Catchment Area Analysis of Forest Management and Market Trends:

Enviva Pellets Cottondale

(Cottondale, Florida, USA)

Prepared for:

Drax Group plc

By:

Hood Consulting
3100 Old Canton Road, Suite 200
Jackson, MS 39216

1-601-540-8602
hbhood@hoodconsultingllc.com

Report date: July 28, 2021

Table of Contents

Table of Tables

Table of Figures

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 Florida panhandle and portions of south Alabama and southwest Georgia that supports the Enviva Cottondale wood pellet mill. Specifically, the catchment area this mill includes a combined 26 counties in Florida, Alabama, and Georgia and covers an area approximately 45,000 square kilometers in total size (Figure 1).

The Enviva Cottondale pellet mill has a permitted production capacity of 760,000 metric tons of wood pellets annually. Raw materials utilized for pellet production include a combination of roundwood, chips, and secondary residuals (i.e. sawdust and shavings), with pine accounting for 80-90% of total raw material purchases and hardwood accounting for the remaining 10-20%.

***Figure 1**. Enviva Cottondale Catchment Area*

Forest Area, Timber Inventory, & Annual Wood Demand

Forest Area. According to US Forest Service (USFS) data, the Enviva Cottondale catchment area contains an estimated 3.02 million hectares of forestland, constituting approximately 70% of the catchment area's total land area. Specifically, 98% of total forestland (2.95 million hectares) is classified as timberland, or forestland that is capable of commercial timber production. Also note that 81% of total timberland area is privately owned versus 19% public.

Total timberland area in the catchment area held relatively steady through the 2000s and averaged roughly 2,906,000 hectares from 2000-2009 before increasing to more than 2,986,000 hectares (+2.8%) in 2015. Timberland area declined slightly over the two years that followed but since 2017 has stabilized and averaged roughly 2,956,000 hectares, up 1.7% compared to 2000-2009 average levels.

Timberland Area by Forest Type (2020)

Forest Type	Hectares	% of Total
Planted Pine	975,422	33%
Natural Pine	594,461	20%
Planted Hardwood	60,634	2%
Natural Hardwood	1,020,771	35%
Mixed Pine-Hardwood	300,522	10%
Total	2,951,810	100%

Inventory. Total growing stock inventory on timberland totaled an estimated 227 million m^3 in the Cottondale catchment area in 2020, of which approximately 69% was softwood (pine) species and 31% was hardwood species. In terms of major timber product, approximately 36% of total growing stock inventory is classified as pine sawtimber, compared to 17% pine chip-n-saw, 16% pine pulpwood, 18% hardwood sawtimber, and 13% hardwood pulpwood.

Total timber inventory had been on an upward climb, increasing an average of 1.5% per year (+31% total) from 206 million m^3 in 2000 to nearly 270 million m^3 in 2018. However, in October 2018, Hurricane Michael struck the Florida panhandle and proceeded inland and through the Cottondale catchment area, destroying an estimated 42 million m^3 (16%) of total catchment area timber inventory. Despite the losses caused by Hurricane Michael, total timber inventory at 227 million m^3 in 2020 was still up 11% compared to 2000 levels.

Timber Inventory by Major Product (2020)

Timber Product	Inventory (000 m^3)	% of Total
Pine Sawtimber	82,877	36%
Pine Chip-n-saw	38,471	17%
Pine Pulpwood	36,333	16%
Hardwood Sawtimber	41,389	18%
Hardwood Pulpwood	28,332	12%
Total	227,402	100%

Wood Demand. As of May 2021, there were over 20 major wood-consuming mills operating within the Enviva Cottondale 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 Cottondale catchment area attributed to these mills was estimated at 10.1 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 4.8 million metric tons in 2020 and represented 48% of total catchment area wood demand.

Of the 4.8 million metric tons of total pulpwood demand in the catchment area in 2020, approximately 84% was attributed to non-bioenergy-related sources (i.e. predominantly pulp/paper); 16% was attributed to the bioenergy sector. Bioenergy-related pulpwood demand totaled an estimated 780,615 metric tons, of which approximately 75% was for softwood (pine) pulpwood and 25% was for hardwood pulpwood.

