Catchment Area Analysis of Forest Management and Market Trends:

Alabama Pellets – Aliceville
Alabama Pellets – Demopolis *(under construction)*
Enviva Pellets Epes *(proposed)*

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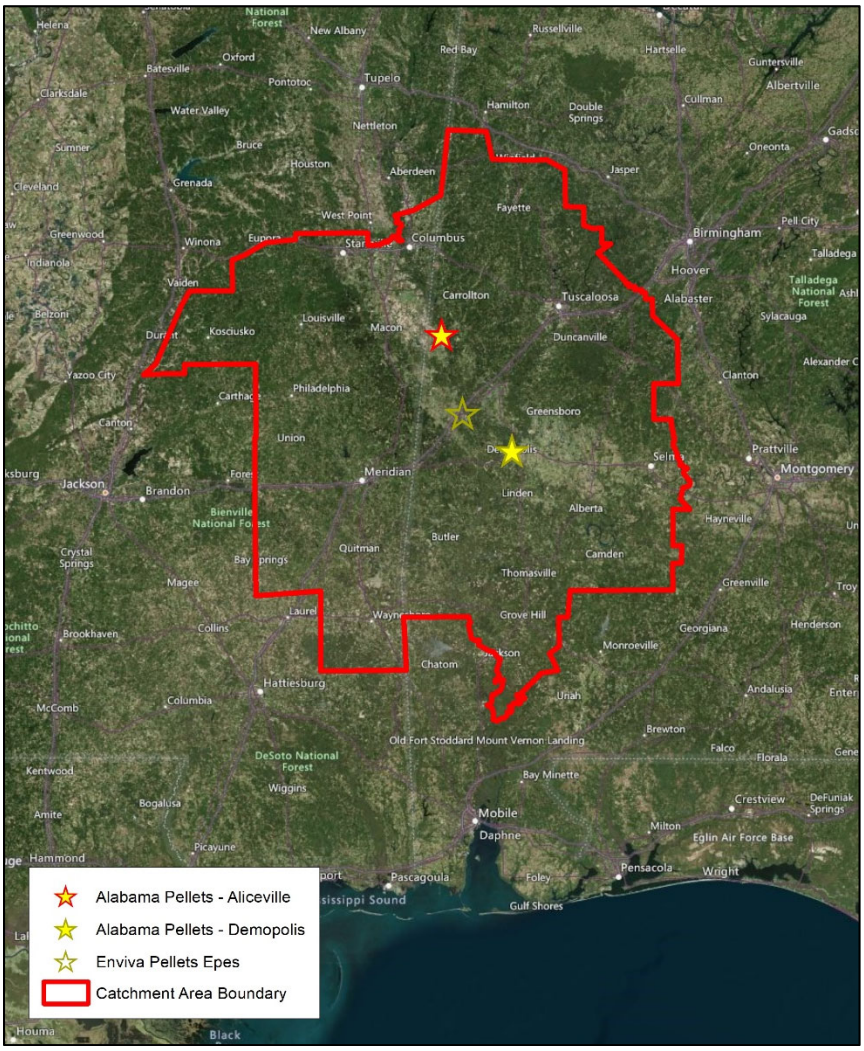
Executive Summary

In accordance with Drax's initiative to monitor forest management and timber market trends across its supply chain, the following report was conducted to examine the fiber catchment area in the west-central portion of Alabama and east-central portion of Mississippi that supports the Alabama Pellets wood pellet mill in Aliceville AL. In addition, this catchment area will support the Alabama Pellets wood pellet mill in Demopolis AL that nears startup as well as the proposed Enviva pellet mill in Epes AL. Specifically, the catchment area for these mills includes a combined 27 counties in Alabama and Mississippi and covers an area more than 50,000 square kilometers in total size (see Figure 1).

The Alabama Pellets-Aliceville mill has a production capacity of 270,000 metric tons of wood pellets annually and utilizes pine sawmill residuals (i.e. pine sawmill chips, sawdust, and shavings) only for wood pellet production. The Alabama Pellets-Demopolis mill, which in scheduled to start up in late-2021, will have an annual production capacity of 360,000 metric tons of wood pellets and also utilize residuals only for wood pellet production.

***Figure 1**. Alabama Cluster Catchment Area*



Forest Area, Timber Inventory, & Annual Wood Demand

Forest Area. According to US Forest Service (USFS) data, the Alabama catchment area contains an estimated 4.19 million hectares of forestland, constituting approximately 80% of the catchment area's total land area. Specifically, 99% of total forestland (4.16 million hectares) is classified as timberland, or forestland that is capable of commercial timber production. Also note that 95% of total timberland area is privately owned versus 5% public.

The total area of timberland in the catchment area increased 2.2% from roughly 4,082,000 hectares in 2000 to more than 4,172,000 hectares in 2008. However, since 2008, timberland area has held relatively stable and averaged 4,172,000 hectares in the Alabama Cluster catchment area.

Timberland Area by Forest Type (2020)

Forest Type	Hectares	% of Total
Planted Pine	1,615,023	39%
Natural Pine	675,052	16%
Planted Hardwood	93,230	2%
Natural Hardwood	1,449,216	35%
Mixed Pine-Hardwood	328,581	8%
Total	4,161,102	100%

Inventory. Total growing stock inventory on timberland totaled an estimated 483 million m^3 in the Alabama Cluster catchment area in 2020, of which approximately 62% was softwood (pine) species and 38% was hardwood species. In terms of major timber product, approximately 31% of total growing stock inventory is classified as pine sawtimber, compared to 16% pine chip-n-saw, 15% pine pulpwood, 25% hardwood sawtimber, and 13% hardwood pulpwood.

Total timber inventory had been on an upward climb, increasing an average of 0.7% per year from 368 million m^3 in 2000 to 395 million m^3 in 2012. However, from 2012-2020, the rate at which timber inventory increased accelerated, with total inventory increasing an average of 1.8% per year and to 483 million m^3 in 2020. Overall, total timber inventory increased 115 million m^3 (+31%) from 2000-2020.

Timber Inventory by Major Product (2020)

Timber Product	Inventory (000 m^3)	% of Total
Pine Sawtimber	150,244	31%
Pine Chip-n-saw	75,473	16%
Pine Pulpwood	74,486	15%
Hardwood Sawtimber	119,145	25%
Hardwood Pulpwood	63,864	13%
Total	483,213	100%

Wood Demand. As of September 2021, there were nearly 50 major wood-consuming mills operating within the Alabama Cluster catchment area, and an additional 80+ mills operating within close proximity and that procure a portion of their wood from this catchment area. Altogether, total wood demand in the Alabama Cluster catchment area attributed to these mills was estimated at 19.5 million metric tons in 2020. Specifically, demand for pine and hardwood pulpwood – the predominant roundwood products consumed by the bioenergy industry for wood pellet production – totaled a combined 7.8 million metric tons in 2020 and represented 40% of total catchment area wood demand.

Of the 7.8 million metric tons of total pulpwood demand in the catchment area in 2020, approximately 97% was attributed to non-bioenergy-related sources (i.e. predominantly pulp/paper); 3% was attributed to the bioenergy sector. Bioenergy-related pulpwood demand totaled an estimated 216,500 metric tons, of which approximately 82% was for softwood (pine) pulpwood and 18% was for hardwood pulpwood.

Catchment Area Wood Demand by Major Product (2020)

Product	Metric Tons	% of Total
Softwood Sawlogs	10,015,149	51%
Softwood Pulpwood	5,570,612	29%
Hardwood Sawlogs	1,657,507	9%
Hardwood Pulpwood	2,212,646	11%
Total	19,455,914	100%

Catchment Area Pulpwood Demand (2020)

Product	Metric Tons	% of Total
Biomass Demand:		
Softwood Biomass	176,972	2%
Hardwood Biomass	39,489	1%
Total Biomass	216,461	3%
Other Pulpwood Demand:		
Other Softwood Pulpwood	5,393,640	69%
Other Hardwood Pulpwood	2,173,157	28%
Total Other Pulpwood	7,566,797	97%
Total Pulpwood Demand:		
Softwood Pulpwood	5,570,612	72%
Hardwood Pulpwood	2,212,646	28%
Pulpwood Total	7,783,258	100%

Summary of Analysis Findings

The following report provides a detailed assessment of the Alabama 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 2023.

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 area has held steady and averaged roughly 4,172,000 hectares in the Alabama Cluster catchment area since Alabama Pellets-Aliceville started up in late-2012. More importantly, planted pine timberland (the predominant source of roundwood utilized by the bioenergy industry for wood pellet production) has increased more than 75,000 hectares (+4.9%) in the catchment area since Alabama Pellets' startup in 2012.
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, the evidence 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 temporarily increased in the Alabama Cluster market (from 2007-2013) due to the weakening of pine sawtimber markets. Specifically, challenging market conditions saw pine sawtimber stumpages prices decline from an average of $47 per ton from 2000-2006 to just over $23 per ton in 2011, or a roughly 50% decrease from 2000-2006 average levels. 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 recovered and have held between $22 and $25 per ton since 2011. Ultimately, landowners returned to more 'normal' management practices by 2014, with thinnings falling back in line with pre-2007 trends. The catchment area has also experienced some conversion. Specifically, from 2000-2020, planted pine timberland increased more than 460,000 hectares while natural hardwood and mixed pine-hardwood timberland decreased a combined 390,000 hectares. Note that the increase in planted pine timberland and decrease in natural hardwood/mixed pine-hardwood timberland over this period were both gradual and occurred simultaneously. This suggests a management trend in which natural timber stands are converted to plantation pine 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 startup of Alabama Pellets and continued nearly unchanged following the pellet mill's startup.
Diversion from other markets?	**No.** Demand for softwood (pine) sawlogs increased an estimated 12% in the catchment area from 2012-2020. Also, there is no evidence that increased demand from bioenergy has caused a diversion from other softwood pulpwood markets (i.e. pulp/paper). Also, even though softwood pulpwood demand not attributed to bioenergy is down 14% since Alabama Pellets-Aliceville's startup in 2012, there is no evidence that increased demand from bioenergy has caused this decrease. Rather,

Is there any evidence that bioenergy demand has caused the following:	Analysis Findings
	the decrease in demand from non-bioenergy sources is due to a combination of reduced product demand (and therefore reduced production) and increased utilization of sawmill residuals.
An unexpected or abnormal increase in wood prices?	**No.** The startup of Alabama Pellets-Aliceville added roughly 450,000 metric tons of softwood pulpwood demand to the catchment area from 2012-2016, and this increase in demand coincided with essentially no change in delivered pine pulpwood (PPW) price over this same period. Ultimately, the additional demand placed on the catchment area following the startup of Alabama Pellets-Aliceville was offset by a decrease in demand from other sources from 2012-2016, and, as a result, delivered PPW prices remained nearly unchanged. However, the Aliceville facility was shut down for a majority of 2017 due to the catastrophic failure of a key piece of environmental equipment, and this was followed by Alabama Pellets' strategic decision to transition to residual-consumption only beginning in 2018, which eliminated more than 360,000 metric tons of annual softwood pulpwood demand from 2016-2018. Over this same period, softwood pulpwood demand from other sources also decreased nearly 360,000 metric tons. So, with the elimination of roughly 720,000 metric tons of annual softwood pulpwood demand from all sources from 2016-2018, delivered PPW prices in the catchment area proceeded to decrease more than 6% over this period. Since 2018, total softwood pulpwood demand has increased roughly 4% in the catchment area (due to increases in demand from non-bioenergy sources), and this increase that has coincided with a simultaneous 4% increase in delivered PPW price. Statistical analysis did identify a positive relationship between softwood biomass demand and delivered PPW price. However, the relationship between delivered PPW price and non-biomass-related softwood pulpwood demand was found to be stronger, which is not unexpected given that pine pulpwood demand not attributed to bioenergy has accounted for 94% of total pine pulpwood demand in the catchment area since 2012. Ultimately, the findings provide evidence that PPW price is influenced by demand from all sources – not just from bioenergy or from pulp/paper, but from both. Furthermore, note that Alabama Pellets' shift to residual-consumption only beginning in 2018 resulted in no increase in pine sawmill chip prices, as the price of pine sawmill chips in the Alabama Cluster catchment area rather decreased from 2018-2020, despite a more than 100,000-metric ton increase in pine sawmill chip consumption by the Aliceville mill over this period.
A reduction in growing stock timber?	**No.** From 2012 (the year Alabama Pellets started up) to 2020, total growing stock inventory increased an average of 2.6% per year (+22% total) in the Alabama Cluster catchment area. Specifically, inventories of pine sawtimber and pine chip-n-saw increased 41% and 40%, respectively, while pine pulpwood (PPW) inventory increased 25% over this same 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 Alabama Cluster catchment area increased from 6.0% in 2012 to 6.2% in 2020, suggesting that the sequestration rate of carbon also increased slightly over this 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 hardwood forests and cropland) has resulted in just the opposite, with the

Is there any evidence that bioenergy demand has caused the following:	Analysis Findings
	average age of softwood (pine) growing stock inventory decreasing from an estimated 35.4 years of age in 2000 to 33.2 years of age in 2010 and to 32.2 years of age in 2020 (total growing stock inventory decreased from 41.9 to 41.0 and to 40.4 years of age over these periods).
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 2020, the latest available, the G:R ratio for pine pulpwood (PPW), the predominant timber product utilized by the bioenergy sector, equaled 3.26 (recall that a value greater than 1.0 indicates sustainable harvest levels). Moreover, note that the PPW G:R ratio has increased in the catchment area since the Aliceville mill's startup in 2012, despite the associated increases in pine pulpwood demand. In this catchment area, pine pulpwood demand from non-bioenergy sources decreased more than 860,000 metric tons from 2012 to 2020, and this decrease more than offset any increase in demand from bioenergy.

Impact of bioenergy demand on:	Analysis Findings
Timber growing stock inventory	**Neutral.** According to USFS data, inventories of pine pulpwood (PPW) increased 25% in the catchment area from 2012-2020, 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 185,000 hectares in the catchment area from 2012-2020. Over this same period, annual harvests of PPW were 65% below maximum sustainable levels.
Timber growth rates	**Neutral.** The average annual growth rate of total growing stock timber increased from 6.0% in 2012 to 6.2% in 2020 in the Alabama Cluster catchment area, despite pine pulpwood (PPW) growth rate decreasing from 15.1% to 12.5% over this period. However, this decrease in PPW growth rate was not due to increased demand attributed to bioenergy but rather to the aging of PPW within its product group and its natural movement along the pine growth rate curve. Specifically, USFS data indicates the average age of PPW inventory in the catchment area increased from an estimated 13.4 years of age in 2012 to 13.6 years of age in 2020.
Forest area	**Neutral.** In the Alabama Cluster catchment area, total forest (timberland) area remained nearly unchanged (decreasing only marginally) from 2012-2020. However, pine timberland – the predominant source of roundwood utilized by the bioenergy industry for wood pellet production – increased more than 185,000 hectares over this period, and this increase can be linked to several factors, including conversion from both hardwood and mixed pine-hardwood forests as well as conversion from cropland. Specifically, the more than 185,000-hectare increase in pine timberland from 2012-2020 coincided with a roughly 197,000-hectare decrease in hardwood/mixed pine-hardwood timberland and a more than 8,000-hectare decrease in cropland over this period. Furthermore, statistical analysis confirmed these inverse relationships, identifying strong negative correlations between pine timberland area and both hardwood/mixed pine-hardwood timberland area and cropland in the catchment area from 2012-2020.
Wood prices	**Negative/Neutral.** Softwood pulpwood demand attributed to bioenergy increased from roughly 80,000 metric tons in 2012 (the year Alabama Pellets-Aliceville started up) to more than 655,000 metric tons in 2015 (the year biomass demand reached peak levels). However, this roughly 575,000-metric ton increase in softwood biomass demand coincided with essentially no change in delivered pine pulpwood (PPW) price – which averaged $26.40 per ton in 2012 and $26.39 per ton in 2015. Ultimately, the additional demand placed on this catchment area following the startup of Alabama Pellets-Aliceville was offset by a more than 680,000-metric ton decrease in demand from other sources over this same period, and, as a result, delivered PPW prices remained nearly unchanged. Also note that Alabama Pellets' strategic shift to consume residuals only (a transition that begun in 2018 and had been completed by 2019) resulted in a nearly 480,000-metric ton decrease in softwood biomass demand in the catchment area from 2015 to 2020. Over this same period, softwood pulpwood demand from other sources decreased more than 180,000 metric tons. In total, softwood pulpwood demand from all sources decreased more than 660,000 metric tons from 2015 to 2020, and this decrease in demand resulted in delivered PPW prices decreasing 5% over this period. Statistical analysis did identify a positive relationship between softwood biomass demand and delivered PPW price. However, the relationship between delivered PPW price and non-biomass-related softwood pulpwood demand was found to be stronger, which is not unexpected given that pine pulpwood demand not attributed to bioenergy has accounted for 94% of total pine pulpwood demand in the catchment area since 2012. Ultimately, the findings provide evidence that PPW price is influenced by demand from all sources – not just from bioenergy or from pulp/paper, but from both.

Impact of bioenergy demand on:	Analysis Findings
Markets for solid wood products	**Positive.** In the Alabama Cluster catchment area, demand for softwood sawlogs used to produce lumber and other solid wood products has increased an estimated 12% since 2012, 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 Alabama Pellets to produce wood pellets. Moreover, the increased availability of sawmill residuals and lower relative cost compared to roundwood (after chipping and other processing costs are considered) led Alabama Pellets to make a strategic shift to utilize residuals only for wood pellet production beginning in 2019. So, not only has Alabama Pellets benefited from the greater availability of this lower-cost sawmill by-product, but lumber producers have also benefited, as Alabama Pellets has provided 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 between 7-8% 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 initiative 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 the west-central portion of Alabama and east-central portion of Mississippi that supports the Alabama Pellets wood pellet mill in Aliceville AL. In addition, this catchment area will support the Alabama Pellets wood pellet mill in Demopolis AL that nears startup as well as the proposed Enviva pellet mill in Epes AL. 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 'Alabama Cluster' catchment area since 2000. It also includes an assessment of long-term market sustainability and provides a market outlook through 2023.

The Alabama Pellets wood pellet mill in Aliceville AL was originally commissioned by The Westervelt Company in late-2012 and has a production capacity of 270,000 metric tons of wood pellets annually. The Alabama Pellets mill in Demopolis AL, which is scheduled to start up in late-2021, will have an annual production capacity of 360,000 metric tons of wood pellets. The Aliceville and Demopolis pellet plants are owned in a joint venture between Drax Group and The Westervelt Company, with Drax holding a 90% interest in the facility and Westervelt holding the remaining 10% interest.

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. Defined Catchment Area

A mill's catchment area is the area in which a single pellet mill ("nucleus mill") has directly acquired fiber since the mill started operations, including any additional forest areas where future purchase contracts exist. However, for the two Alabama Pellets wood pellet mills and the proposed Enviva Pellets Epes mill, the catchment areas of these mills overlap to form a single, slightly larger catchment area (denoted 'Alabama Cluster' catchment area hereafter). This combined catchment area includes a combined 27 counties in Alabama and Mississippi and covers an area more than 50,000 square kilometers (≈5.2 million hectares) in size.

***Figure 2**. Alabama Cluster Catchment Area Boundary*

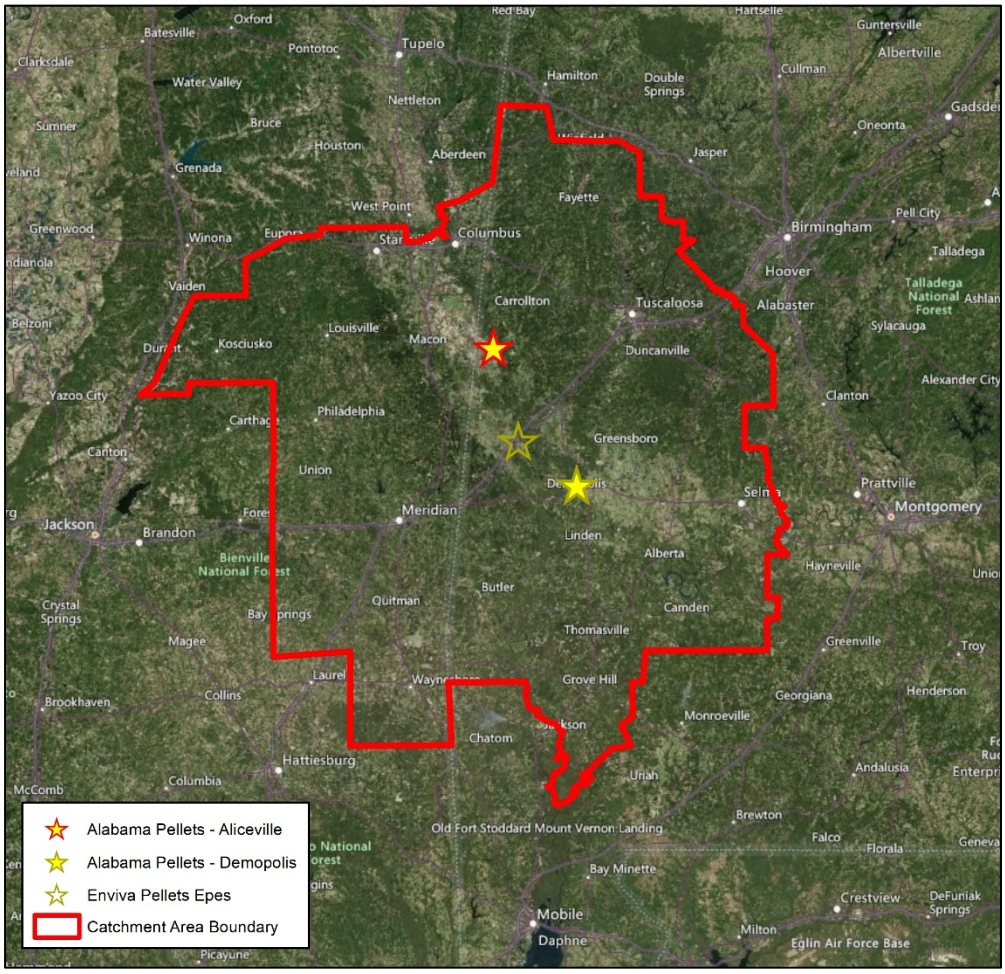


***Table 1**. Alabama Cluster Catchment Area – County List*

State	County	State	County	State	County	State	County
AL	Bibb	AL	Lamar	MS	Attala	MS	Neshoba
AL	Choctaw	AL	Marengo	MS	Choctaw	MS	Newton
AL	Clarke	AL	Perry	MS	Clarke	MS	Noxubee
AL	Dallas	AL	Pickens	MS	Jasper	MS	Oktibbeha
AL	Fayette	AL	Sumter	MS	Kemper	MS	Wayne
AL	Greene	AL	Tuscaloosa	MS	Lauderdale	MS	Winston
AL	Hale	AL	Wilcox	MS	Lowndes		

3. Market Profile & Resource Assessment

The following section provides a current market profile of the Alabama Cluster 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

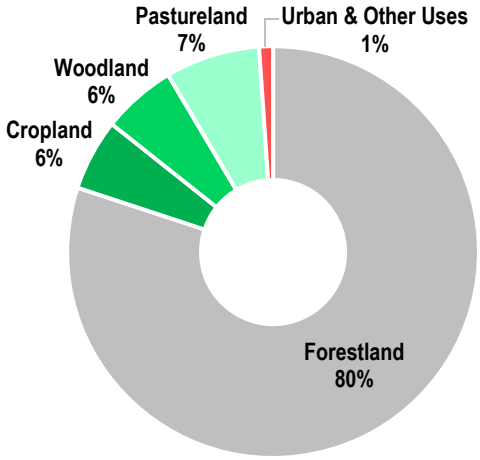
According to the US Department of Agriculture (USDA), the Alabama Cluster catchment area totals approximately 5,227,493 hectares in size. Approximately 80% (4,185,226 hectares) of the total land area is classified as forestland, 19% (985,063 hectares) is farmland, and 1% (57,150 hectares) is urban areas or land that is classified as having other uses.

***Table 2**. Alabama Cluster Catchment Area - Land Area by Land Classification & Use (2020)*

Land Classification / Use	Hectares	% of Total
Forestland	4,185,226	80%
Farmland:		
Cropland	293,530	6%
Woodland	303,587	6%
Pastureland	387,946	7%
Total Farmland	985,063	19%
Urban & Other Uses	57,150	1%
Total	**5,227,439**	**100%**

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

***Figure 3**. Alabama Cluster Catchment Area - Area Distribution by Land Classification & Use (2020)*



3.1.1 *Forestland*

Forestland, defined by the USDA as land at least 10% stock with trees of any kind, totals approximately 4,185,226 hectares and constitutes 80% of the catchment area's total land area.

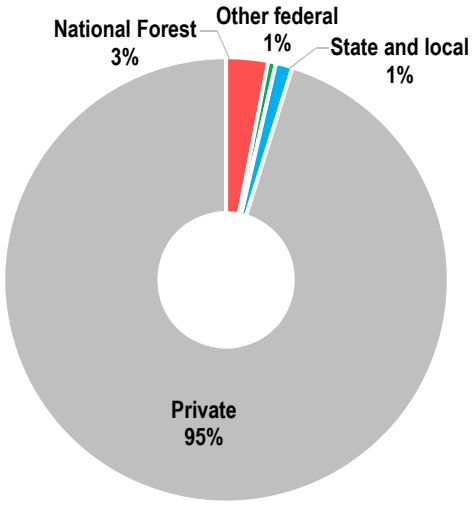
Ownership of forestland in the Alabama Cluster catchment area is predominantly privately owned. According to US Forest Service - Forest Inventory and Analysis (FIA) data from 2020, the latest available, privately-owned forestland constitutes 95% of total forestland and totals approximately 3,964,533 hectares. Public forestland constitutes 5% of total forestland in the catchment area, with National Forests totaling 126,703 hectares (3%), other federal forestland totaling 43,296 hectares (1%), and forestland owned by state and local authorities totaling 50,695 hectares (1%).

***Table 3**. Alabama Cluster Catchment Area - Forestland Area by Ownership Group (2020)*

Ownership Group	Hectares	% of Total
National Forest	126,703	3%
Other Federal	43,296	1%
State and Local	50,695	1%
Private	3,964,533	95%
Total	**4,185,226**	**100%**

Source: USDA – US Forest Service

***Figure 4**. Alabama Cluster Catchment Area - Distribution of Forestland Area by Ownership Group (2020)*



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 Alabama Cluster catchment area, timberland constitutes 99% of total forestland and totals approximately 4,161,102 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.*

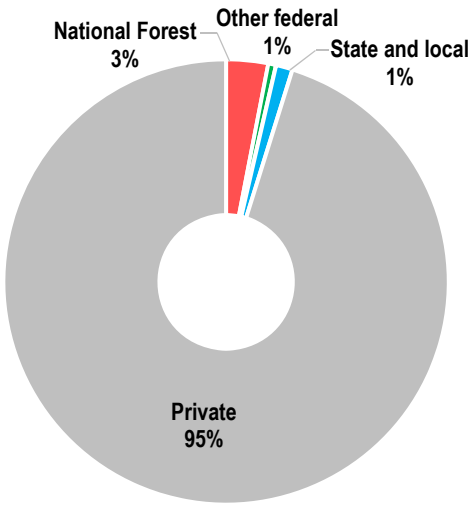
Ownership of timberland in the Alabama Cluster catchment area is nearly identical to that of forestland, with 95% (3,960,139 hectares) of total timberland privately owned, compared to 3% (126,703 hectares) National Forests, 1% (23,566 hectares) other federal, and 1% (50,695 hectares) owned by state and local authorities.

***Table 4**. Alabama Cluster Catchment Area - Timberland Area by Ownership Group (2020)*

Ownership Group	Hectares	% of Total
National Forest	126,703	3%
Other Federal	23,566	1%
State and Local	50,695	1%
Private	3,960,139	95%
Total	**4,161,102**	**100%**

Source: USDA – US Forest Service

***Figure 5**. Alabama Cluster Catchment Area - Distribution of Timberland Area by Ownership Group (2020)*



Age Class Distribution

According to US Forest Service data, of the 4,161,102 hectares of timberland in the catchment area, approximately 53% (2,211,994 hectares) is classified as softwood timberland, 37% (1,524,966 hectares) is classified as hardwood timberland, and 10% (424,142 hectares) is classified as mixed pine-hardwood timberland.

Distribution of timberland area by age class varies by forest type. Specifically, 84% of softwood timberland is 35 years of age or younger, with the average age of softwood timberland (based on area) estimated at 23.3 years of age. In comparison, hardwood timberland is much more evenly distributed across age classes, with 63% of hardwood timberland 21-75 years of age. The average age of hardwood timberland is estimated at 42.0 years of age.

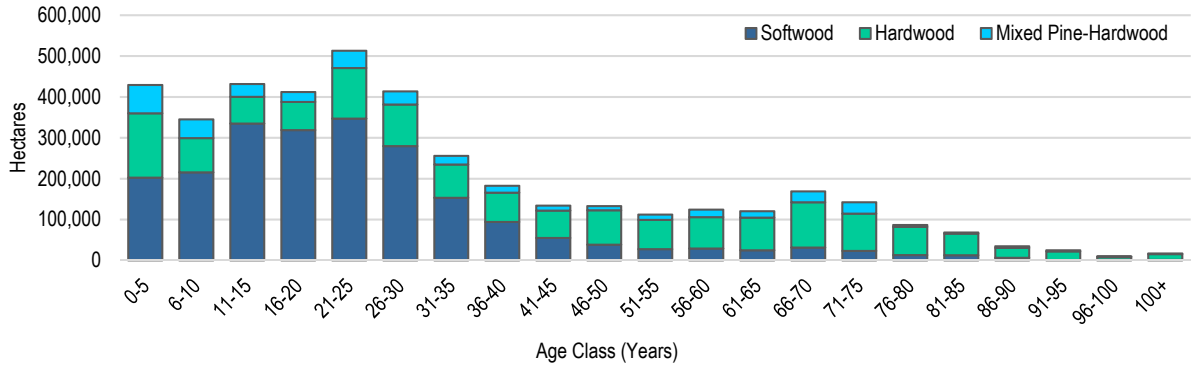
The distribution of mixed pine-hardwood timberland by age class is somewhat of a blend of those associated with both pine and hardwood timberland. Specifically, 96% of mixed pine-hardwood timberland is 75 years of age or younger, with the average age of mixed pine-hardwood timberland estimated at 31.9 years of age.

***Table 5**. Alabama Cluster Catchment Area - Distribution of Timberland Area by Age Class & Forest Type (2020)*

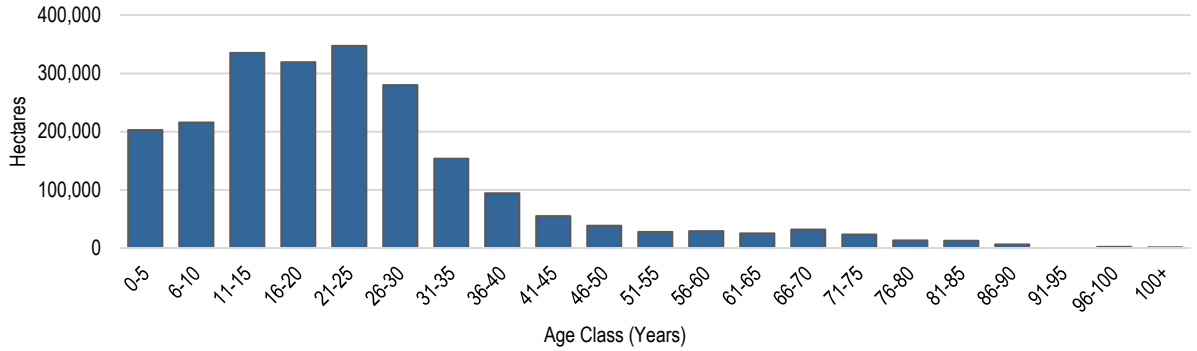
Age Class (Years)	*Softwood*		*Hardwood*		*Mixed Pine-Hardwood*		*Total*	
	Hectares	Distribution	Hectares	Distribution	Hectares	Distribution	Hectares	Distribution
0-5	202,661	9%	157,262	10%	69,430	16%	429,353	10%
6-10	215,456	10%	84,057	6%	45,740	11%	345,254	8%
11-15	334,997	15%	65,476	4%	31,033	7%	431,505	10%
16-20	319,050	14%	68,586	4%	24,450	6%	412,086	10%
21-25	347,074	16%	123,600	8%	42,447	10%	513,122	12%
26-30	279,949	13%	101,686	7%	32,168	8%	413,803	10%
31-35	153,345	7%	81,478	5%	21,091	5%	255,913	6%
36-40	94,234	4%	71,640	5%	16,808	4%	182,683	4%
41-45	54,837	2%	67,229	4%	12,229	3%	134,295	3%
46-50	38,453	2%	84,307	6%	10,084	2%	132,844	3%
51-55	27,698	1%	71,563	5%	12,850	3%	112,110	3%
56-60	29,070	1%	77,021	5%	18,232	4%	124,323	3%
61-65	25,022	1%	79,678	5%	15,669	4%	120,369	3%
66-70	31,678	1%	110,773	7%	26,682	6%	169,133	4%
71-75	23,236	1%	91,265	6%	27,995	7%	142,496	3%
76-80	13,054	1%	68,832	5%	4,848	1%	86,733	2%
81-85	12,540	1%	53,039	3%	2,824	1%	68,403	2%
86-90	6,280	0%	24,591	2%	3,610	1%	34,481	1%
91-95	0	0%	22,116	1%	2,789	1%	24,905	1%
96-100	2,050	0%	6,784	0%	1,265	0%	10,100	0%
100+	1,311	0%	13,983	1%	1,898	0%	17,192	0%
Total	**2,211,994**	**100%**	**1,524,966**	**100%**	**424,142**	**100%**	**4,161,102**	**100%**

Source: USDA - US Forest Service

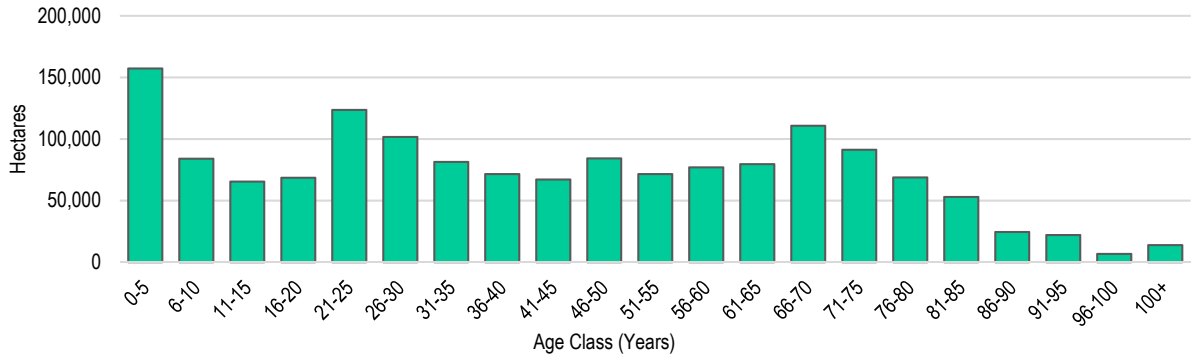
***Figure 6**. Alabama Cluster Catchment Area - Distribution of Timberland Area by Age Class & Forest Type (2020)*



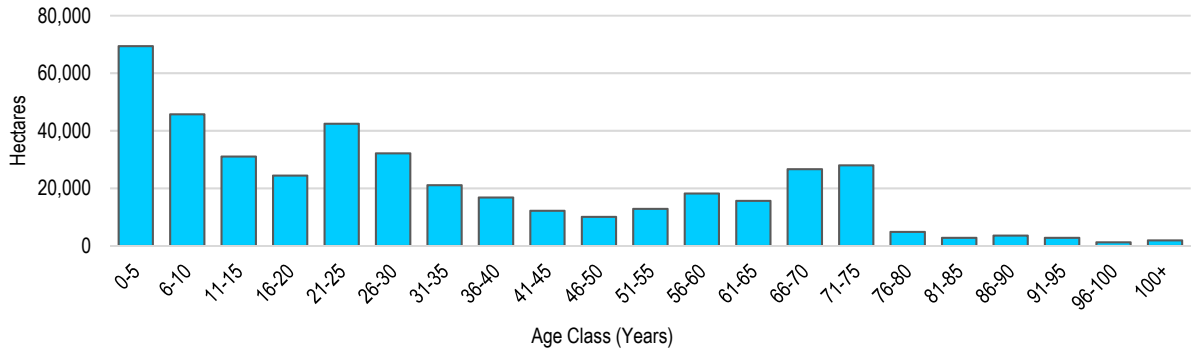
(a) Total Timberland



(b) Softwood Timberland



(c) Hardwood Timberland



(d) Mixed Pine-Hardwood Timberland

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 seedling.

According to the most current USFS estimates, approximately 59% (2,452,850 hectares) of total catchment area timberland is classified as naturally regenerated forests, compared to 41% (1,708,253 hectares) planted forests. However, stand origin area distribution varies widely by major forest type.

US Forest Service data shows 34% (839,343 hectares) of softwood timberland is naturally regenerated versus 66% (1,615,023 hectares) planted. In contrast, 95% (1,613,507 hectares) of hardwood timberland is naturally regenerated, compared to 5% (93,230 hectares) planted.

***Table 6**. Alabama Cluster Catchment Area - Timberland Area by Stand Origin & Major Forest Type (2020)*

	Softwood		*Hardwood*		*Total*	
Stand Origin	**Hectares**	**Distribution**	**Hectares**	**Distribution**	**Hectares**	**Distribution**
Naturally Regenerated	839,343	34%	1,613,507	95%	2,452,850	59%
Planted	1,615,023	66%	93,230	5%	1,708,253	41%
Total	**2,454,366**	**100%**	**1,706,736**	**100%**	**4,161,102**	**100%**

Source: USDA - US Forest Service

***Figure 7**. Alabama Cluster Catchment Area - Distribution of Timberland Area by Stand Origin & Major Forest Type (2020)*

3.2 Timber Inventory

Timber inventory data for the Georgia 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 this section profiles timber inventory, growth, and removal details as of 2020[1], the most current available. Further analysis, including inventory trends since 2000, is provided in the *Market Trends, Analysis, & Outlook* section beginning on page 53.

3.2.1 *Ownership Group*

Growing stock inventory on timberland in the Alabama Cluster catchment area in 2020, the latest available, totaled an estimated 483 million m^3, of which approximately 93% (449 million m^3) is privately owned, 5% (23 million m^3) is National Forest, 1% (4 million m^3) is owned by state and local authorities, and 1% (6 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, National Forests contain approximately 5% of total softwood inventory but only 4% of hardwood inventory. Also, timberland owned by state and local authorities contains 1% of total softwood inventory but 2% of total hardwood inventory. See Table 7 for details.

***Table 7**. Alabama Cluster Catchment Area - Growing Stock Volume on Timberland by Ownership Group and Major Species (2020)*

Ownership Group	Softwood Inventory	Hardwood Inventory	Total Inventory
		(000 Cubic Meters)	
National Forest	15,796	7,497	23,292
Other Federal	1,517	2,526	4,043
State and Local	3,211	3,181	6,392
Private	279,680	169,806	449,486
Total	**300,203**	**183,009**	**483,213**

Source: USDA - US Forest Service

[1] US Forest Service-FIA data for those counties located in Mississippi are only available through 2019. Estimates through 2020 have been included and are based on historical trends and a local area inventory model.

3.2.2 *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 72% (217 million m^3) of total softwood growing stock inventory is 7- 17 inches in diameter, with 93% (278 million m^3) less than 21 inches in diameter. In comparison, 55% (116 million m^3) of total hardwood growing stock inventory is 5-17 inches in diameter, with 80% (147 million m^3) less than 21 inches in diameter.

Based on these diameter class distributions, softwood growing stock inventory averages an estimated 8.5 inches in diameter, compared to 9.1 inches for hardwood growing stock inventory.

