
2023	1	52.14	43.14	29.43	74.81	36.43
2023	2	52.57	45.36	29.67	68.48	38.58
2023	3	54.93	43.31	30.10	75.32	39.83

Source: TimberMart-South

AR Cluster Catchment Area - Pulp Quality Chip & Planer Shaving Prices ($/Metric Ton - FOB Point of Production)

Year	Quarter	Pine Sawmill Chips	Hardwood Sawmill Chips	Pine Chip Mill Chips	Hardwood Chip Mill Chips	Pine Planer Shavings
2000	1	24.05	24.80	32.51	31.41	
2000	2	25.08	29.48	28.06	28.52	
2000	3	24.20	29.48	31.83	28.52	
2000	4	24.89	27.55	31.41	28.24	
2001	1	24.80	25.35	31.41	28.65	
2001	2	24.24	22.59	31.41	31.41	
2001	3	23.42	25.07	33.06	32.51	
2001	4	24.24	25.35	33.20	30.31	
2002	1	22.59	23.14	32.23	30.17	
2002	2	23.29	24.24	31.55	29.75	
2002	3	23.69	23.69	31.83	30.31	
2002	4	24.45	26.45	32.18	31.96	
2003	1	22.57	26.50	32.78	32.24	
2003	2	22.59	23.69	31.27	33.61	
2003	3	23.14	24.24	33.34	34.16	
2003	4	22.59	22.04	28.65	33.06	
2004	1	22.93	22.04	28.65	30.86	
2004	2	22.59	22.04	28.65	30.86	
2004	3	23.14	22.04	29.75	30.86	
2004	4	23.69	22.04	29.75	32.51	
2005	1	24.80	22.04	29.20	31.96	
2005	2	24.80	22.04	28.65	32.51	
2005	3	23.14	22.04	28.65	31.41	
2005	4	24.52	26.45	29.75	31.41	
2006	1	24.24	26.45	29.75	30.17	
2006	2	23.14	24.80	30.31	28.93	
2006	3	24.24	23.14	33.89	33.61	
2006	4	28.10	23.69	37.47	34.71	
2007	1	27.07	23.69	33.61	35.26	
2007	2	25.07	23.84	36.92	35.26	
2007	3	27.55	26.45	36.92	35.26	
2007	4	30.86	24.80	39.67	39.67	
2008	1	35.26	26.45	43.53	39.67	
2008	2	29.94	26.45	43.52	35.26	
2008	3	31.41	26.45	47.94	36.37	
2008	4	32.23	26.72	47.97	36.64	
2009	1	33.06	26.45	44.36	37.47	
2009	2	31.75	26.08	42.89	36.92	
2009	3	30.61	25.71	41.83	38.29	
2009	4	30.78	24.43	43.71	40.09	
2010	1	30.92	24.89	47.54	42.36	37.47
2010	2	30.60	24.56	46.23	43.64	36.92
2010	3	30.08	26.03	42.07	42.66	36.81
2010	4	29.51	25.96	42.13	43.09	33.79
2011	1	29.08	25.65	41.96	42.48	36.00
2011	2	28.87	25.48	39.79	40.34	33.84
2011	3	28.43	25.85	38.96	38.70	29.48
2011	4	27.59	25.87	38.86	38.33	26.39
2012	1	27.63	26.27	38.44	38.72	33.60
2012	2	27.94	25.96	39.94	41.91	31.98
2012	3	28.72	27.14	39.10	43.33	29.52
2012	4	28.78	26.21	39.38	41.43	27.12