Catchment Area Wood Demand by Major Product (2020)

Product	Demand (Metric Tons)	% of Total
Softwood Sawlogs	4,823,678	48%
Softwood Pulpwood	4,142,500	41%
Hardwood Sawlogs	440,643	4%
Hardwood Pulpwood	703,974	7%
Total	10,110,794	100%

Catchment Area Pulpwood Demand (2020)

Product	Demand (Metric Tons)	% of Total
Biomass Demand:		
Softwood Biomass	583,761	12%
Hardwood Biomass	196,854	4%
Total Biomass	780,615	16%
Other Pulpwood Demand:		
Other Softwood Pulpwood	3,558,739	73%
Other Hardwood Pulpwood	507,120	10%
Total Other Pulpwood	4,065,859	84%
Total Pulpwood Demand:		
Softwood Pulpwood	4,142,500	85%
Hardwood Pulpwood	703,974	15%
Pulpwood Total	4,846,473	100%

Summary of Analysis Findings

The following report provides a detailed assessment of the Enviva Cottondale 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 a 55,166-hectare (+1.9%) increase in the total area of timberland in the Enviva Cottondale catchment area since the Enviva Cottondale pellet mill commenced production in 2008. Furthermore, a strong positive relationship was identified between biomass demand and timberland area, suggesting that the increase in timberland area since 2008 can be linked, to a degree, to increased demand attributed to bioenergy.
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 these 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 thinnings accounted for 63% of total reported harvest area in the Cottondale market from 2005-2011 but only 39% of total harvest area reported from 2012-2020. Specifically, the decreased prevalence of thinning since 2012 can be linked to the strengthening of pine pulpwood markets and concurrent weakening of pine sawtimber markets beginning in the mid-2000s. Prior to the bursting of the US housing bubble in 2006, timber management in this market had been driven to a large degree by pine sawtimber production. However, challenging market conditions saw pine sawtimber stumpages prices decline more than 40% from 2006-2011. At the same time, pine pulpwood markets started to strengthen, with pine pulpwood stumpage prices increasing more than 50% from 2006-2010. So, with sawtimber markets weakening and pulpwood markets strengthening, the data suggests that many landowners decided to alter their management approach (i.e. to take advantage of strong pulpwood markets) and focus on short pulpwood rotations that typically do not utilize thinnings. Bioenergy has had an impact on this market by adding an average of roughly 680,000 metric tons of additional pine pulpwood demand to this catchment area annually since 2008. However, bioenergy has accounted for only 17% of total softwood pulpwood demand in this market since Enviva Cottondale's startup. Ultimately, the shift in management approach that occurred in this market can be more closely linked to other factors, such as increased softwood pulpwood demand from non-bioenergy sources (i.e. pulp/paper) as well as the weakening of pine sawtimber markets.

Is there any evidence that bioenergy demand has caused the following:	Analysis Findings
Diversion from other markets?	**No.** Demand for softwood (pine) sawlogs increased an estimated 23% in the Cottondale catchment area from 2008-2020. Also, there is no evidence that increased demand from bioenergy has caused a diversion from other softwood pulpwood markets (i.e. pulp/paper), as softwood pulpwood demand not attributed to bioenergy has increased 25% since the Cottondale mill's startup in 2008.
An unexpected or abnormal increase in wood prices?	**Inconclusive.** The startup of Enviva Cottondale added more than 900,000 metric tons of softwood pulpwood demand to the catchment area from 2008-2013, and this increase in demand coincided with a 28% increase in the delivered price of pine pulpwood (PPW) – the primary roundwood product consumed by the Enviva Cottondale mill. However, since 2013, delivered PPW prices have held flat, despite biomass-related softwood pulpwood demand falling to an average of roughly 635,000 tons per year since 2016, down more than 40% compared to 2013 peak levels. (Note the decrease in roundwood consumption was due to a higher utilization of secondary residuals). It's also important to point out that the roughly 410,000-metric ton decrease in softwood biomass demand from 2013 to 2020 was offset by a roughly 455,000-metric ton increase in softwood pulpwood demand from other sources. Statistical analysis did identify a positive relationship between softwood biomass demand and delivered PPW price. However, that relationship was found to be relatively weak. The relationship between delivered PPW price and softwood pulpwood demand from other sources was found to be much stronger, which was not unexpected to find given that softwood pulpwood demand not attributed to bioenergy has accounted for 83% of total softwood pulpwood demand in the catchment area since 2008. Furthermore, there is some evidence linking the increase in pine sawmill chip prices to increased consumption of secondary pine residuals by Enviva Cottondale. Specifically, consumption of secondary pine residuals by Enviva Cottondale more than doubled from roughly 213,000 metric tons in 2012 to nearly 490,000 metric tons in 2016, and this increased consumption of pine residuals coincided with a nearly 20% increase in the price of pine sawmill chips. However, increased consumption of residuals by the bioenergy sector was only one of several contributing factors that can be linked to the increase in pine sawmill chip prices. Increased consumption of pine residuals by the pulp/paper industry also contributed to higher pine sawmill chip prices. In addition, there is a strong linkage between pine sawmill chip prices and softwood lumber production. Specifically, the increase in softwood lumber production that begun in the early-to-mid-2010s consequently resulted in the increased production of secondary residuals, and the increased availability of this lower-cost material led to greater competition and ultimately higher pine residual prices.
A reduction in growing stock timber?	**No.** From 2008 (the year Enviva Cottondale commenced production) up until Hurricane Michael struck in late-2018, total growing stock inventory increased an average of 1.8% per year (+19% total) in the Cottondale catchment area. Specifically, inventories of pine sawtimber and pine chip-n-saw increased 58% and 28%, respectively, while pine pulpwood (PPW) inventory decreased 4% over this same period. However, note that the decrease in pine pulpwood inventory from 2008-2018 was not due to increased demand from bioenergy or increased harvesting above the sustainable yield capacity of the forest area, as annual growth of pine