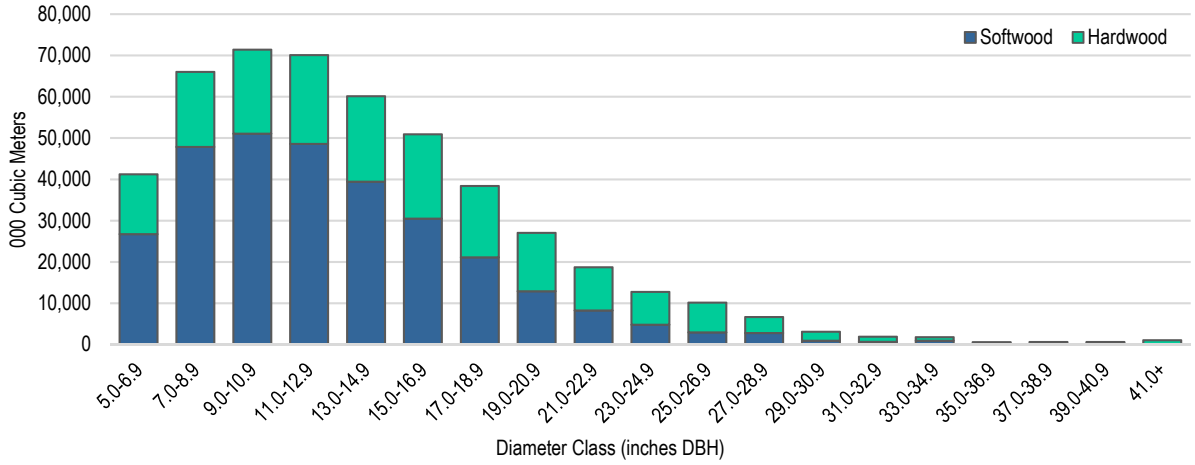
***Table 8**. Alabama Cluster Catchment Area - Timber Inventory by Major Species Group & Diameter Class (2020)*

Diameter Class (inches DBH)	Softwood		Hardwood		Total	
	Volume (000 m^3)	Distribution	Volume (000 m^3)	Distribution	Volume (000 m^3)	Distribution
5.0-6.9	26,727	9%	14,513	8%	41,240	9%
7.0-8.9	47,850	16%	18,149	10%	65,999	14%
9.0-10.9	51,059	17%	20,359	11%	71,417	15%
11.0-12.9	48,572	16%	21,511	12%	70,083	15%
13.0-14.9	39,445	13%	20,671	11%	60,116	12%
15.0-16.9	30,502	10%	20,423	11%	50,925	11%
17.0-18.9	21,132	7%	17,253	9%	38,385	8%
19.0-20.9	12,908	4%	14,140	8%	27,048	6%
21.0-22.9	8,253	3%	10,464	6%	18,717	4%
23.0-24.9	4,827	2%	7,940	4%	12,767	3%
25.0-26.9	2,946	1%	7,204	4%	10,150	2%
27.0-28.9	2,810	1%	3,876	2%	6,686	1%
29.0-30.9	926	0%	2,170	1%	3,096	1%
31.0-32.9	673	0%	1,249	1%	1,921	0%
33.0-34.9	938	0%	845	0%	1,783	0%
35.0-36.9	335	0%	244	0%	579	0%
37.0-38.9	0	0%	608	0%	608	0%
39.0-40.9	301	0%	323	0%	624	0%
41.0+	0	0%	1,067	1%	1,067	0%
Total	**300,203**	**100%**	**183,009**	**100%**	**483,213**	**100%**

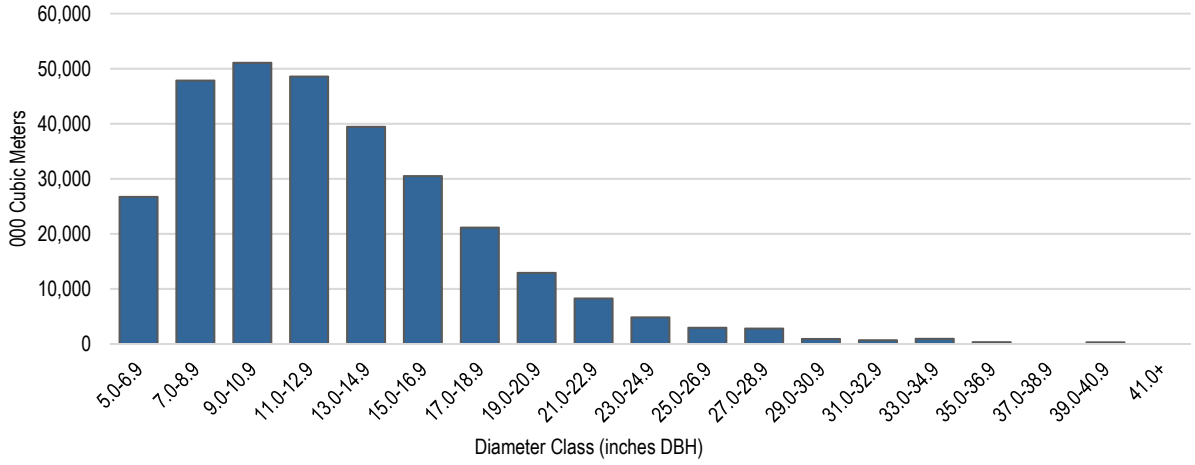
Pine Pulpwood Pine Chip-n-saw Pine Sawtimber Hardwood Pulpwood Hardwood Sawtimber

Source: USDA - US Forest Service

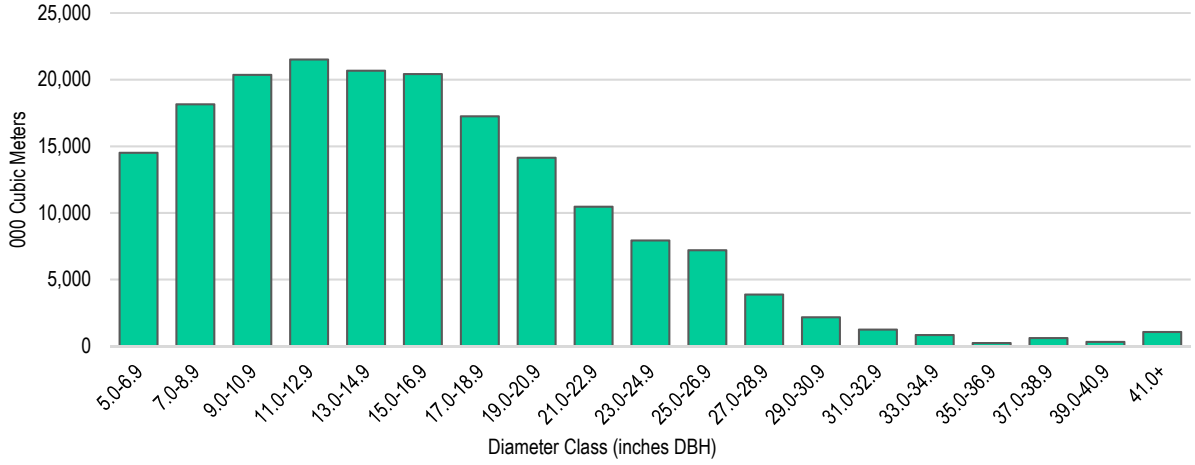
***Figure 8**. Alabama Cluster Catchment Area - Distribution of Growing Stock Volume on Timberland by Diameter Class (2020)*



(a) Total Growing Stock Inventory



(b) Softwood Growing Stock Inventory



(c) Hardwood Growing Stock Inventory

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 99% of total softwood inventory in the catchment area (according to FIA data). Individual product specifications are defined as follows:

Major Product	DBH (inches)
Pine Pulpwood	5.0 – 8.9
Pine Chip-n-saw	9.0 – 11.9
Pine Sawtimber	12.0+
Hardwood Pulpwood	5.0 – 11.9
Hardwood Sawtimber	12.0+

Based on these product specifications, approximately 150 million m^3 (31%) of total growing stock inventory is classified as pine sawtimber, compared to 75 million m^3 (16%) of pine chip-n-saw, 74 million m^3 (15%) of pine pulpwood, 119 million m^3 (25%) of hardwood sawtimber, and 64 million m^3 (13%) of hardwood pulpwood.

***Table 9**. Alabama Cluster Catchment Area - Distribution of Total Growing Stock Volume by Major Timber Product (2020)*

Product	Volume (000 m^3)	Distribution
Pine Sawtimber	150,244	31%
Pine Chip-n-saw	75,473	16%
Pine Pulpwood	74,486	15%
Hardwood Sawtimber	119,145	25%
Hardwood Pulpwood	63,864	13%
Total	**483,213**	**100%**

Source: USDA - US Forest Service

3.2.3 *Age Class Distribution*

Distribution of total growing stock volume on timberland by age class is bimodal, with 51% of total inventory 11-35 years of age and 23% of total inventory 56-80 years of age (see Figure 9 on the following page). However, this is explained by major species composition and its respective age class distribution.

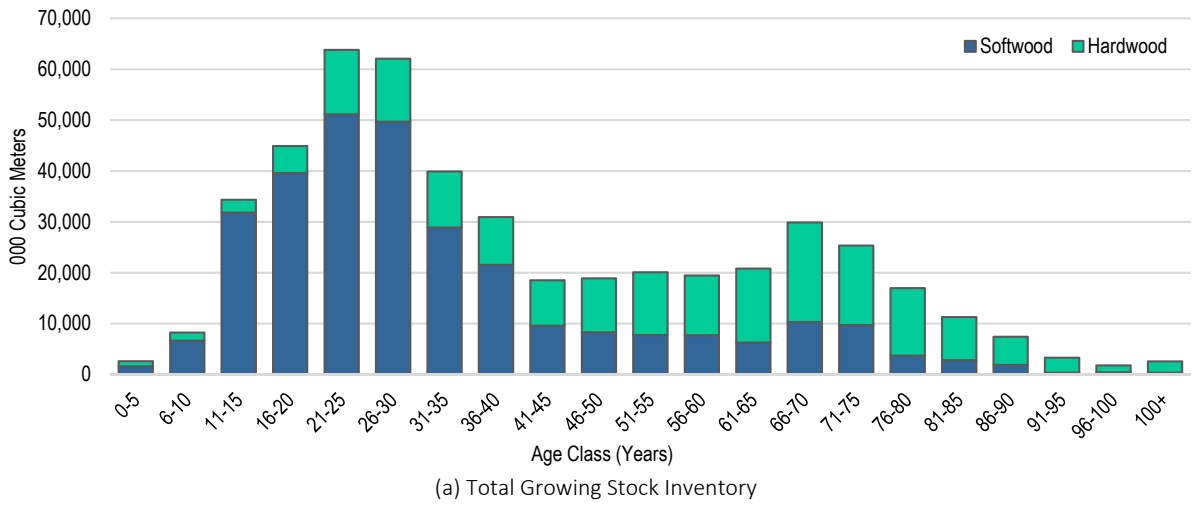
According to USFS estimates, softwood growing stock inventory averages an estimated 32.2 years of age, with 72% (223 million m^3) of total softwood inventory 11-40 years of age. In contrast, hardwood inventory averages an estimated 54.0 years of age, with 58% (106 million m^3) of hardwood inventory 46-85 years of age.

***Table 10**. Alabama Cluster Catchment Area - Distribution of Growing Stock Volume by Age Class & Major Species (2020)*

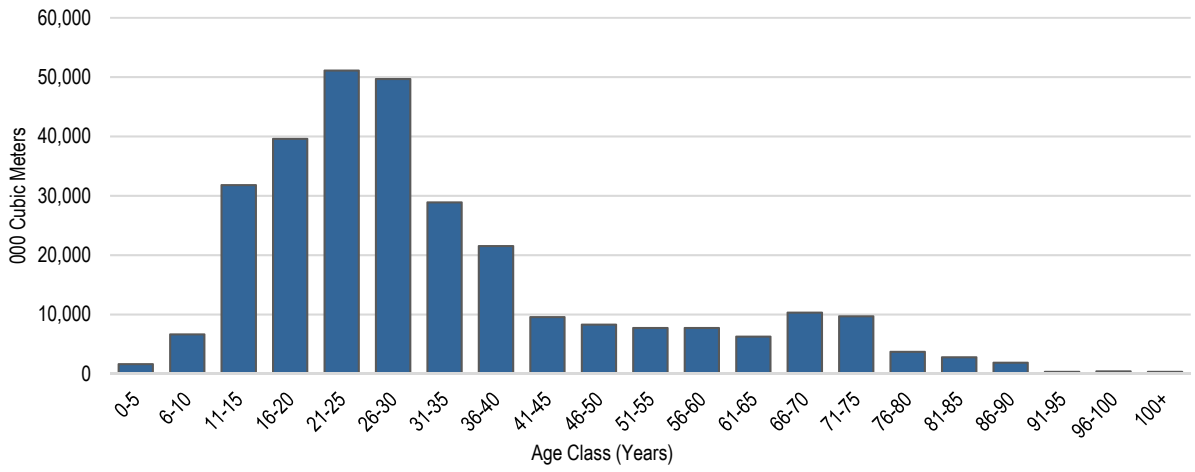
Age Class (Years)	Softwood		Hardwood		Total	
	Volume (000 m^3)	Distribution	Volume (000 m^3)	Distribution	Volume (000 m^3)	Distribution
0-5	1,640	1%	967	1%	2,608	1%
6-10	6,655	2%	1,587	1%	8,242	2%
11-15	31,809	11%	2,527	1%	34,336	7%
16-20	39,592	13%	5,319	3%	44,910	9%
21-25	51,118	17%	12,691	7%	63,810	13%
26-30	49,681	17%	12,403	7%	62,084	13%
31-35	28,892	10%	11,015	6%	39,908	8%
36-40	21,547	7%	9,389	5%	30,937	6%
41-45	9,576	3%	8,936	5%	18,511	4%
46-50	8,297	3%	10,614	6%	18,911	4%
51-55	7,755	3%	12,346	7%	20,100	4%
56-60	7,736	3%	11,741	6%	19,477	4%
61-65	6,292	2%	14,527	8%	20,820	4%
66-70	10,317	3%	19,543	11%	29,860	6%
71-75	9,702	3%	15,632	9%	25,334	5%
76-80	3,714	1%	13,280	7%	16,994	4%
81-85	2,820	1%	8,474	5%	11,294	2%
86-90	1,889	1%	5,522	3%	7,411	2%
91-95	358	0%	2,934	2%	3,292	1%
96-100	449	0%	1,355	1%	1,805	0%
100+	362	0%	2,207	1%	2,569	1%
Total	**300,203**	**100%**	**183,009**	**100%**	**483,213**	**100%**

Source: USDA - US Forest Service

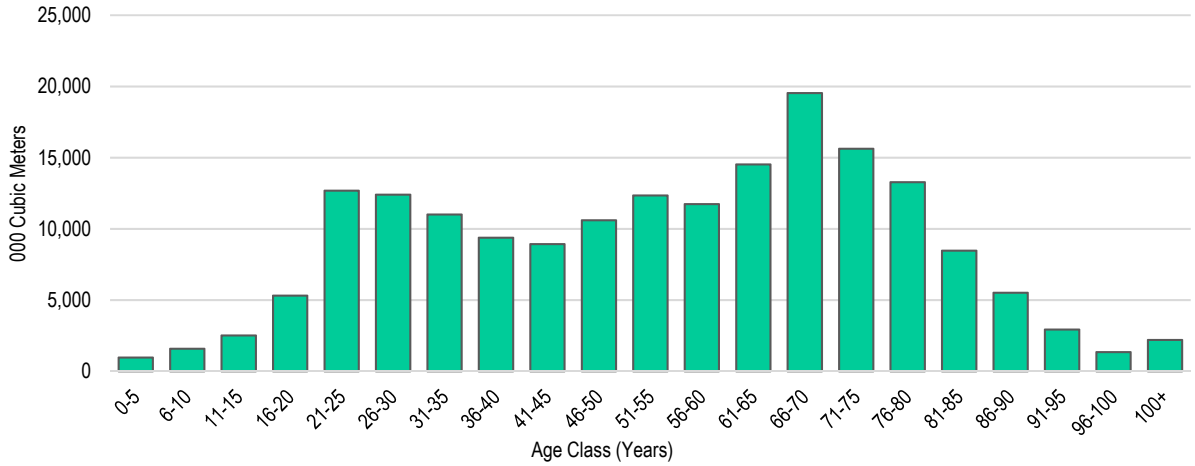
***Figure 9**. Alabama Cluster Catchment Area - Distribution of Growing Stock Volume on Timberland by Age Class (2020)*



(a) Total Growing Stock Inventory



(b) Softwood Growing Stock Inventory



(c) Hardwood Growing Stock Inventory

3.2.4 *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 61% of total growing stock volume in the catchment area, or 297 million m^3, is naturally regenerated timber, compared to 39% (186 million m^3) planted. However, stand origin distribution varies widely by major species group.

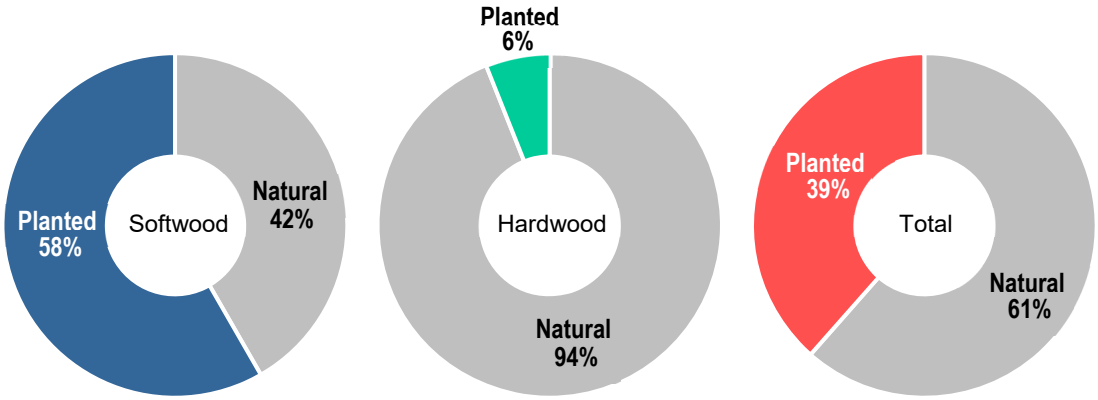
US Forest Service data shows approximately 42% (125 million m^3) of softwood growing stock inventory is naturally regenerated versus 58% (175 million m^3) planted. In contrast, approximately 94% (172 million m^3) of hardwood inventory is naturally regenerated, compared to 6% (11 million m^3) planted.

***Table 11**. Alabama Cluster Catchment Area - Growing Stock Volume on Timberland by Stand Origin & Major Species (2020)*

Stand Origin	Softwood		Hardwood		Total	
	Volume (000 m^3)	Distribution	Volume (000 m^3)	Distribution	Volume (000 m^3)	Distribution
Naturally Regenerated	125,165	42%	171,995	94%	297,159	61%
Planted	175,039	58%	11,015	6%	186,054	39%
Total	**300,203**	**100%**	**183,009**	**100%**	**483,213**	**100%**

Source: USDA - US Forest Service

***Figure 10**. Alabama Cluster Catchment Area - Distribution of Growing Stock Volume on Timberland by Stand Origin & Major Species (2020)*



3.3 Timber Growth & Removals

3.3.1 *Timber Growth*

According to US Forest Service estimates, net annual growth of growing stock timber in the Alabama Cluster catchment area totaled an estimated 30.0 million m^3 in 2020, the latest available. Specifically, 78% (23.5 million m^3) of total growth was attributed to softwood species compared to 22% (6.5 million m^3) hardwood species.

Annual growth was highest for pine pulpwood, which totaled 9.3 million m^3 and accounted for 31% of total volume growth, followed by pine sawtimber at 7.5 million m^3 (25%), pine chip-n-saw at 6.6 million m^3 (22%), hardwood pulpwood at 3.7 million m^3 (12%), and hardwood sawtimber at 2.9 million m^3 (10%).

***Table 12**. Alabama Cluster Catchment Area - Net Growth of Growing Stock Timber by Major Timber Product (2020)*

Product	Volume Growth (000 m^3)	% of Total Growth
Pine Sawtimber	7,523	25%
Pine Chip-n-saw	6,641	22%
Pine Pulpwood	9,336	31%
Hardwood Sawtimber	2,867	10%
Hardwood Pulpwood	3,674	12%
Total	**30,041**	**100%**

Source: USDA - US Forest Service

3.3.2 *Timber Removals*

According to the USFS, timber removals in the catchment area totaled 16.2 million m^3 in 2020, of which approximately 79% (12.8 million m^3) was softwood timber and 21% (3.4 million m^3) was hardwood timber.

Of the five major timber products, removals were highest for pine sawtimber, which totaled 6.4 million m^3 and accounted for 40% of total removals, followed by pine chip-n-saw at 3.5 million m^3 (22%), pine pulpwood at 2.9 million m^3 (18%), hardwood sawtimber at 2.0 million m^3 (13%), and hardwood pulpwood at 1.3 million m^3 (8%).

***Table 13**. Alabama Cluster Catchment Area - Timber Removals by Major Timber Product (2020)*

Product	Removals (000 m^3)	% of Total Removals
Pine Sawtimber	6,397	40%
Pine Chip-n-saw	3,548	22%
Pine Pulpwood	2,861	18%
Hardwood Sawtimber	2,047	13%
Hardwood Pulpwood	1,310	8%
Total	**16,163**	**100%**

Source: USDA - US Forest Service

3.3.3 *Growth-to-Removals Ratios*

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 2020, the latest available, overall inventory growth totaled 30.0 million m^3, compared to total removals of 16.2 million m^3, or a growth-to-removals ratio of 1.86. The growth-to-removal ratio for softwood species was 1.84 versus 1.94 for hardwood species.

Growth-to-removals ratios by species and individual timber product in 2020 were as follows: pine sawtimber=1.16, pine chip-n-saw=1.88, pine pulpwood=3.27, hardwood sawtimber=1.40, and hardwood pulpwood=2.83. Note that growth-to-removals ratios for all five major products were well above 1.0, indicating sustainable market conditions as well as oversupply.

***Table 14**. Alabama Cluster Catchment Area - Annual Growth, Removals, & Growth-to-Removal Ratios by Major Timber Product (2020)*

Softwood (Pine)	Growth (000 m^3)	Removals (000 m^3)	G:R Ratio
Pine Sawtimber	7,523	6,397	1.16
Pine Chip-n-saw	6,641	3,548	1.88
Pine Pulpwood	9,336	2,861	3.27
Softwood (Pine) Total	**23,500**	**12,806**	**1.84**

Hardwood	Growth (000 m^3)	Removals (000 m^3)	G:R Ratio
Hardwood Sawtimber	2,867	2,047	1.40
Hardwood Pulpwood	3,674	1,310	2.83
Hardwood Total	**6,541**	**3,357**	**1.94**

Product	Growth (000 m^3)	Removals (000 m^3)	G:R Ratio
Sawtimber	17,032	11,992	1.42
Pulpwood	13,009	4,171	3.13
Total	**30,041**	**16,163**	**1.86**

Source: USDA - US Forest Service

4. Wood Demand & Raw Material Cost Assessment

4.1 Mill Capacity & Wood Demand

According to TimberMart-South's mill database, as of September 2021, there were 135 wood-consuming mills operating in or around the Alabama Cluster catchment area (within roughly 160 miles of the catchment area center). This includes 61 lumber mills (43 softwood mills and 18 hardwood mills), 16 pulp/paper mills, 27 panel (plywood/OSB) mills, 27 chip mills, and 4 pellet mills.

Total production capacity associated with these 135 mills translates to over 60 million metric tons of roundwood per year. However, not all wood consumed by these mills are procured from within the Alabama Cluster catchment area. Based on the relative location of these mills to this catchment area, total annual wood demand allocated to the Alabama Cluster catchment area by these mills is estimated at approximately 21,846,700 metric tons of roundwood.

***Table 15**. Alabama Cluster Catchment Area - Number of Mills, Total Mill Capacity, & Catchment Area Allocated Mill Capacity (2021)*

Mill Type	No. Mills	Total Capacity (Metric Tons*)	Catchment Area Allocation (Metric Tons*)
Lumber	61	23,071,511	8,587,635
Pulp / Paper	16	23,421,854	8,513,240
Plywood / OSB	27	6,760,938	1,971,119
Chip	27	6,417,291	2,531,845
Pellet	4	498,952	242,830
Total	**135**	**60,170,544**	**21,846,668**

*Roundwood equivalent volume

Source: TimberMart-South; Hood Consulting

***Table 16**. Alabama Cluster Catchment Area - Mill List (2021)*

Mill Name / Company	City	County	State	Capacity	Units	Demand*
		Softwood Sawmill				
Millry Mill Co. Inc.	Millry	Washington	AL	14	MM Bf	110,180
Lincoln Lumber	Forest	Scott	MS	17	MM Bf	133,790
Thomasville Lumber Co.	Thomasville	Clarke	AL	20	MM Bf	157,400
Pate Lumber Company, Inc.	Carrollton	Pickens	AL	22	MM Bf	173,140
Jack Batte & Sons	Forest	Scott	MS	25	MM Bf	196,750
Barge Forest Products	Macon	Noxubee	MS	26	MM Bf	204,620
McShan Lumber Co.	McShan	Pickens	AL	27	MM Bf	313,480
Homan Forest Products	Fulton	Itawamba	MS	30	MM Bf	125,920
W. G. Sullivan Lumber	Northport	Tuscaloosa	AL	33	MM Bf	259,710
Buchanan Lumber	Meridian	Lauderdale	MS	38	MM Bf	299,060
Swift Lumber Company Inc.	Atmore	Escambia	AL	40	MM Bf	196,750
Westervelt	Moundville	Hale	Al	50	MM Bf	358,500
Coastal Forest Products	Chapman	Butler	AL	60	MM Bf	327,310
Grayson Lumber	Houston	Winston	AL	65	MM Bf	354,970
Georgia-Pacific	Taylorsville	Smith	MS	67	MM Bf	364,190
Southeastern Timber Products	Ackerman	Choctaw	MS	76	MM Bf	442,560
Hankins, Inc.	Ripley	Tippah	MS	95	MM Bf	442,560
Jasper Lumber	W. Jasper	Walker	AL	100	MM Bf	350,360
Harrigan Lumber	Monroeville	Monroe	AL	110	MM Bf	469,790
Weyerhaeuser	Millport	Lamar	AL	110	MM Bf	474,100
Canfor	Mobile	Mobile	AL	115	MM Bf	633,570
West Fraser	Maplesville	Chilton	AL	115	MM Bf	461,170
Canfor	Jackson	Clarke	AL	120	MM Bf	517,200
Georgia-Pacific	Mexia	Monroe	AL	120	MM Bf	419,510
Georgia-Pacific	Bay Springs	Jasper	MS	120	MM Bf	474,100
Hankins Lumber	Grenada	Grenada	MS	120	MM Bf	517,200
T. R. Miller Mill Co.	Brewton	Escambia	AL	120	MM Bf	465,480
Georgia-Pacific	Belk	Fayette	AL	122	MM Bf	499,960
Shuqualak Lumber	Shuqualak	Noxubee	MS	130	MM Bf	530,130
Canfor	Fulton	Clarke	AL	170	MM Bf	737,010
Hood Industries	Silver Creek	Lawrence	MS	170	MM Bf	689,600
Hood Industries	Waynesboro	Wayne	MS	170	MM Bf	732,700
Vicksburg Forest Products	Vicksburg	Warren	MS	180	MM Bf	638,130
Two Rivers Lumber	Demopolis	Marengo	AL	200	MM Bf	862,000
Weyerhaeuser	Philadelphia	Neshoba	MS	225	MM Bf	965,440
Georgia-Pacific	Talladega	Talladega	AL	230	MM Bf	991,300
Westervelt	Moundville	Hale	AL	230	MM Bf	1,124,910
Weyerhaeuser	Bruce	Lafayette	MS	235	MM Bf	1,012,850
Rex Lumber	Troy	Pike	AL	240	MM Bf	1,034,400
Westervelt	Thomasville	Clarke	AL	250	MM Bf	1,077,500
Biewer Lumber	Newton	Newton	MS	350	MM Bf	1,395,000
		Hardwood Sawmill				
KyKenKee, Inc.	Vance	Tuscaloosa	AL	10	MM Bf	63,700
Graham Lumber	Fulton	Itawamba	MS	12	MM Bf	86,040
Kelwood Products	Enterprise	Clarke	MS	12	MM Bf	86,040
T.K. Stanley	Waynesboro	Wayne	MS	12	MM Bf	86,040
Lewis Brothers Lumber Company	Aliceville	Pickens	AL	14	MM Bf	100,380
Oakman Hardwood	Oakman	Walker	AL	15	MM Bf	107,550
Pro South Wood Products	Booneville	Prentiss	MS	15	MM Bf	89,700
Sturgis Mat Company	Sturgis	Oktibbeha	MS	15	MM Bf	107,550
Jachin Tie & Timber	Jachin	Choctaw	AL	17	MM Bf	121,890
Rutland Lumber Company	Collins	Covington	MS	18	MM Bf	129,060
Winston Hardwood Lumber	Double Springs	Winston	AL	18	MM Bf	129,060
Monticello Tie & Timber	Monticello	Lawrence	MS	22	MM Bf	157,740
Buchanan Lumber Company	Aliceville	Pickens	AL	25	MM Bf	179,250
Jones Lumber Company	Bay Springs	Jasper	MS	37	MM Bf	265,290
Jones Lumber Company	Hazlehurst	Copiah	MS	40	MM Bf	286,800
Jones Lumber Company	Sandy Hook	Walthall	MS	40	MM Bf	286,800

Mill Name / Company	City	County	State	Capacity	Units	Demand*
Linden Lumber	Linden	Marengo	AL	45	MM Bf	322,650
		Plywood/Panel Mill				
Georgia-Pacific	Monroeville	Monroe	AL	-	MM SqFt	-
Wallace Wood Products	Demopolis	Marengo	AL	8	MM SqFt	14,625
Mannington Wood Floors	Epes	Sumter	AL	12	MM SqFt	23,156
Browder & Son Veneer	Thomasville	Clarke	AL	25	MM SqFt	48,750
Browder Veneer Co.	Camden	Wilcox	AL	25	MM SqFt	48,750
Browder Veneer Works	Montgomery	Montgomery	AL	25	MM SqFt	48,750
Capital Veneer Works	Montgomery	Montgomery	AL	25	MM SqFt	48,750
D & L Veneers Inc.	Collins	Covington	MS	25	MM SqFt	48,750
H.E. Browder Veneer Co.	Petrey	Crenshaw	AL	25	MM SqFt	48,750
Quality Plywood Co	Waynesboro	Wayne	MS	25	MM SqFt	48,750
Cahaba Veneer	Centreville	Bibb	AL	50	MM SqFt	97,500
Boise Cascade	Thorsby	Chilton	AL	125	MM SqFt	243,750
Scotch Plywood	Waynesboro	Wayne	MS	125	MM SqFt	243,750
Roseburg Forest Products	Taylorsville	Smith	MS	137	MM SqFt	250,481
Hood Industries	Wiggins	Stone	MS	180	MM SqFt	351,000
Wilsonart Engineered Surfaces	Oxford	Lafayette	MS	200	MM SqFt	-
Georgia-Pacific	Talladega	Talladega	AL	230	MM SqFt	-
Hood Industries	Beaumont	Perry	MS	240	MM SqFt	468,000
Armstrong Hardwood Veneer	Vicksburg	Warren	MS	250	MM SqFt	487,500
Coastal Forest Resources	Chapman	Butler	AL	304	MM SqFt	593,531
Kronospan	Eastaboga	Calhoun	AL	340	MM SqFt	-
Georgia-Pacific	Taylorsville	Smith	MS	355	MM SqFt	692,250
Scotch Plywood	Beatrice	Monroe	AL	359	MM SqFt	699,563
Winston Plywood & Veneer	Louisville	Winston	MS	400	MM SqFt	-
Louisiana Pacific	Hanceville	Cullman	AL	410	MM SqFt	750,300
Norboard	Guntown	Lee	MS	450	MM SqFt	823,500
Louisiana Pacific	Thomasville	Clarke	AL	750	MM SqFt	1,372,500
		Pulp/Paper Mill				
Kimberly-Clark	Mobile	Mobile	AL	-	M tons	-
Resolute Forest Products	Grenada	Grenada	MS	231	M tons	829,290
Resolute Forest Products	Coosa Pines	Talladega	AL	268	M tons	962,120
Georgia-Pacific	Perdue Hill	Monroe	AL	432	M tons	1,550,880
WestRock	Demopolis	Marengo	AL	450	M tons	1,615,500
Georgia-Pacific	Brewton	Escambia	AL	464	M tons	-
Packaging Corporation of America	Jackson	Clarke	AL	469	M tons	1,683,710
International Paper	Columbus	Lowndes	MS	500	M tons	1,795,000
International Paper	Selma	Dallas	AL	570	M tons	2,046,300
International Paper	Vicksburg	Warren	MS	571	M tons	2,049,890
Georgia-Pacific	Pennington	Choctaw	AL	607	M tons	2,179,130
Georgia-Pacific	New Augusta	Perry	MS	628	M tons	2,254,520
Georgia-Pacific	Perdue Hill	Monroe	AL	821	M tons	2,947,390
International Paper	Pine Hill	Wilcox	AL	870	M tons	3,123,300
Georgia-Pacific	Monticello	Lawrence	MS	895	M tons	3,213,050
International Paper	Prattville	Autauga	AL	1051	M tons	3,773,090
		Chip Mill				
American Chips, Inc.	Alpine	Talladega	AL	-	M tons	-
Amory Chips	Amory	Monroe	MS	-	M tons	-
Cooper Marine and Timberland	Mulga	Jefferson	AL	-	M tons	-
Cooper Marine and Timberland	Aliceville	Pickens	AL	-	M tons	-
Georgia-Pacific	Jackson's Gap	Tallapoosa	AL	-	M tons	-
Georgia-Pacific	Louisville	Winston	MS	-	M tons	-
Green Valley Chipping	Brundidge	Pike	AL	-	M tons	-
International Paper	Sandy Hook	Walthall	MS	-	M tons	-
International Paper	Columbia	Marion	MS	-	M tons	-
Masonite Corp.	Laurel	Jones	MS	-	M tons	-
Scott Davis Chip Co.	Brent	Bibb	AL	-	M tons	-
Shuler Bros. Chip Co.	Opp	Covington	AL	-	M tons	-
Jones Lumber Co.	Sandy Hook	Walthall	MS	5	M tons	5,250
Reynolds Wood Products	Maplesville	Chilton	AL	17	M tons	17,850

Mill Name / Company	City	County	State	Capacity	Units	Demand*
American Wood Fibre	Montgomery	Montgomery	AL	150	M tons	157,500
Cooper Marine and Timberland	Dennis	Tishomingo	MS	200	M tons	210,000
Georgia-Pacific	Elba	Coffee	AL	250	M tons	262,500
Rentech, Inc.	Carrollton	Carroll	MS	250	M tons	262,500
Georgia-Pacific	Taylorsville	Smith	MS	300	M tons	315,000
Rentech, Inc.	Yazoo City	Yazoo	MS	400	M tons	420,000
Rentech, Inc.	Ohatchee	Calhoun	AL	400	M tons	420,000
Rentech, Inc.	Meridian	Lauderdale	MS	465	M tons	488,250
Jasper Lumber	Jasper	Walker	AL	500	M tons	525,000
Georgia-Pacific	Bague Chitto	Lincoln	MS	700	M tons	735,000
WestRock	Coatopa	Sumter	AL	700	M tons	735,000
Rentech, Inc.	Brewton	Escambia	AL	1100	M tons	1,155,000
WestRock	Demopolis	Marengo	AL	1300	M tons	1,365,000
		Pellet Mill				
Nature's Earth Pellet	Reform	Pickens	AL	90	M tons	180,000
Enviva Biomass	Amory	Monroe	MS	100	M tons	200,000
Mohegan Renewable Energy	Quitman	Clarke	MS	250	M tons	500,000
Pinnacle Renewable Energy	Aliceville	Pickens	AL	275	M tons	550,000
Pinnacle Renewable Energy	Demopolis	Marengo	AL	360	M tons	720,000

*Roundwood equivalent volume (green tons)

Note: Table includes all major mills located within or that procure wood from within the Alabama Cluster catchment area. Also, only sawmills with annual production capacity of 10 million board feet or greater are included in this list.