Year	Quarter	Pine Sawmill Chips	Hardwood Sawmill Chips	Pine Chip Mill Chips	Hardwood Chip Mill Chips	Pine Planer Shavings
2013	1	29.13	25.99	39.24	41.54	27.34
2013	2	29.57	28.60	39.66	40.77	27.75
2013	3	29.14	29.13	40.68	41.83	28.11
2013	4	29.56	30.65	39.54	42.08	28.69
2014	1	28.45	29.22	39.97	42.16	29.45
2014	2	28.88	34.05	40.53	43.25	32.39
2014	3	30.79	32.40	40.37	45.36	33.27
2014	4	29.97	31.68	40.02	46.50	32.76
2015	1	31.57	35.80	41.94	43.94	33.39
2015	2	30.48	36.61	41.11	45.79	34.62
2015	3	30.96	33.63	39.99	47.08	34.66
2015	4	31.21	34.01	39.67	46.58	34.80
2016	1	31.03	34.94	39.50	47.06	34.43
2016	2	29.61	27.27	38.86	45.41	35.00
2016	3	27.48	30.03	37.09	44.31	35.45
2016	4	28.19	30.78	38.72	44.54	35.53
2017	1	26.89	31.41	38.33	43.05	34.59
2017	2	28.62	31.58	38.60	40.94	35.36
2017	3	29.34	32.75	39.72	41.13	36.94
2017	4	28.88	32.17	40.44	40.65	36.82
2018	1	29.41	31.90	41.30	41.62	36.10
2018	2	28.88	32.23	39.49	41.76	35.95
2018	3	28.46	30.34	38.14	42.35	36.98
2018	4	28.82	31.28	38.60	42.78	36.85
2019	1	28.73	31.86	40.25	43.35	36.97
2019	2	29.16	32.70	38.19	44.74	36.86
2019	3	29.05	36.92	38.33	46.64	38.18
2019	4	29.39	35.71	38.63	44.35	39.61
2020	1	29.00	34.25	39.52	42.84	39.61
2020	2	29.46	33.32	38.25	41.30	38.25
2020	3	28.29	32.41	37.45	40.21	37.62
2020	4	27.58	31.87	37.76	39.78	38.07
2021	1	27.47	31.65	37.67	39.71	39.83
2021	2	27.84	34.86	37.63	42.68	42.04
2021	3	27.93	35.07	39.31	42.96	46.86
2021	4	27.88	34.99	39.87	43.76	49.24
2022	1	27.55	35.82	39.78	44.21	53.83
2022	2	28.49	33.36	39.75	44.66	58.39
2022	3	27.70	33.73	40.19	44.22	50.47
2022	4	25.36	31.49	39.82	44.35	52.04
2023	1	24.71	32.57	39.59	43.68	52.55
2023	2	23.32	33.08	39.16	43.91	49.02
2023	3	23.29	34.00	39.20	44.10	48.47

Source: TimberMart-South

Appendix B. Log Rules, Weight Equivalents, & Conversion Rates

Log Rule and Weight Equivalents

Pine: *Sawtimber and large logs* 15,000 lbs. (Range 13,000-17,000 lbs.) or 7.50 Tons per MBF Scribner; 16,000 lbs. or 8.0 Tons per MBF Doyle; 12,450 lbs. or 6.225 Tons per MBF International.

Chip-n-saw 15,000 lbs. (Range 13,000-17,000 lbs.) or 7.50 Tons per MBF Scribner; 19,950 lbs. or 9.975 Tons per MBF Doyle; 12,450 lbs. or 6.225 Tons per MBF International.

Pulpwood and Chip-n-saw 5,350 lbs. (Range 5,000-5,620 lbs.) or 2.68 Tons per Std.Cord. Ratio of weights between sawtimber & pulpwood is 2.80 cds. to MBF (Scribner).

Hardwood: *Sawtimber* 17,500 lbs. (Range 15,000-19,000 lbs.) or 8.75 Tons per MBF Doyle; 13,125 lbs. or 6.563 Tons per MBF Scribner; 10,850 lbs. or 5.425 Tons per MBF International.

Pulpwood 5,800 lbs./Std.Cord or 2.90 Tons (Range 5,400-6,075 lbs.) Ratio of weights between sawtimber & pulpwood 3.02 cds. to MBF (Doyle).