Is there any evidence that bioenergy demand has caused the following:	Analysis Findings
	pulpwood exceeded annual removals every year throughout this period. Rather, this slight decrease in PPW inventory levels is more a reflection of the aging of the catchment area forest and the movement of stands classified as pulpwood to stands classified as chip-n-saw.
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 Cottondale catchment area decreased from 5.9% in 2008 to 5.2% in 2020, suggesting that the sequestration rate of carbon also declined slightly over this period. However, there is little evidence to suggest that increased demand attributed to bioenergy is responsible for this change. The reduction in overall growth rate (and therefore reduction in the sequestration rate of carbon) is more a reflection of the aging of the catchment area forest. Specifically, growth rates decline as timber ages, and this is exactly what USFS data shows in the Cottondale catchment area, with the average age of growing stock timber increasing from less than 44 years of age in 2008 to nearly 46 years of age in 2020.
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 1.26 (recall that a value greater than 1.0 indicates sustainable harvest levels). Note, however, that the PPW G:R ratio averaged 1.57 in the catchment area from 2013-2017 before falling to 1.20 in 2018 and averaging 1.27 since. This notable drop in 2018 was due to a nearly 35% increase in PPW removals (due to Hurricane Michael). It's also important to note that while annual removals have moved back in line with pre-Michael levels since 2019, this lower PPW G:R ratio is likely reflective of the new norm (at least over the midterm). Hurricane Michael destroyed an estimated 22% of total pine pulpwood inventory in the Cottondale catchment area, and this loss in inventory will be reflected in reduced growth until the destroyed forests regenerate. However, in spite of this loss, adequate PPW inventory levels still remain and sustainable market conditions are expected to persist moving forward.

Impact of bioenergy demand on:	Analysis Findings
Timber growing stock inventory	**Neutral.** According to USFS data, inventories of pine pulpwood (PPW) decreased 25% in the catchment area from 2008-2020. However, this substantial decrease was due to Hurricane Michael, which destroyed nearly 520,000 hectares of catchment area timberland when it hit the Florida panhandle in late-2018. Prior to this event occurring, PPW inventory levels had held relatively steady, decreasing slightly but averaging 47.2 million m^3 in the catchment area from 2008-2018. However, the destruction caused by Hurricane Michael resulted in the immediate loss of more than 10.3 million m^3 of PPW inventory, or a 22% decrease compared to pre-hurricane levels. Moreover, the slight decrease in PPW inventory levels that did occur from 2008-2018 was not due to increased demand from bioenergy. Typically, a reduction in inventory is linked to harvest levels above the sustainable yield capacity of the forest area, but in the Cottondale catchment area, annual growth of PPW exceeded annual removals every year throughout this period. Ultimately, the decrease in PPW inventory from 2008-2018 can be more closely linked to decreased pine sawtimber production beginning in the early to mid-2000s. Specifically, annual removals of pine sawtimber decreased 28% from 2003-2014, and the reduction in harvest levels over this period translated to a reduction in newly-reestablished pine stands and ultimately the slight reduction in PPW inventory levels that occurred in the mid-to-late 2010s.
Timber growth rates	**Neutral.** Overall, timber growth rates declined slightly in the catchment area from 2008 (the year Enviva Cottondale commenced operations) through 2020. However, this decrease in timber growth rates was not due to increased demand attributed to bioenergy but rather to the aging of the catchment area forest. Specifically, USFS data shows the average age timber inventory in the Cottondale catchment area increased from an estimated 43.6 years of age in 2008 to 45.7 years of age in 2020.
Forest area	**Positive.** In the Enviva Cottondale catchment area, total forest area (i.e. timberland) increased more than 55,100 hectares (+1.9%) from 2008 through 2020, and this increase can be linked to several factors, including increases in softwood pulpwood demand (from both bioenergy and other sources) as well as conversion from farmland. Specifically, the more than 55,100-hectare increase in catchment area timberland from 2008-2020 coincided with a 1.1-million metric ton increase in annual softwood pulpwood demand (roughly half of which was attributed to bioenergy). While statistical analysis identified moderately strong positive relationships between timberland area and both softwood biomass demand and non-bioenergy-related softwood pulpwood demand, a *strong* positive correlation was found between timberland and total softwood pulpwood demand – suggesting that the increases in timberland since 2008 can be attributed, in part, to the increase in total softwood pulpwood demand (from both bioenergy and other sources). The more than 55,100-hectare increase timberland from 2008-2020 also coincided with a roughly 75,000-hectare decrease in farmland (i.e. cropland, woodland, and pastureland) over this period. Specifically, the catchment area experienced a roughly 31,800-hectare loss in cropland, 8,900-hectare loss in pastureland, and 34,300-hectare loss in woodland from 2008-2020. Furthermore, statistical analysis confirmed this inverse relationship, identifying a strong negative correlation between timberland and farmland in the Cottondale catchment area.