***Figure 11**. Alabama Cluster Catchment Area - Mill Map (2021)*

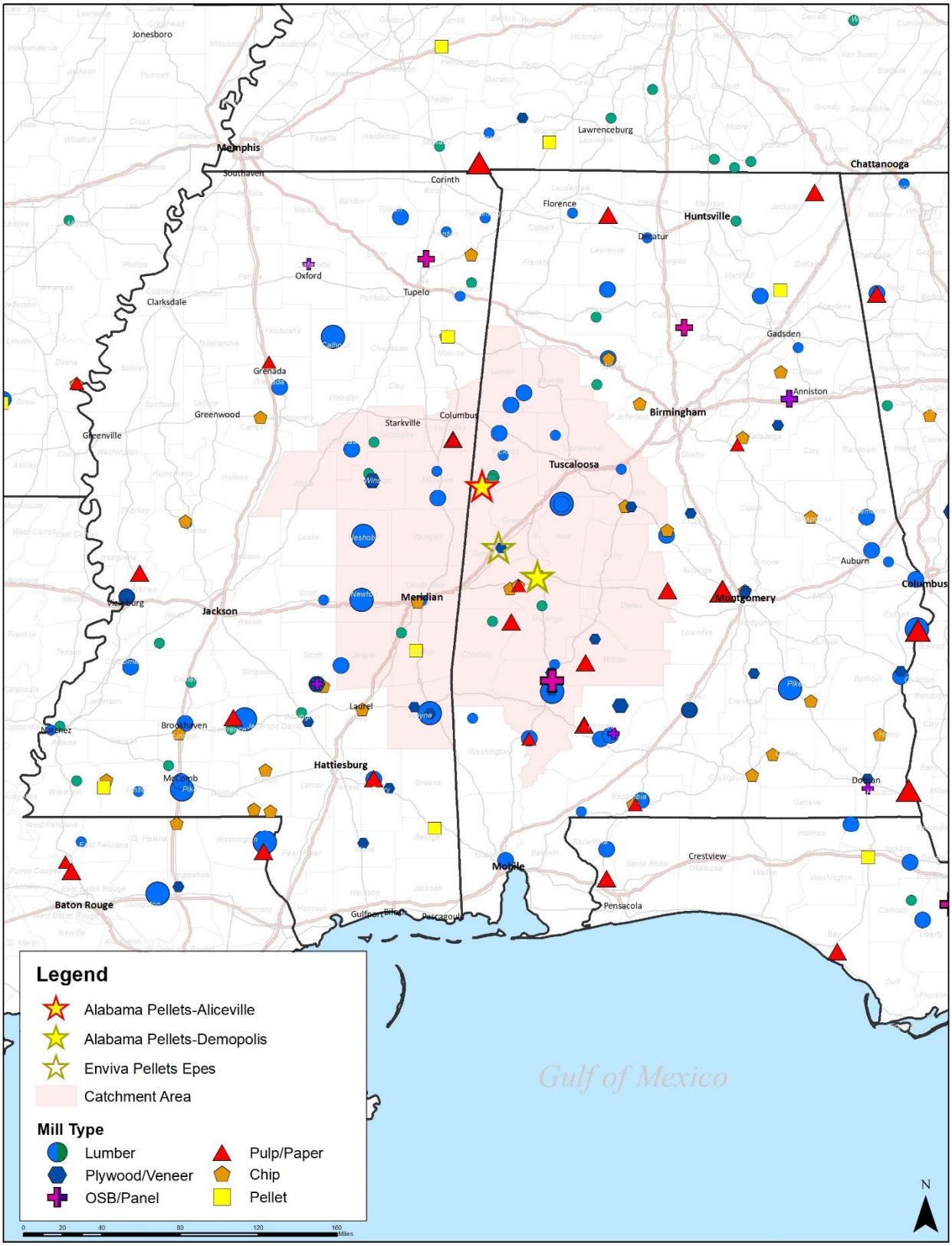


***Figure 12**. Alabama Cluster Catchment Area - Lumber Mills (2021)*

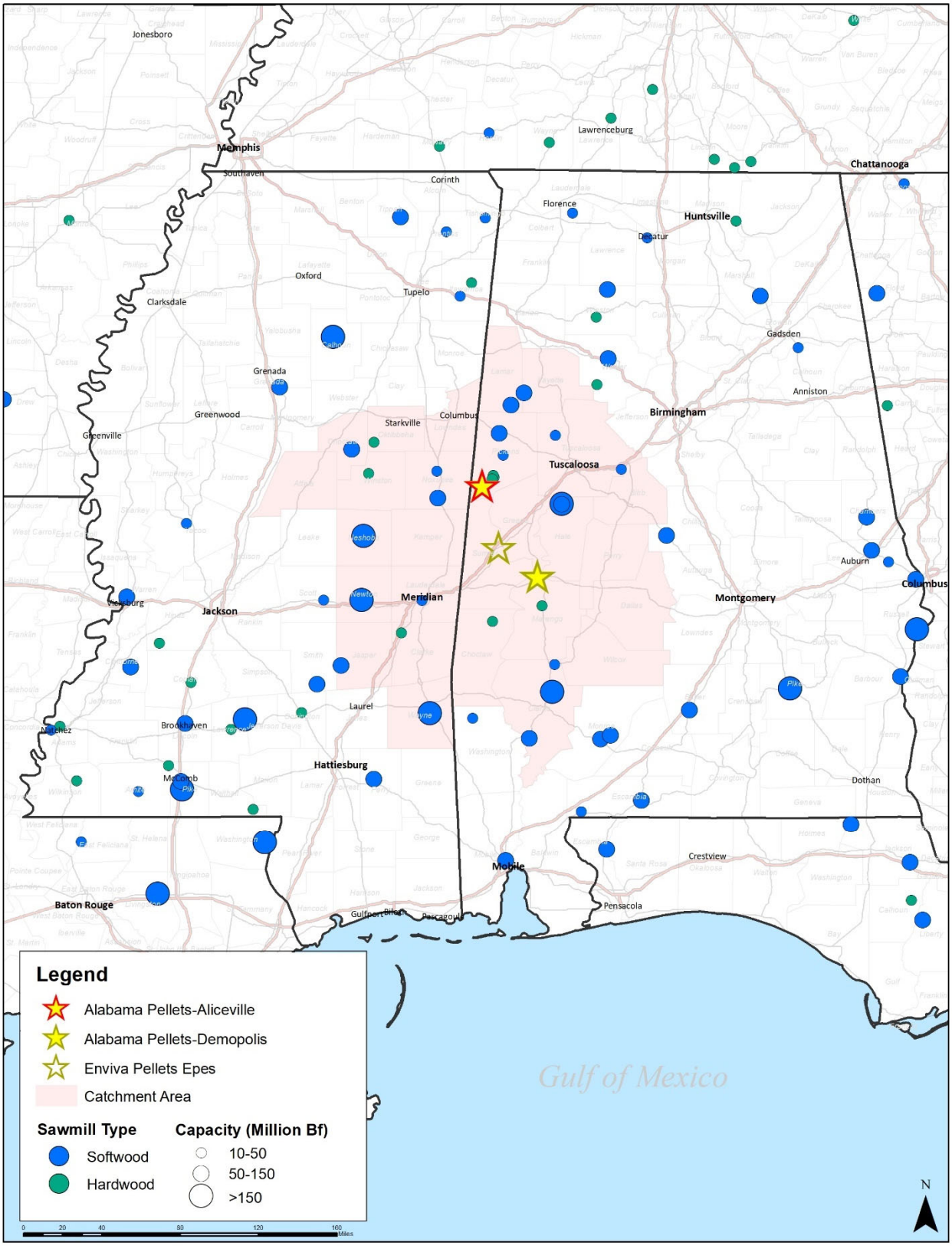


***Figure 13**. Alabama Cluster Catchment Area - Panel Mills (2021)*

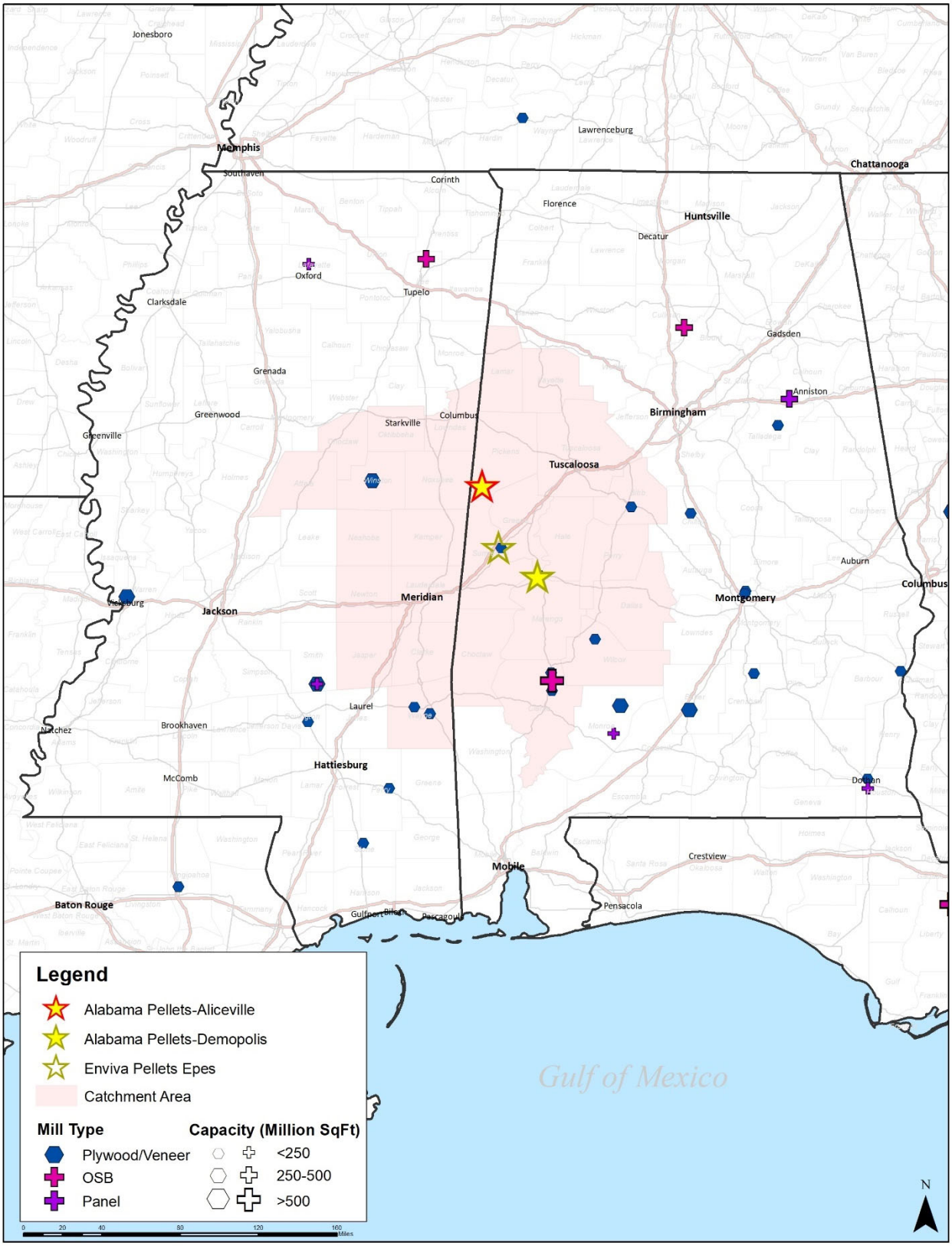
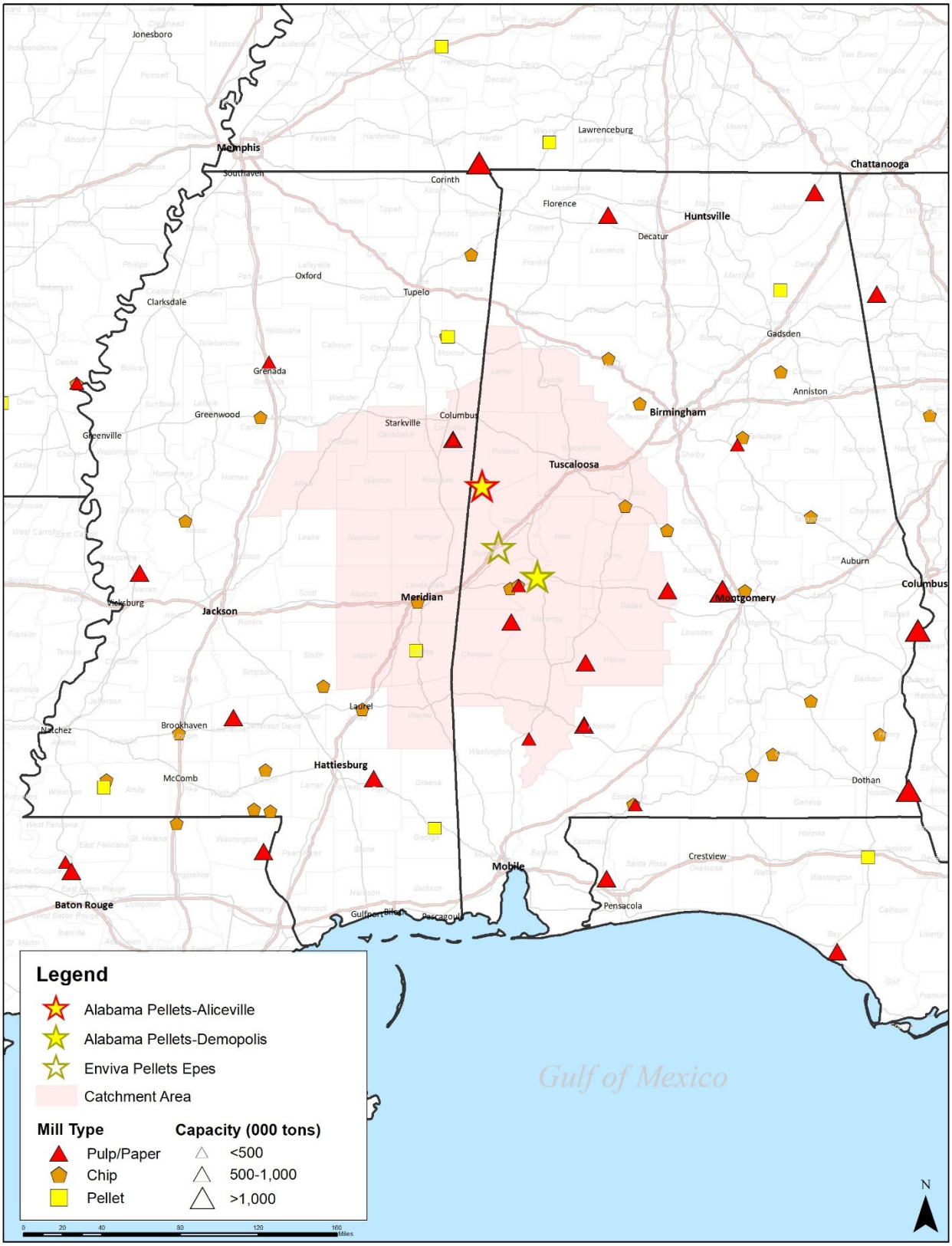


***Figure 14**. Alabama Cluster Catchment Area - Pulp/Paper, Pellet, & Chip Mills (2021)*



4.1.1 *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 21.8 million metric tons annually, actual wood demand[2] in the Alabama Cluster catchment area in 2020, the latest available, was estimated at 19.5 million metric tons.

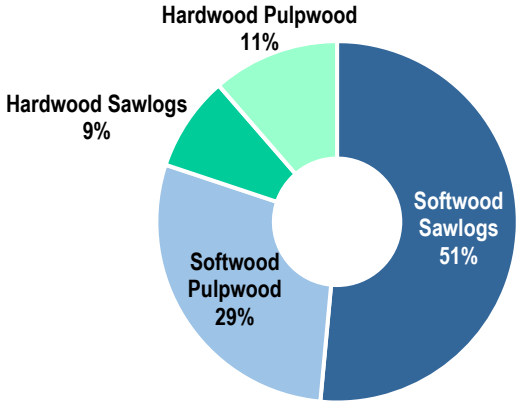
Distribution of total wood demand by major species in 2020 included 80% (15.6 million metric tons) softwood versus 20% (3.9 million metric tons) hardwood. Specifically, 36% of total softwood demand was attributed to softwood pulpwood compared to 64% softwood sawlogs. Conversely, of total hardwood demand, 57% was attributed to hardwood pulpwood versus 43% hardwood sawlogs.

***Table 17**. Alabama Cluster Catchment Area - Wood Demand (2020)*

Major Species / Product	Demand (Metric Tons)	% of Total
Softwood:		
Sawlogs	10,015,149	51%
Pulpwood	5,570,612	29%
Softwood Total	*15,585,760*	*80%*
Hardwood:		
Sawlogs	1,657,507	9%
Pulpwood	2,212,646	11%
Hardwood Total	*3,870,154*	*20%*
Total	**19,455,914**	**100%**

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

***Figure 15**. Alabama Cluster Catchment Area - Distribution of Wood Demand by Major Species & Product (2020)*



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

4.1.1.1 *Biomass Demand*

Biomass demand, defined in this analysis as softwood and hardwood pulpwood (roundwood) consumed by pellet or other bioenergy facilities, totaled an estimated 216,460 metric tons in 2020, the latest available, accounting for approximately 3% of total pulpwood demand (and 1% of total wood demand) in the catchment area. Non-bioenergy related pulpwood demand, almost entirely attributed to the pulp/paper industry, accounted for approximately 97% of total pulpwood demand in the catchment area.

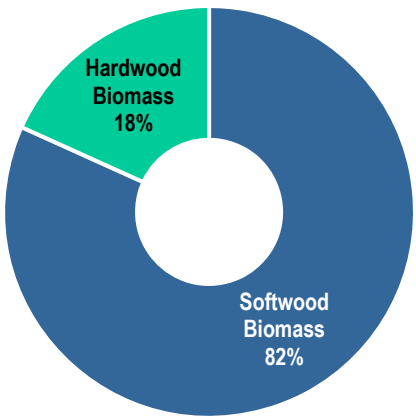
Note that not all wood consumed by a pellet mill or other bioenergy facility is encompassed in biomass demand. Wood consumption (demand) at pellet and other bioenergy facilities generally includes a combination of roundwood, wood chips, and sawmill residuals. However, sawmill residuals are a by-product 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.

***Table 18**. Alabama Cluster Catchment Area - Biomass Demand & Total Pulpwood Demand (2020)*

Product	Demand (Metric Tons)	% of Total
Softwood Pulpwood:		
Biomass	176,972	2%
Other Pulpwood	5,393,640	69%
Softwood Pulpwood Total	*5,570,612*	*72%*
Hardwood Pulpwood:		
Biomass	39,489	1%
Other Pulpwood	2,173,157	28%
Hardwood Pulpwood Total	*2,212,646*	*28%*
Total Pulpwood	**7,783,258**	**100%**

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

***Figure 16**. Alabama Cluster Catchment Area - Distribution of Biomass Demand by Major Species (2020)*



4.2 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 Alabama Cluster catchment area and are average market prices calculated from actual timber sales reported to TMS.

4.2.1 *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 19 below provides annual average stumpage prices in the Alabama Cluster catchment area for each of the five major timber products since 2000. Prices are also shown graphically in Figure 17 on the following page. In particular, we'd like to highlight several notable trends and observations. First, note that pine sawtimber (PST) stumpage prices were already on the decline prior to the Great Recession (which officially lasted from December 2007 through June 2009). Specifically, PST prices peaked in 2004 and declined 26% over the three years that followed (from 2004-2007). And following the onset of the Great Recession, PST declined even further, falling 38% from 2007-2011 (PST prices declined a total of 54% from 2004-2011).

***Table 19**. Alabama Cluster Catchment Area – Annual Stumpage Prices ($/Ton)*

Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
			($/Ton)		
2000	49.28	35.80	7.36	23.51	5.60
2001	42.21	28.19	6.02	22.69	6.24
2002	48.20	26.89	6.20	24.38	6.36
2003	46.43	27.93	7.65	26.05	10.13
2004	50.50	27.68	6.63	27.85	7.13
2005	47.30	26.18	8.34	25.53	8.97
2006	42.30	21.81	7.12	24.49	5.91
2007	37.36	17.25	7.29	26.11	6.73
2008	34.45	16.33	8.24	27.72	10.28
2009	28.12	15.25	8.34	25.80	11.67
2010	29.42	18.16	9.46	30.17	11.69
2011	23.21	14.36	7.07	26.91	8.73
2012	23.90	13.97	6.97	29.38	11.06
2013	24.79	15.31	9.19	40.28	18.68
2014	24.22	14.57	8.07	44.13	20.15
2015	22.88	14.96	7.46	43.17	17.79
2016	23.96	14.31	7.90	46.37	15.35
2017	22.57	14.57	6.13	42.01	11.51
2018	22.71	14.19	5.37	41.93	17.11
2019	22.89	14.36	4.90	44.51	19.16
2020	22.15	14.54	4.12	41.18	13.86

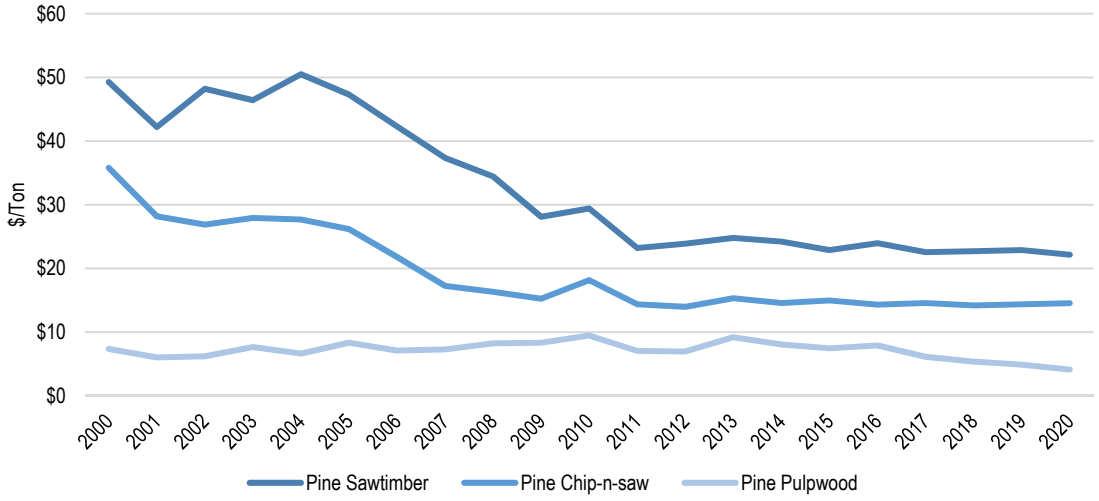
Source: TimberMart-South

Second, we'd like to point out the notable contrast between PST and hardwood sawtimber (HST) stumpage prices, particularly over the last 8-10 years. Specifically, PST stumpage prices have held relatively flat while HST stumpage prices experienced a substantial increase in the early-2010s and have averaged 80-95% higher than PST stumpage prices since 2014.

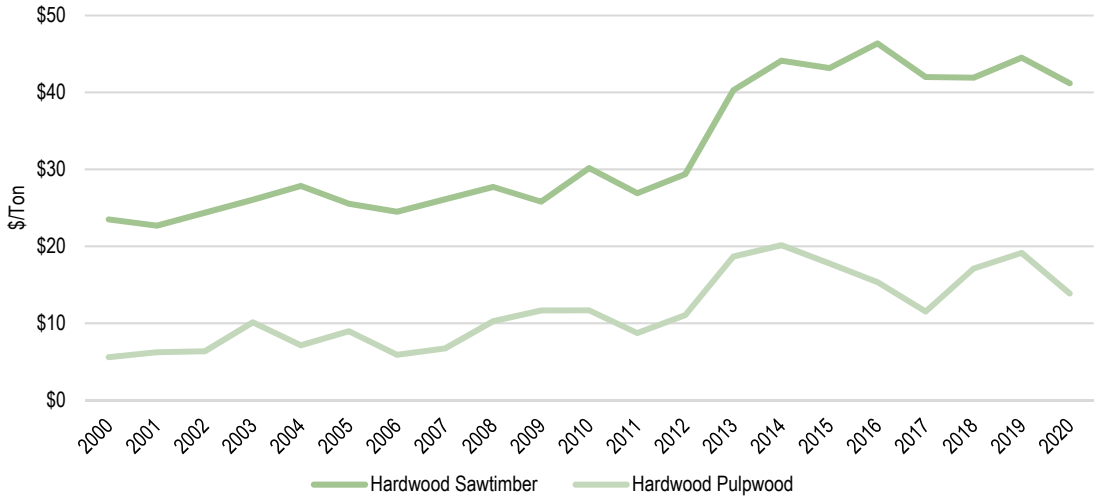
The contrast between pine and hardwood sawtimber prices is due to a combination of both product usage and demand. Hardwood sawtimber is used to produce higher-quality products like flooring, cabinetry, etc., and log quality is extremely important. Also, supply of high-quality hardwoods is limited because 1) most landowners have continued to manage for pine sawtimber production and 2) mature hardwoods are more valuable to many landowners from a recreational perspective (e.g. habitat diversity; food source for wildlife), so landowners are less inclined to harvest and sell their high-quality hardwoods.

For a more detailed assessment of stumpage prices and historic trends, see the *Market Trends, Analysis, & Outlook* section beginning on page 53.

***Figure 17**. Alabama Cluster Catchment Area – Annual Stumpage Prices (2000-2020)*



(a) Pine Stumpage Prices



(b) Hardwood Stumpage Prices

4.2.2 *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.

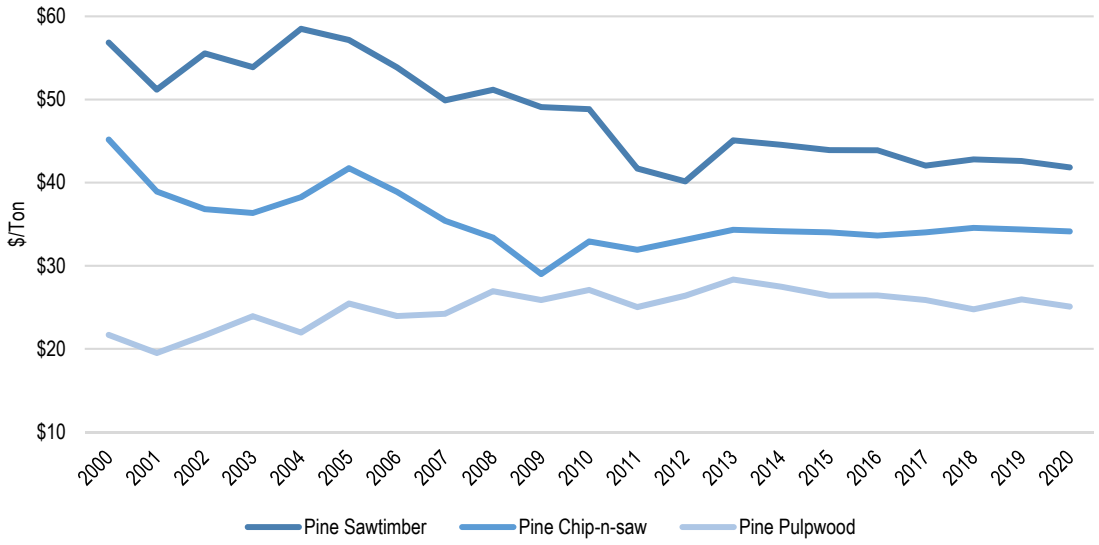
Table 20 below provides annual average delivered timber prices in the Alabama Cluster catchment area for each of the five major timber products since 2000. Prices are also shown graphically in Figure 18 on the following page. For a detailed assessment of delivered timber prices and historic trends, see the *Market Trends, Analysis, & Outlook* section beginning on page 53.

***Table 20**. Alabama Cluster Catchment Area – Annual Delivered Timber Prices ($/Ton)*

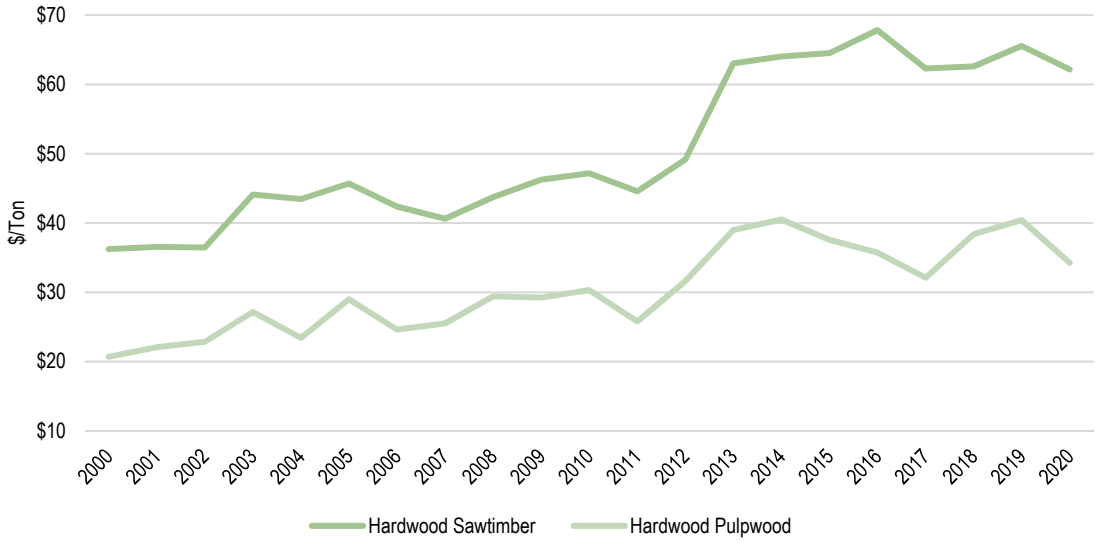
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
			($/Ton)		
2000	56.85	45.17	21.68	36.23	20.70
2001	51.19	38.92	19.51	36.56	22.06
2002	55.54	36.82	21.64	36.47	22.85
2003	53.88	36.34	23.93	44.10	27.14
2004	58.49	38.24	21.97	43.46	23.42
2005	57.15	41.73	25.45	45.70	28.99
2006	53.86	38.88	23.96	42.37	24.61
2007	49.89	35.40	24.22	40.62	25.50
2008	51.16	33.37	26.94	43.74	29.42
2009	49.09	29.00	25.88	46.24	29.24
2010	48.84	32.92	27.08	47.17	30.31
2011	41.70	31.93	25.03	44.56	25.78
2012	40.15	33.11	26.40	49.16	31.61
2013	45.08	34.32	28.34	63.04	38.99
2014	44.54	34.15	27.47	64.03	40.50
2015	43.90	34.02	26.39	64.52	37.58
2016	43.90	33.64	26.44	67.83	35.72
2017	42.04	34.03	25.88	62.29	32.09
2018	42.79	34.55	24.75	62.59	38.39
2019	42.61	34.37	25.95	65.56	40.41
2020	41.84	34.13	25.08	62.15	34.25

Source: TimberMart-South

***Figure 18**. Alabama Cluster Catchment Area – Annual Delivered Timber Prices (2000-2020)*



(a) Delivered Pine Prices



(b) Delivered Hardwood Prices

4.2.3 *Pulp Quality Chip Prices*

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

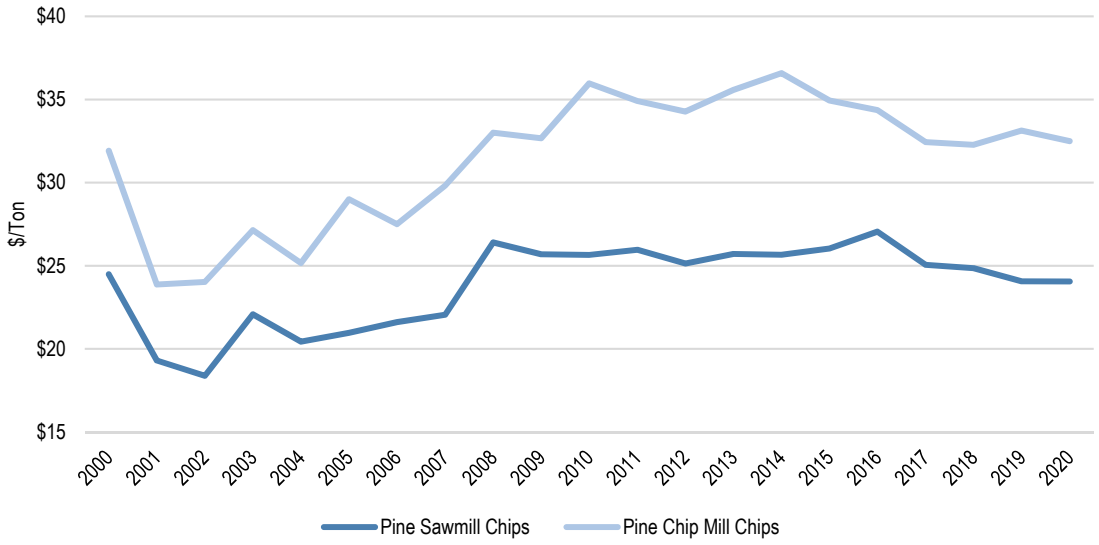
Table 21 below provides annual average pulp quality chip prices in the Alabama Cluster catchment area since 2000. Prices are also shown graphically in Figure 19 on the following page. For a detailed assessment of these prices and historic trends, see the *Market Trends, Analysis, & Outlook* section beginning on page 53.

***Table 21**. Alabama Cluster Catchment Area – Annual Pulp Quality Chip Prices ($/Ton)*

Year	Pine Sawmill Chips	Hardwood Sawmill Chips	Pine Chip Mill Chips	Hardwood Chip Mill Chips
		($/Ton – FOB point of production)		
2000	24.49	17.60	31.92	25.75
2001	19.30	17.85	23.87	24.68
2002	18.38	17.49	24.02	23.86
2003	22.08	18.54	27.15	30.57
2004	20.43	18.07	25.16	26.18
2005	20.96	18.75	29.00	26.23
2006	21.61	20.39	27.50	29.74
2007	22.06	21.67	29.82	31.29
2008	26.41	24.12	33.01	33.63
2009	25.69	24.33	32.66	33.87
2010	25.65	23.72	35.97	39.67
2011	25.96	24.58	34.91	36.91
2012	25.13	23.32	34.27	35.50
2013	25.71	25.01	35.57	38.21
2014	25.66	26.25	36.58	40.72
2015	26.04	27.28	34.94	38.94
2016	27.05	28.74	34.36	39.09
2017	25.05	28.36	32.44	35.13
2018	24.85	28.92	32.27	38.17
2019	24.07	31.02	33.13	42.31
2020	24.05	29.62	32.49	37.67

Source: TimberMart-South

***Figure 19**. Alabama Cluster Catchment Area – Annual Pulp Quality Chip Prices (2000-2020)*



(a) Pine Chip Prices

(b) Hardwood Chip Prices

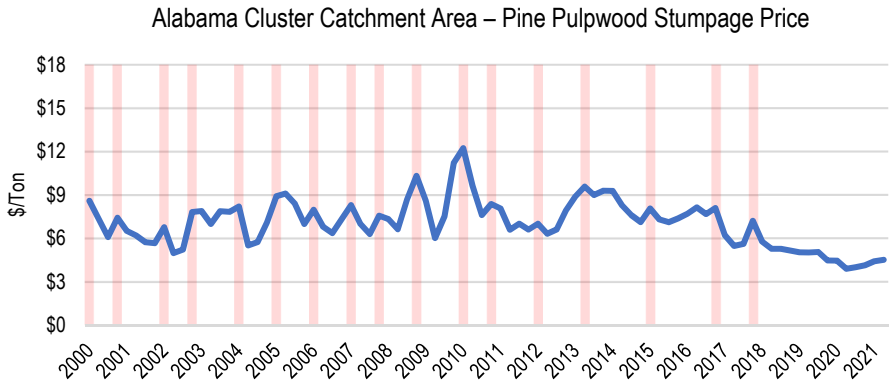
4.2.4 *Timber Price Drivers*

A detailed assessment of raw material prices and price trends is provided in the *Market Trends, Analysis, & Outlook* section beginning on page 53. However, we would like to point out and highlight some of the major price drivers of pine pulpwood – the predominant roundwood product consumed by the bioenergy sector in the Alabama Cluster catchment area.

- Domestic Economy. The state of the domestic economy, historically, has been a strong indicator of timber prices in both the Alabama Cluster catchment area and across the South. Financial markets generally reflect economic conditions, and pine stumpage prices in the catchment area have historically tracked the Dow Jones Industrial Average (DJIA). However, pine timber prices and the DJIA have deviated from one another slightly over the last 8-10 years, as the imbalance of supply and demand that emerged following the Great Recession has had an impact on this market.

- Weather. Weather trends also impact timber prices in this catchment area and across the South. However, these trends are much more seasonal in nature and affect short-term price movements. In this region, wet conditions typically persist throughout the winter (in the 4th and 1st quarters of the year), creating wood accessibility issues and constraining supply. As a result, timber prices increase over the short term. However, wet winters are followed by hot summers, which alleviate supply constraints and provide greater access to wood, which in turn results in a short-term decrease in timber prices (typically during the 2nd or 3rd quarter of the year).

  The figure below shows quarterly average pine pulpwood stumpage prices in the Alabama Cluster catchment from 1Q 2000 through 2Q 2021, with seasonal weather-related price spikes highlighted in red. Note that of the 18 of the 19 seasonal spikes (95%) identified in this figure occurred in either the 1st or 4th quarter of the year.



Source: TimberMart-South

- Competition. In the Alabama Cluster catchment area, demand for pine pulpwood (the primary roundwood product consumed for pellet production) is largely driven by the pulp/paper industry. Specifically, there are 16 pine pulpwood-consuming pulp/paper mills located within roughly 150 miles of the catchment area center that together consume more than 25 million metric tons of roundwood (pulpwood) annually. Competition is also inherently high as a result of the Gulf of Mexico serving as a barrier to the south.

5. Forest Management Practices Assessment

Historic timber sales reported to TimberMart-South were examined to help assess how forest management practices in the Alabama Cluster catchment area and surrounding markets have changed since 2000. Specifically, we examined trends related to total sale volume, total sale area (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.

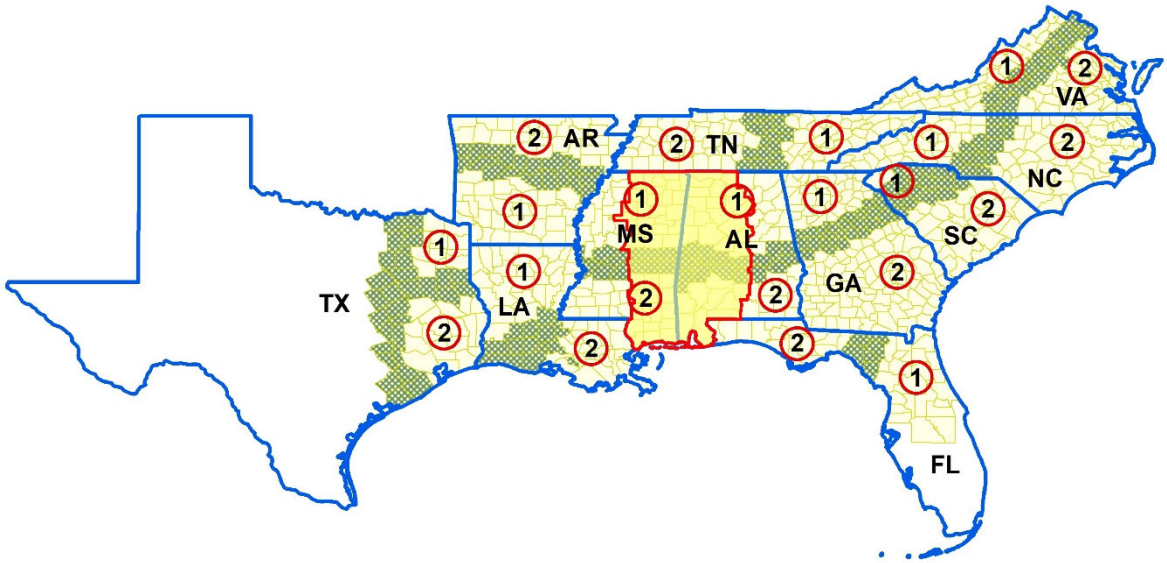
5.1 TimberMart-South Harvest Trends

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 Alabama Cluster catchment area is located in four different TMS regions: Alabama Region 1, Alabama Region 2, Mississippi Region 1, and Mississippi Region 2 (see highlighted portion in Figure 21 below). Data and trends for this milti-region area (denoted 'Alabama Cluster 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 450 and 45,000 metric tons. Sales that fell outside these parameters were excluded to ensure consistency and to mitigate potential bias from major outliers.

***Figure 20**. TimberMart-South Region Map*



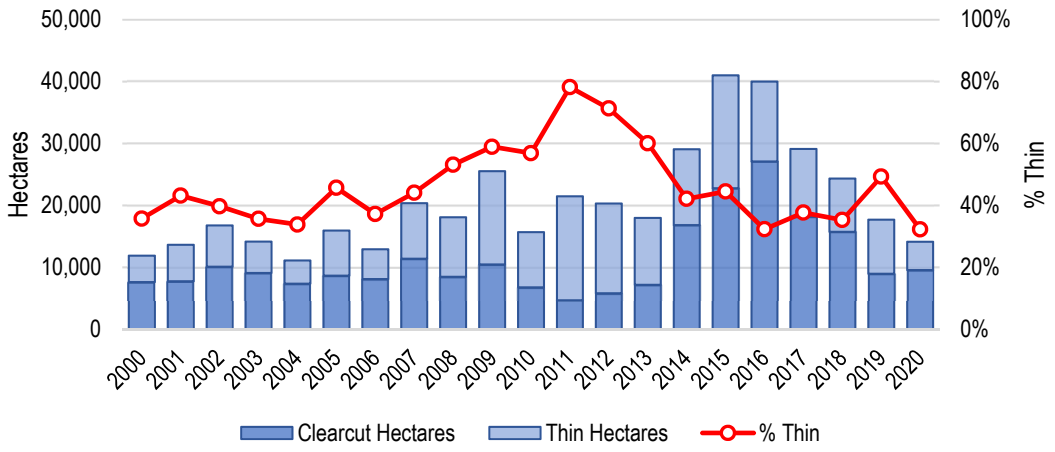
5.1.1 *Total Sale Area*

In the Alabama Cluster market, the total area of all timber sales reported to TMS has averaged roughly 20,540 hectares per year since 2000 (see Figure 21). However, TMS data shows a temporary 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 Alabama Cluster market, thinnings accounted for approximately 40% of the total reported harvest area (hectares) from 2000-2006 as well as 40% of total reported harvest area from 2014-2020. However, from 2007-2013, thinning accounted for over 60% of total reported harvest area.

Note that this temporary 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 45% in the catchment area from 2006-2011. 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 stabilized below pre-recession levels. With this price stabilization, clearcuts increased and harvest activities reverted back to pre-recession trends.

***Figure 21**. Total Reported Sale Area by Harvest Type (2000-2020)*



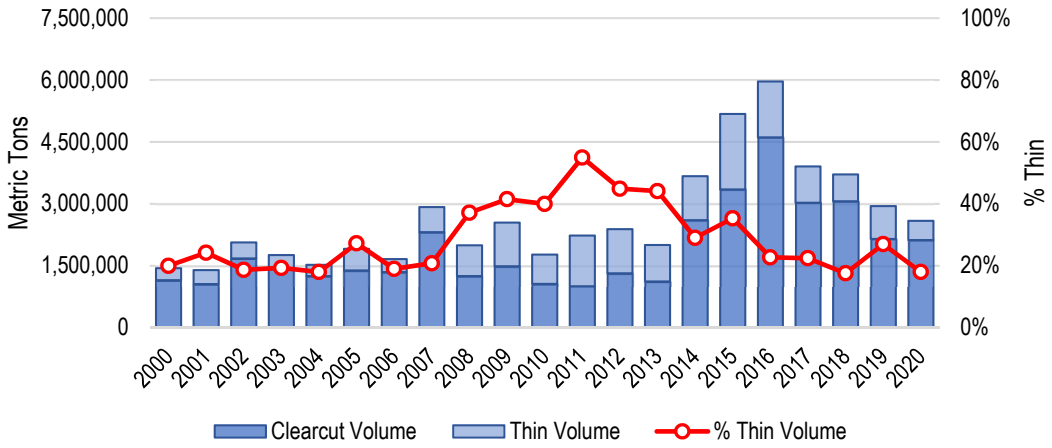
**Please note that these values do not represent the actual hectares of all timber harvested in this market, but rather the total number of hectares reported to TimberMart-South by its contributing reporters.*

5.1.2 *Total Sale Volume*

In the Alabama Cluster market, the total volume of all timber sales reported to TMS has averaged approximately 2.6 million metric tons per year since 2000 (see Figure 22). However, as with reported sale area, what's of specific interest are those trends, identified by data reported to TMS, as they relate to changes in harvest volume by specific harvest type.

Examination of total sale volume reported to TMS by harvest type shows the proportion of total volume attributed to thinnings increased substantially from 2008-2013. Specifically, thinnings accounted for 21% of total reported harvest volume in this market from 2000-2007, compared to 44% from 2008-2013. Note that the increased distribution of volume thinned (relative to volume clearcut) in the late-2000s and early-2010s coincided with the weakening of sawtimber markets. However, as pine sawtimber stumpage stabilized at their 'new norm', harvest practices reverted to pre-recession trends and the percentage of total volume attributed to thinnings declined and have since stabilized at just over 20%.

***Figure 22**. Total Reported Sale Volume by Harvest Type (2000-2020)*



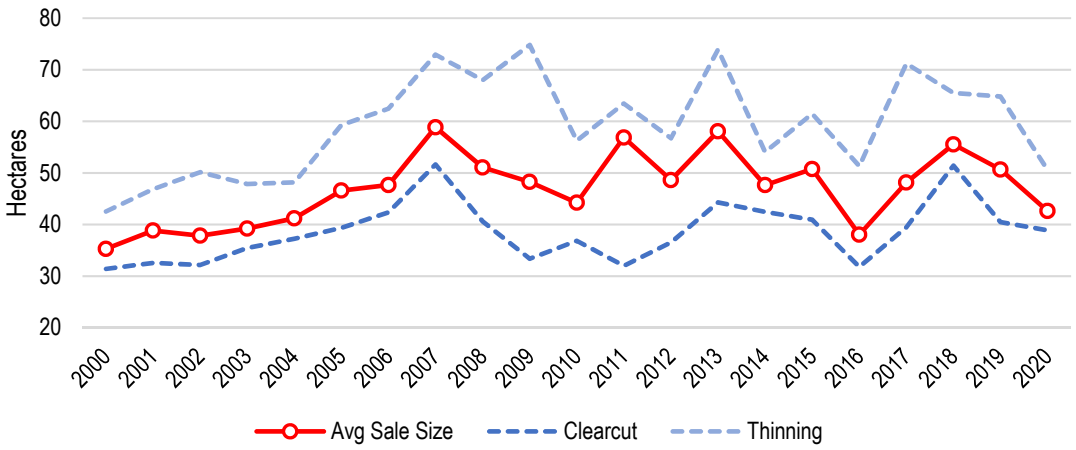
**Please note that these values do not represent the actual volume of all timber harvested in this market, but rather the total volume of harvested timber reported to TimberMart-South by its contributing reporters.*

5.1.3 *Average Sale Size*

The average size of timber sales reported to TMS in the Alabama Cluster market averaged approximately 116 hectares from 2000-2020. TimberMart-South data also shows that thinnings have averaged 53% larger (+21 hectares) than clearcuts since 2000, with thinnings averaging 59 hectares in size compared to 39 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 49 hectares or less.

***Figure 23**. Average Reported Sale Size by Harvest Type (2000-2020)*



6. Market Trends, Analysis, & Outlook

The following section provides an examination and assessment of forest market trends in the Alabama Cluster catchment area since 2000. It also includes a market outlook through 2023 which details anticipated changes in wood demand and how these changes are likely to impact this market over the next several years.

6.1 Market Trends & Analysis

6.1.1 *Wood Demand*

Annual wood demand[3] in the Alabama Cluster catchment area held relatively steady through the early and mid-2000s, averaging 20.6 million metric tons per year from 2000-2005 before declining nearly 20% to 16.5 million metric tons in 2009. Note that the decrease in total wood demand was due to reduced demand from the lumber/solid wood products industry. However, total wood demand rebounded over the three years that followed, stabilizing and averaging 19.7 million metric tons per year from 2012-2020, down 4% from the 2000-2005 average of 20.6 million metric tons per year.