English & Metric Conversions

1 Std. Cord has 128 ft^3 of stacked logs: bark, air and solid wood.

1 Std. Cord has 90 ft^3 of solid wood and bark.

1 Std. Cord of pine has about 75 ft^3 or 2.124 m^3 of solid wood.

1 Std. Cord of mixed hardwood has about 80 ft^3 or 2.265 m^3 of solid wood.

1 cubic meter (m^3) = 35.315 cubic feet (ft^3)

1 short ton (2,000 lb.) of green southern pine, wood & bark, has about 0.822 m^3 of solid wood.

1 short ton (2,000 lb.) of green mixed hardwood, wood & bark, has about 0.787 m^3 of solid wood.

1 metric tonne = 1.102 short tons = 2,204 pounds

1 acre = 0.405 hectares

1 mile = 1.609 kilometers

These are "general product guides." Specific requirements may vary by area and buyer.

Glossary of Terms

Average annual mortality of growing stock: The average cubic foot volume of sound wood in growing-stock trees that died in one year.

Average annual net growth of growing stock: The annual change in cubic foot volume of sound wood in live sawtimber and poletimber trees, and the total volume of trees entering these classes through ingrowth, less volume losses resulting from natural causes, between 1999 and 2003.

Average annual removals from growing stock: The average net growing-stock volume in growing-stock trees removed annually for roundwood forest products, in addition to the volume of logging residues and the volume of other removals.

Basal area: Tree area in square feet of the cross section at breast height of a single tree. When the basal areas of all trees in a stand are summed, the result is usually expressed as square feet of basal area per acre.

Commercial species: Tree species suitable for industrial wood products.

County and municipal: An ownership class of public lands owned by counties or local public agencies, or lands leased by these governmental units for more than 50 years.

Cropland: Land under cultivation within the last 24 months, including cropland harvested, crop failures, cultivated summer fallow, idle cropland used only for pasture, orchards, active Christmas tree plantations indicated by annual shearing, nurseries, and land in soil improvement crops, but excluding land cultivated in developing improved pasture.

Diameter class: A classification of trees based on diameter outside bark, measured at breast height 4.5 feet (DBH) (1.37m) above the ground or at root collar (DRC). Note: Diameter classes are commonly in 2-inch (5cm) increments, beginning with 2-inches (5cm). Each class provides a range of values with the class name being the approximate mid-point. For example, the 6-inch class (15-cm class) includes trees 5.0 through 6.9 inches (12.7 cm through 17.5 cm) DBH, inclusive.

Federal Land: An ownership class of public lands owned by the U.S. Government.

Forest land: Land that has at least 10 percent crown cover by live tally trees of any size or has had at least 10 percent canopy cover of live tally species in the past, based on the presence of stumps, snags, or other evidence. To qualify, the area must be at least 1.0 acre in size and 120.0 feet wide. Forest land includes transition zones, such as areas between forest and nonforest lands that meet the minimal tree stocking/cover and forest areas adjacent to urban and built—up lands. Roadside, streamside, and shelterbelt strips of trees must have a width of at least 120 feet and continuous length of at least 363 feet to qualify as forest land. Unimproved roads and trails, streams, and clearings in forest areas are classified as forest if they are less than 120 feet wide or less than an acre in size. Tree-covered areas in agricultural production settings, such as fruit orchards, or tree—covered areas in urban settings, such as city parks, are not considered forest land.

Forest type: A classification of forest land based upon and named for the tree species that forms the plurality of live-tree stocking. A forest type classification for a field location indicates the predominant live-tree species cover for the field location; hardwoods and softwoods are the first group to be determine predominant group, and Forest Type is selected from the predominant group.

Growing stock tree: All live trees 5.0 inches (12.7) cm) DBH or larger that meet (now or prospectively) regional merchantability requirements in terms of saw-log length, grade, and cull deductions. Excludes rough and rotten cull trees.

Hardwood: Tree species belonging to the botanical subdivision Angiospermae, class Dicotyledonous, usually broad-leaved and deciduous.

Land: The area of dry land and land temporarily or partly covered by water, such as marshes, swamps, and river flood plains.

Logging residues: The unused portions of trees cut or destroyed during harvest and left in the woods.

Merchantable: Refers to a pulpwood or sawlog section that meets pulpwood or sawlog specifications, respectively.

National forest: An ownership class of Federal lands, designated by Executive order or statute as National Forests or purchase units, and other lands under the administration of the Forest Service including experimental areas.

Net annual growth: The average annual net increase in the volume of trees during the period between inventories. Components include the increment in net volume of trees at the beginning of the specific year surviving to its end, plus the net volume of trees reaching the minimum size class during the year, minus the volume of trees that died during the year, and minus the net volume of trees that became cull trees during the year.

Net volume in cubic feet: The gross volume in cubic feet less deductions for rot, roughness, and poor form. Volume is computed for the central stem from a 1-foot stump to a minimum 4.0-inch top diameter outside bark, or to the point where the central stem breaks into limbs.

Nonforest land: Land that does not support or has never supported, forests and lands formerly forested where use of timber management is precluded by development for other uses. Includes area used for crops, improved pasture, residential areas, city parks, improved roads of any width and adjoining rights-of-way, powerline clearings of any width, and noncensus water. If intermingled in forest areas, unimproved roads and nonforest strips must be more than 120 feet (36.6m) wide, and clearings, etc., more than one acre (0.4ha) in size, to qualify as nonforest land.

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

Pulpwood: Roundwood, whole-tree chips, or wood residues used for the production of wood pulp.

Roundwood products: Logs, bolts, or other round timber generated from harvesting trees for industrial or consumer uses. Includes sawlogs; veneer and cooperage logs and bolts; pulpwood; fuelwood; pilings; poles; posts; hewn ties; mine timbers; and various other round, split or hewn products.

Saw log: A log 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 and 8 inches for hardwoods, or meeting other combinations of size and defect specified by regional standards.

Sawtimber tree: A live tree of commercial species containing at least a 12-foot sawlog or two noncontiguous saw logs 8 feet or longer and meeting regional specifications for freedom from defect. Softwoods must be at least 9.0 inches d.b.h. Hardwoods must be at least 11.0 inches diameter outside bark (d.o.b.).

Softwood: A coniferous tree, usually evergreen, having needles or scale-like leaves.

Stand: A group of trees on a minimum of 1 acre of forest land that is stocked by forest trees of any size.

State land: An ownership class of public lands owned by States or lands leased by States for more than 50 years.

Timberland: 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. (Note: Areas qualifying as timberland are capable of producing in excess of 20 cubic feet per acre per year of industrial wood in natural stands. Currently inaccessible and inoperable areas are included.)

Timber products output (TPO): All timber products cut from roundwood and byproducts of wood manufacturing plants. Roundwood products include logs, bolts, or other round sections cut from growing-stock trees, cull trees, salvable dead trees, trees on nonforest land, noncommercial species, sapling-size trees, and limbwood. Byproducts from primary manufacturing plants include slabs, edging, trimmings, miscuts, sawdust, shavings, veneer cores and clippings, and screenings of pulpmills that are used as pulpwood chips or other products.

Tree: A woody perennial plant, typically large, with a single well-defined stem carrying a more or less definite crown; sometimes defined as attaining a minimum diameter of 3 inches (7.6) and a minimum height of 15 ft (4.6 m) at maturity. For FIA, any plant on the tree list in the current field manual is measured as a tree.

Tree size class: A classification of trees based on diameter at breast height, including sawtimber trees, poletimber trees, saplings, and seedlings.

Urban forest land: Land that would otherwise meet the criteria for timberland but is in an urban-suburban area surrounded by commercial, industrial, or residential development and not likely to be managed for the production of industrial wood products on a continuing basis. Wood removed would be for land clearing, fuelwood, or esthetic purposes. Such forest land may be associated with industrial, commercial, residential subdivision, industrial parks, golf course perimeters, airport buffer strips, and public urban parks that qualify as forest land.

Veneer log: A roundwood product from which veneer is sliced or sawn and that usually meets certain standards of minimum diameter and length and maximum defect.

Weight: The weight of wood and bark, oven-dry basis (approximately 12 percent moisture content).

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