***Table 22**. Alabama Cluster Catchment Area - Annual Wood Demand (2000-2020)*

Year	Softwood Sawlogs	Softwood Pulpwood	Hardwood Sawlogs	Hardwood Pulpwood	Total Wood Demand
			(Metric Tons)		
2000	10,512,812	4,140,170	2,950,291	3,617,887	21,221,160
2001	10,430,111	4,158,972	2,950,279	3,484,845	21,024,206
2002	10,128,752	4,155,039	2,947,722	3,335,777	20,567,290
2003	10,031,342	4,172,611	2,946,820	3,199,588	20,350,361
2004	9,995,258	4,125,146	2,842,283	3,188,149	20,150,836
2005	10,116,919	4,156,085	2,750,213	3,290,180	20,313,397
2006	9,372,552	4,382,209	2,783,568	3,345,054	19,883,383
2007	8,663,122	4,453,350	2,434,599	3,179,688	18,730,759
2008	8,085,908	4,683,113	1,859,080	2,773,173	17,401,274
2009	7,737,594	4,912,287	1,400,509	2,479,896	16,530,286
2010	7,758,165	5,526,086	1,715,094	2,608,731	17,608,077
2011	8,236,822	6,112,008	1,644,348	2,623,499	18,616,678
2012	8,920,828	6,338,936	1,870,650	2,757,500	19,887,914
2013	9,032,126	6,279,974	1,924,387	2,818,085	20,054,572
2014	9,149,336	6,275,491	1,977,105	2,711,484	20,113,416
2015	9,102,447	6,230,698	2,106,919	2,684,053	20,124,117
2016	9,189,597	6,034,095	2,107,224	2,591,207	19,922,121
2017	9,279,755	5,815,824	1,953,570	2,466,195	19,515,344
2018	9,134,702	5,349,145	1,834,061	2,307,352	18,625,261
2019	9,705,550	5,515,319	1,836,356	2,220,104	19,277,330
2020	10,015,149	5,570,612	1,657,507	2,212,646	19,455,914

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

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

***Figure 24**. Alabama Cluster Catchment Area – Total Annual Wood Demand (2000-2020)*

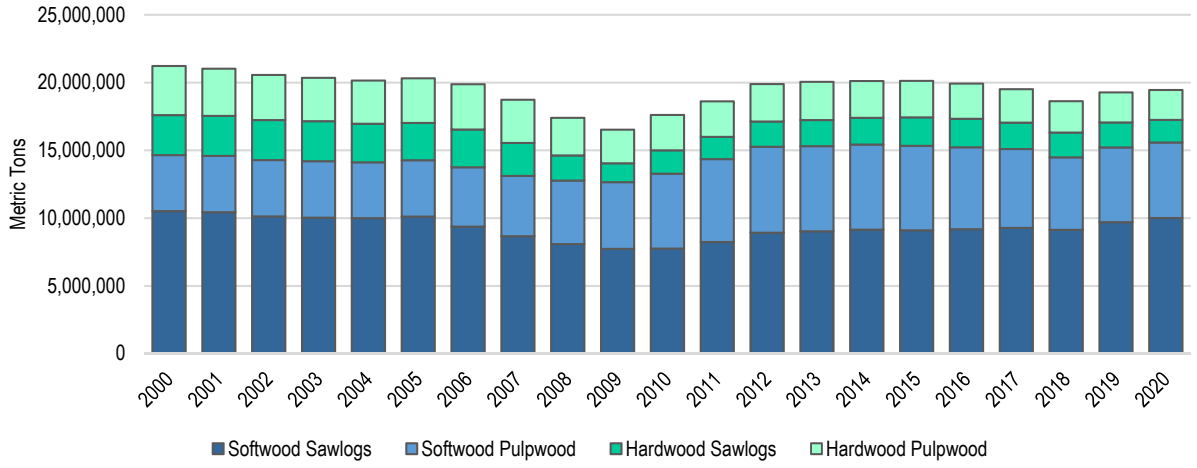
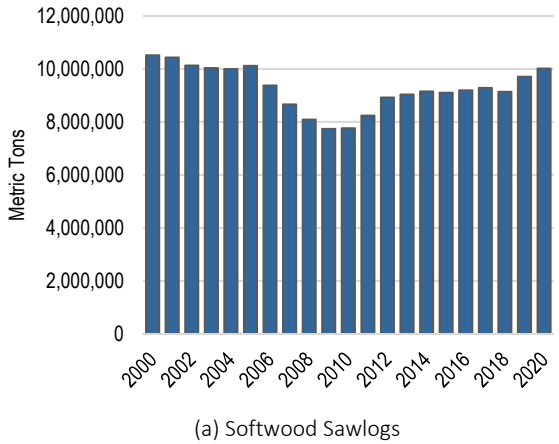
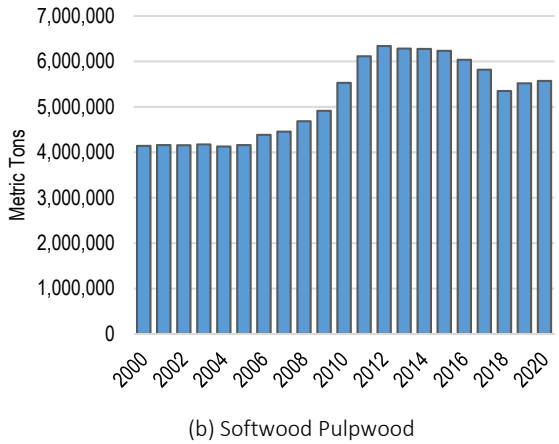


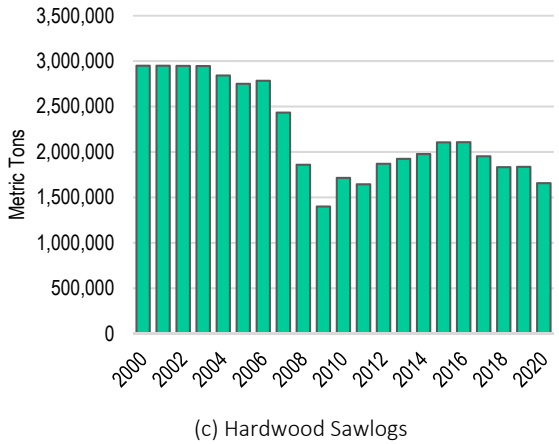
***Figure 25**. Alabama Cluster Catchment Area – Annual Wood Demand by Major Species & Product (2000-2020)*



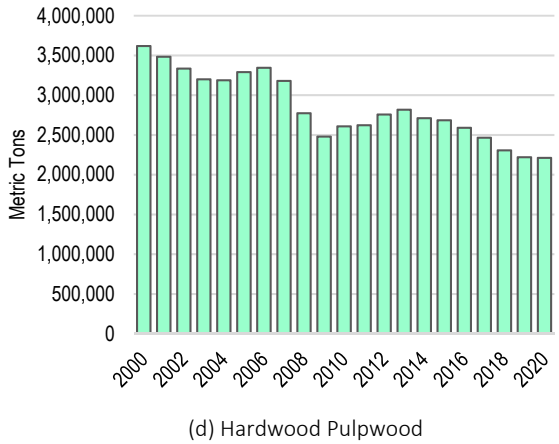
(a) Softwood Sawlogs



(b) Softwood Pulpwood



(c) Hardwood Sawlogs



(d) Hardwood Pulpwood

6.1.1.1 Biomass Demand & Total Pulpwood Demand

Biomass demand is defined as softwood and hardwood pulpwood (roundwood) consumed by pellet or other bioenergy facilities. Presently, Alabama Pellets-Aliceville and Mohegan Renewable Energy (MRE)-Quitman are the only major wood pellet mills operating within the catchment area. However, several other pellet mills are located outside the catchment area but procure some level of roundwood from within the Alabama Cluster catchment area.

Total biomass demand in the catchment area remained below 70,000 metric tons per year from 2007-2011 before increasing to roughly 700,000 metric tons in 2015 and 2016 (following the startup of Alabama Pellets-Aliceville in 2012 and Zilkha Biomass-Selma in 2015). However, by 2019, total biomass demand had fallen to less than 220,000 metric tons. Note that decrease in total biomass demand since 2016 is largely due to decreased roundwood consumption by Alabama Pellets. Specifically, the Aliceville facility was shut down for a majority of 2017 due to the catastrophic failure of a key piece of environmental equipment at the mill, and this was followed by the mill's decision to transition to residual-consumption only – a transition that begun in 2018 and had been completed by 2019.

Note that biomass demand is predominantly softwood (pine), with softwood biomass demand accounting for 83% of total biomass demand in the catchment area since 2007 (compared to 17% hardwood biomass demand). Also, biomass-related pulpwood demand has accounted for 3% of total pulpwood demand in the catchment area since 2007. For a detailed breakdown of biomass and non-biomass-related pulpwood demand in the catchment area since 2000, see Table 23 below.

***Table 23**. Alabama Cluster Catchment Area - Biomass Demand & Total Pulpwood Demand (2000-2020)*

	Biomass Demand			Other Pulpwood Demand			Total Pulpwood Demand		
Year	Softwood	Hardwood	Total	Softwood	Hardwood	Total	Softwood	Hardwood	Total
					(Metric Tons)				
2000	-	-	-	4,140,170	3,617,887	7,758,057	4,140,170	3,617,887	7,758,057
2001	-	-	-	4,158,972	3,484,845	7,643,817	4,158,972	3,484,845	7,643,817
2002	-	-	-	4,155,039	3,335,777	7,490,817	4,155,039	3,335,777	7,490,817
2003	-	-	-	4,172,611	3,199,588	7,372,199	4,172,611	3,199,588	7,372,199
2004	-	-	-	4,125,146	3,188,149	7,313,295	4,125,146	3,188,149	7,313,295
2005	-	-	-	4,156,085	3,290,180	7,446,265	4,156,085	3,290,180	7,446,265
2006	-	-	-	4,382,209	3,345,054	7,727,262	4,382,209	3,345,054	7,727,262
2007	4,058	-	4,058	4,449,292	3,179,688	7,628,980	4,453,350	3,179,688	7,633,037
2008	23,203	11,968	35,171	4,659,910	2,761,205	7,421,115	4,683,113	2,773,173	7,456,286
2009	42,421	24,229	66,650	4,869,866	2,455,666	7,325,532	4,912,287	2,479,896	7,392,182
2010	38,397	18,566	56,963	5,487,689	2,590,165	8,077,854	5,526,086	2,608,731	8,134,817
2011	34,379	12,897	47,276	6,077,629	2,610,602	8,688,232	6,112,008	2,623,499	8,735,507
2012	81,091	38,055	119,146	6,257,845	2,719,445	8,977,290	6,338,936	2,757,500	9,096,436
2013	279,516	64,021	343,537	6,000,458	2,754,063	8,754,522	6,279,974	2,818,085	9,098,058
2014	460,204	62,304	522,508	5,815,287	2,649,180	8,464,467	6,275,491	2,711,484	8,986,975
2015	655,654	69,212	724,866	5,575,045	2,614,841	8,189,885	6,230,698	2,684,053	8,914,751
2016	617,597	81,945	699,543	5,416,497	2,509,261	7,925,758	6,034,095	2,591,207	8,625,301
2017	221,708	90,347	312,056	5,594,115	2,375,847	7,969,962	5,815,824	2,466,195	8,282,018
2018	285,577	94,850	380,427	5,063,568	2,212,502	7,276,071	5,349,145	2,307,352	7,656,497
2019	176,421	39,800	216,221	5,338,898	2,180,304	7,519,202	5,515,319	2,220,104	7,735,423
2020	176,972	39,489	216,461	5,393,640	2,173,157	7,566,797	5,570,612	2,212,646	7,783,258

Source: USDA-US Forest Service; TimberMart-South; The Westervelt Company, Pinnacle Renewable Energy

Figure 26. Alabama Cluster Catchment Area – Softwood Pulpwood Demand (2000-2020)

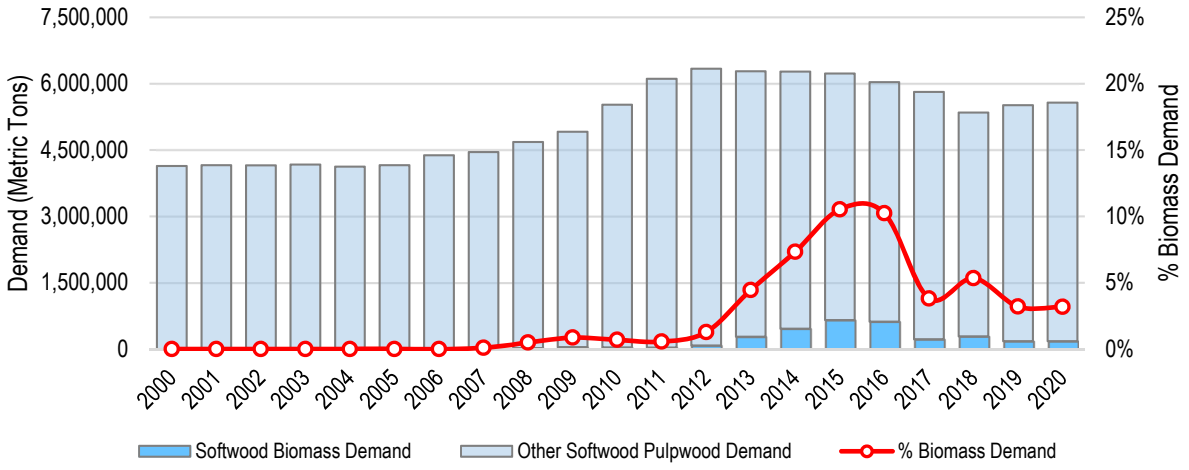


Figure 27. Alabama Cluster Catchment Area – Hardwood Pulpwood Demand (2000-2020)

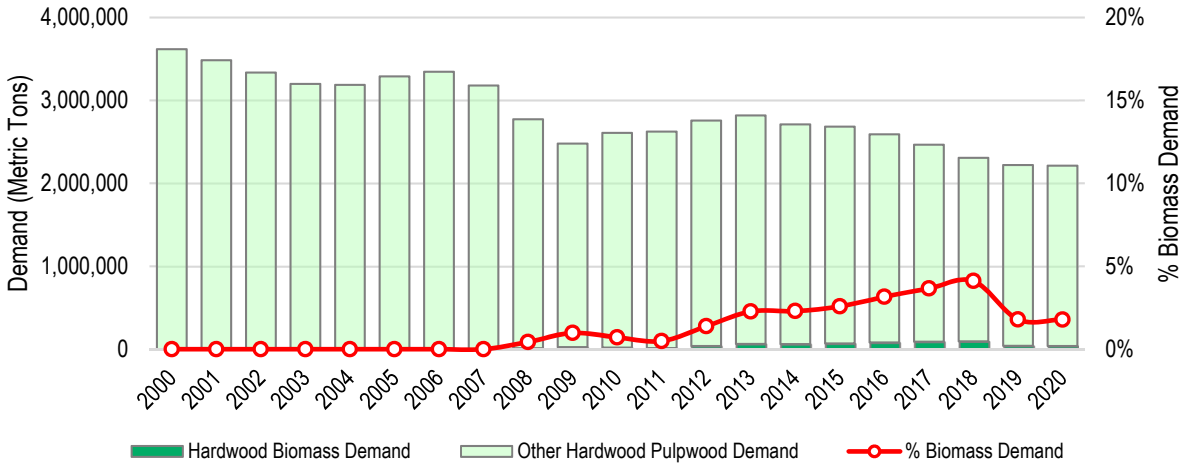
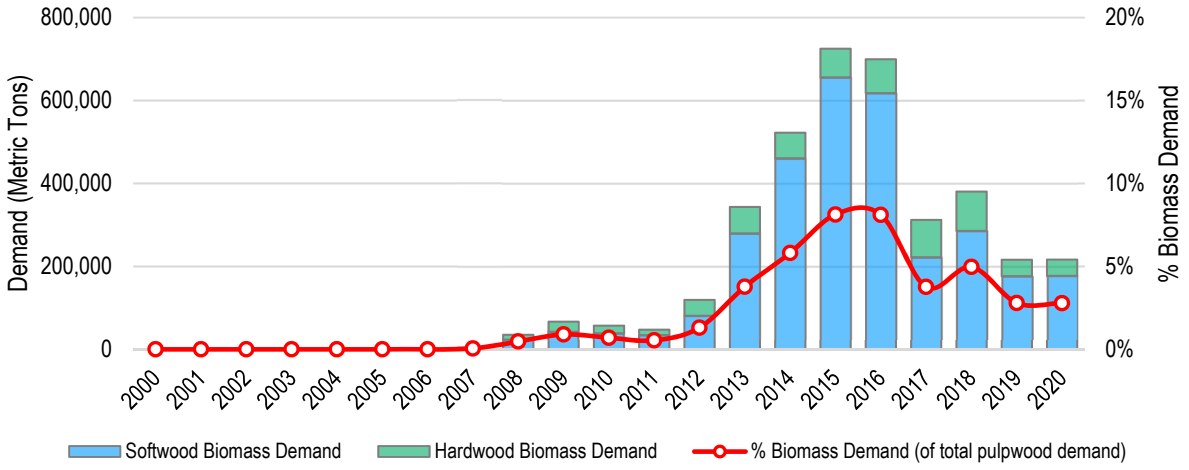


Figure 28. Alabama Cluster Catchment Area – Total Biomass Demand (2000-2020)



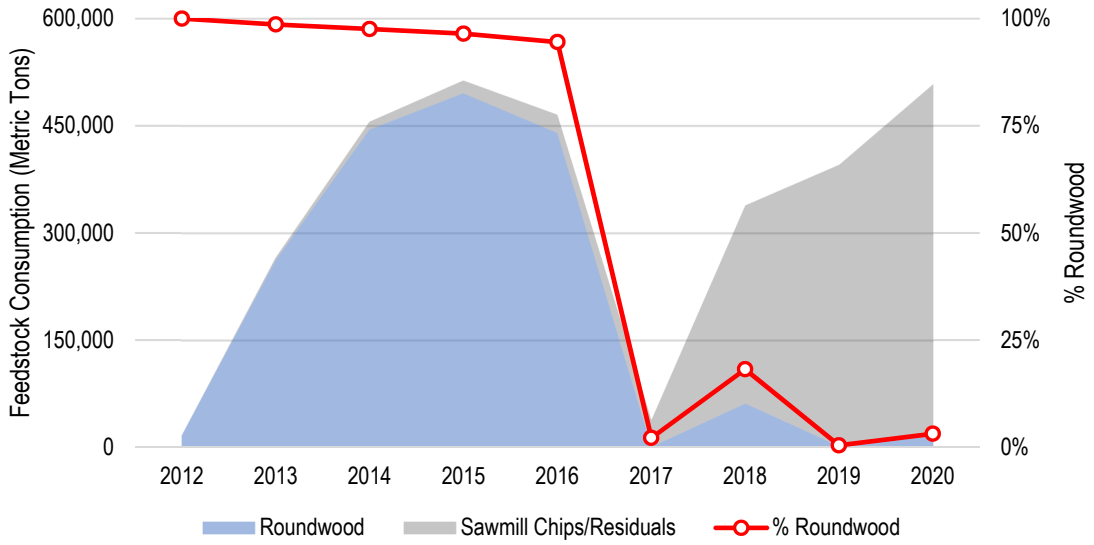
Changes in Bioenergy Feedstock Composition

The Alabama Pellets-Aliceville pellet mill currently utilizes pine residuals only (i.e. sawmill chips, shavings, and sawdust) for wood pellet production. However, prior to 2017, the Aliceville facility utilized primarily roundwood for wood pellet production, with pine pulpwood accounting for more than 95% of total raw material purchases.

From 2013 (the first full year of operations) through 2016, roundwood accounted for 97% of the total feedstock consumed by the Aliceville mill, with sawmill residuals accounting for the remaining 3%. However, since the facility recommenced operations in late-2017 (following its temporary shutdown due to the failure of a key piece of environmental equipment), residuals have accounted for 94% of total feedstock consumption, with roundwood accounting for the remaining 6% (see Figure 29).

Note that the increased utilization of sawmill residuals at the Aliceville mill coincided with a more than 20% increase in softwood lumber production from 2013-2017. As softwood lumber production began to increase, so too did the production of sawmill residuals – a lower-cost feedstock (compared to roundwood) the Aliceville mill could utilize for wood pellet production.

***Figure 29**. Alabama Pellets-Aliceville Feedstock Composition (2012-2020)*



6.1.2 *Changes in Land Area & Use*

Notable changes in land use occurred in the Alabama Cluster catchment area from 2000-2020, including a 2.0% increase in forestland and a 1.4% increase in land in farms (i.e. cropland, woodland, and pastureland).

According to the USDA, total catchment area forestland increased more than 92,000 hectares (+2.3%) from roughly 4,102,000 hectares in 2000 to roughly 4,194,000 hectares in 2008. (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)). However, since that time, total forestland has held relatively steady, averaging approximately 4,195,000 hectares from 2008-2020. Overall, total forestland increased from an estimated 4,101,642 hectares in 2000 to 4,185,226 hectares in 2020, or a net increase of 83,584 hectares (+2.0%) over this 20-year period.

Over this same period, total land in farms increased 13,859 hectares (+1.4%) in the catchment area. In particular, pastureland increased an estimated 80,516 hectares (+26%) from 2000-2020, compared to a 81,300-hectare decrease (-22%) in cropland over this same period. Woodland increased an estimated 14,644 hectares (+5%) from 2000-2020. See Table 24 for details.

***Table 24**. Alabama Cluster Catchment Area – Land Area by Land Classification & Use (2000-2020)*

	Forestland			*Land in Farms*				Urban & Other Land Uses	Total Land Area
Year	Timberland	Other Forestland	Total	Cropland	Woodland	Pastureland	Total		
					(Hectares)				
2000	4,082,459	19,183	4,101,642	374,832	288,943	307,430	971,205	154,593	5,227,440
2001	4,084,045	21,547	4,105,592	366,975	286,638	313,670	967,284	154,565	5,227,440
2002	4,087,541	21,592	4,109,133	359,119	284,333	319,910	963,362	154,945	5,227,440
2003	4,106,172	21,671	4,127,843	353,049	286,364	329,558	968,971	130,626	5,227,440
2004	4,114,829	21,766	4,136,595	346,980	287,628	339,205	973,814	117,032	5,227,440
2005	4,129,098	21,863	4,150,961	340,911	288,892	348,853	978,656	97,824	5,227,440
2006	4,143,076	21,907	4,164,983	334,842	290,156	358,501	983,498	78,960	5,227,440
2007	4,158,786	21,978	4,180,764	328,772	291,420	368,148	988,340	58,336	5,227,440
2008	4,172,138	21,979	4,194,117	323,367	290,309	371,761	985,438	47,886	5,227,440
2009	4,173,860	22,017	4,195,877	317,962	289,199	375,375	982,535	49,028	5,227,440
2010	4,175,320	21,988	4,197,308	312,557	288,088	378,988	979,633	50,499	5,227,440
2011	4,175,239	21,992	4,197,232	307,152	286,978	382,601	976,731	53,478	5,227,440
2012	4,172,822	24,544	4,197,366	301,747	286,634	386,214	974,595	55,479	5,227,440
2013	4,178,714	22,131	4,200,845	300,742	289,030	386,463	976,235	50,360	5,227,440
2014	4,194,431	22,261	4,216,692	299,737	291,425	386,713	977,874	32,874	5,227,440
2015	4,190,709	22,305	4,213,014	298,731	293,821	386,962	979,514	34,913	5,227,440
2016	4,170,978	22,171	4,193,149	297,726	296,216	387,211	981,153	53,138	5,227,440
2017	4,168,214	22,198	4,190,413	296,721	298,611	387,461	982,793	54,235	5,227,440
2018	4,153,444	22,233	4,175,677	295,658	300,270	387,622	983,550	68,213	5,227,440
2019	4,154,104	22,301	4,176,405	294,594	301,928	387,784	984,307	66,729	5,227,440
2020	4,161,102	24,124	4,185,226	293,530	303,587	387,946	985,064	57,150	5,227,440

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

6.1.3 *Changes in Forest Area (Timberland)*

According to the US Forest Service, total timberland in the Alabama Cluster catchment area experienced a net increase of 78,644 hectares (+1.9%) from 2000-2020, increasing from 4,082,459 to 4,161,102 hectares over this 20-year period. However, note that much of this increase occurred in the 2000s, with total timberland stabilizing and averaging roughly 4,172,000 hectares since 2008.

In particular, planted pine timberland (the predominant supplier of pine pulpwood consumed by the pulp/paper and bioenergy industries in this market) increased approximately 460,000 hectares (+40%) from 2000 to 2020. Note that this increase coincided with an approximately 248,000-hectare decrease in natural hardwood timberland and a more than 143,000-hectare decrease in mixed pine-hardwood timberland.

***Table 25**. Alabama Cluster Catchment Area - Timberland Area by Stand Origin (2000-2020)*

	Planted		*Naturally Regenerated*			
Year	Pine	Hardwood	Pine	Hardwood	Mixed Pine-Hardwood	Total
			(Hectares)			
2000	1,153,263	77,881	682,692	1,696,853	471,769	4,082,459
2001	1,189,058	67,974	671,864	1,698,432	456,717	4,084,045
2002	1,216,655	67,907	670,963	1,694,932	437,083	4,087,541
2003	1,258,581	69,867	656,636	1,683,227	437,861	4,106,172
2004	1,306,543	70,450	645,937	1,646,312	445,585	4,114,829
2005	1,347,824	63,514	651,598	1,632,929	433,233	4,129,098
2006	1,408,557	66,026	639,957	1,607,221	421,315	4,143,076
2007	1,424,823	86,806	626,836	1,602,589	417,733	4,158,786
2008	1,437,458	90,789	619,459	1,623,471	400,961	4,172,138
2009	1,453,426	94,929	614,925	1,626,917	383,663	4,173,860
2010	1,480,006	96,375	596,344	1,622,941	379,654	4,175,320
2011	1,500,286	108,595	584,142	1,615,319	366,896	4,175,239
2012	1,539,596	111,934	565,306	1,583,251	372,735	4,172,822
2013	1,571,136	119,531	558,791	1,565,782	363,474	4,178,714
2014	1,616,348	123,471	554,845	1,527,230	372,537	4,194,431
2015	1,655,117	121,200	548,736	1,499,479	366,178	4,190,709
2016	1,630,939	117,372	572,923	1,488,524	361,219	4,170,978
2017	1,618,432	123,477	615,459	1,445,020	365,826	4,168,214
2018	1,608,528	116,611	632,393	1,426,956	368,956	4,153,444
2019	1,605,748	96,045	673,860	1,441,904	336,549	4,154,104
2020	1,615,023	93,230	675,052	1,449,216	328,581	4,161,102

Source: USDA-US Forest Service

***Figure 30**. Alabama Cluster Catchment Area - Timberland Area by Year (2000-2020)*

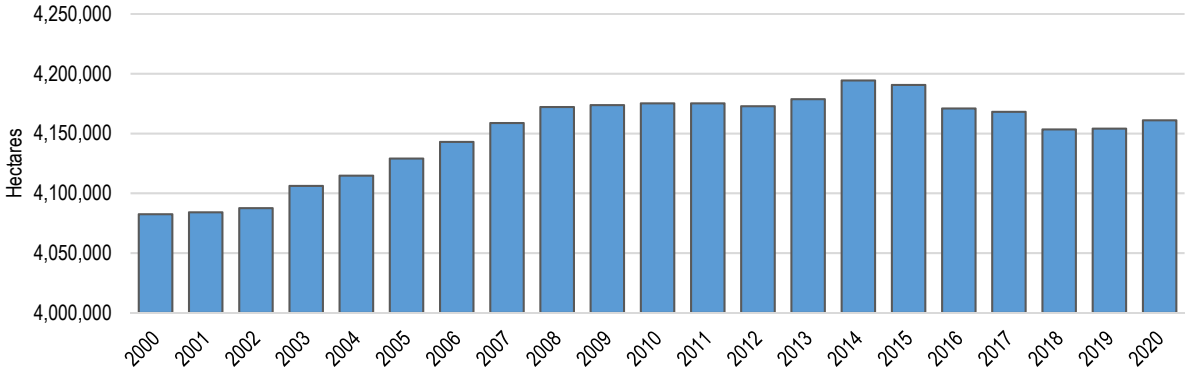
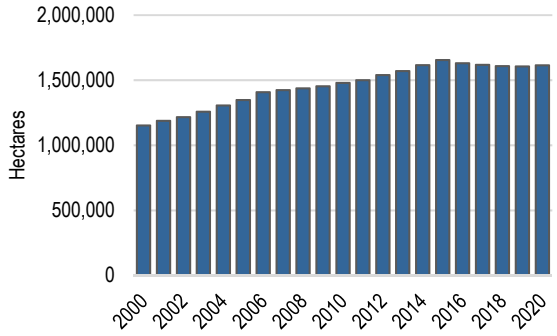
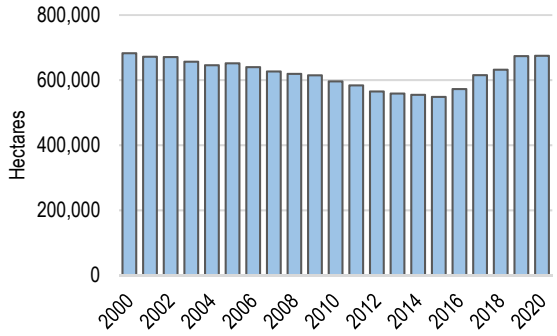


***Figure 31**. Alabama Cluster Catchment Area – Timberland Area by Stand Origin (2000-2020)*

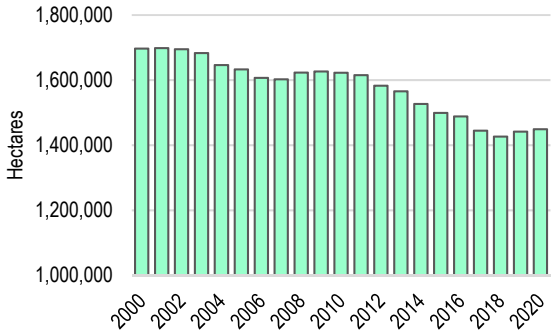


(a) Planted Pine

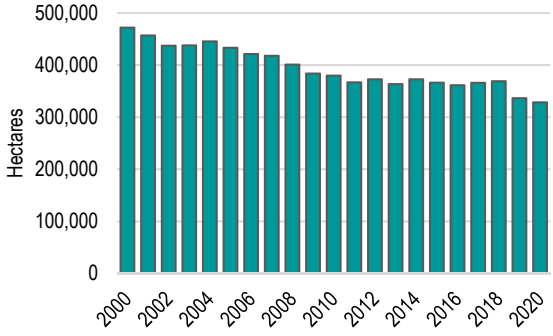
(b) Planted Hardwood



(c) Naturally Regenerated Pine



(d) Naturally Regenerated Hardwood



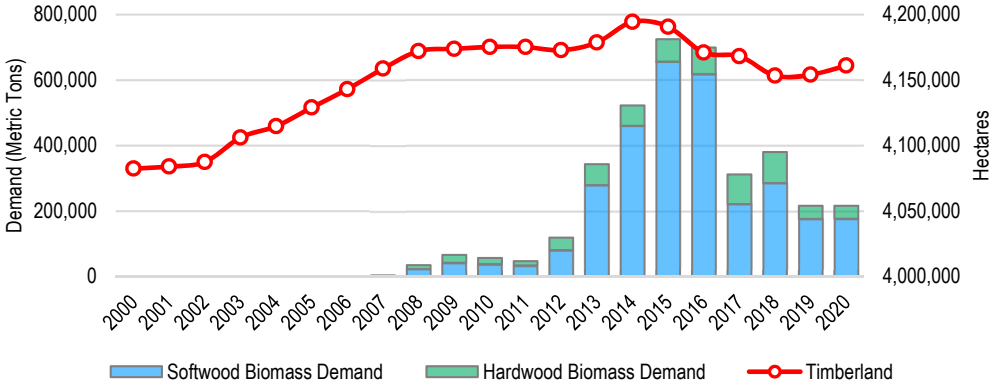
(e) Naturally Regenerated Mixed Pine-Hardwood

Correlation Analysis: *Biomass Demand vs. Timberland*

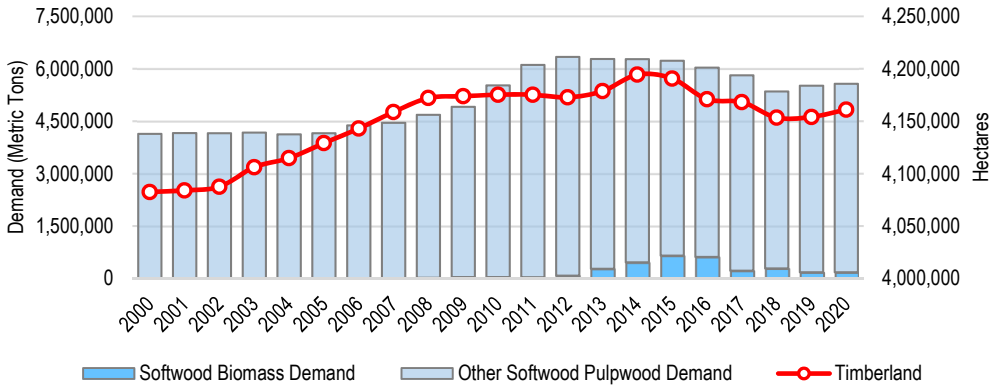
Figure 32 provides a side-by-side comparison of both biomass demand and softwood pulpwood demand versus timberland area in the catchment area from 2000-2020. In comparing changes in biomass demand to changes in timberland area, a positive, albeit weak, linear relationship appears evident. Specifically, total biomass demand increased from roughly 120,000 metric tons in 2012 to nearly 725,000 metric tons in 2015, and this increase in demand coincided with a 17,900-hectare increase in timberland. In addition, the more than 500,000-metric ton decrease in total biomass demand from 2015-2020 corresponded with a more than 29,600-hectare decrease in timberland over this same period.

Correlation analysis did identify a positive correlation (correlation coefficient=0.57) between total biomass demand and timberland area from 2000-2020. However, this relationship appears to be more coincidental in nature and does not provide sufficient evidence to suggest causation. Furthermore, the increase in timberland area in the 2000s appears to more closely linked to the strength of pine sawtimber markets and the financial opportunities associated with the management of pine sawtimber. It's also important to point out that the alternatives provided by agricultural markets have an impact on this catchment area as well. Specifically, cropland and timberland were found to have a strong negative relationship (correlation coefficient=-0.90), which link the gains in timberland to losses in cropland.

***Figure 32**. Alabama Cluster Catchment Area – Biomass Demand & Total Softwood Pulpwood Demand vs. Timberland Hectares (2000-2020)*



(a) Biomass Demand vs. Timberland Hectares



(b) Softwood Pulpwood Demand vs. Timberland Hectares

***Table 26**. Correlation Analysis –Biomass Demand, Pulpwood Demand & Timberland Area (2000-2020)*

	Softwood Biomass Demand	*Other Softwood Pulpwood Demand*	*Total Softwood Pulpwood Demand*	*Pine Timberland*	*Total Timberland*
Softwood Biomass Demand	1				
Other Softwood Pulpwood Demand	0.55	1			
Total Softwood Pulpwood Demand	0.70	0.98	1		
Pine Timberland	0.65	0.72	0.77	1	
Total Timberland	0.56	0.81	0.82	-0.80	1

	Hardwood Biomass Demand	*Other Hardwood Pulpwood Demand*	*Total Hardwood Pulpwood Demand*	*Hardwood Timberland*	*Total Timberland*
Hardwood Biomass Demand	1				
Other Hardwood Pulpwood Demand	-0.74	1			
Total Hardwood Pulpwood Demand	-0.71	0.99	1		
Hardwood Timberland	-0.76	0.79	0.77	1	
Total Timberland	0.61	-0.75	-0.74	-0.62	1

	Softwood Biomass Demand	*Hardwood Biomass Demand*	*Total Biomass Demand*	*Total Timberland*
Softwood Biomass Demand	1			
Hardwood Biomass Demand	0.82	1		
Total Biomass Demand	0.99	0.87	1	
Total Timberland	0.56	0.61	0.58	1

6.1.4 *Changes in Timber Inventory*

Timber inventory data for the Alabama Cluster catchment area was provided by the US Forest Service - Forest Inventory & Analysis (FIA) program from 2000 through 2020[4], the most current available. According to FIA estimates, total growing stock inventory on timberland in the Alabama Cluster catchment area increased an average of 1.4% per year (+31% total) from 368 million m^3 in 2000 to 483 million m^3 in 2020. However, note that the rate at which inventory levels have increased has accelerated since 2012. Specifically, total growing stock inventory increased an average of 0.6% per year from 2000-2012, compared to 2.6% per year since 2012.

Table 27 below (as well as Figures 33 and 34 on the following page) provides a breakdown of timber inventory in the catchment area by major timber product from 2000-2020. Note that inventories increased for all five major products over this period, with the exception of hardwood pulpwood, which decreased 7% from 2000-2020.

***Table 27**. Alabama Cluster Catchment Area - Timber Inventory by Major Timber Product (2000-2020)*

	Softwood			*Hardwood*		
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
			(000 Cubic Meters)			
2000	96,428	44,139	50,441	107,978	68,940	367,926
2001	95,492	43,916	51,177	107,666	68,277	366,527
2002	95,520	44,830	51,328	108,313	67,259	367,250
2003	97,271	46,303	52,208	109,359	66,763	371,904
2004	98,230	47,556	53,306	109,305	65,755	374,152
2005	100,250	48,678	54,548	110,110	64,581	378,166
2006	101,646	50,477	56,767	111,102	64,342	384,334
2007	101,357	50,546	58,706	110,347	64,807	385,764
2008	100,474	51,722	60,891	111,694	65,003	389,784
2009	100,900	51,216	60,553	112,013	64,989	389,670
2010	103,167	51,840	59,659	111,152	64,640	390,458
2011	103,966	53,304	58,835	111,830	65,120	393,054
2012	106,442	54,082	59,512	111,059	63,764	394,859
2013	111,159	56,322	62,092	110,739	61,654	401,965
2014	117,250	58,301	63,830	111,602	61,064	412,046
2015	122,422	61,671	63,255	111,774	59,807	418,929
2016	128,615	64,925	65,597	112,773	59,541	431,451
2017	136,217	68,509	68,140	112,746	60,228	445,839
2018	145,692	71,774	69,176	113,659	61,561	461,861
2019	147,569	73,569	73,146	116,170	62,854	473,309
2020	150,244	75,473	74,486	119,145	63,864	483,213

Source: USDA - US Forest Service

[4] US Forest Service FIA data for Mississippi was only available through 2019. Estimates for 2020 have been included and are based on historical trends and a local area inventory model.

***Figure 33**. Alabama Cluster Catchment Area - Timber Inventory by Major Timber Product (2000-2020)*

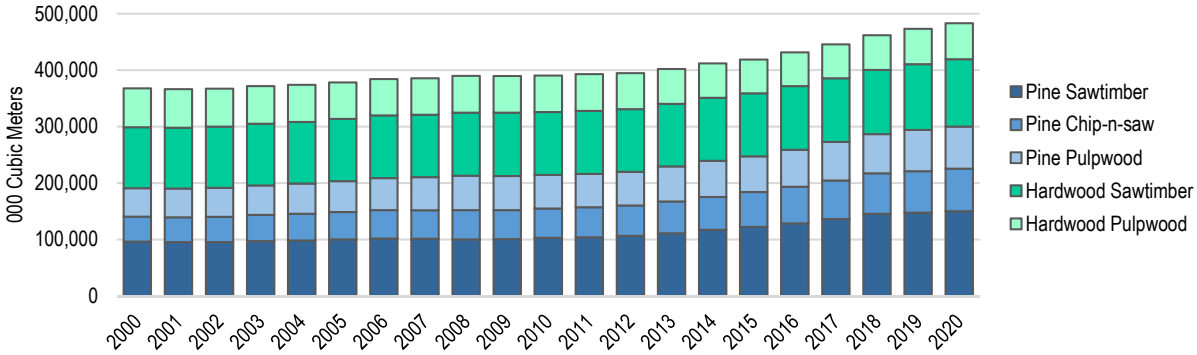
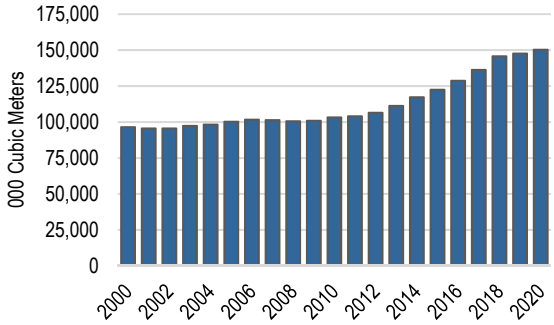
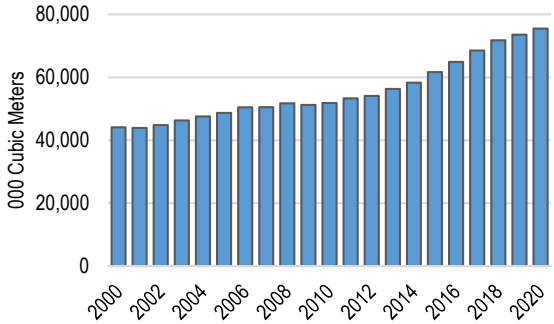


***Figure 34**. Alabama Cluster Catchment Area - Timber Inventory by Major Timber Product (2000-2020)*

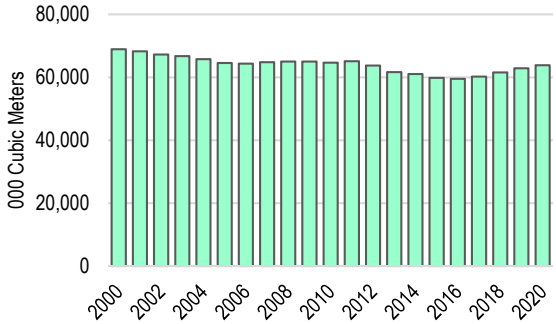


(a) Pine Sawtimber

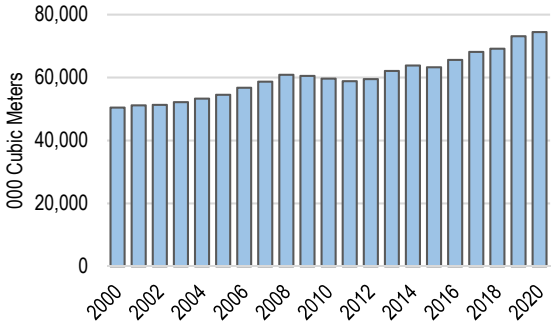
(d) Hardwood Sawtimber



(b) Pine Chip-n-saw



(e) Hardwood Pulpwood



(c) Pine Pulpwood

6.1.4.1 *Diameter Class Distribution*

Total growing stock inventory on timberland increased from 368 million m^3 in 2000 to 483 million m^3 in 2020, or a net increase of 115 million m^3 (+31%) 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 28 below provides a comparison of growing stock inventory estimates in the catchment area by major species group and diameter class in 2000, 2010, and 2020. Specifically, USFS data shows that in 2000, approximately 26% of softwood growing stock inventory was less than 9 inches in diameter (i.e. pulpwood classification), increasing to 28% within these parameters in 2010 but falling to 25% in 2020. In terms of average diameter size, softwood inventory averaged 12.9 inches in diameter in 2000, 12.7 inches in diameter in 2010, and 12.9 inches in diameter in 2020.

The historic distributions of hardwood growing stock inventory by diameter class show 61% of hardwood inventory was 12 inches in diameter or greater (i.e. sawtimber classification) in 2000, increasing to 63% within these same parameters in 2010 and to 75% in 2020. Hardwood growing stock inventory averaged an estimated 14.6 inches in diameter in 2000, compared to 15.0 inches in 2010 and 15.5 inches in 2020.

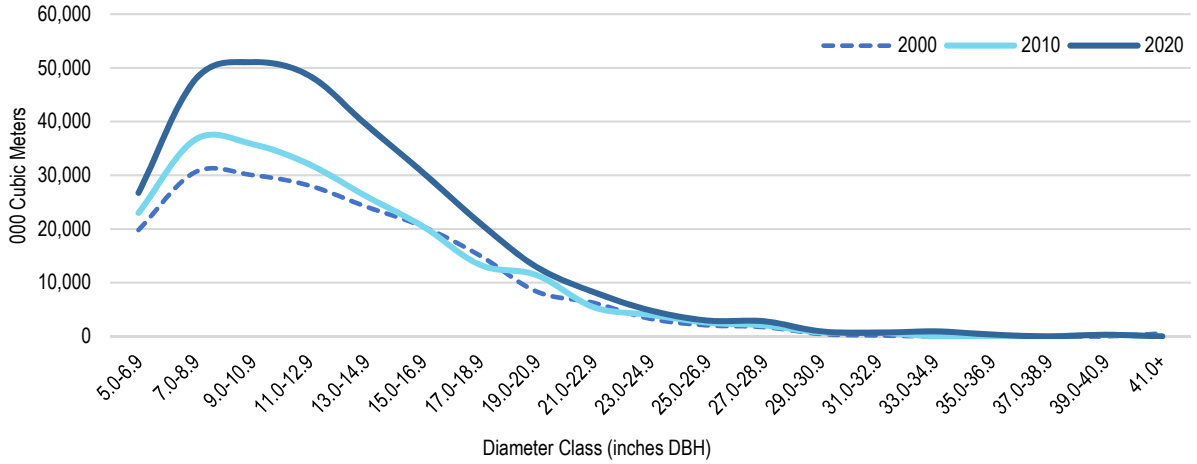
***Table 28**. Alabama Cluster Catchment Area - Timber Inventory by Major Species Group & Diameter Class (2000, 2010, & 2020)*

Diameter Class	Softwood			Hardwood			Total		
(inches DBH)	2000	2010	2020	2000	2010	2020	2000	2010	2020
					(000 Cubic Meters)				
5.0-6.9	19,801	22,995	26,727	14,760	13,772	14,513	34,561	36,767	41,240
7.0-8.9	30,595	36,664	47,850	20,152	18,639	18,149	50,747	55,303	65,999
9.0-10.9	30,038	35,813	51,059	22,556	21,115	20,359	52,594	56,928	71,417
11.0-12.9	28,089	32,054	48,572	22,774	22,229	21,511	50,863	54,283	70,083
13.0-14.9	24,159	26,109	39,445	23,132	21,206	20,671	47,290	47,315	60,116
15.0-16.9	20,453	20,484	30,502	19,647	20,532	20,423	40,100	41,016	50,925
17.0-18.9	15,065	13,338	21,132	15,778	16,144	17,253	30,843	29,482	38,385
19.0-20.9	8,342	11,408	12,908	11,505	12,980	14,140	19,847	24,388	27,048
21.0-22.9	6,245	5,442	8,253	9,077	9,034	10,464	15,321	14,477	18,717
23.0-24.9	3,270	4,003	4,827	5,749	7,077	7,940	9,020	11,079	12,767
25.0-26.9	2,065	2,563	2,946	4,399	4,842	7,204	6,464	7,405	10,150
27.0-28.9	1,735	2,047	2,810	2,649	3,317	3,876	4,384	5,364	6,686
29.0-30.9	451	740	926	1,614	1,422	2,170	2,066	2,162	3,096
31.0-32.9	158	727	673	1,218	822	1,249	1,376	1,550	1,921
33.0-34.9	13	0	938	654	573	845	667	573	1,783
35.0-36.9	0	0	335	480	258	244	480	258	579
37.0-38.9	0	0	0	216	665	608	216	665	608
39.0-40.9	0	279	301	171	615	323	171	893	624
41.0+	530	0	0	387	548	1,067	916	548	1,067
Total	**191,008**	**214,666**	**300,203**	**176,918**	**175,792**	**183,009**	**367,926**	**390,458**	**483,213**

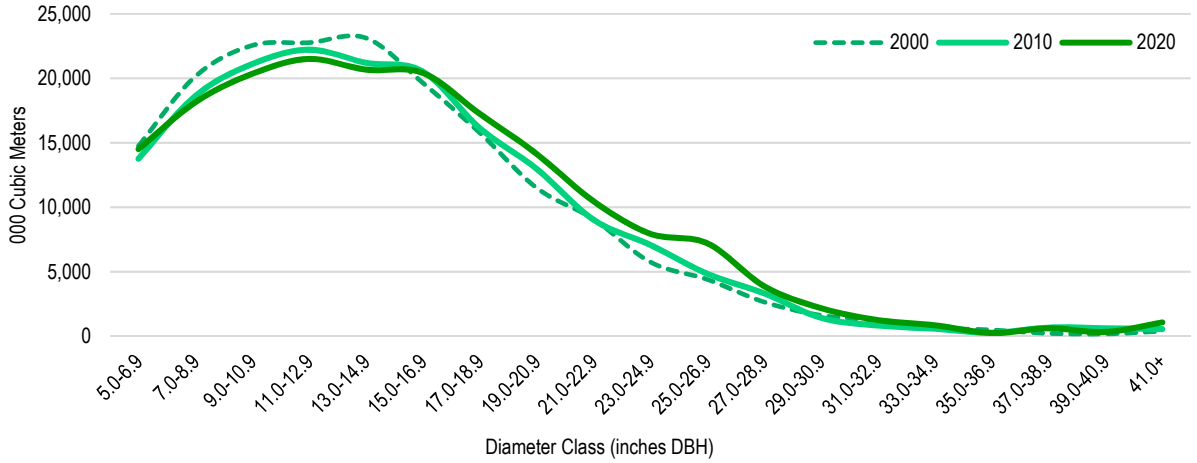
Pine Pulpwood Pine Chip-n-saw Pine Sawtimber Hardwood Pulpwood Hardwood Sawtimber

Source: USDA - US Forest Service

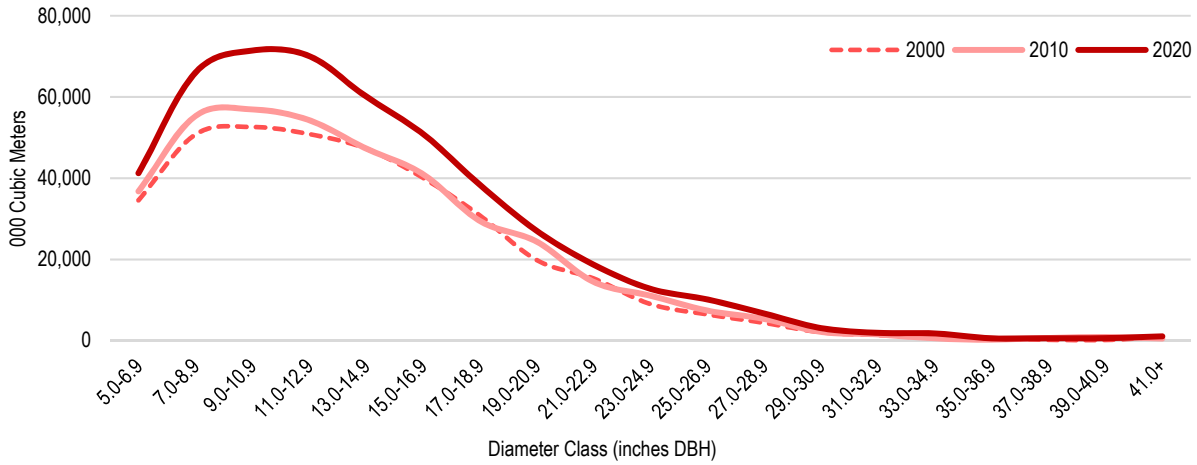
***Figure 35**. Alabama Cluster Catchment Area - Timber Inventory by Major Species Group & Diameter Class (2000, 2010, & 2020)*



(a) Softwood Growing Stock Inventory



(b) Hardwood Growing Stock Inventory



(c) Total Growing Stock Inventory

6.1.4.2 *Age Class Distribution*

US Forest Service data indicates the average age of softwood growing stock inventory decreased from 35.4 years old in 2000 to 32.2 years old in 2020. Conversely, the average age of hardwood growing stock inventory increased from 48.9 to 54.0 years of age over this 20-year period.

The decrease in the average age of softwood growing stock inventory was reflected in changes in age class distribution over this period. Specifically, the distribution of softwood growing stock inventory 50 years of age or younger increased from 77% in 2000 to 83% in 2020. Similarly, the increase in the average age of hardwood growing stock inventory was also reflected in changes in age class distribution, as the distribution of hardwood growing stock inventory greater than 50 years of age increased from 46% in 2000 to 59% in 2020.

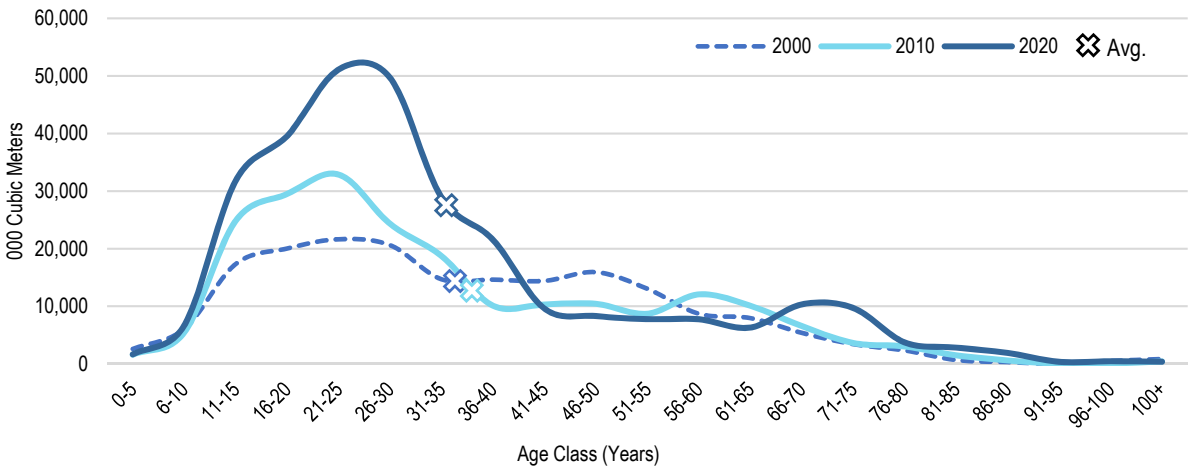
Table 29 below provides US Forest Service estimates of softwood and hardwood growing stock inventory by age class in 2000, 2010, and 2020. Corresponding values are shows graphically in Figure 36 on the following page.

***Table 29**. Alabama Cluster Catchment Area - Timber Inventory by Major Species Group & Age Class (2000, 2010, & 2020)*

Age Class	Softwood			Hardwood			Total		
(years)	2000	2010	2020	2000	2010	2020	2000	2010	2020
					(000 Cubic Meters)				
0-5	2,585	1,591	1,640	2,753	2,956	967	5,337	4,547	2,608
6-10	6,076	5,444	6,655	3,104	2,424	1,587	9,180	7,868	8,242
11-15	17,334	24,839	31,809	4,528	5,051	2,527	21,862	29,889	34,336
16-20	20,033	29,491	39,592	5,310	6,835	5,319	25,343	36,326	44,910
21-25	21,638	32,883	51,118	5,451	7,094	12,691	27,089	39,977	63,810
26-30	20,610	24,310	49,681	8,427	8,197	12,403	29,037	32,507	62,084
31-35	14,683	18,719	28,892	9,215	9,350	11,015	23,898	28,068	39,908
36-40	14,626	10,089	21,547	13,593	11,788	9,389	28,219	21,876	30,937
41-45	14,409	10,320	9,576	17,417	12,014	8,936	31,826	22,334	18,511
46-50	15,923	10,420	8,297	25,522	12,423	10,614	41,445	22,843	18,911
51-55	13,035	8,702	7,755	16,272	17,937	12,346	29,307	26,639	20,100
56-60	8,691	12,060	7,736	17,331	19,859	11,741	26,022	31,919	19,477
61-65	7,941	10,087	6,292	15,916	16,113	14,527	23,857	26,200	20,820
66-70	5,380	6,554	10,317	9,344	13,542	19,543	14,724	20,096	29,860
71-75	3,415	3,618	9,702	7,429	9,124	15,632	10,844	12,742	25,334
76-80	2,327	3,020	3,714	4,932	11,796	13,280	7,259	14,816	16,994
81-85	663	1,467	2,820	2,157	2,522	8,474	2,820	3,989	11,294
86-90	311	602	1,889	2,496	1,758	5,522	2,807	2,361	7,411
91-95	0	0	358	101	1,782	2,934	101	1,782	3,292
96-100	485	48	449	4,256	1,042	1,355	4,742	1,091	1,805
100+	842	403	362	1,365	2,186	2,207	2,207	2,588	2,569
Total	**191,008**	**214,666**	**300,203**	**176,918**	**175,792**	**183,009**	**367,926**	**390,458**	**483,213**

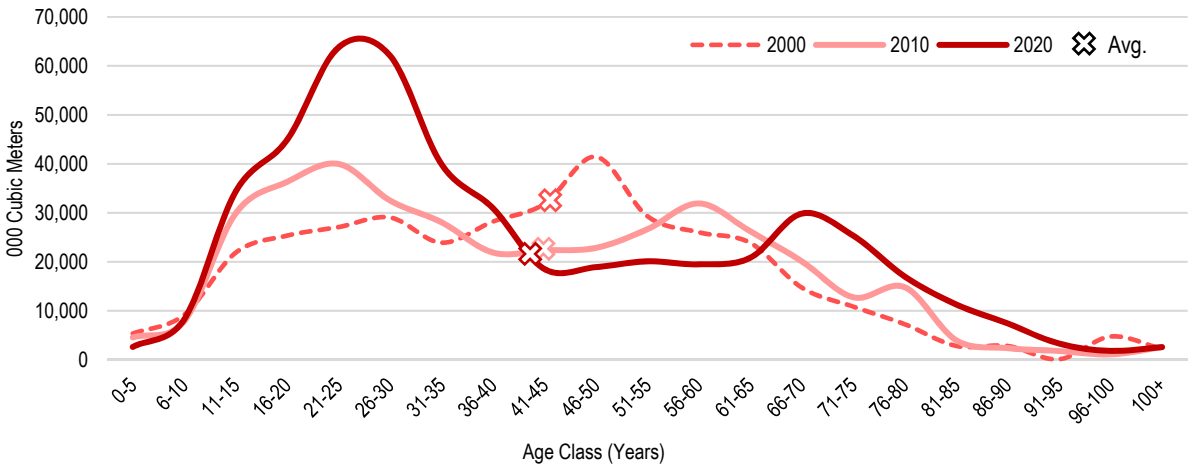
Source: USDA - US Forest Service

***Figure 36**. Alabama Cluster Catchment Area - Timber Inventory by Major Species Group & Age Class (2000, 2010, & 2020)*



(a) Softwood Growing Stock Inventory

(b) Hardwood Growing Stock Inventory



(c) Total Growing Stock Inventory

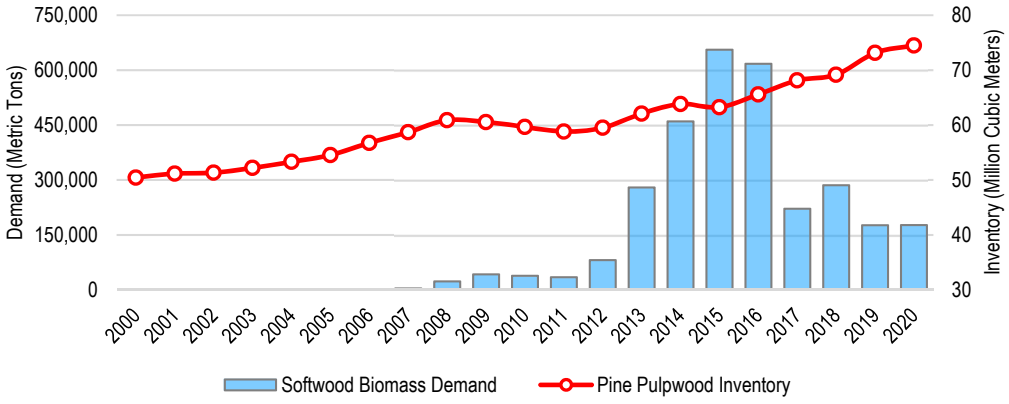
Correlation Analysis: *Biomass Demand vs. Timber Inventory*

US Forest Service data shows that total timber inventory increased 31% in the Alabama Cluster catchment area from 2000-2020. 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.

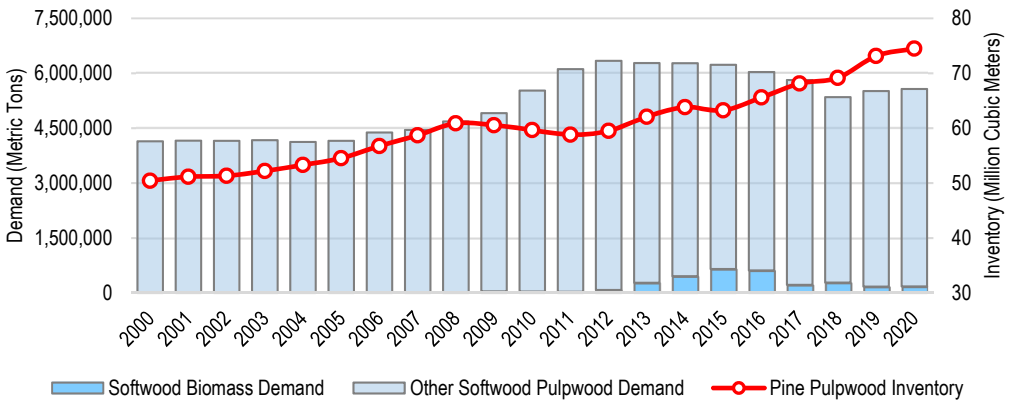
In particular, inventories of pine pulpwood – the predominant timber product utilized by the bioenergy industry – steadily increased at an average rate of 2.4% per year (+21% total) from 2000-2008 before declining 3% from 2008-2011. Note that this 3% decrease from 2008-2011 coincided with a 31% increase in softwood pulpwood demand. Pine pulpwood inventory levels proceeded to increase 27% from 2011-2020, and this increase occurred alongside a 9% decrease in softwood pulpwood demand over this same period.

Ultimately, correlation analysis identified a moderately strong positive relationship between pine pulpwood inventory and pine pulpwood demand (correlation coefficient=0.66) from 2000-2020. However, the increase in pine pulpwood inventory over this period was not due to increased softwood pulpwood demand (from bioenergy or other sources). Rather, the increase in inventory level can be more closely linked to increases in timberland, particularly increases in planted pine timberland.

***Figure 37**. Alabama Cluster Catchment Area – Softwood Pulpwood Demand vs. Pine Pulpwood Inventory (2000-2020)*



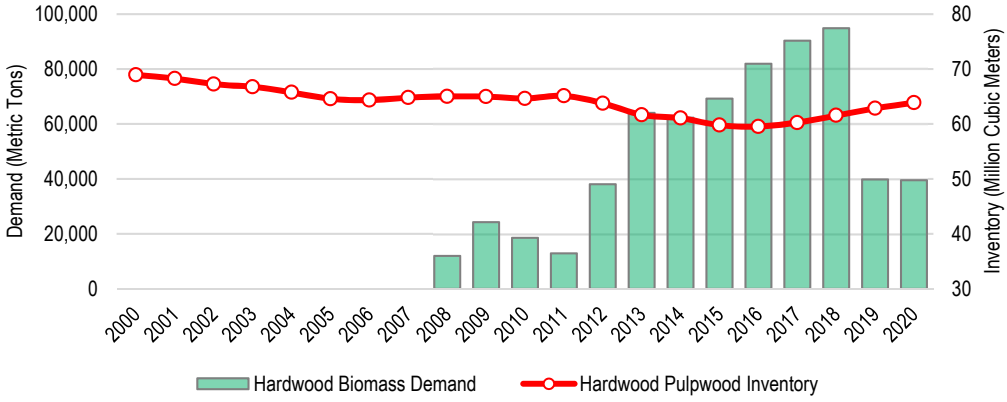
(a) Softwood Biomass Demand vs. Pine Pulpwood Inventory



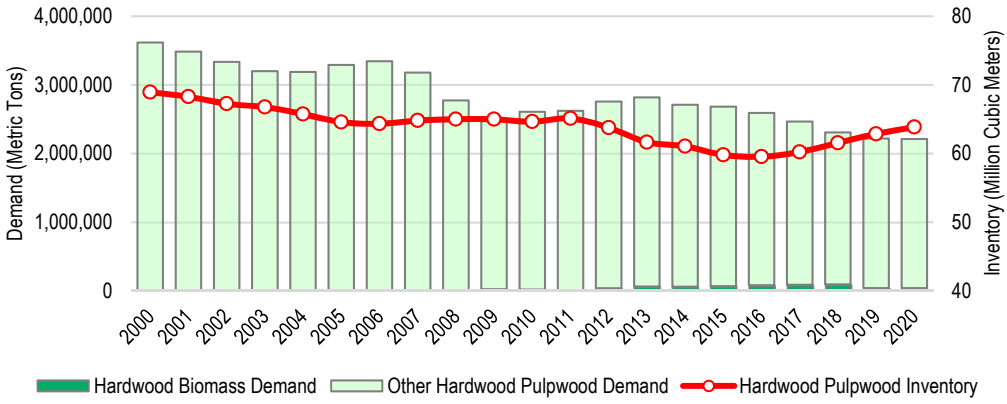
(b) Softwood Pulpwood Demand vs. Softwood Pulpwood Inventory

Hardwood pulpwood inventory was also examined alongside hardwood pulpwood demand, and correlation analysis identified a moderately strong positive relationship between these two variables, which is opposite of what we'd expect to see. Intuitively, a decrease in demand should result in an increase in inventory. However, hardwood inventory decreased despite a decrease in total hardwood pulpwood demand. Ultimately, decreases in hardwood pulpwood inventory since 2000 can be linked to decreases in hardwood timberland, not decreases in demand for hardwood pulpwood.

***Figure 38**. Alabama Cluster Catchment Area – Hardwood Pulpwood Demand vs. Hardwood Pulpwood Inventory (2000-2020)*



(a) Hardwood Biomass Demand vs. Hardwood Pulpwood Inventory



(b) Hardwood Pulpwood Demand vs. Hardwood Pulpwood Inventory

***Table 30**. Correlation Analysis –Biomass Demand, Pulpwood Demand & Timber Inventory (2000-2020)*

	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	0.55	1			
Total Softwood Pulpwood Demand	0.70	0.98	1		
Pine Pulpwood Inventory	0.56	0.63	0.66	1	
Total Pine Inventory	0.59	0.54	0.60	0.97	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	-0.74	1			
Total Hardwood Pulpwood Demand	-0.71	0.99	1		
Hardwood Pulpwood Inventory	-0.89	0.71	0.68	1	
Total Hardwood Inventory	-0.40	-0.14	-0.18	0.47	1

	Softwood Biomass Demand	*Hardwood Biomass Demand*	*Total Biomass Demand*	*Total Pulpwood Inventory*	*Total Inventory*
Softwood Biomass Demand	1				
Hardwood Biomass Demand	0.82	1			
Total Biomass Demand	0.99	0.87	1		
Total Pulpwood Inventory	0.31	0.53	0.35	1	
Total Inventory	0.54	0.74	0.58	0.93	1

6.1.5 *Changes in Annual Timber Growth*

Timber growth data for the Alabama Cluster catchment area was also provided by the US Forest Service - Forest Inventory & Analysis (FIA) program. According to FIA data, net annual growth of growing stock timber held relatively steady and averaged 20.9 million m^3 from 2000-2006 before increasing and averaging 23.2 million m^3 from 2008-2012. However, total timber growth proceeded to increase 21% over the eight years that followed, increasing to 30.0 million m^3 in 2020, or an overall increase of 8.9 million m^3 (+43%) from 2000-2020.

Table 31 below (as well as Figure 39 on the following page) provides a breakdown of annual timber growth by major timber product from 2000 through 2020. Note that annual growth of softwood timber increased 73%, with pine sawtimber, pine chip-n-saw, and pine pulpwood increasing 68%, 83%, and 70%, respectively, from 2000-2020. However, annual growth of hardwood timber decreased 12% from 2000-2020, with hardwood sawtimber and hardwood pulpwood decreasing 14% and 10%, respectively, over this 20-year period.

***Table 31**. Alabama Cluster Catchment Area - Annual Growth by Major Timber Product (2000-2020)*

	Softwood			*Hardwood*		
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
			(000 Cubic Meters)			
2000	4,500	3,645	5,601	3,331	4,071	21,149
2001	4,428	3,564	5,885	3,163	3,901	20,942
2002	4,356	3,445	6,392	2,960	3,731	20,884
2003	4,160	3,323	6,585	2,773	3,562	20,402
2004	4,066	3,477	6,843	2,548	3,565	20,499
2005	4,105	3,738	6,985	2,570	3,535	20,933
2006	4,347	3,894	7,229	2,550	3,534	21,554
2007	4,231	3,791	8,206	2,286	3,525	22,039
2008	4,298	3,967	8,803	2,117	3,456	22,640
2009	4,434	4,064	9,111	1,775	3,453	22,837
2010	4,846	4,236	8,908	1,728	3,493	23,211
2011	4,973	4,474	8,820	1,698	3,455	23,421
2012	5,127	4,615	8,973	1,742	3,408	23,865
2013	5,373	5,090	9,222	1,729	3,294	24,708
2014	5,730	5,286	9,234	1,946	3,259	25,456
2015	5,982	5,541	9,015	2,130	3,297	25,965
2016	6,355	5,814	9,118	2,293	3,248	26,829
2017	6,812	6,111	9,099	2,468	3,341	27,831
2018	7,243	6,310	8,862	2,637	3,450	28,502
2019	7,430	6,498	9,352	2,792	3,592	29,664
2020	7,523	6,641	9,336	2,867	3,674	30,041

Source: USDA-US Forest Service

***Figure 39**. Alabama Cluster Catchment Area - Net Annual Growth of Growing Stock Timber on Timberland (2000-2020)*

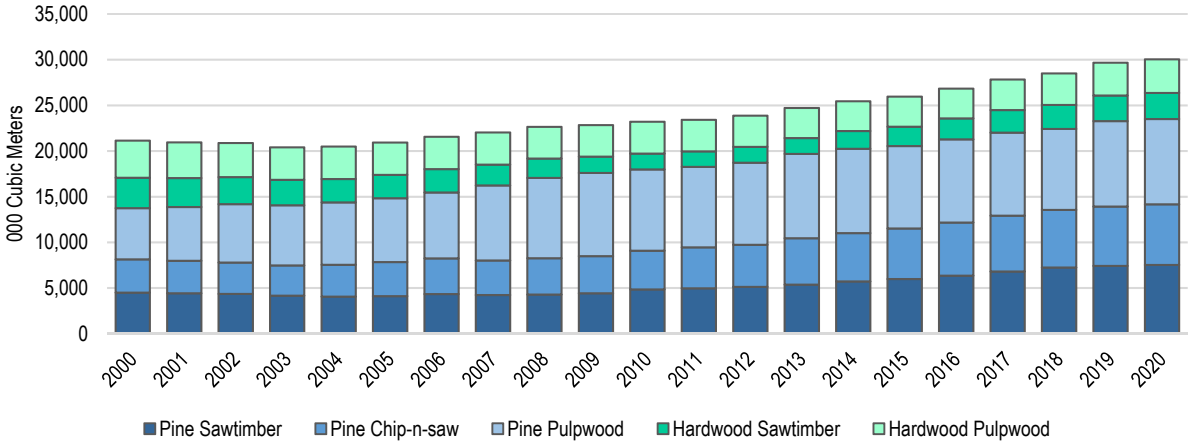
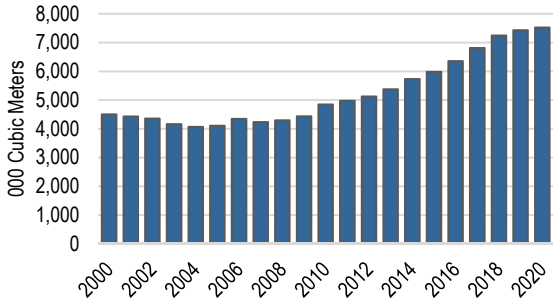
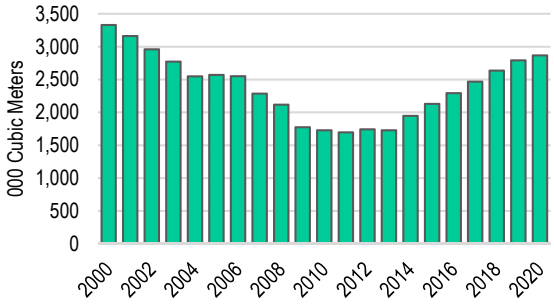


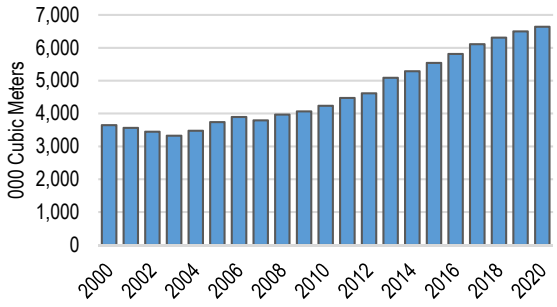
***Figure 40**. Alabama Cluster Catchment Area - Net Annual Growth by Major Timber Product (2000-2020)*



(a) Pine Sawtimber

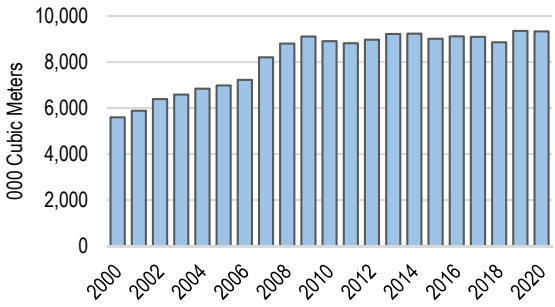


(d) Hardwood Sawtimber



(b) Pine Chip-n-saw

(e) Hardwood Pulpwood



(c) Pine Pulpwood

6.1.5.1 *Growth Rates & Per-Hectare Growth*

According to USFS data, the annual growth rate of timber in the catchment area averaged 5.6% from 2000-2006 but steadily increased over the eight years that followed to 6.2% in 2014. Since 2014, the average growth rate of timber has held steady and averaged 6.2% per year in the catchment area. Specifically, the average annual growth rate of pine pulpwood, the primary timber product consumed by the bioenergy sector, increased from 11.1% in 2000 to 15.1% in 2012 but has since declined, falling to 12.5% in 2020. See Table 32 below for details.

***Table 32**. Alabama Cluster Catchment Area - Average Annual Growth Rate by Major Timber Product (2000-2020)*

	Softwood			Hardwood		
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
			Annual Growth Rate (%)			
2000	4.7%	8.3%	11.1%	3.1%	5.9%	5.7%
2001	4.6%	8.1%	11.5%	2.9%	5.7%	5.7%
2002	4.6%	7.7%	12.5%	2.7%	5.5%	5.7%
2003	4.3%	7.2%	12.6%	2.5%	5.3%	5.5%
2004	4.1%	7.3%	12.8%	2.3%	5.4%	5.5%
2005	4.1%	7.7%	12.8%	2.3%	5.5%	5.5%
2006	4.3%	7.7%	12.7%	2.3%	5.5%	5.6%
2007	4.2%	7.5%	14.0%	2.1%	5.4%	5.7%
2008	4.3%	7.7%	14.5%	1.9%	5.3%	5.8%
2009	4.4%	7.9%	15.0%	1.6%	5.3%	5.9%
2010	4.7%	8.2%	14.9%	1.6%	5.4%	5.9%
2011	4.8%	8.4%	15.0%	1.5%	5.3%	6.0%
2012	4.8%	8.5%	15.1%	1.6%	5.3%	6.0%
2013	4.8%	9.0%	14.9%	1.6%	5.3%	6.1%
2014	4.9%	9.1%	14.5%	1.7%	5.3%	6.2%
2015	4.9%	9.0%	14.3%	1.9%	5.5%	6.2%
2016	4.9%	9.0%	13.9%	2.0%	5.5%	6.2%
2017	5.0%	8.9%	13.4%	2.2%	5.5%	6.2%
2018	5.0%	8.8%	12.8%	2.3%	5.6%	6.2%
2019	5.0%	8.8%	12.8%	2.4%	5.7%	6.3%
2020	5.0%	8.8%	12.5%	2.4%	5.8%	6.2%

Source: USDA - US Forest Service

Furthermore, average per-hectare volume growth in the Alabama Cluster catchment area averaged 5.1 m^3 per year from 2000-2006. However, since 2006, average per-hectare growth has increased an average of 2.4% per year and to 7.2 m^3 in 2020. In terms of individual timber products, combined per-hectare growth of pine sawtimber and chip-n-saw increased more than 70% from 2000-2020 while pine pulpwood per-hectare growth increased roughly 65% over this period (see Table 33 on the following page).

Ultimately, this data suggests that the catchment area forest, overall, has become more productive. However, it also shows a forest that nears transition and a period in which pine pulpwood will be moving up into chip-n-saw classification. In general, growth rates decline as timber ages, and this is what we see with pine pulpwood. However, pine chip-n-saw growth rates remain stable and have yet to increase (which is what we'd expect to see if pine pulpwood had started to move up in classification).

***Table 33**. Alabama Cluster Catchment Area - Average Per-Hectare Volume Growth by Major Timber Product (2000-2020)*

Year	Softwood			Hardwood		Total
	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	
	(Cubic Meters/Hectare/Year)					
2000	1.10	0.89	1.37	0.82	1.00	5.18
2001	1.08	0.87	1.44	0.77	0.96	5.13
2002	1.07	0.84	1.56	0.72	0.91	5.11
2003	1.01	0.81	1.60	0.68	0.87	4.97
2004	0.99	0.85	1.66	0.62	0.87	4.98
2005	0.99	0.91	1.69	0.62	0.86	5.07
2006	1.05	0.94	1.74	0.62	0.85	5.20
2007	1.02	0.91	1.97	0.55	0.85	5.30
2008	1.03	0.95	2.11	0.51	0.83	5.43
2009	1.06	0.97	2.18	0.43	0.83	5.47
2010	1.16	1.01	2.13	0.41	0.84	5.56
2011	1.19	1.07	2.11	0.41	0.83	5.61
2012	1.23	1.11	2.15	0.42	0.82	5.72
2013	1.29	1.22	2.21	0.41	0.79	5.91
2014	1.37	1.26	2.20	0.46	0.78	6.07
2015	1.43	1.32	2.15	0.51	0.79	6.20
2016	1.52	1.39	2.19	0.55	0.78	6.43
2017	1.63	1.47	2.18	0.59	0.80	6.68
2018	1.74	1.52	2.13	0.63	0.83	6.86
2019	1.79	1.56	2.25	0.67	0.86	7.14
2020	1.81	1.60	2.24	0.69	0.88	7.22

Source: USDA - US Forest Service

***Figure 41**. Alabama Cluster Catchment Area – Average Timber Growth Rate & Total Per-Hectare Volume Growth (2000-2020)*

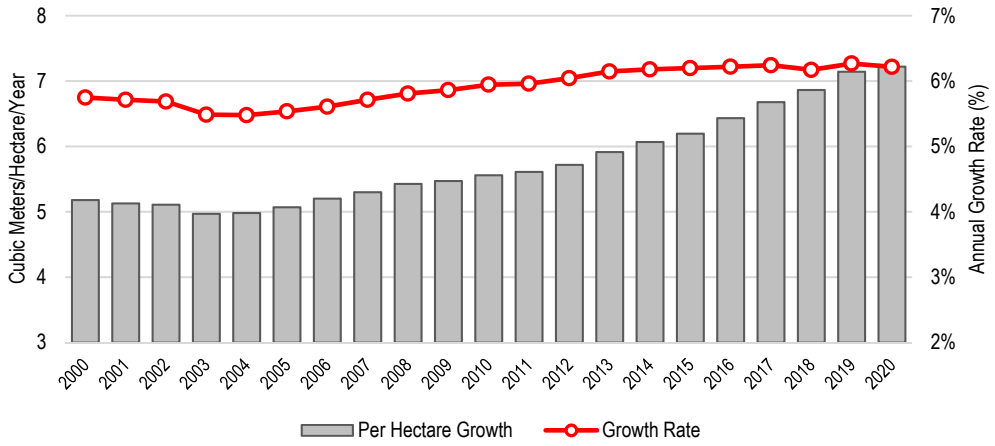
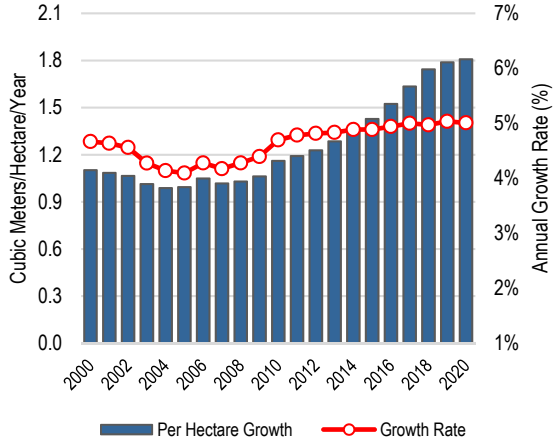
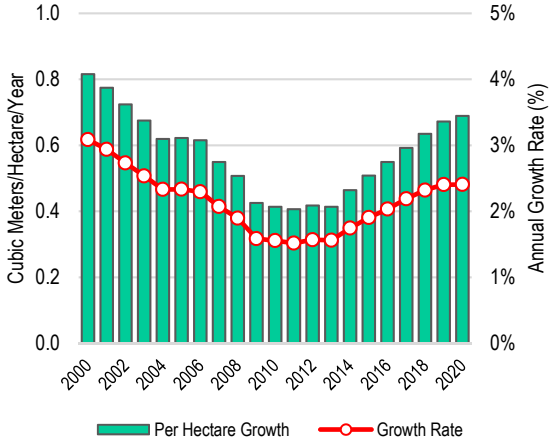


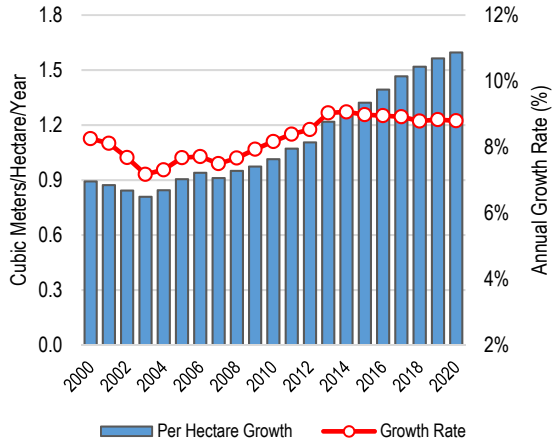
Figure 42. *Alabama Cluster Catchment Area - Annual Growth Rates & Per-Hectare Growth by Major Timber Product (2000-2020)*



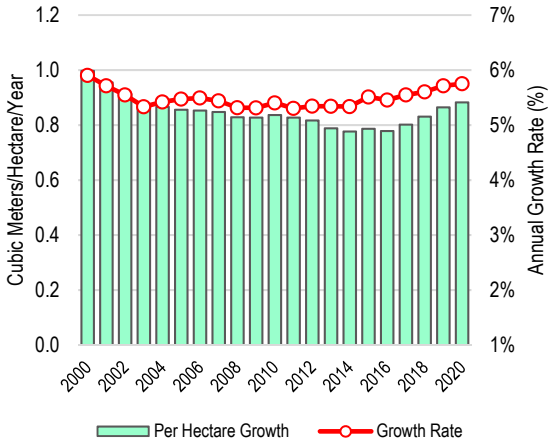
(a) Pine Sawtimber



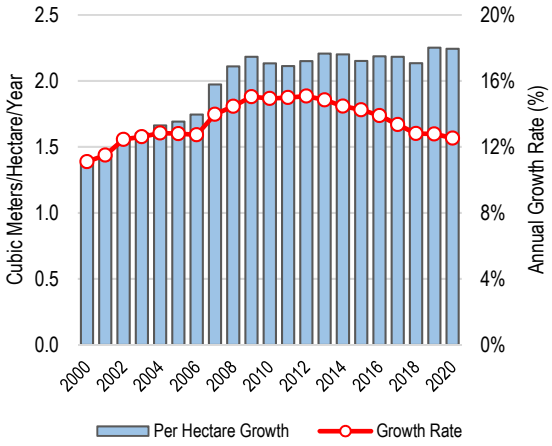
(d) Hardwood Sawtimber



(b) Pine Chip-n-saw



(e) Hardwood Pulpwood



(c) Pine Pulpwood

Growth Rates & Age Class

As was noted on page 74, the decrease in pine pulpwood growth rate suggests that the catchment area forest nears transition, with a significant portion of softwood inventory soon to move up in product class (from pine pulpwood to pine chip-n-saw). To demonstrate and help further explain this transition – including how this will impact growth rates – Figure 43 below shows softwood growing stock inventory in the catchment area by age class in 2020 along with the corresponding growth rate associated with each respective diameter class. Also note that specific product classifications have been identified and are highlighted in this figure.

Looking at this figure, notice that the majority of pine pulpwood inventory (highlighted in green) is located at the top end of its age class range (and the bottom end of its growth rate range). Similarly, a majority of pine chip-n-saw inventory (highlighted in yellow) is also located the top end of its age class range (and the bottom end of its growth rate range). However, on its current trajectory, a transition is expected in the coming years. The movement of pine pulpwood into the bottom end of the chip-n-saw range (along with the transitioning of older chip-n-saw into pine sawtimber) will result in increased growth rates associated with pine chip-n-saw. We'd also expect to see an increase in pine pulpwood growth rates, as that older-aged pine pulpwood inventory will be replaced by younger timber.

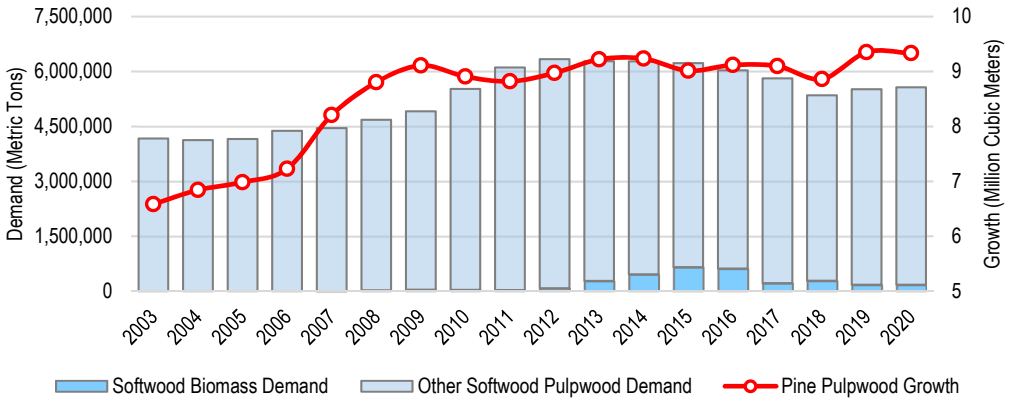
***Figure 43**. Distribution of Softwood Growing Stock Inventory by Age Class vs. Softwood Growth Rate Curve*

Correlation Analysis: *Biomass Demand vs. Timber Growth*

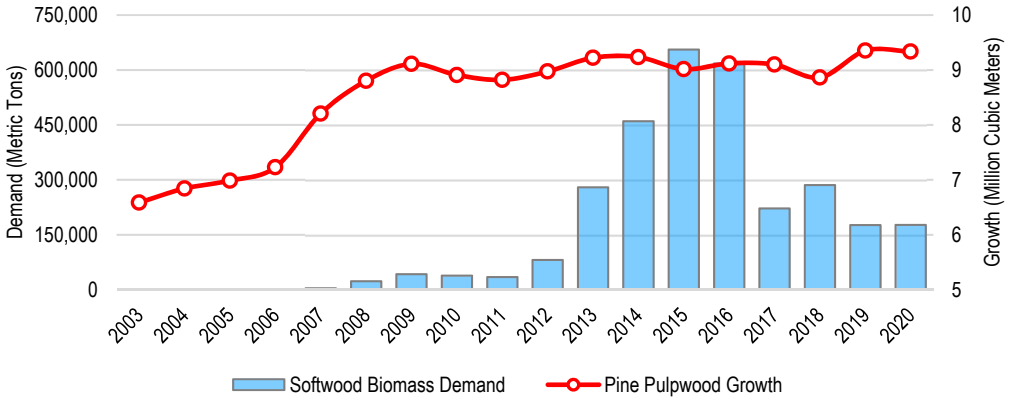
Figure 44 provides a side-by-side comparison of softwood pulpwood demand (including biomass demand) and annual pine pulpwood growth in the catchment area from 2000-2020. In particular, Figure 44(a) shows that total softwood pulpwood demand and pine pulpwood growth, in general, have tracked one another in the catchment area since 2000. Statistical analysis confirms this relationship, identifying a strong positive correlation (correlation coefficient=0.84) between these two variables from 2000-2020.

However, note that this positive relationship opposes what we would typically expect to see. Intuitively, an increase in demand would result in a reduction in inventory, but Figure 44(a) shows the opposite. Similarly, Figure 44(b) also shows that softwood biomass demand has more-or-less tracked softwood pulpwood growth in the catchment area since 2000 (correlation coefficient=0.56). However, note that these positive relationships do not link increases in softwood pulpwood growth to increased demand from bioenergy or other sources, as these positive relationships are more coincidental in nature. In the Alabama Cluster catchment area, the increase in softwood pulpwood growth can be more closely linked to increases in planted pine timberland, which translated into increased inventory and ultimately increased growth.

***Figure 44**. Alabama Cluster Catchment Area – Softwood Pulpwood Demand vs. Annual Pine Pulpwood Growth (2000-2020)*



(a) Softwood Pulpwood Demand vs. Pine Pulpwood Growth

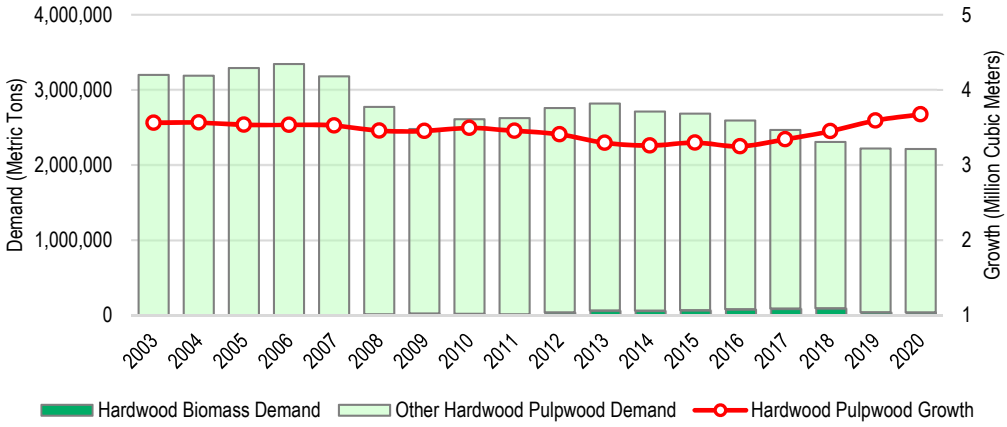


(b) Softwood Biomass Demand vs. Pine Pulpwood Growth

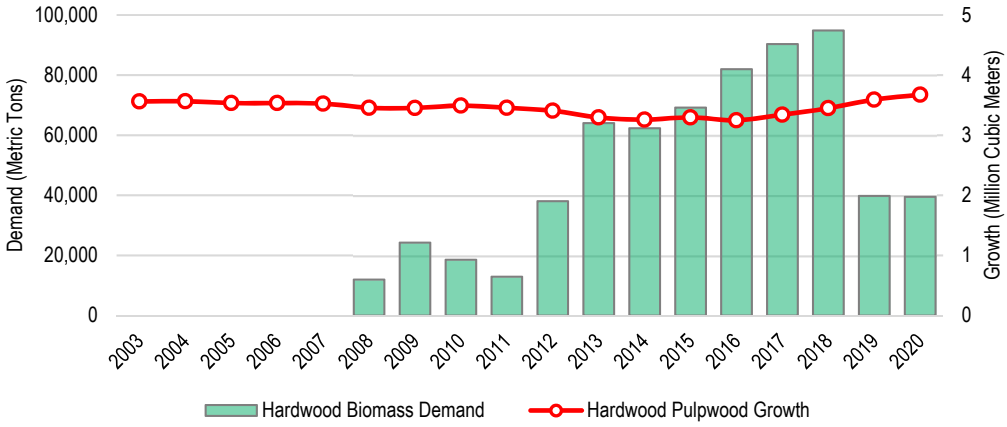
As with softwood pulpwood demand and pine pulpwood growth, Figure 45 shows that hardwood pulpwood demand and hardwood pulpwood growth generally tracked one another from 2000-2020 (correlation coefficient=0.57). However, note that since 2017 the two have moved inversely to one another – which is what we would typically expect to find.

The decrease in hardwood pulpwood growth can be more closely linked to the roughly 250,000-hectare decrease in natural hardwood timberland (on account of conversion to pine) that occurred from 2000-2017. However, hardwood timberland area (hectares) has held relatively stable since 2017, and, as a result, further decreases in hardwood pulpwood demand (from both bioenergy and other sources) have resulted in increases in hardwood pulpwood growth.

***Figure 45**. Alabama Cluster Catchment Area – Hardwood Pulpwood Demand vs. Annual Hardwood Pulpwood Growth (2000-2020)*



(a) Hardwood Pulpwood Demand vs. Hardwood Pulpwood Growth



(b) Hardwood Biomass Demand vs. Hardwood Pulpwood Growth

***Table 34**. Correlation Analysis –Biomass Demand, Pulpwood Demand & Annual Timber Growth (2000-2020)*

	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	0.55	1			
Total Softwood Pulpwood Demand	0.70	0.98	1		
Pine Pulpwood Growth	0.56	0.83	0.84	1	
Total Pine Growth	0.67	0.75	0.79	0.87	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	-0.74	1			
Total Hardwood Pulpwood Demand	-0.71	0.99	1		
Hardwood Pulpwood Growth	-0.64	0.59	0.57	1	
Total Hardwood Growth	-0.40	0.50	0.50	0.98	1

	Softwood Biomass Demand	*Hardwood Biomass Demand*	*Total Biomass Demand*	*Total Pulpwood Growth*	*Total Growth*
Softwood Biomass Demand	1				
Hardwood Biomass Demand	0.82	1			
Total Biomass Demand	0.99	0.87	1		
Total Pulpwood Growth	0.52	0.67	0.55	1	
Total Growth	0.63	0.81	0.67	0.79	1

6.1.6 *Changes in Annual Removals*

According to the US Forest Service, annual removals of growing stock timber declined slightly through the early and mid-2000s but overall averaged 18.1 million m^3 per year from 2000-2006 before declining more than 30% over the three years that followed and to 12.1 million m^3 in 2009. However, total removals steadily increased through the early-2010s and since 2015 have averaged 15.6 million m^3 per year in the catchment area, down 14% compared to 2000-2006 average levels.

Table 35 below provides a breakdown of annual removal estimates by major timber product in the Alabama Cluster catchment area from 2000 through 2020. Annual removals of pine sawtimber and pine chip-n-saw (i.e. softwood sawlogs) averaged 9.3 million m^3 per year from 2000-2006 before declining 30% to 5.9 million m^3 in 2009. Softwood sawlog removals have steadily increased since, increasing an average of 4.8% per year (+68% total) and to 9.9 million m^3 in 2020.

Annual removals of pine pulpwood (the primary roundwood product consumed by the bioenergy sector) averaged 2.6 million m^3 per year from 2000-2009 before increasing to an average of 3.3 million m^3 per year from 2010-2017. Pine pulpwood removals have since declined, averaging 2.8 million ft^3 per year from 2018-2020, down 15% compared to 2010-2017 levels but up 8% compared to 2000-2009 levels.

***Table 35**. Alabama Cluster Catchment Area - Annual Removals by Major Timber Product (2000-2020)*

	Softwood			*Hardwood*		
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
			(000 Cubic Meters)			
2000	6,958	3,091	2,612	3,607	2,538	18,806
2001	6,725	3,066	2,598	3,681	2,565	18,635
2002	6,493	3,041	2,584	3,755	2,593	18,465
2003	6,260	3,016	2,571	3,829	2,620	18,295
2004	6,088	3,027	2,561	3,619	2,464	17,759
2005	5,845	3,186	2,609	3,450	2,466	17,555
2006	5,423	3,021	2,629	3,525	2,344	16,942
2007	5,042	2,800	2,536	2,917	1,979	15,275
2008	4,653	2,690	2,684	2,386	1,669	14,082
2009	3,729	2,199	2,636	2,056	1,479	12,098
2010	4,065	2,183	2,967	2,267	1,620	13,101
2011	4,220	2,249	3,282	2,070	1,563	13,384
2012	4,280	2,374	3,411	2,400	1,618	14,083
2013	4,576	2,548	3,380	2,418	1,697	14,619
2014	4,717	2,718	3,420	2,427	1,605	14,888
2015	4,720	3,012	3,407	2,596	1,631	15,366
2016	4,899	3,240	3,273	2,657	1,586	15,654
2017	5,097	3,451	3,151	2,438	1,512	15,649
2018	5,470	3,471	2,754	2,269	1,422	15,385
2019	5,720	3,371	2,829	2,193	1,341	15,455
2020	6,397	3,548	2,861	2,047	1,310	16,163

Source: USDA - US Forest Service

***Figure 46**. Alabama Cluster Catchment Area - Annual Removals by Year (2000-2020)*

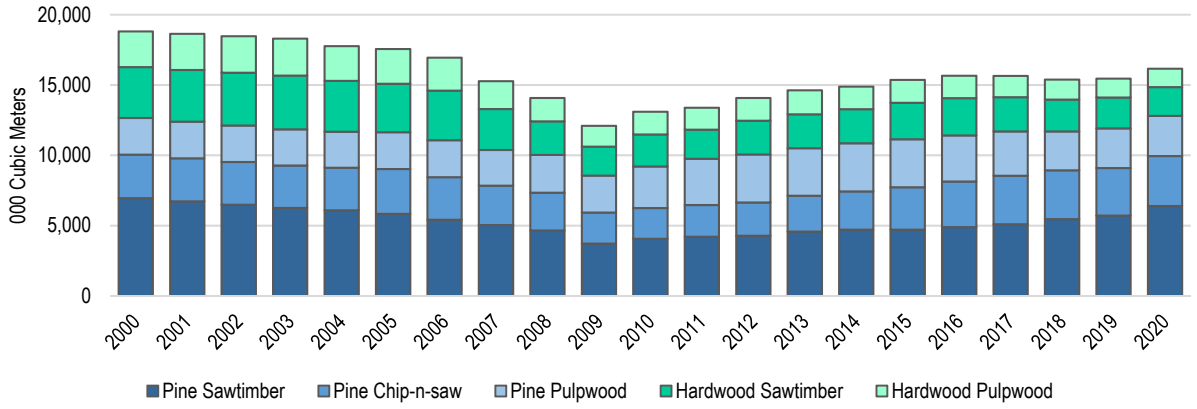
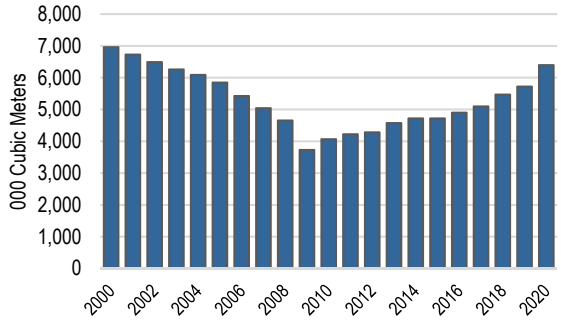
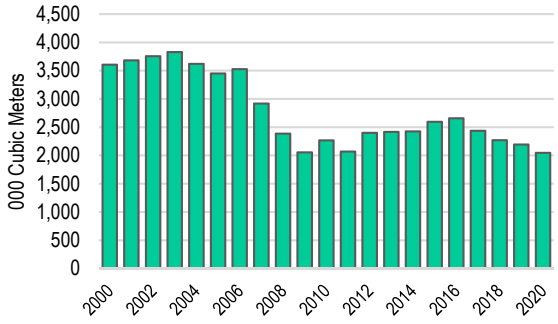


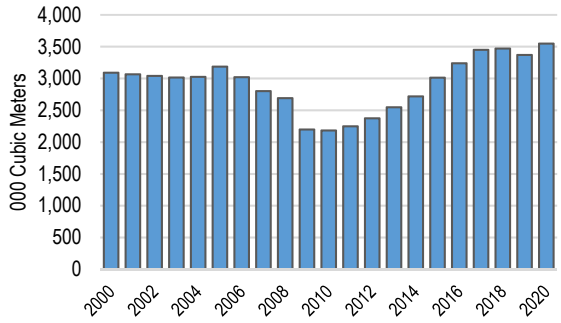
***Figure 47**. Alabama Cluster Catchment Area - Annual Removals by Major Timber Product (2000-2020)*



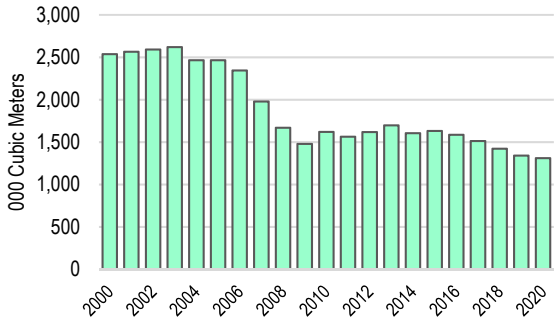
(a) Pine Sawtimber



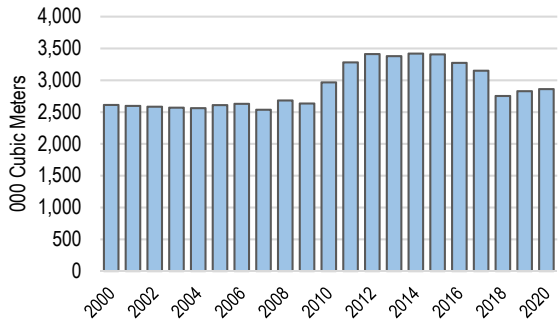
(d) Hardwood Sawtimber



(b) Pine Chip-n-saw



(e) Hardwood Pulpwood



(c) Pine Pulpwood

6.1.6.1 *Growth-to-Removals Ratios*

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, the growth-to-removals (G:R) ratio for pine pulpwood, the primary bioenergy feedstock, remained well above 1.0 in the catchment area from 2000-2020, 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 2.14 in 2000 to 2.75 in 2006, and since 2007 has averaged 2.99.

Note that unsustainable harvest levels persisted in the catchment area for pine sawlogs (combined pine sawtimber and chip-n-saw) from 2000-2006. However, since 2007, pine sawlog markets have remained sustainable – with harvest levels remaining below the sustainable yield capacity of the forest area. Also, while G:R ratios for hardwood sawtimber indicate unsustainable harvest levels from 2000-2017, those values are likely unrepresentative of the true conditions and lower than the true values due to how hardwood sawtimber and hardwood pulpwood have been defined within this assessment.

***Table 36**. Alabama Cluster Catchment Area – Growth-to-Removals Ratios (2000-2020)*

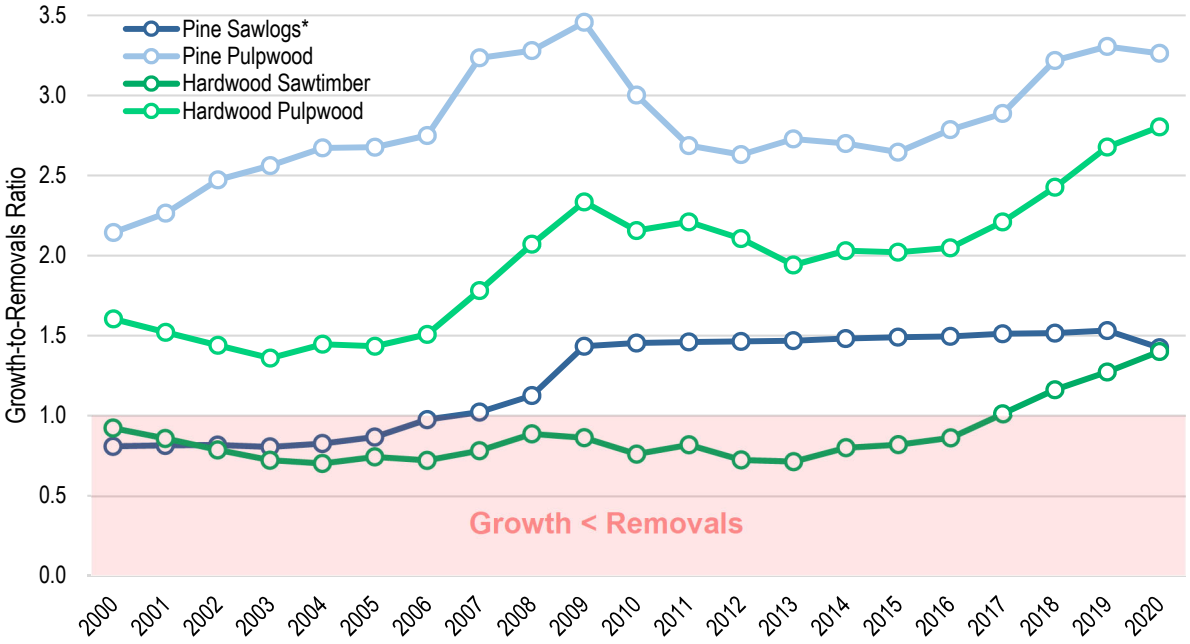
	Softwood			*Hardwood*		
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
			(Growth-to-Removals Ratio)			
2000	0.65	1.18	2.14	0.92	1.60	1.12
2001	0.66	1.16	2.26	0.86	1.52	1.12
2002	0.67	1.13	2.47	0.79	1.44	1.13
2003	0.66	1.10	2.56	0.72	1.36	1.12
2004	0.67	1.15	2.67	0.70	1.45	1.15
2005	0.70	1.17	2.68	0.74	1.43	1.19
2006	0.80	1.29	2.75	0.72	1.51	1.27
2007	0.84	1.35	3.24	0.78	1.78	1.44
2008	0.92	1.47	3.28	0.89	2.07	1.61
2009	1.19	1.85	3.46	0.86	2.34	1.89
2010	1.19	1.94	3.00	0.76	2.16	1.77
2011	1.18	1.99	2.69	0.82	2.21	1.75
2012	1.20	1.94	2.63	0.73	2.11	1.69
2013	1.17	2.00	2.73	0.72	1.94	1.69
2014	1.21	1.94	2.70	0.80	2.03	1.71
2015	1.27	1.84	2.65	0.82	2.02	1.69
2016	1.30	1.79	2.79	0.86	2.05	1.71
2017	1.34	1.77	2.89	1.01	2.21	1.78
2018	1.32	1.82	3.22	1.16	2.43	1.85
2019	1.30	1.93	3.31	1.27	2.68	1.92
2020	1.18	1.87	3.26	1.40	2.80	1.86

Source: USDA - US Forest Service

Figure 48, below, shows growth-to-removals ratios in the catchment area for the major timber products from 2000-2020. As this figure shows (and was noted on the previous page), the pine pulpwood G:R ratio steadily increase from 2.14 in 2000 to 2.75 in 2006 and since 2007 has remained between roughly 2.60 and 3.50 (2.99 average from 2007-2020). Note that the overall increase in the pine pulpwood G:R ratio from 2000 to 2020 can ultimately be linked to increased growth attributed to increases in pine timberland.

Also note the increase in pine pulpwood G:R ratio since 2015 can be linked to increases in softwood lumber production. Specifically, according to USDA-TPO data, softwood lumber production increased more than 20% in the catchment area from 2015-2020. This increase in production resulted in an increase in sawmill residuals, and, as a result, pine pulpwood removals have also decreased – leading to an increase in the pine pulpwood G:R ratio.

***Figure 48**. Alabama Cluster Catchment Area – Growth-to-Removals Ratios by Major Timber Product (2000-2020)*



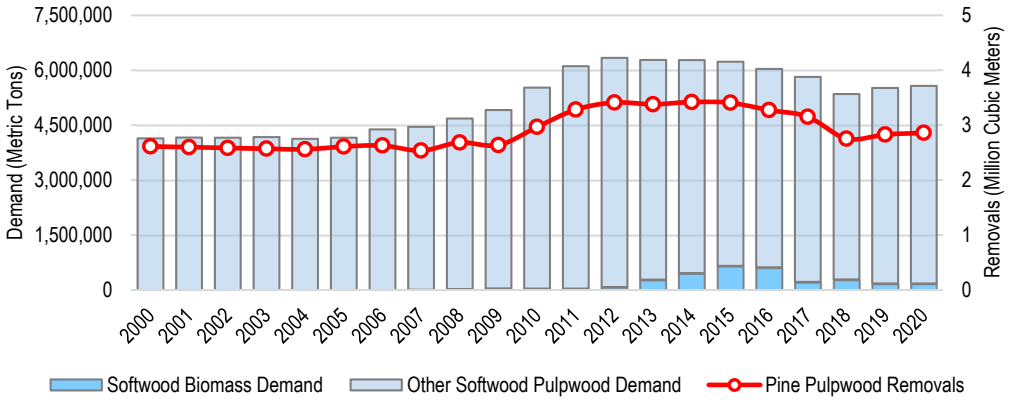
*Pine sawlogs includes pine sawtimber and pine chip-n-saw.

Correlation Analysis: *Biomass Demand vs. Timber Removals*

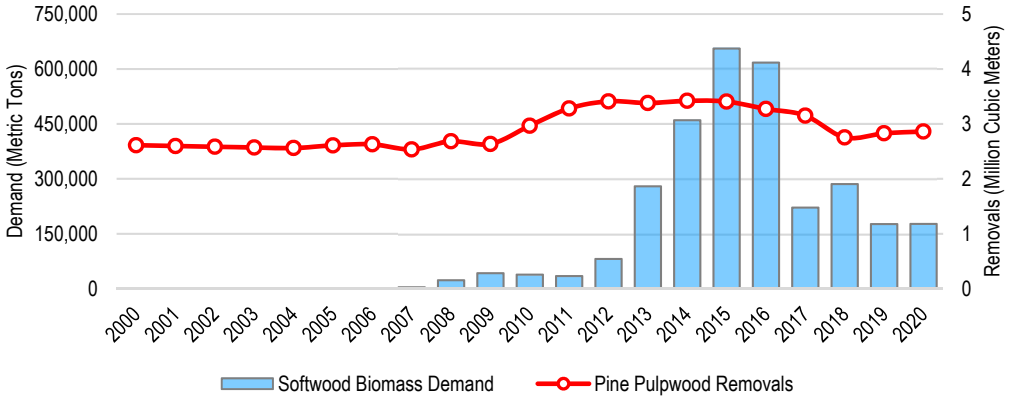
Figure 49 provides a side-by-side comparison of softwood biomass demand and total softwood pulpwood demand versus pine pulpwood removals in the catchment area from 2000-2020. In general, removals should be representative of pulpwood demand and we'd expect these two to be very strongly (positively) correlated, and that's exactly what we see in Figure 49. Statistical analysis confirms this relationship, identifying a strong positive correlation between total softwood pulpwood demand and pine pulpwood removals (correlation coefficient=0.95) from 2000-2020.

Looking specifically at Figure 49(b), we also see that softwood biomass demand and pine pulpwood removals have generally tracked one another, with statistical analysis identifying a moderately strong positive relationship between the two from 2000-2020 (correlation coefficient=0.71). 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 94% of total softwood pulpwood demand since Alabama Pellets-Aliceville's startup in 2012 and 97% of softwood pulpwood demand since 2000.

***Figure 49**. Alabama Cluster Catchment Area – Softwood Pulpwood Demand vs. Pine Pulpwood Removals (2000-2020)*



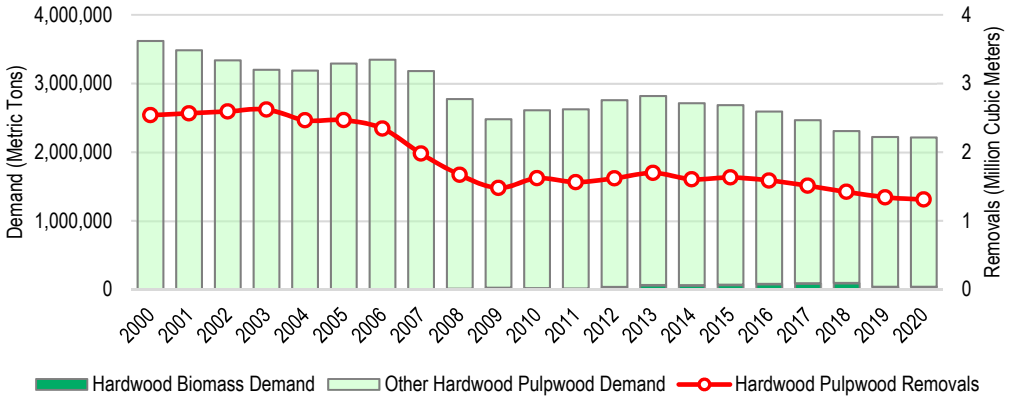
(a) Softwood Pulpwood Demand vs. Pine Pulpwood Removals



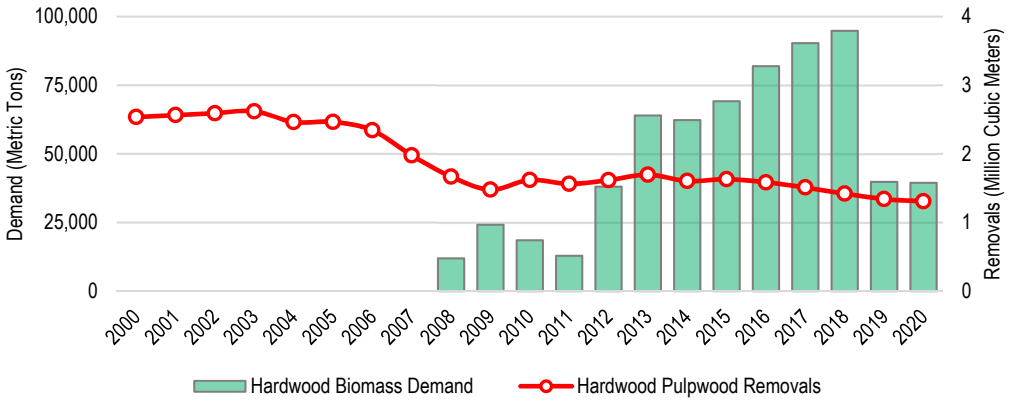
(b) Softwood Biomass Demand vs. Pine Pulpwood Removals

Similarly, a strong positive relationship was found between total hardwood pulpwood demand and hardwood pulpwood removals (correlation coefficient=0.95) from 2000-2020. However, note that demand from non-bioenergy-related sources, which accounts for 98% of total hardwood pulpwood demand, is the primary driver of hardwood pulpwood removals in the catchment area. Furthermore, statistical analysis identified no meaningful relationship between hardwood biomass demand and hardwood pulpwood removals since 2008 (correlation coefficient=-0.08).

***Figure 50**. Alabama Cluster Catchment Area –Pulpwood Demand vs. Annual Pulpwood Removals (2000-2020)*



(a) Hardwood Pulpwood Demand vs. Hardwood Pulpwood Removals



(b) Hardwood Biomass Demand vs. Hardwood Pulpwood Removals

***Table 37**. Correlation Analysis –Biomass Demand, Pulpwood Demand & Annual Timber Removals (2000-2020)*

	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	0.55	1			
Total Softwood Pulpwood Demand	0.70	0.98	1		
Pine Pulpwood Removals	0.71	0.92	0.95	1	
Total Pine Removals	0.06	-0.40	-0.33	-0.27	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	-0.74	1			
Total Hardwood Pulpwood Demand	-0.71	0.99	1		
Hardwood Pulpwood Removals	-0.71	0.95	0.95	1	
Total Hardwood Removals	-0.63	0.92	0.92	0.99	1

	Softwood Biomass Demand	*Hardwood Biomass Demand*	*Total Biomass Demand*	*Total Pulpwood Removals*	*Total Removals*
Softwood Biomass Demand	1				
Hardwood Biomass Demand	0.82	1			
Total Biomass Demand	0.99	0.87	1		
Total Pulpwood Removals	-0.02	-0.28	-0.05	1	
Total Removals	-0.21	-0.36	-0.24	0.57	1

***Table 38**. Alabama Cluster Catchment Area - Timber Inventory, Growth, Removals, & Mortality (2004-2020)*

Category	Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
				000 Cubic Meters			
Inventory	2020	150,244	75,473	74,486	119,145	63,864	483,213
	2019	147,569	73,569	73,146	116,170	62,854	473,309
	2018	145,692	71,774	69,176	113,659	61,561	461,861
	2017	136,217	68,509	68,140	112,746	60,228	445,839
	2016	128,615	64,925	65,597	112,773	59,541	431,451
	2015	122,422	61,671	63,255	111,774	59,807	418,929
	2014	117,250	58,301	63,830	111,602	61,064	412,046
	2013	111,159	56,322	62,092	110,739	61,654	401,965
	2012	106,442	54,082	59,512	111,059	63,764	394,859
	2011	103,966	53,304	58,835	111,830	65,120	393,054
	2010	103,167	51,840	59,659	111,152	64,640	390,458
	2009	100,900	51,216	60,553	112,013	64,989	389,670
	2008	100,474	51,722	60,891	111,694	65,003	389,784
	2007	101,357	50,546	58,706	110,347	64,807	385,764
	2006	101,646	50,477	56,767	111,102	64,342	384,334
	2005	100,250	48,678	54,548	110,110	64,581	378,166
	2004	98,230	47,556	53,306	109,305	65,755	374,152
Growth	2020	7,523	6,641	9,336	2,867	3,674	30,041
	2019	7,430	6,498	9,352	2,792	3,592	29,664
	2018	7,243	6,310	8,862	2,637	3,450	28,502
	2017	6,812	6,111	9,099	2,468	3,341	27,831
	2016	6,355	5,814	9,118	2,293	3,248	26,829
	2015	5,982	5,541	9,015	2,130	3,297	25,965
	2014	5,730	5,286	9,234	1,946	3,259	25,456
	2013	5,373	5,090	9,222	1,729	3,294	24,708
	2012	5,127	4,615	8,973	1,742	3,408	23,865
	2011	4,973	4,474	8,820	1,698	3,455	23,421
	2010	4,846	4,236	8,908	1,728	3,493	23,211
	2009	4,434	4,064	9,111	1,775	3,453	22,837
	2008	4,298	3,967	8,803	2,117	3,456	22,640
	2007	4,231	3,791	8,206	2,286	3,525	22,039
	2006	4,347	3,894	7,229	2,550	3,534	21,554
	2005	4,105	3,738	6,985	2,570	3,535	20,933
	2004	4,066	3,477	6,843	2,548	3,565	20,499
Removals	2020	6,376	3,511	2,838	2,021	1,292	16,027
	2019	5,702	3,341	2,806	2,165	1,322	15,348
	2018	5,454	3,436	2,732	2,240	1,402	15,264
	2017	5,082	3,417	3,126	2,409	1,491	15,525
	2016	4,821	3,207	3,246	2,632	1,563	15,470
	2015	4,644	2,982	3,380	2,571	1,608	15,186
	2014	4,642	2,691	3,393	2,397	1,583	14,706
	2013	4,503	2,523	3,353	2,389	1,673	14,441
	2012	4,212	2,350	3,384	2,362	1,596	13,903
	2011	4,153	2,226	3,256	2,031	1,541	13,207
	2010	4,000	2,161	2,943	2,252	1,597	12,953
	2009	3,669	2,177	2,614	2,036	1,458	11,954
	2008	4,579	2,663	2,662	2,333	1,646	13,883
	2007	4,846	2,753	2,516	2,821	1,933	14,869
	2006	5,128	2,944	2,600	3,378	2,266	16,316
	2005	5,617	3,132	2,588	3,336	2,409	17,082
	2004	5,804	2,962	2,537	3,484	2,395	17,182
Mortality	2020	20	35	23	26	18	123
	2019	18	34	23	28	19	121
	2018	16	35	22	29	20	121
	2017	15	35	25	29	21	125
	2016	78	32	26	25	22	184
	2015	76	30	27	24	23	180
	2014	75	27	27	30	22	182
	2013	73	25	27	29	24	178
	2012	68	24	27	38	23	180
	2011	68	22	26	39	22	177
	2010	65	22	24	15	23	148
	2009	60	22	21	20	21	143
	2008	74	27	21	52	23	199
	2007	197	48	20	96	46	406
	2006	295	77	29	147	78	625
	2005	228	54	21	114	57	474
	2004	284	64	24	135	69	577

Source: USDA - US Forest Service
Note: USDA FIA mortality data only available since 2004.

6.1.7 *Changes in Raw Material Costs*

Historically, raw material purchases by the Alabama Pellets-Aliceville plant has included a combination of pulpwood (roundwood), sawmill chips, and other sawmill residuals. However, in this section, pine and hardwood sawtimber prices are also examined to assess how these prices have changed and trended in the catchment area since 2000.

Note that all prices have been provided by TimberMart-South and, unless otherwise stated, are specific to the Alabama Cluster catchment area. Also, historic quarterly raw material prices are provided in tabular form in Appendix A.

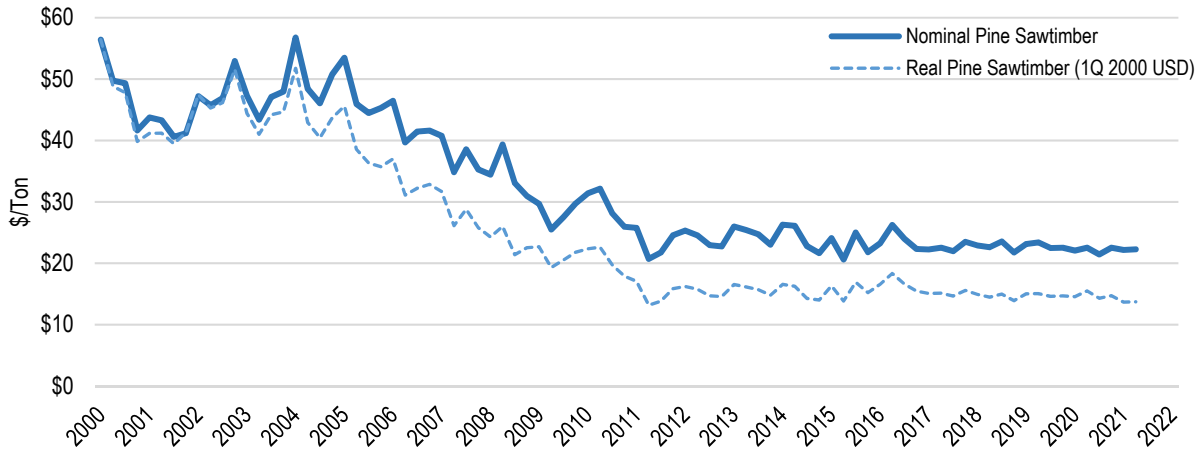
6.1.7.1 *Stumpage Prices*

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

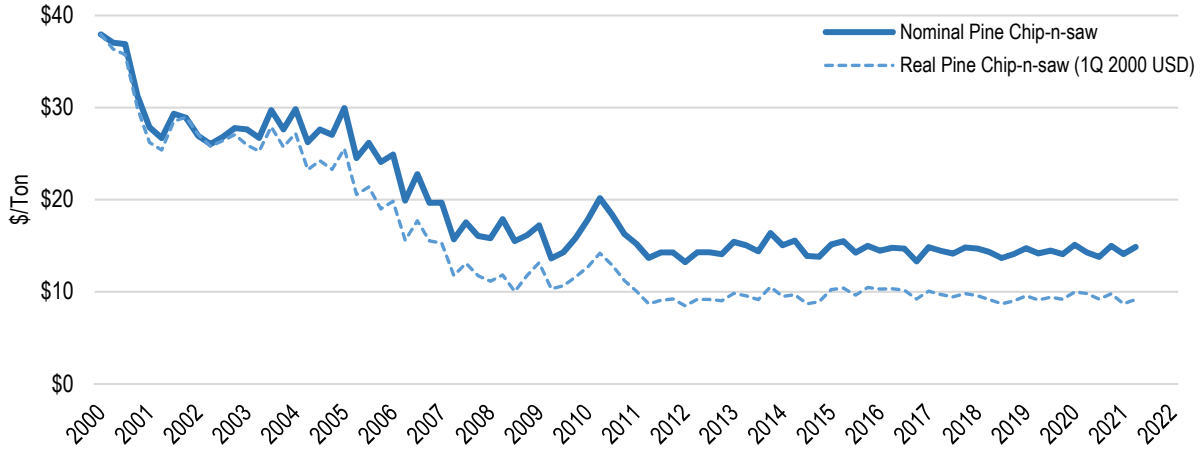
- Pine Sawtimber Stumpage. Pine sawtimber (PST) stumpage prices averaged more than $47 per ton in the catchment area from 1Q 2000-1Q 2006. However, PST stumpage prices proceeded to decline more than 55% over the five years that followed, bottoming out at $20.72 per ton in 2Q 2011. Prices rebounded a bit but since 2012 have held more-or-less flat and generally remained between $21 and $26 per ton ($23.38 per ton average).
- Pine Chip-n-saw Stumpage. Pine chip-n-saw (CNS) stumpage prices in the Alabama Cluster catchment area trended very similarly to those of pine sawtimber, holding relatively steady through the mid-2000s ($27.26 per ton average from 1Q 2001-1Q 2006) before declining 50% to $13.68 per ton in 2Q 2011. Prices have held flat since and have remained between $13 and $16 per ton ($14.50 per ton average from 2Q 2011-2Q 2021).
- Pine Pulpwood Stumpage. Pine pulpwood (PPW) stumpage prices exhibited a bit of volatility (falling as low as $4.98 per ton in 2Q 2002 and reaching as high as $12.23 per ton in 1Q 2010) but overall trended flat and averaged approximately $7.60 per ton from 1Q 2000 – 4Q 2016. However, since 4Q 2016, PPW prices have trended downwards, falling 44% and to $4.51 per ton in 2Q 2021.
- Hardwood Sawtimber Stumpage. Hardwood sawtimber (HST) stumpage prices trended upwards slightly, increasing from $23.33 per ton in 1Q 2000 to $28.94 per ton in 3Q 2012. However, HST prices increased nearly 60% over the four quarters that followed (to $46.01 per ton in 3Q 2013), stabilizing since and averaging $43.20 per ton from 3Q 2013 through 2Q 2021.
- Hardwood Pulpwood Stumpage. Hardwood pulpwood (HPW) stumpage prices, although somewhat volatile, trended upwards slightly from $5.32 per ton in 1Q 2000 to $8.40 per ton in 3Q 2012. However, HPW prices more than doubled over the six month that followed and from 1Q 2013 through 3Q 2019 averaged $17.17 per ton in the catchment area. HPW prices have since declined, falling to $11.93 per ton in 2Q 2021.

See Figures 51 and 52 for nominal and real quarterly average stumpage prices in the Alabama Cluster catchment area for the five major timber products from 1Q 2000 – 2Q 2021. Corresponding prices are provided in tabular form in Appendix A.

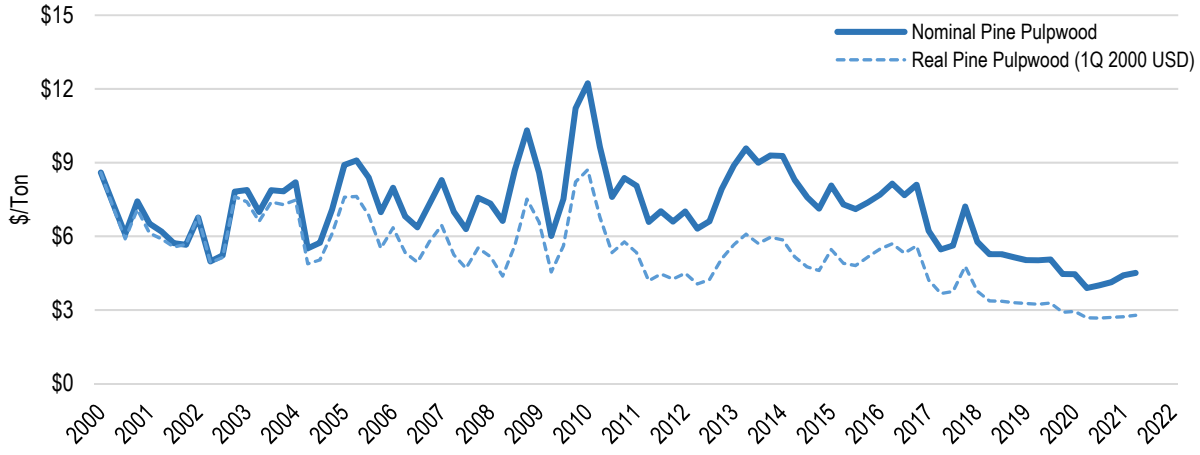
***Figure 51**. Alabama Cluster Catchment Area – Nominal & Real Quarterly Pine Stumpage Prices ($/Ton)*



(a) Pine Sawtimber Stumpage

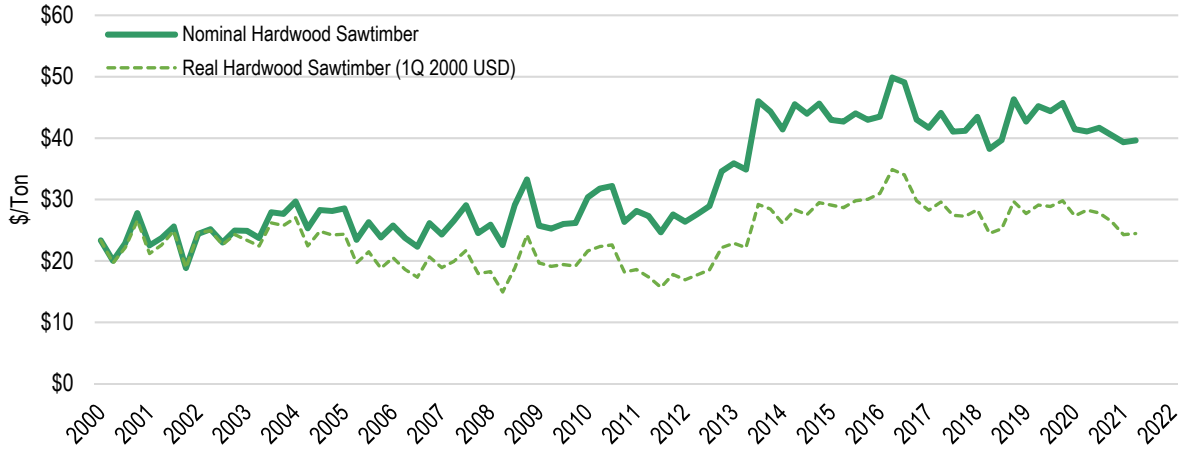


(b) Pine Chip-n-saw Stumpage

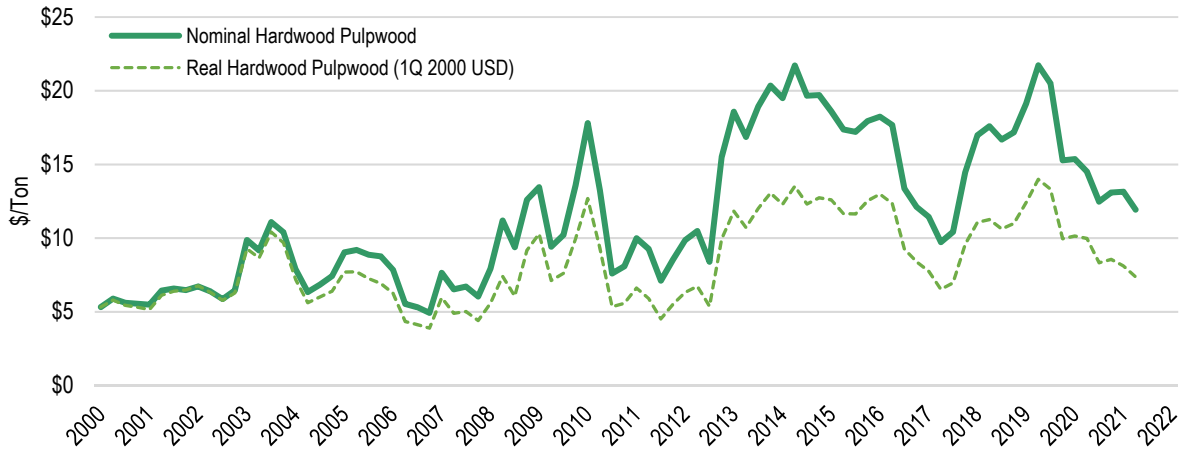


(c) Pine Pulpwood Stumpage

***Figure 52**. Alabama Cluster Catchment Area – Nominal & Real Quarterly Hardwood Stumpage Prices ($/Ton)*



(a) Hardwood Sawtimber Stumpage



(b) Hardwood Pulpwood Stumpage

5.1.7.2 *Delivered Timber Prices*

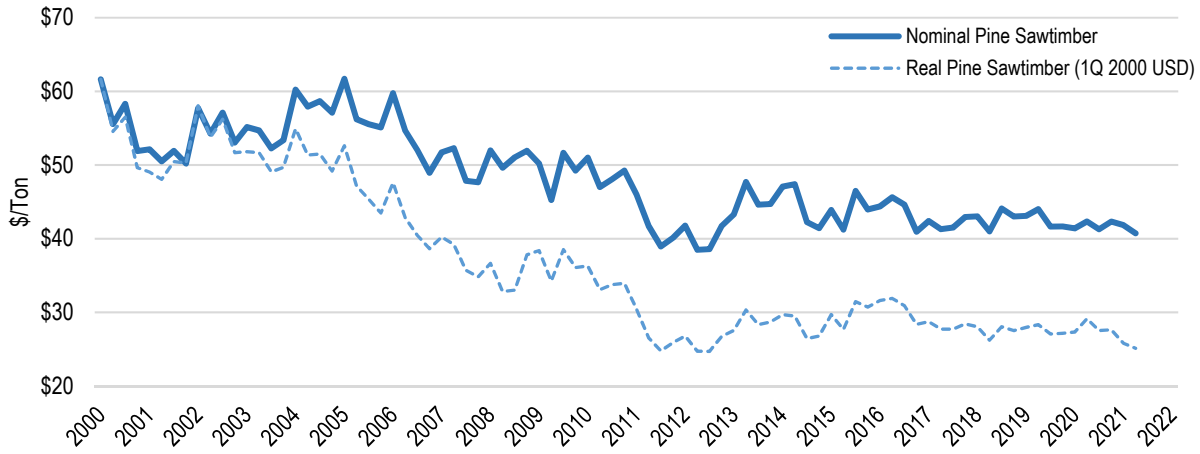
Delivered prices are those paid for timber delivered to the mill. These prices include stumpage (standing timber) price plus any costs associated with cutting, loading, and hauling timber to the mill.

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

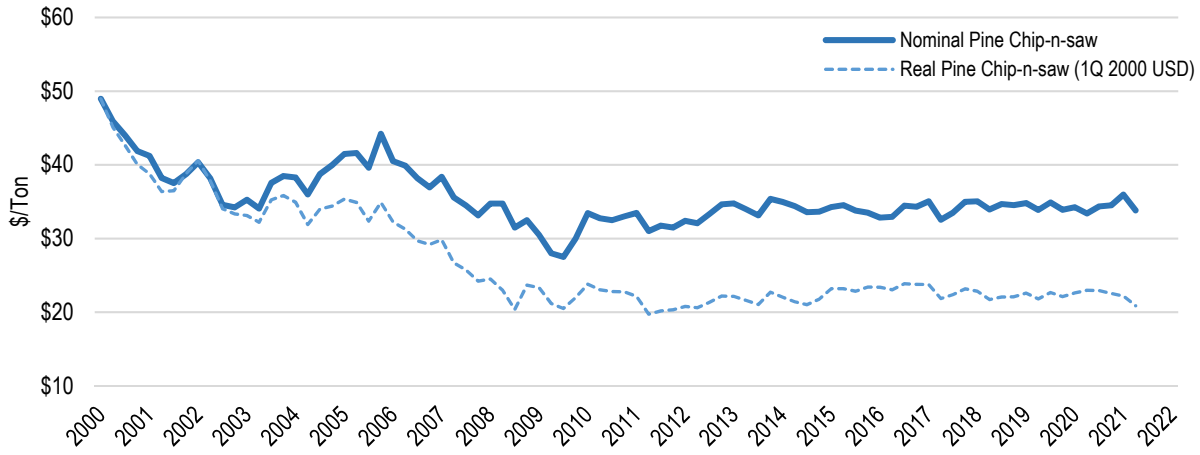
- Delivered Pine Sawtimber. Delivered pine sawtimber (PST) prices averaged $55.70 per ton from 1Q 2000 – 1Q 2006 before falling 30% to $38.96 per ton in 3Q 2011. Delivered PST prices rebounded a bit but since 2013 have held relatively steady and averaged $43.22 per ton in the Alabama Cluster catchment area.
- Delivered Pine Chip-n-saw. Delivered pine chip-n-saw (CNS) prices declined in the early-2000s but stabilized and averaged $38.50 per ton from 1Q 2001 – 1Q 2006. Prices proceeded to decline nearly 30% over the three years that followed, falling to $27.50 per ton in 3Q 2009. However, delivered CNS prices rebounded over the next several quarters and since 2010 have averaged $33.80 per ton in the Alabama Cluster catchment area.
- Delivered Pine Pulpwood. Delivered pine pulpwood (PPW) prices trended upwards and increased an average 2.3% per year (+35% total) from $21.56 per ton in 1Q 2000 to $29.06 per ton in 2Q 2013. However, delivered PPW prices declined slightly over the next six quarters but since 4Q 2014 have stabilized and averaged $25.80 per ton in the Alabama Cluster catchment area.
- Delivered Hardwood Sawtimber. Delivered hardwood sawtimber (HST) prices had been on steady upward climb through the 2000s and early 2010s, increasing an average of 2.6% per year (+39% total) from $36.24 per ton in 1Q 2000 to $50.26 per ton in 4Q 2012. However, delivered HST prices increased nearly 30% over the two quarters that followed, stabilizing since and averaging $64.00 per ton in the catchment area since 2Q 2013.
- Delivered Hardwood Pulpwood. Delivered hardwood pulpwood (HPW) prices, although a bit volatile, increased at an average rate of 2.2% per year (+29% total) from $22.46 per ton in 1Q 2000 to $29.50 per ton in 3Q 2012. Prices increased more than 25% over the six months that followed and since 2013 have averaged $37.15 per ton in the catchment area.

See Figures 53 and 54 for nominal and real quarterly average delivered prices in the Alabama Cluster catchment area for the five major timber products from 1Q 2000 – 2Q 2021. Corresponding prices are provided in tabular form in Appendix A.

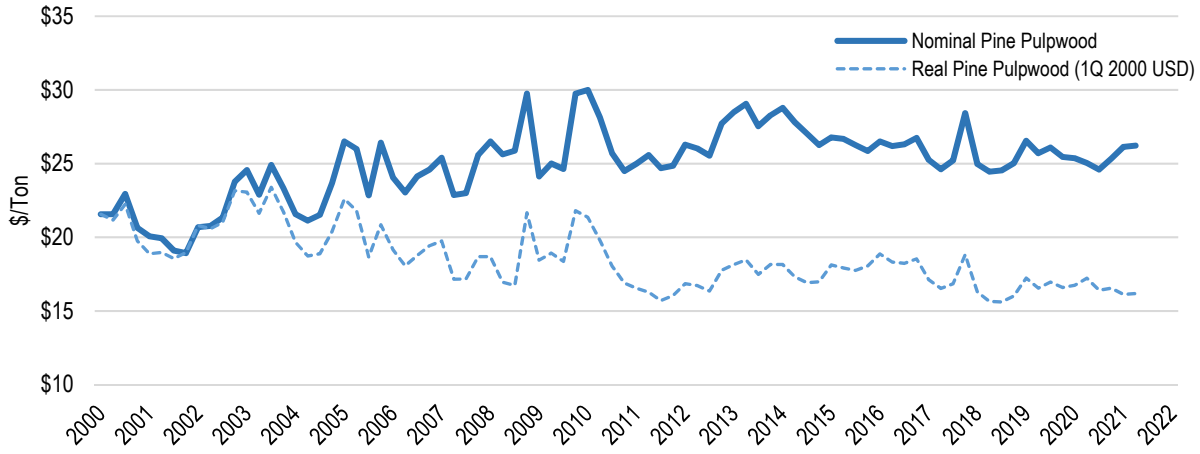
Figure 53. Alabama Cluster Catchment Area - Nominal & Real Quarterly Delivered Pine Prices ($/Ton)



(a) Delivered Pine Sawtimber

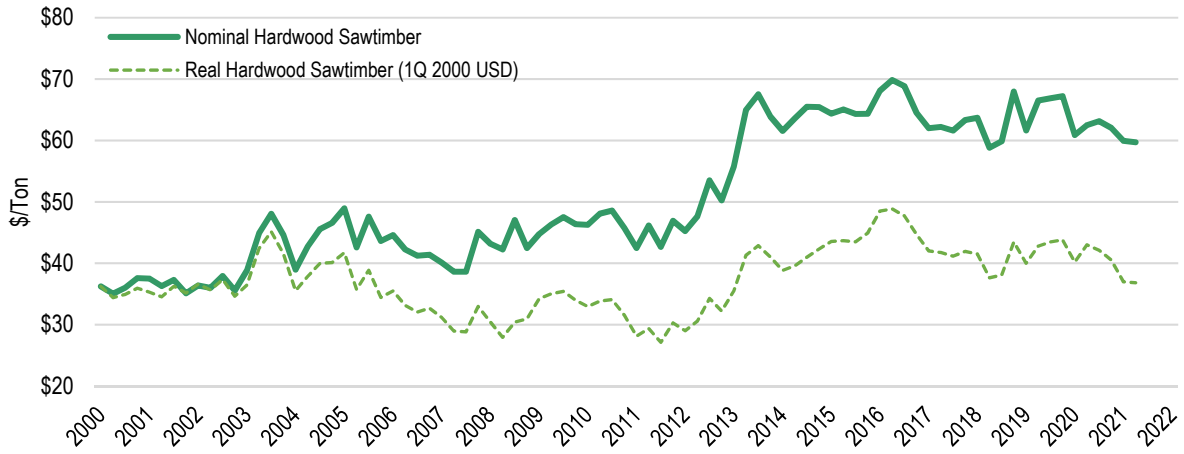


(b) Delivered Pine Chip-n-saw

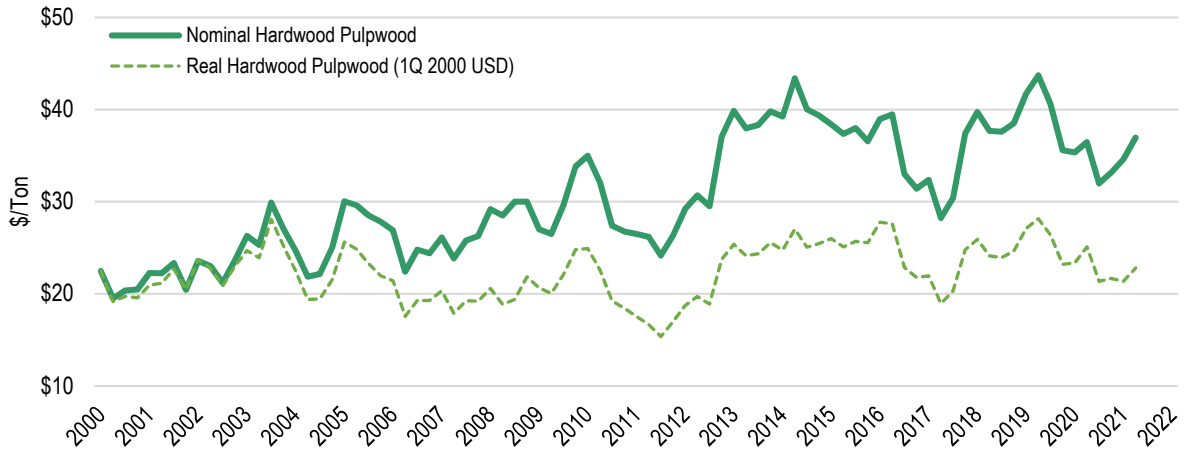


(c) Delivered Pine Pulpwood

***Figure 54**. Alabama Cluster Catchment Area - Nominal & Real Quarterly Delivered Hardwood Prices ($/Ton)*



(a) Delivered Hardwood Sawtimber



(b) Delivered Hardwood Pulpwood

5.1.7.3 *Pulp Quality Chip & Sawmill Residual Prices*

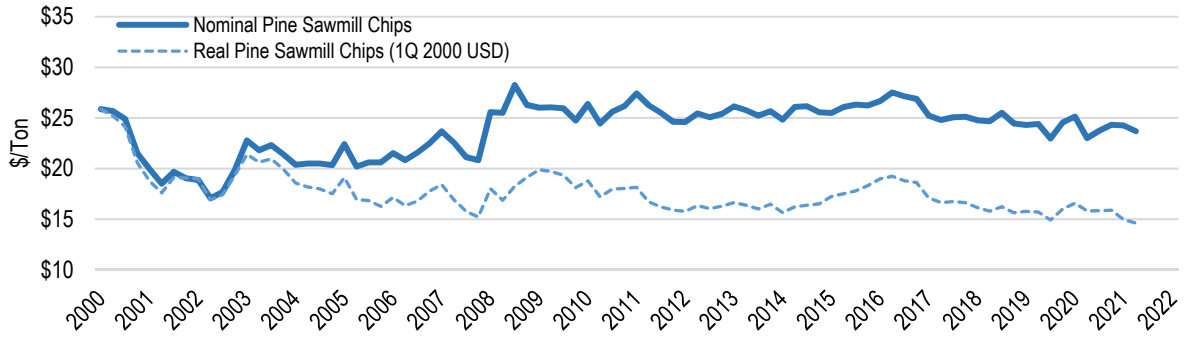
Pulpwood quality chips (FOB point of production) include both pine and hardwood sawmill chips (sawmill residuals) and pine and hardwood chip mill chips. Trends/changes with nominal chip and sawmill residual prices since 2000 are as follows:

- Pine Sawmill Chips (Sawmill Residuals). Pine sawmill chip prices were down slightly in the early 2000s but increased an average of 3.6% per year (+28%) from $19.97 per ton in 1Q 2001 to $25.58 per ton in 1Q 2008. Prices held steady and averaged $25.90 per ton from 1Q 2008 – 1Q 2017 but have since declined, falling 6% and to $23.70 per ton in 2Q 2021.
- Pine Chip Mill Chips. Pine chip mill chip prices increased an average of 3.9% per year (+40% total) from $24.98 per ton in 1Q 2001 to $35.08 per ton in 4Q 2009, holding steady thereafter and averaging $35.45 per ton through 2Q 2015. However, prices have trended downwards since, falling roughly 15% and to $30.68 per ton in 2Q 2021.
- Hardwood Sawmill Chips (Sawmill Residuals). Prices for hardwood sawmill chips have been on a steady, upward climb the last two decades, increasing an average of 2.9% per year (+86% total) from $16.85 per ton in 1Q 2000 to $31.38 per ton in 2Q 2021.
- Hardwood Chip Mill Chips. Hardwood chip mill chip prices increased 58% (+2.8% per year average) from $25.51 per ton in 1Q 2000 to $40.29 per ton in 2Q 2016. However, prices have trended overall flat since and averaged $38.40 per ton in the catchment area since 2Q 2016.

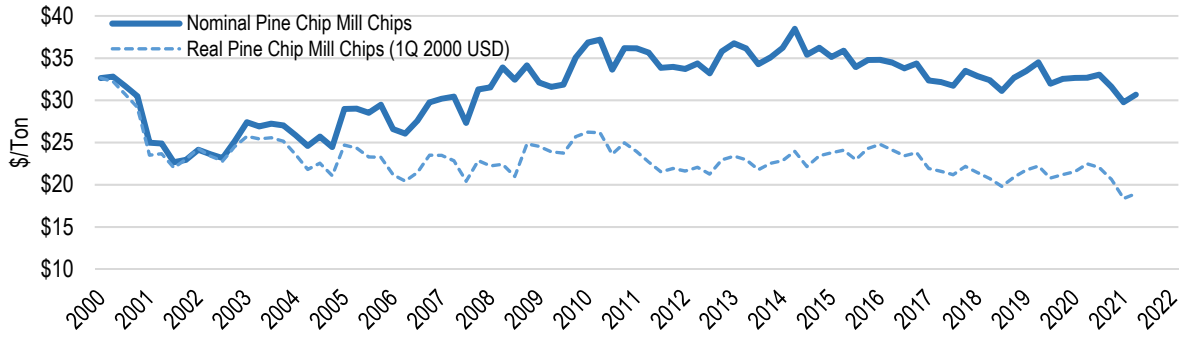
  In addition, we'd like to note that chip mill chip prices have historically remained above sawmill chip prices, with pine and hardwood chip mill chip prices averaging a 32% and 43% premium, respectively, over pine and hardwood sawmill chip prices since 2000.

See Figure 55 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 Alabama Cluster catchment area from 1Q 2000 – 1Q 2021. Corresponding prices are provided in tabular form in Appendix A.

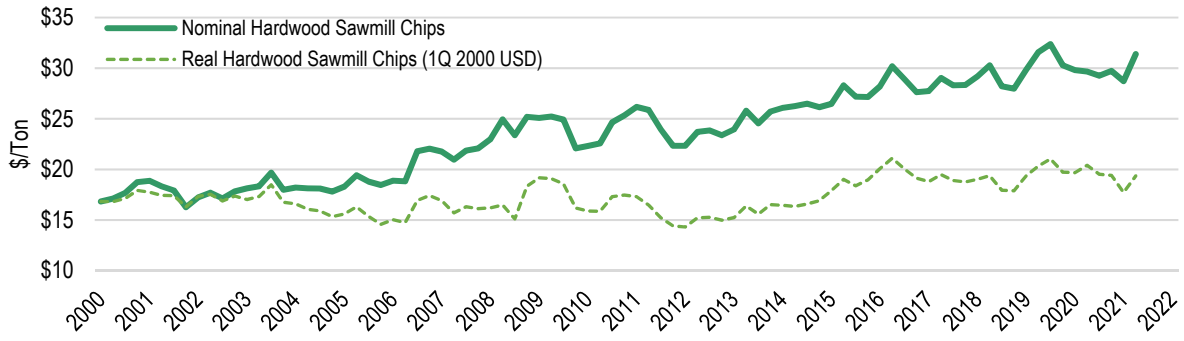
***Figure 55**. Alabama Cluster Catchment Area - Nominal & Real Quarterly Pulp Quality Chip Prices ($/Ton)*



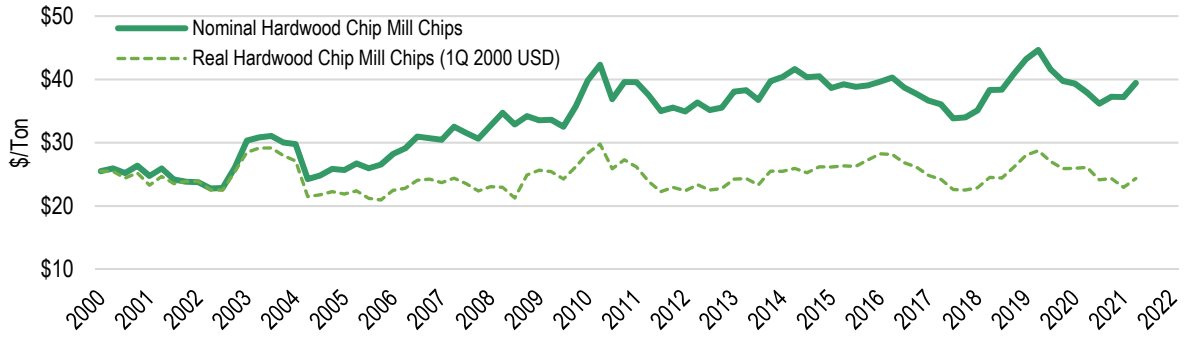
(a) Pine Sawmill Chips



(b) Pine Chip Mill Chips



(c) Hardwood Sawmill Chips



(d) Hardwood Chip Mill Chips

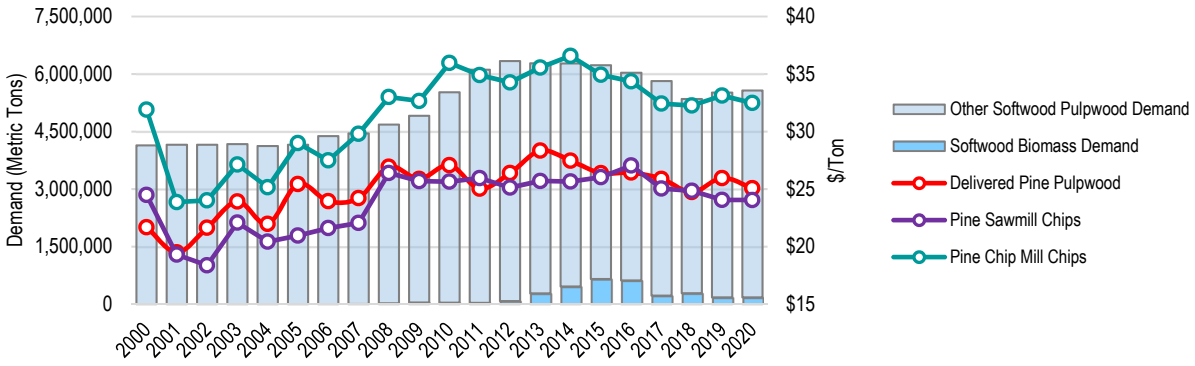
Correlation Analysis: *Biomass Demand vs. Raw Material Costs*

Historically, raw material purchases at Alabama Pellets-Aliceville mill have included a combination of softwood pulpwood (roundwood), pine sawmill chips, and other pine sawmill residuals. Specifically, softwood roundwood and residuals have constituted 100% of all raw materials consumed by this mill since its startup in late-2012.

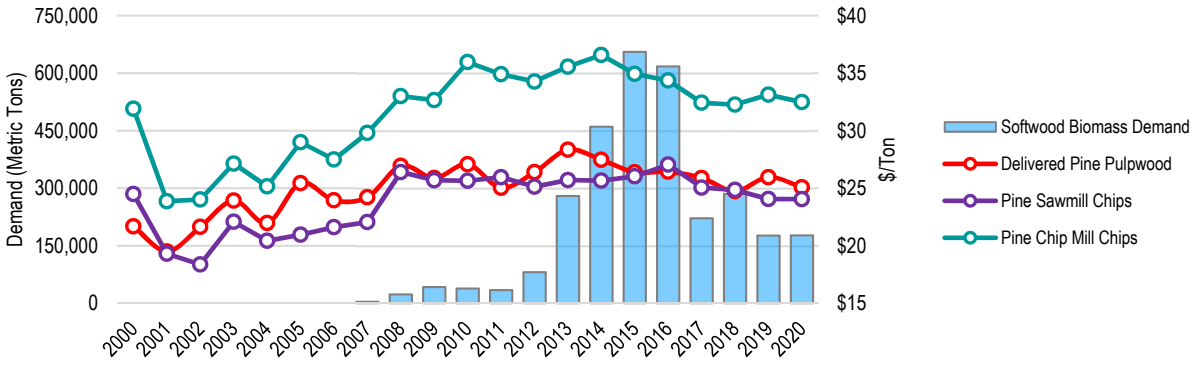
Figure 56 provides a side-by-side comparison of softwood biomass demand and total softwood pulpwood demand versus delivered pine pulpwood, pine sawmill chip, and pine chip mill chip prices in the catchment area from 2000-2020. Intuitively, we'd expect to see prices and demand moving in the same direction, and that's what this figure shows. Specifically, correlation analysis identified strong positive relationships between total softwood pulpwood demand and each of these three pine raw material prices (see Table 39 on pg. 100). The relationships between softwood biomass demand and these raw material prices were also positive. However, those relationships were weaker than those associated with non-biomass-related softwood pulpwood demand.

Ultimately, evidence suggests that changes in these pine raw material prices is more closely linked to softwood pulpwood demand from all sources (and to a much larger degree to demand from non-bioenergy sources). However, the strength of that relationship has weakened over the last 10-15 years as supply has become less and less of a constraint.

***Figure 56**. Alabama Cluster Catchment Area – Softwood Pulpwood Demand vs. Delivered Pine Pulpwood, Sawmill Chip, & Chip Mill Chip Prices (2000-2020)*



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



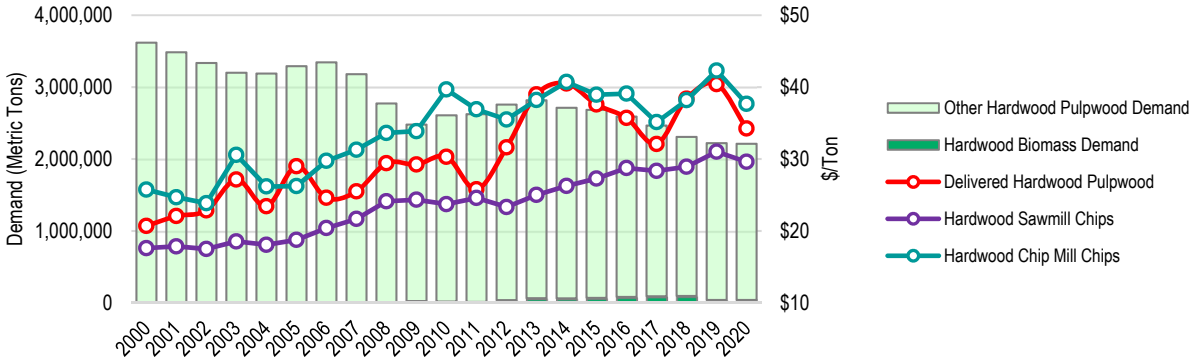
(b) Softwood Biomass Demand vs. Delivered Pine Pulpwood & Pine Chip Prices

Hardwood Pulpwood & Hardwood Chip Prices

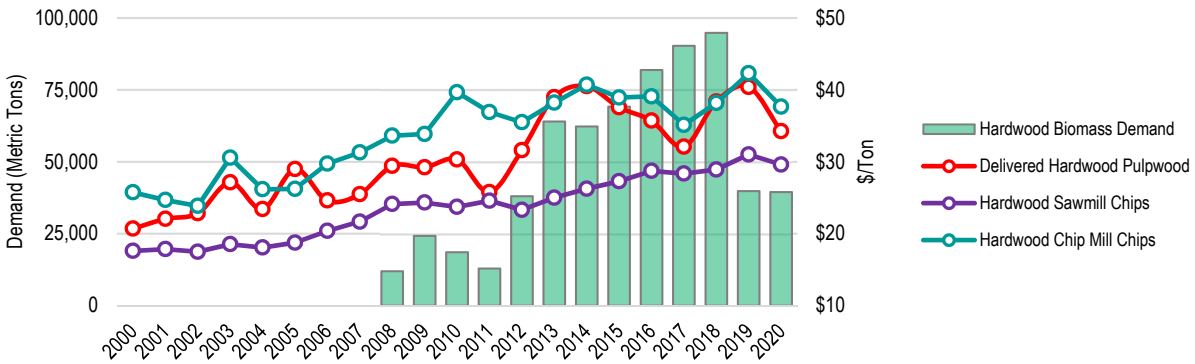
Figure 57 provides a side-by-side comparison of hardwood pulpwood demand and hardwood raw material prices in the catchment area since 2000. As this figure shows, hardwood raw material costs have steadily increased in the catchment area despite demand for hardwood pulpwood steadily decreasing. Ultimately, statistical analysis identified moderately strong *negative* correlations between hardwood pulpwood demand and hardwood raw material prices from 2000-2020 (see Table 40 on pg. 100). However, just the opposite was found between hardwood biomass demand and these hardwood raw material prices. Delivered hardwood pulpwood and hardwood chip prices were all found to have strong positive correlation to hardwood biomass demand since 2000.

These strong 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 Alabama 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 57**. Alabama Cluster Catchment Area – Hardwood Pulpwood Demand vs. Delivered Hardwood Pulpwood, Hardwood Sawmill Chip, & Hardwood Chip Mill Chip Prices (2000-2020)*



(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 58 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 2000-2020.

Looking at this figure, the prices of all three of these sawtimber products have loosely followed total biomass demand since the late-2000s. However, note that these common trends appear to be more coincidental in nature and there is little evidence to suggest that increases in biomass-related wood demand has caused these changes.

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 through the 2000s and early-2010s (see Figure 59). However, we'd like to note that this relationship has weakened substantially over the last decade (due to a growing imbalance between supply and demand). Specifically, delivered pine sawtimber and pine chip-n-saw prices have generally held flat or decreased slightly since the early-2010s while demand for softwood sawlogs has increased.

***Figure 58**. Alabama Cluster Catchment Area – Biomass Demand vs. Delivered Pine Sawtimber, Pine Chip-n-saw, & Hardwood Sawtimber Prices (2000-2020)*

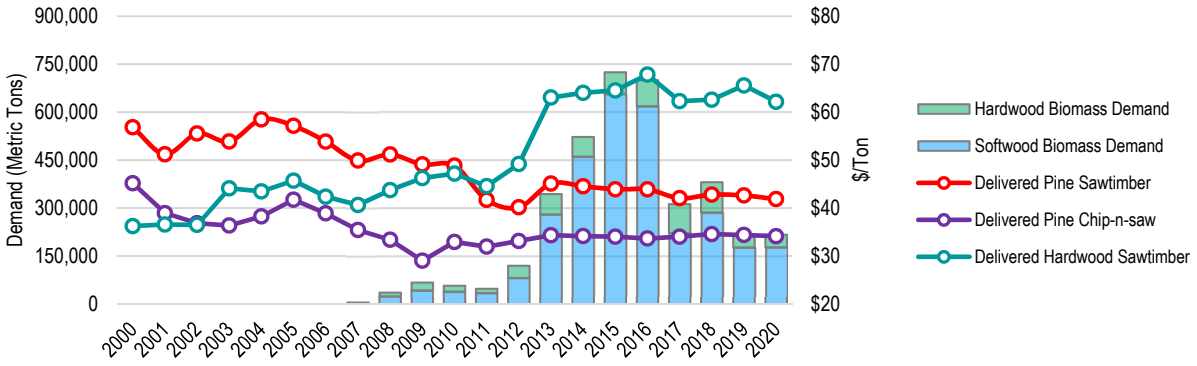


***Figure 59**. Alabama Cluster Catchment Area – Sawlog Demand vs. Delivered Pine Sawtimber, Pine Chip-n-saw, & Hardwood Sawtimber Prices (2000-2020)*

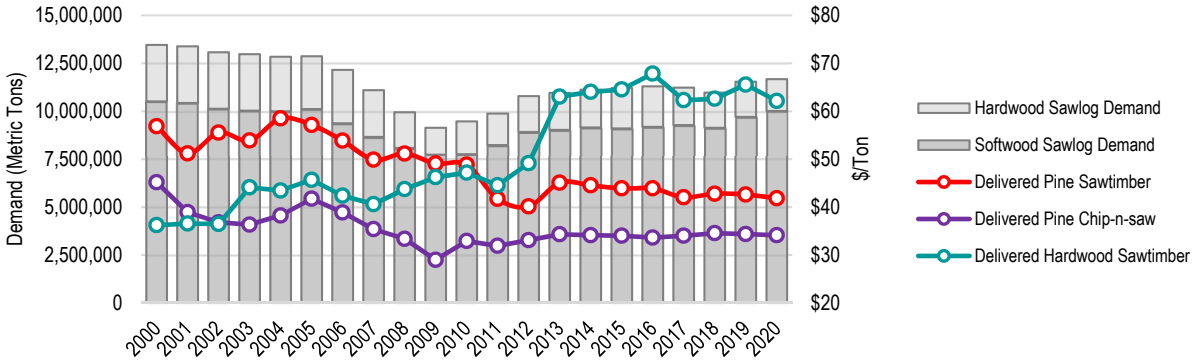


***Table 39**. Correlation Analysis – Softwood Biomass Demand, Delivered Pine Pulpwood Price, Pine Sawmill Chip Price & Pine Chip Mill Chip Price (2000-2020)*

	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	0.55	1				
Total Softwood Pulpwood Demand	0.70	0.98	1			
Delivered Pine Pulpwood Price	0.50	0.74	0.75	1		
Pine Sawmill Chip Price	0.56	0.75	0.77	0.79	1	
Pine Chip Mill Chip Price	0.56	0.84	0.84	0.85	0.94	1

***Table 40**. Correlation Analysis – Hardwood Biomass Demand, Delivered Hardwood Pulpwood Price, Hardwood Sawmill Chip Price & Hardwood Chip Mill Chip Price (2000-2020)*

	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	-0.74	1				
Total Hardwood Pulpwood Demand	-0.71	0.99	1			
Delivered Hardwood Pulpwood Price	0.82	-0.79	-0.77	1		
Hardwood Sawmill Chip Price	0.82	-0.95	-0.93	0.85	1	
Hardwood Chip Mill Chip Price	0.72	-0.88	-0.87	0.83	0.90	1

***Table 41**. Correlation Analysis – Sawlog Demand & Delivered Sawtimber Prices (2000-2020)*

	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	0.74	1				
Total Sawlog Demand	0.96	0.90	1			
Delivered Pine Sawtimber	0.39	0.79	0.58	1		
Delivered Pine Chip-n-saw	0.77	0.84	0.85	0.69	1	
Delivered Hardwood Sawtimber	-0.13	-0.58	-0.32	-0.74	-0.45	1

5.2 Market Outlook: 2021-2023

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

- Biewer Lumber commenced construction in April 2021 on its new softwood sawmill in Winona MS. The new mill will have annual production capacity of 350 million board feet (mmbf), with startup scheduled in December 2021. The mill is expected to increase wood demand in the Alabama Cluster catchment area by an estimated 15,000-30,000 tons in 2021 and by an additional 250,000-320,000 metric tons per year beginning in 2022.

- Enviva nears startup of its new wood pellet plant in Lucedale MS. The plant has a proposed capacity of 750,000 metric tons of wood pellets annually, with the ability to expand to over 1.0 million metric tons annually. The startup of this new mill is expected to increase wood demand in the Alabama Cluster catchment area by an estimated 90,000-135,000 metric tons in 2022 and by an additional 20,000-45,000 metric tons beginning in 2023.

  Enviva has also completed the purchase of the project site and commenced certain pre-construction activities for its proposed new wood pellet plant in Epes AL. The proposed mill has a production capacity of 750,000 metric tons of wood pellets annually. However, at this time, no final investment decision has been made by Enviva. Should Enviva move forward with this project, the startup of this facility is expected to increase wood demand in the Alabama Cluster catchment area by an estimated 800,000-1,000,000 metric tons annually.

  In April 2021, Enviva announced plans to develop a new wood pellet plant in Bond MS that is designed to produce between 750,000 and 1.0 million metric tons of wood pellets annually. A schedule for construction and startup was not disclosed. Should Enviva move forward with this project, the startup of this facility (which would occur no sooner than 2024) is expected to increase wood demand in the Alabama Cluster catchment area by an estimated 65,000-115,000 metric tons annually following startup.

- Hankins Lumber commenced production in 3Q 2021 at its new 40 mmbf small-log pine sawmill, Hankins Timbers, located near the company's existing pine sawmill in Grenada MS. The mill is expected to increase wood demand in the Alabama Cluster catchment area by an estimated 5,000-9,000 metric tons in 2021 and by an additional 14,000-18,000 metric tons per year beginning in 2022.

- Jasper Forest Products announced in 4Q 2020 plans to expand capacity at its existing sawmill in Jasper AL from 70 to 200 mmbf of softwood lumber. The mill expansion is expected to be complete by mid-2022 and increase wood demand in the Alabama Cluster catchment area by an estimated 18,000-36,000 metric tons in 2022 and by an additional 36,000-54,000 metric tons per year beginning in 2023.

- Packaging Corporation of America (PCA) announced in 1Q 2021 plans to invest $440 million to permanently convert a paper machine to linerboard production at its mill in Jackson AL. The new linerboard machine will have an annual production capacity of 635,000 metric tons, with the conversion taking place in a phased approach over the ensuing 36 months. The machine will continue production at the current rate until the first phase outage in 2Q 2022. A second phase

outage is planned for mid-2023, with project completion scheduled for the end of 2023. The project is expected to decrease roundwood demand attributed to the Alabama Cluster catchment area by an estimated 115,000-155,000 metric tons in 2022 and by an additional 125,000-165,000 metric tons in 2023.

- Pinnacle Renewable Energy nears completion of its new wood pellet mill in Demopolis AL, with startup expected by year-end 2021. The new mill, Alabama Pellets-Demopolis, will have an annual production capacity of 360,000 metric tons of wood pellets. The facility will utilize residuals only (no roundwood) for wood pellet production and place no additional wood demand on the Alabama Cluster catchment area.
- Scotch Plywood experienced a major fire at its southern pine plywood plant in Waynesboro MS on January 6th, 2021. The company ceased production at the plant. However, Scotch plans to rebuild the plant, with a tentative restart in January 2022. The facility continued to take wood, transporting logs from its Waynesboro plant to its Beatrice AL plant (located 100 miles away), where the company started up a 2nd shift to maintain production. Ultimately, the shutdown of the Scotch plant is expected to decrease wood demand in the Alabama Cluster catchment area by an estimated 55,000-85,000 metric tons in 2021 but increase by a similar amount in 2022 following the startup of the rebuilt plant.
- Westervelt commenced production at its new 250 mmbf pine lumber mill in Thomasville AL in February 2021. The new mill is expected to increase wood demand in the Alabama Cluster catchment area by an estimated 270,000-320,000 metric tons in 2021 and by an additional 65,000-115,000 metric tons in 2022 and thereafter.
- Zilkha Biomass filed for bankruptcy in March 2021, and the machinery, equipment, and hundreds of tons of finished product at the Selma AL facility were subsequently offered for sale via auction. The plant, which had an annual production capacity of 240,000 metric tons of black pellets, had been idle since the 3Q 2018.

5.2.1 *Wood Demand Outlook*

Based on the announcements highlighted on the previous page and other expected production changes, we anticipate total wood demand in the Alabama Cluster catchment area to increase an estimated 9.4% from 2020 to 2023.

In particular, biomass demand is projected to increase from roughly 216,000 metric tons in 2020 to more than 1.3 million metric tons in 2023, or a roughly 6x increase over this period. Note that this expected increase is due to the anticipated startup of Enviva Pellets Lucedale in Lucedale MS as well as the assumed startup of Enviva Pellets Epes in Sumter County, Alabama.

***Table 42**. Alabama Cluster Catchment Area - Projected Wood Demand (2020-2023)*

Product	2020	2021	2022	2023
	Catchment Area – Annual Wood Demand (Metric Tons)			
Sawlogs:				
Softwood	10,015,149	10,289,493	10,568,553	10,894,970
Hardwood	1,657,507	1,702,220	1,735,754	1,760,904
Total Sawlogs	11,672,656	11,991,712	12,304,307	12,655,874
Pulpwood:				
Softwood	5,570,612	5,617,374	5,577,997	6,252,770
Hardwood	2,212,646	2,211,164	2,222,657	2,381,302
Total Pulpwood	7,783,258	7,828,538	7,800,654	8,634,072
Total	**19,455,914**	**19,820,250**	**20,104,961**	**21,289,946**

**projected*

***Table 43**. Alabama Cluster Catchment Area – Projected Biomass & Total Pulpwood Demand (2020-2023)*

Product	2020	2021	2022	2023
	Catchment Area – Pulpwood Demand (Metric Tons)			
Biomass Demand:				
Softwood Biomass	176,972	196,363	273,927	1,082,229
Hardwood Biomass	39,489	43,367	58,880	220,540
Total Biomass	**216,461**	**239,730**	**332,807**	**1,302,769**
Other Pulpwood Demand:				
Other Softwood Pulpwood	5,393,640	5,421,011	5,304,070	5,170,541
Other Hardwood Pulpwood	2,173,157	2,167,797	2,163,776	2,160,761
Total Other Pulpwood	**7,566,797**	**7,588,808**	**7,467,847**	**7,331,302**
Total Pulpwood Demand:				
Total Softwood Pulpwood	5,570,612	5,617,374	5,577,997	6,252,770
Total Hardwood Pulpwood	2,212,646	2,211,164	2,222,657	2,381,302
Total Pulpwood	**7,783,258**	**7,828,538**	**7,800,654**	**8,634,072**

**projected*

***Figure 60**. Alabama Cluster Catchment Area - Projected Wood Demand (2020 – 2023)*

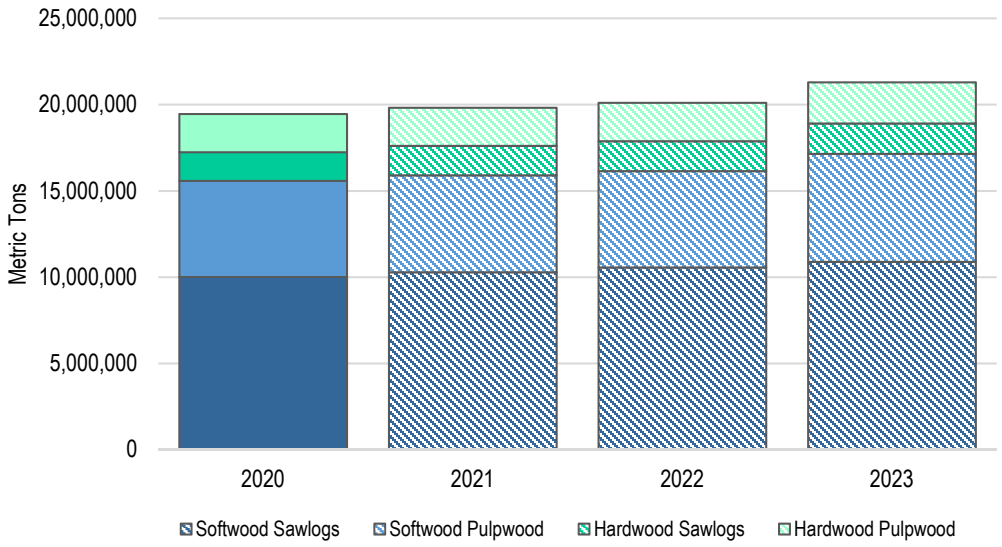
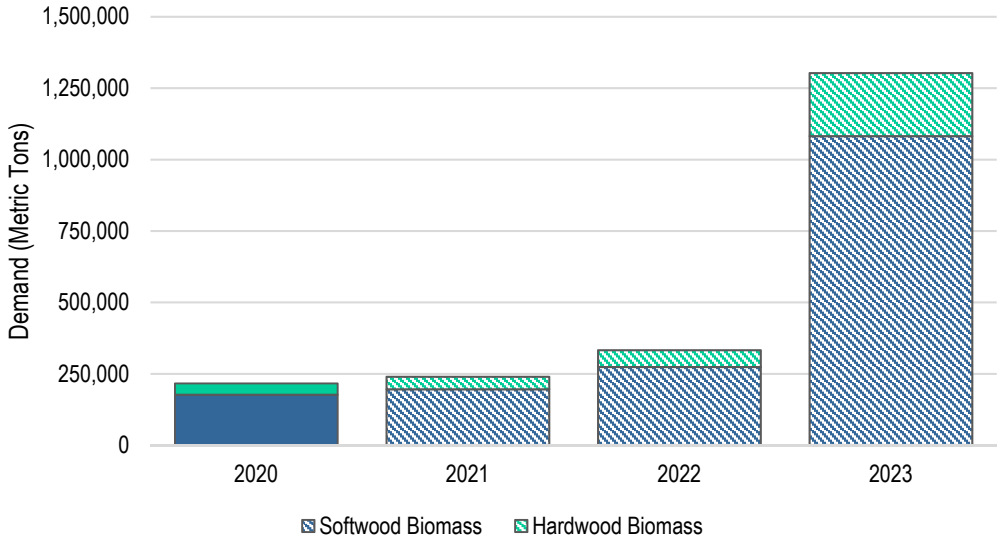


***Figure 61**. Alabama Cluster Catchment Area - Projected Biomass Demand (2020 – 2023)*



5.2.2 *Raw Material Price Outlook*

Historically, raw material purchases for pellet mills operating in and around the Alabama Cluster catchment area have predominantly included a mix of pine pulpwood (roundwood), pine chips, and other pine sawmill residuals. Specifically, since the startup of Alabama Pellets-Aliceville in 2012, pine pulpwood and pine residuals have accounted for 83% of total raw material purchases by the bioenergy sector in this catchment area. Hardwood pulpwood, hardwood chips, and secondary hardwood residuals have accounted for the remaining 17% of raw material purchases.

Given that pine pulpwood and pine chips 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 chip mill chip 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 an 6% increase in delivered pine pulpwood (PPW) price from 2020 through 2023. Specifically, delivered PPW price is forecasted to remain nearly unchanged from 2020-2022 before increasing 5.6% Y/Y in 2023 due in large part to increased demand from Enviva Pellets Epes. Overall, delivered PPW prices are forecasted to average $25.59 per ton from 2021-2023, up 2.0% (+$0.51 per ton) from the 2020 average of $25.08 per ton.
- Pine Sawmill Chips. Pine sawmill chip prices are forecasted to hold steady and average $24.10 per ton in 2021 and 2022 before increasing to $25.20 per ton (+4.7%) in 2023. Overall, pine sawmill chip prices are forecasted to average $24.46 per ton from 2021-2023, up 1.7% (+$0.41 per ton) from the 2020 average of $24.05 per ton.
- Pine Chip Mill Chips. As with pine pulpwood and pine sawmill chips, pine chip mill chip prices are also forecasted hold steady through 2022 before increasing in 2023. Specifically, pine chip mill chip prices are forecasted to average $32.55 per ton from 2020-2022 but increase 7.2% to $34.83 per ton in 2023. Overall, pine chip mill chip prices are forecasted to average $33.33 per ton from 2021-2023, up 2.6% (+$0.84 per ton) from the 2020 average of $32.49 per ton.

  (Note: chip mill chips are produced by dedicated chipping mills that buy roundwood, chip the roundwood into wood chips, and sell those wood chips mostly to pulp/paper mills but also to bioenergy facilities.)

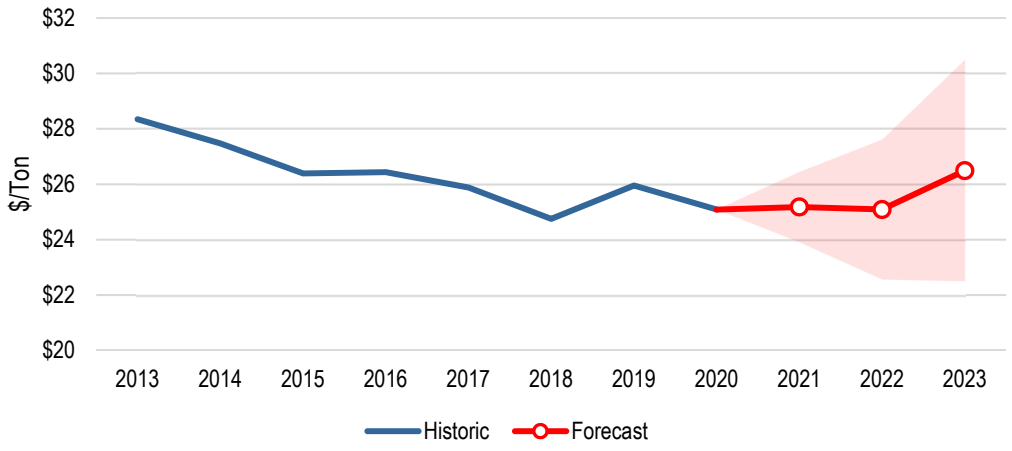
***Table 44**. Alabama Cluster Catchment Area - Forecasted Delivered Pine Pulpwood, Pine Sawmill Chip, & Pine Chip Mill Chip Prices (2021-2023)*

Year	Delivered Pine Pulpwood	Pine Sawmill Chips	Pine Chip Mill Chips
		($/Ton)	
2000	$21.68	$24.49	$31.92
2001	$19.51	$19.30	$23.87
2002	$21.64	$18.38	$24.02
2003	$23.93	$22.08	$27.15
2004	$21.97	$20.43	$25.16
2005	$25.45	$20.96	$29.00
2006	$23.96	$21.61	$27.50
2007	$24.22	$22.06	$29.82
2008	$26.94	$26.41	$33.01
2009	$25.88	$25.69	$32.66
2010	$27.08	$25.65	$35.97
2011	$25.03	$25.96	$34.91
2012	$26.40	$25.13	$34.27
2013	$28.34	$25.71	$35.57
2014	$27.47	$25.66	$36.58
2015	$26.39	$26.04	$34.94
2016	$26.44	$27.05	$34.36
2017	$25.88	$25.05	$32.44
2018	$24.75	$24.85	$32.27
2019	$25.95	$24.07	$33.13
2020	$25.08	$24.05	$32.49
2021	$25.18	$24.13	$32.65
2022	$25.09	$24.06	$32.51
2023	$26.49	$25.20	$34.83

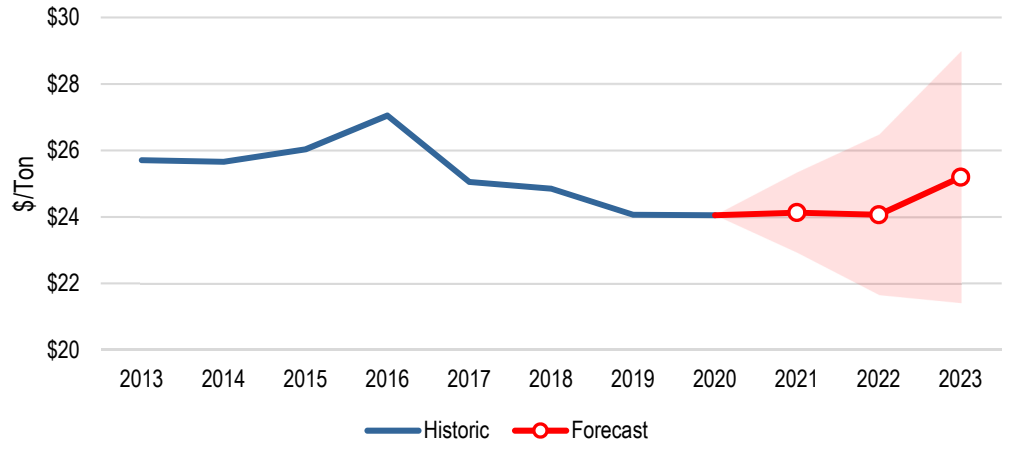
**Forecasted values*

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

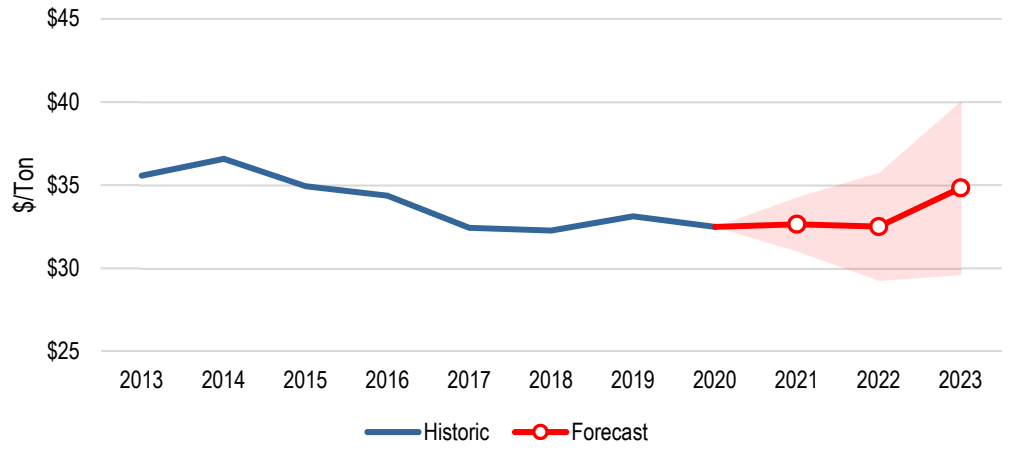
***Figure 62**. Alabama Cluster Catchment Area Price Forecasts: Delivered Pine Pulpwood, Pine Sawmill Chips, & Pine Chip Mill Chips (2021-2023)*



(a) Delivered Pine Pulpwood



(b) Pine Sawmill Chips



(c) Pine Chip Mill Chips

Table 45 provides a cost index (2020=100) of historic and forecasted per-unit pine raw material costs for the wood pellet mills in the Alabama Cluster catchment area from 2013 through 2023. These index values are based on the historic distributions of pine pulpwood, pine sawmill chips, and pine chip mill chips purchases by the pellet mills in the catchment area as well as respective product prices, and these index values are intended to show how average per-unit raw material costs have changed and are projected to change for this type of mill over the next several years. Note that these index calculations are not based on actual raw material costs incurred by Alabama Pellets-Aliceville or any other facility but rather based on average market prices in the Alabama Cluster catchment area.

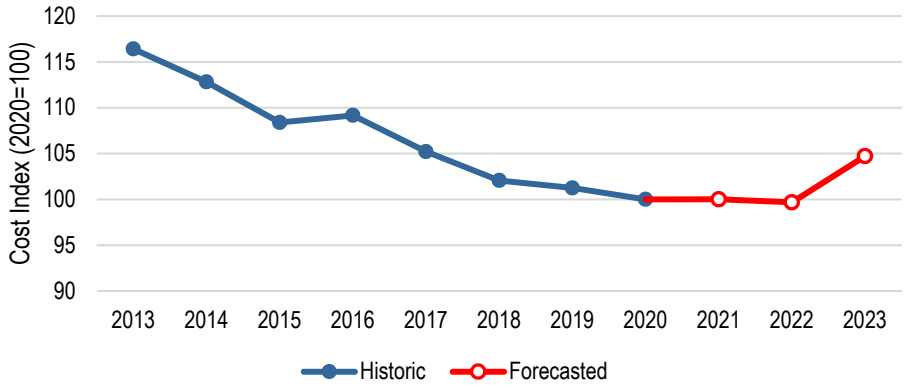
Average per-unit pine costs for a pellet mill in the catchment area decreased an estimated 14% from 2013-2020 due primarily to increased utilization of sawmill residuals – a lower-cost feedstock compared to roundwood. Based on our forecasts and anticipated changes in product mix consumption, average per-unit pine raw material costs are projected to hold steady in catchment area in 2021 and 2022 before increasing an estimated 5% in 2023.

***Table 45**. Alabama Cluster Catchment Area – Pine Raw Material Per-Unit Cost Index (2020=100)*

Year	Pine Raw Material Cost Index (2020 = 100)
2013	116
2014	113
2015	108
2016	109
2017	105
2018	102
2019	101
2020	100
2021	100
2022	100
2023	105

**Forecasted*

***Figure 63**. Historic & Projected Raw Material Per Unit Index Cost (2020=100)*



6. 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 Alabama Cluster catchment area as well as our professional expertise and market knowledge.

- Changes in Forest Area

  According to the US Forest Service (USFS), total timberland area in the Alabama Cluster catchment area experienced a net increase of 78,644 hectares (+1.9%) from 2000-2020, increasing from 4,082,459 to 4,161,102 hectares over this 20-year period. However, much of this increase took place between 2000 and 2008, with total timberland holding relatively steady and averaging approximately 4,172,000 hectares since 2008.

  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 an estimated 461,760 hectares (+40%) from 2000-2020, while natural hardwood and mixed pine-hardwood timberland decreased a combined 390,825 hectares (-18%) over this same period. Note that the increase in planted pine timberland and decrease in natural hardwood/mixed pine-hardwood timberland over this period were both gradual and occurred simultaneously. This suggests a management trend in which natural timber stands were converted to plantation pine following final harvest.

  Ultimately, pine timberland (planted and natural) has stabilized and totaled more than 2.2 million hectares in the catchment area since 2015, a level that has been able to provide more than adequate supply to both the pulp/paper and bioenergy industries. Furthermore, even with anticipated increases in demand for pine pulpwood from the bioenergy industry over the next several years, adequate wood supply is expected to remain in the Alabama Cluster catchment area (at least over the short to mid-term).

- Changes in Timber Inventory, Growth, & Removals

  According to USFS estimates, total growing stock inventory on timberland in the Alabama Cluster catchment area increased from less than 368 million m^3 in 2000 to more than 483 million m^3 in 2020, or a net increase of more than 115 million m^3 (+31%) over this period.

  Specifically, inventories of pine pulpwood (PPW) increased 48% in the catchment area from 2000-2020. This increase was largely due to increases in pine timberland that begun in the 1990s and continued through the mid-2010s. However, also note that inventories of pine sawtimber and pine chip-n-saw increased 56% and 71%, respectively, from 2000-2020. Note that 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 reflected trends in both growth and removals in the catchment area, as total annual timber growth has outpaced total annual removals every year since 2000. Specifically, total annual growth of growing stock timber decreased slightly in the early-2000s but increased an average of 2.3% per year (+47% total) from 20.4 million m^3 in 2003 to 30.0 million m^3 in 2020. In comparison, total annual removals averaged 18.3 million m^3 per year from 2000-2005 before decreasing more than 30% to 12.1 million m^3 in 2009. Total removals steadily increased to more than 15.7 million m^3 in 2016 but have stabilized and averaged 15.7 million m^3 per year in the catchment area since.

Similarly, the increase in PPW inventory levels also reflects trends in both growth and removals as well as general forest trends. Specifically, annual growth of PPW increased through the 2000s alongside increases in PPW inventory (which resulted from increases in pine timberland). Increased PPW removal levels in the early and mid-2010s slowed the rate at which PPW levels were increasing. However, annual growth still exceeded annual removals and PPW inventory levels have continued to increase in the Alabama 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 Alabama Cluster catchment area since 2000. (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, held very consistent and averaged 2.68 from 2012-2015 before increasing and then stabilizing and averaging 3.26 from 2018-2020. So, even with anticipated increases in demand, inventories of pine pulpwood are expected to remain more than adequate and the long-term sustainability of this market is expected to remain intact over the long term.

- Changes in Wood Demand

Total wood demand in the Alabama Cluster catchment area held relatively steady and averaged 20.6 million metric tons per year from 2000-2005 but proceeded to decrease 20% over the four years that followed and to 16.5 million metric tons in 2009. Total wood demand rebounded through the early-2010s but have stabilized and averaged 19.7 million metric tons per year since 2012, down 4.4% compared to 2000-2005 average levels.

Specifically, demand for softwood sawlogs, which accounts for roughly 50% of total wood demand in the catchment area, fell from an average of 10.2 million metric tons per year from 2000-2005 to 7.7 million metric tons in 2009. However, softwood sawlog demand rebounded and stabilized at an average of 9.1 million metric tons per year from 2012-2018 before further increasing to 10.0 million metric tons in 2020.

Demand for softwood pulpwood, which accounts for nearly 30% of total wood demand in the catchment area, increased from an average of 4.2 million metric tons per year from 2000-2005 to an average of 6.2 million metric tons per year from 2011-2015. However, softwood pulpwood demand has declined slightly since, falling to 5.6 million metric tons in 2020, up nearly 35% compared to 2000-2005 levels but down more than 10% from 2011-2015 average levels. Note that the increase in softwood pulpwood demand in the early and mid-2010s was largely due to increased demand from the pulp/paper industry, with non-biomass-related softwood pulpwood

demand increasing roughly 1.8 million metric tons from 2000-2005 levels. However, the decrease in total softwood pulpwood demand since 2015 can be directly linked to Alabama Pellets-Aliceville, which eliminated roughly 500,000 metric tons of annual softwood pulpwood demand between 2015 and 2020.

In terms of the short-term outlook, demand for pine pulpwood is projected to increase 12% in the Alabama Cluster catchment area from 2020-2023, and this anticipated increase is entirely due to increased demand from the bioenergy industry. Specifically, biomass-related softwood pulpwood demand is projected to increase to approximately 1.1 million metric tons in 2023 (+0.9 million metric tons from 2020 levels). However, note that this anticipated increase in largely based on the assumption that Enviva moves forward with its Enviva Pellets Epes project and that this new mill starts up in 2023.

- Changes in Raw Material Prices

Raw material purchases for the Alabama Pellets-Aliceville mill includes a combination of pine pulpwood (roundwood), pine sawmill chips. and other pine sawmill residuals (i.e. sawdust and shavings). Specifically, pine pulpwood (roundwood) accounted for approximately 95% of total raw material purchases by this mill from 2012-2017, with pine residuals accounting for the remaining 42%. However, from 2018-2020, raw material purchases at the Alabama Pellets-Aliceville mill included only 6% roundwood versus 94% residuals.

In the Alabama Cluster catchment area, the price of delivered pine pulpwood (PPW) – the predominant raw material purchased by Alabama Pellets-Aliceville from 2012-2017 – increased from $25.03 per ton in 2011 (the year prior to the Aliceville mill's startup) to $28.34 per ton in 2013, or a 13% increase over this 2-year period. However, since 2013, delivered pine pulpwood prices have steadily decreased, falling to $25.08 per ton in 2020.

Pine sawmill chip prices remained nearly unchanged in the catchment area from 2011-2017, averaging $25.80 per ton over this period. However, since 2017, pine sawmill chip prices have decreased slightly, falling 4% and to $24.05 per ton in 2020.

Ultimately, our analysis identified a positive relationship between softwood biomass demand and both delivered PPW price and pine sawmill chip price, suggesting that changes in these raw material prices, to some degree, can be linked to changes in softwood pulpwood demand from bioenergy. However, the relationships between these raw material prices and non-biomass-related softwood pulpwood demand were found to be stronger, suggesting that these prices are impacted to a larger degree by PPW demand from non-biomass sources (i.e. pulp/paper), which has accounted for 94% of total softwood pulpwood demand in the catchment area since 2012.

In terms of the short-term outlook, delivered PPW and pine sawmill chip prices are projected to increase alongside increased demand from bioenergy. Specifically, with the assumed startup of Enviva Pellets Epes in 2023, softwood biomass demand is expected to increase nearly 1.0 million tons compared to 2020 levels. As a result of this increase in demand, delivered PPW prices are forecasted to increase an estimated 5.6% in the catchment area from 2020-2023. Also, with the startup of Alabama Pellets-Demopolis, pine sawmill chip prices are forecasted to increase 4.8% in the catchment area from 2020-2023.

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 temporary shift occurred in the distribution of hectares clearcut versus hectares thinned in the west-central Alabama and east-central Mississippi market in the late-2000s and early-2010s. Specifically, thinnings accounted for roughly 60% of total (annual) reported harvest area in this market from 2007-2013. However, both prior to 2007 (from 2000-2006) and after 2013 (from 2014-2020), thinnings accounted for roughly 40% of the total (annual) reported harvest area in this market.

The increased prevalence of thinning from 2007-2013 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 2000-2006, pine sawtimber (PST) stumpage prices averaged nearly $47 per ton. However, challenging market conditions resulted in PST stumpage prices falling to just over $23 per ton by 2011 (or a roughly 50% decrease compared to 2000-2006 average levels). But PST stumpage prices never truly recovered and have held between $22 and $25 per ton since 2011.

The weakening of PST markets in the late-2000s and early-2010s 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 never recovered and landowners were forced to abandon the 'wait it out' strategy and return to more normal management practices that base the decision of when to harvest on revenue or return maximization.

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 in demand should result in an increase in price, and this is what the data shows occurred in the catchment area. However, increased demand attributed to bioenergy, alone, is not responsible for the increase in raw material prices in this catchment area since Alabama Pellets-Aliceville started up in late-2012.

Specifically, the startup of Alabama Pellets-Aliceville added nearly 500,000 metric tons of softwood pulpwood demand to the catchment area from 2012-2015, and this increase in demand coincided with no change in delivered pine pulpwood (PPW) price over this period. However, Alabama Pellets' elimination of nearly 500,000 metric tons of annual softwood pulpwood demand from 2015-2020 coincided with a 5% decrease in delivered PPW price over this period.

Ultimately, the additional demand placed on the catchment area with the startup of Alabama Pellets-Aliceville was offset by a decrease in demand from other sources from 2012-2015, and, as a result, delivered PPW prices remained nearly unchanged. However, Alabama Pellets' strategic shift to consume residuals only (a transition that begun in 2018 and had been completed by 2019) eliminated more than 500,000 metric tons per year of softwood pulpwood demand in the catchment area from 2015-2020. Over this same period, softwood pulpwood demand from other sources decreased more than 180,000 metric tons. So, with the elimination of roughly 680,000 metric tons of annual softwood pulpwood demand from all sources from 2015-2020, the catchment area experienced a 5% decrease in delivered PPW price over this period.

Statistical analysis did identify a positive relationship between softwood biomass demand and delivered PPW price. However, the relationship between delivered PPW price and non-biomass-related softwood pulpwood demand was found to be stronger, which is not unexpected given that pine pulpwood demand not attributed to bioenergy has accounted for 94% of total pine pulpwood demand in the catchment area since 2012. Ultimately, the findings provide evidence that PPW price is influenced by demand from all sources – not just from bioenergy or from pulp/paper, but from both.

Additionally, prices of non-biomass-related timber products (i.e. pine sawtimber, pine chip-n-saw, and hardwood sawtimber) were also examined, and our 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 (1Q 2000 – 2Q 2021)

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

Year	Quarter	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
2000	1	56.42	37.94	8.60	23.33	5.32
2000	2	49.74	37.04	7.33	20.02	5.90
2000	3	49.32	36.89	6.09	22.88	5.61
2000	4	41.64	31.32	7.42	27.80	5.55
2001	1	43.75	27.86	6.51	22.54	5.48
2001	2	43.30	26.69	6.19	23.76	6.44
2001	3	40.60	29.33	5.72	25.60	6.58
2001	4	41.20	28.89	5.66	18.85	6.48
2002	1	47.22	26.94	6.77	24.42	6.73
2002	2	45.72	26.03	4.98	25.17	6.38
2002	3	46.89	26.81	5.23	23.00	5.87
2002	4	52.96	27.77	7.82	24.94	6.45
2003	1	47.30	27.63	7.88	24.89	9.88
2003	2	43.39	26.72	6.99	23.72	9.16
2003	3	47.08	29.72	7.88	27.92	11.09
2003	4	47.97	27.63	7.83	27.66	10.40
2004	1	56.76	29.83	8.20	29.67	7.89
2004	2	48.42	26.24	5.51	25.32	6.34
2004	3	46.08	27.61	5.74	28.28	6.85
2004	4	50.75	27.05	7.09	28.13	7.43
2005	1	53.47	29.95	8.91	28.55	9.03
2005	2	45.95	24.52	9.09	23.45	9.20
2005	3	44.48	26.17	8.40	26.30	8.88
2005	4	45.29	24.09	6.99	23.83	8.77
2006	1	46.45	24.90	7.97	25.77	7.85
2006	2	39.69	19.90	6.81	23.72	5.54
2006	3	41.46	22.77	6.36	22.32	5.31
2006	4	41.62	19.65	7.32	26.15	4.93
2007	1	40.75	19.68	8.29	24.30	7.65
2007	2	34.84	15.71	7.00	26.55	6.53
2007	3	38.56	17.54	6.30	29.06	6.72
2007	4	35.29	16.07	7.56	24.55	6.04
2008	1	34.45	15.81	7.33	25.90	7.93
2008	2	39.34	17.88	6.63	22.59	11.20
2008	3	33.07	15.51	8.69	29.12	9.38
2008	4	30.95	16.13	10.32	33.26	12.60
2009	1	29.68	17.21	8.60	25.73	13.46
2009	2	25.52	13.62	6.02	25.27	9.41
2009	3	27.52	14.30	7.52	26.02	10.21
2009	4	29.76	15.85	11.21	26.17	13.58
2010	1	31.41	17.83	12.23	30.35	17.81

Year	Quarter	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
2010	2	32.16	20.16	9.63	31.78	13.23
2010	3	28.13	18.38	7.61	32.19	7.61
2010	4	25.96	16.27	8.38	26.35	8.10
2011	1	25.77	15.20	8.06	28.12	10.00
2011	2	20.72	13.68	6.59	27.29	9.26
2011	3	21.77	14.27	7.02	24.67	7.11
2011	4	24.57	14.28	6.60	27.55	8.54
2012	1	25.32	13.22	7.01	26.39	9.86
2012	2	24.55	14.29	6.32	27.60	10.48
2012	3	22.96	14.30	6.62	28.94	8.40
2012	4	22.76	14.07	7.93	34.60	15.51
2013	1	25.98	15.42	8.88	35.90	18.58
2013	2	25.41	15.05	9.58	34.89	16.87
2013	3	24.74	14.40	9.00	46.01	18.93
2013	4	23.04	16.38	9.29	44.32	20.35
2014	1	26.29	15.05	9.27	41.43	19.50
2014	2	26.12	15.56	8.29	45.51	21.72
2014	3	22.81	13.88	7.60	43.98	19.67
2014	4	21.66	13.80	7.13	45.60	19.70
2015	1	24.09	15.14	8.06	42.97	18.60
2015	2	20.63	15.48	7.30	42.71	17.37
2015	3	25.01	14.25	7.11	44.04	17.21
2015	4	21.80	14.98	7.38	42.98	17.95
2016	1	23.25	14.46	7.69	43.51	18.24
2016	2	26.24	14.77	8.15	49.87	17.68
2016	3	24.00	14.68	7.68	49.08	13.37
2016	4	22.34	13.31	8.10	43.01	12.12
2017	1	22.26	14.85	6.22	41.69	11.45
2017	2	22.54	14.45	5.47	44.10	9.73
2017	3	21.97	14.15	5.62	41.07	10.42
2017	4	23.51	14.82	7.21	41.19	14.46
2018	1	22.91	14.69	5.77	43.46	16.97
2018	2	22.62	14.31	5.27	38.25	17.60
2018	3	23.55	13.67	5.27	39.68	16.69
2018	4	21.77	14.09	5.15	46.33	17.18
2019	1	23.14	14.73	5.03	42.70	19.13
2019	2	23.39	14.17	5.03	45.20	21.73
2019	3	22.49	14.46	5.06	44.40	20.50
2019	4	22.53	14.08	4.46	45.73	15.28
2020	1	22.07	15.11	4.46	41.44	15.36
2020	2	22.54	14.27	3.89	41.09	14.51
2020	3	21.45	13.78	4.00	41.69	12.48
2020	4	22.54	14.98	4.13	40.52	13.10
2021	1	22.18	14.09	4.42	39.33	13.15
2021	2	22.27	14.87	4.51	39.63	11.93

Source: TimberMart-South

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

Year	Quarter	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
2000	1	61.64	48.96	21.56	36.24	22.46
2000	2	55.57	45.89	21.56	35.05	19.50
2000	3	58.31	43.98	22.95	36.04	20.36
2000	4	51.89	41.86	20.65	37.58	20.46
2001	1	52.13	41.22	20.07	37.51	22.26
2001	2	50.51	38.22	19.94	36.29	22.23
2001	3	51.92	37.53	19.10	37.31	23.34
2001	4	50.21	38.71	18.93	35.11	20.43
2002	1	57.72	40.34	20.69	36.38	23.58
2002	2	54.27	38.14	20.77	35.99	23.00
2002	3	57.11	34.57	21.34	37.94	21.20
2002	4	53.05	34.22	23.77	35.56	23.59
2003	1	55.16	35.26	24.56	38.84	26.29
2003	2	54.69	34.08	22.89	44.90	25.30
2003	3	52.27	37.54	24.92	48.07	29.91
2003	4	53.37	38.48	23.34	44.60	27.08
2004	1	60.24	38.30	21.56	38.97	24.67
2004	2	57.94	35.99	21.13	42.75	21.86
2004	3	58.68	38.73	21.52	45.55	22.16
2004	4	57.11	39.96	23.68	46.58	24.98
2005	1	61.71	41.48	26.51	48.95	30.04
2005	2	56.22	41.61	26.00	42.59	29.61
2005	3	55.54	39.61	22.85	47.59	28.49
2005	4	55.12	44.22	26.42	43.65	27.81
2006	1	59.76	40.51	24.05	44.59	26.88
2006	2	54.69	39.90	23.04	42.26	22.39
2006	3	52.03	38.18	24.14	41.23	24.79
2006	4	48.94	36.95	24.59	41.40	24.40
2007	1	51.73	38.38	25.40	40.11	26.11
2007	2	52.30	35.58	22.87	38.62	23.84
2007	3	47.85	34.49	23.00	38.63	25.78
2007	4	47.66	33.15	25.59	45.13	26.27
2008	1	51.98	34.74	26.51	43.16	29.19
2008	2	49.64	34.75	25.63	42.25	28.50
2008	3	51.06	31.50	25.88	47.05	30.00
2008	4	51.94	32.50	29.75	42.50	30.00
2009	1	50.21	30.50	24.13	44.76	27.00
2009	2	45.25	28.00	25.01	46.31	26.50
2009	3	51.67	27.50	24.63	47.52	29.62
2009	4	49.25	30.00	29.75	46.38	33.83
2010	1	51.00	33.44	30.00	46.26	35.00
2010	2	47.02	32.75	28.14	48.10	32.13
2010	3	48.09	32.48	25.70	48.58	27.38
2010	4	49.25	33.00	24.50	45.75	26.75
2011	1	46.00	33.47	25.00	42.50	26.50

Year	Quarter	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
2011	2	41.71	31.01	25.58	46.16	26.18
2011	3	38.96	31.74	24.69	42.66	24.15
2011	4	40.12	31.49	24.86	46.90	26.30
2012	1	41.78	32.41	26.29	45.25	29.21
2012	2	38.50	32.08	26.03	47.62	30.69
2012	3	38.59	33.33	25.54	53.52	29.50
2012	4	41.75	34.64	27.73	50.26	37.04
2013	1	43.29	34.78	28.50	55.76	39.85
2013	2	47.72	33.99	29.06	64.99	37.96
2013	3	44.62	33.15	27.54	67.53	38.33
2013	4	44.71	35.37	28.27	63.88	39.80
2014	1	47.08	34.96	28.78	61.56	39.24
2014	2	47.39	34.41	27.81	63.58	43.39
2014	3	42.25	33.58	27.04	65.50	40.03
2014	4	41.43	33.64	26.25	65.46	39.35
2015	1	43.91	34.28	26.78	64.37	38.40
2015	2	41.23	34.53	26.69	65.06	37.35
2015	3	46.50	33.79	26.25	64.32	37.99
2015	4	43.97	33.50	25.85	64.34	36.56
2016	1	44.39	32.84	26.50	68.10	38.98
2016	2	45.63	32.94	26.19	69.85	39.48
2016	3	44.63	34.46	26.31	68.86	33.00
2016	4	40.95	34.31	26.75	64.50	31.42
2017	1	42.41	35.05	25.26	62.00	32.38
2017	2	41.31	32.55	24.62	62.21	28.21
2017	3	41.51	33.51	25.22	61.62	30.38
2017	4	42.95	35.00	28.43	63.33	37.41
2018	1	43.05	35.05	24.98	63.70	39.74
2018	2	41.00	33.95	24.45	58.84	37.69
2018	3	44.10	34.69	24.54	59.87	37.60
2018	4	43.03	34.53	25.03	67.96	38.51
2019	1	43.10	34.81	26.55	61.64	41.73
2019	2	44.02	33.88	25.70	66.50	43.72
2019	3	41.65	34.89	26.10	66.87	40.61
2019	4	41.67	33.91	25.45	67.21	35.58
2020	1	41.42	34.26	25.37	60.89	35.36
2020	2	42.35	33.39	25.04	62.51	36.47
2020	3	41.27	34.36	24.59	63.14	31.99
2020	4	42.33	34.50	25.34	62.06	33.16
2021	1	41.85	35.96	26.13	59.94	34.61
2021	2	40.74	33.82	26.22	59.71	36.95

Source: TimberMart-South

Alabama Cluster Catchment Area - Pulp Quality Chip Prices ($/Ton - FOB Point of Production)

Year	Quarter	Pine Sawmill Chips	Hardwood Sawmill Chips	Pine Chip Mill Chips	Hardwood Chip Mill Chips
2000	1	25.88	16.85	32.64	25.51
2000	2	25.66	17.13	32.81	25.93
2000	3	24.90	17.68	31.70	25.20
2000	4	21.51	18.75	30.50	26.37
2001	1	19.97	18.88	24.98	24.74
2001	2	18.51	18.32	24.88	25.94
2001	3	19.68	17.93	22.67	24.20
2001	4	19.05	16.27	22.96	23.85
2002	1	18.89	17.25	24.14	23.76
2002	2	17.08	17.71	23.62	22.77
2002	3	17.70	17.14	23.16	22.85
2002	4	19.86	17.84	25.17	26.07
2003	1	22.78	18.14	27.40	30.34
2003	2	21.82	18.34	26.92	30.84
2003	3	22.32	19.69	27.24	31.06
2003	4	21.41	18.00	27.02	30.04
2004	1	20.38	18.21	25.87	29.77
2004	2	20.51	18.14	24.61	24.26
2004	3	20.50	18.12	25.69	24.81
2004	4	20.34	17.81	24.47	25.87
2005	1	22.42	18.32	28.98	25.69
2005	2	20.20	19.43	29.03	26.71
2005	3	20.62	18.80	28.52	25.96
2005	4	20.61	18.47	29.47	26.55
2006	1	21.54	18.89	26.60	28.22
2006	2	20.84	18.83	26.07	29.09
2006	3	21.59	21.80	27.57	30.96
2006	4	22.50	22.06	29.76	30.71
2007	1	23.68	21.76	30.19	30.45
2007	2	22.56	20.96	30.44	32.53
2007	3	21.14	21.87	27.34	31.55
2007	4	20.84	22.08	31.29	30.63
2008	1	25.58	22.98	31.54	32.70
2008	2	25.51	24.94	33.89	34.72
2008	3	28.25	23.38	32.46	32.89
2008	4	26.29	25.19	34.13	34.21
2009	1	26.02	25.08	32.11	33.56
2009	2	26.05	25.24	31.60	33.62
2009	3	25.95	24.92	31.86	32.54
2009	4	24.75	22.09	35.08	35.76
2010	1	26.38	22.32	36.84	39.86
2010	2	24.46	22.57	37.19	42.33
2010	3	25.60	24.66	33.64	36.89
2010	4	26.16	25.34	36.19	39.60

Year	Quarter	Pine Sawmill Chips	Hardwood Sawmill Chips	Pine Chip Mill Chips	Hardwood Chip Mill Chips
2011	1	27.43	26.17	36.17	39.56
2011	2	26.25	25.88	35.65	37.51
2011	3	25.52	23.95	33.85	35.01
2011	4	24.63	22.34	33.97	35.55
2012	1	24.60	22.33	33.72	34.94
2012	2	25.45	23.71	34.36	36.36
2012	3	25.07	23.86	33.21	35.15
2012	4	25.40	23.38	35.81	35.53
2013	1	26.15	23.95	36.75	38.07
2013	2	25.77	25.80	36.14	38.31
2013	3	25.23	24.55	34.30	36.76
2013	4	25.68	25.72	35.09	39.71
2014	1	24.83	26.08	36.23	40.39
2014	2	26.09	26.26	38.47	41.64
2014	3	26.17	26.50	35.41	40.34
2014	4	25.56	26.15	36.23	40.49
2015	1	25.50	26.47	35.14	38.65
2015	2	26.09	28.31	35.88	39.23
2015	3	26.33	27.19	33.95	38.83
2015	4	26.24	27.16	34.78	39.05
2016	1	26.67	28.21	34.81	39.65
2016	2	27.51	30.18	34.48	40.29
2016	3	27.14	28.93	33.80	38.70
2016	4	26.88	27.62	34.36	37.71
2017	1	25.23	27.74	32.36	36.64
2017	2	24.80	29.03	32.17	36.04
2017	3	25.06	28.31	31.72	33.84
2017	4	25.12	28.34	33.49	34.01
2018	1	24.76	29.19	32.88	35.11
2018	2	24.67	30.29	32.39	38.32
2018	3	25.52	28.22	31.12	38.38
2018	4	24.45	27.98	32.69	40.90
2019	1	24.31	29.84	33.48	43.20
2019	2	24.41	31.57	34.51	44.65
2019	3	22.97	32.38	31.99	41.61
2019	4	24.57	30.28	32.55	39.76
2020	1	25.13	29.81	32.65	39.34
2020	2	23.01	29.66	32.67	37.91
2020	3	23.74	29.26	33.04	36.18
2020	4	24.33	29.72	31.60	37.27
2021	1	24.26	28.72	29.78	37.21
2021	2	23.70	31.38	30.68	39.44

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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