Wood prices	**Negative / Positive.** Total softwood pulpwood demand attributed to bioenergy in the Cottondale catchment area increased from zero tons in 2007 (the year prior to Enviva Cottondale's startup) to over 1.0 million metric tons in 2013. Over this same period, the price of delivered pine pulpwood (PPW) – the predominant roundwood product utilized by Enviva Cottondale for wood pellet production – increased 42% (from $21.06 per ton in 2007 to $29.82 per ton in 2013). However, the apparent link between increased softwood biomass demand and increased delivered PPW price is only loosely supported by statistical analysis, which identified a relatively weak positive relationship between these two variables. Furthermore, delivered PPW price has remained nearly unchanged in the catchment area since 2013, despite softwood biomass demand declining and averaging roughly 577,000 metric tons per year since 2016. (Note that the roughly 410,000-metric ton decrease in softwood biomass demand from 2013-2020 was offset by a roughly 455,000-metric ton increase in softwood pulpwood demand from other sources). Ultimately, the increase in delivered PPW prices in the catchment area can be linked to increased demand for softwood pulpwood from all sources, and roughly half of the 1.2-million metric ton increase in softwood pulpwood demand since 2007 can be attributed to bioenergy. However, it's also important to note that the increase in bioenergy-related wood demand has been a positive for forest landowners in the Enviva Cottondale catchment area. Not only has bioenergy provided an additional outlet for pulpwood in this market, but the increase in delivered PPW price resulting from increased softwood pulpwood demand from bioenergy has transferred through to landowners in the form of higher PPW stumpage prices. Specifically, over the six years prior to Enviva Cottondale's startup, PPW stumpage price – the price paid to landowners – averaged roughly $7.40 per ton in the Cottondale catchment area. However, since 2010, PPW stumpage prices have averaged more than $11.15 per ton, representing a more than 50% increase compared to pre-mill startup levels.
Markets for solid wood products	**Positive.** In the Enviva Cottondale catchment area, demand for softwood sawlogs used to produce lumber and other solid wood products increased an estimated 23% from 2008-2020. This increase in softwood lumber production has consequentially resulted in an increase in sawmill residuals (i.e. chips, sawdust, and shavings) – by-products of the sawmilling process and materials utilized by Enviva Cottondale to produce wood pellets. Specifically, softwood sawlog demand has increased more than 16% in the catchment area since 2014, and this increase in demand has coincided with a nearly 60% increase in pine residual purchases by Enviva Cottondale. (Note that pine residuals constituted 25% of total raw material purchases by Enviva Cottondale in 2014 but 41% of total raw material purchases in 2020). So, not only has Enviva Cottondale benefited from the greater availability of this sawmill by-product, but lumber producers have also benefited, as Enviva Cottondale 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 Florida panhandle and portions of southeast Alabama and southwest Georgia that supports the Enviva Cottondale pellet mill. 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 Cottondale catchment area since 2000. It also includes an assessment of long-term market sustainability and provides a market outlook through 2023.

The Enviva Cottondale mill was originally commissioned by Green Circle Energy Inc. in 2008 and acquired by Enviva in 2015. This mill has a permitted production capacity of 760,000 metric tons of wood pellets annually, with annual roundwood demand totaling between 500,000 and 1.0 million tons.

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. For Enviva Pellets Cottondale, this mill's catchment area (denoted 'Enviva Cottondale' catchment area hereafter), as identified by Enviva, includes a combined 26 counties in Alabama, Florida, and Georgia and covers an area nearly 45,000 square kilometers (≈4.3 million hectares) in size. It extends as far north as Montgomery AL to the Gulf of Mexico in the south, and beyond Tallahassee FL in the east and Crestview FL in the west.

***Figure 2**. Enviva Cottondale Catchment Area Boundary*

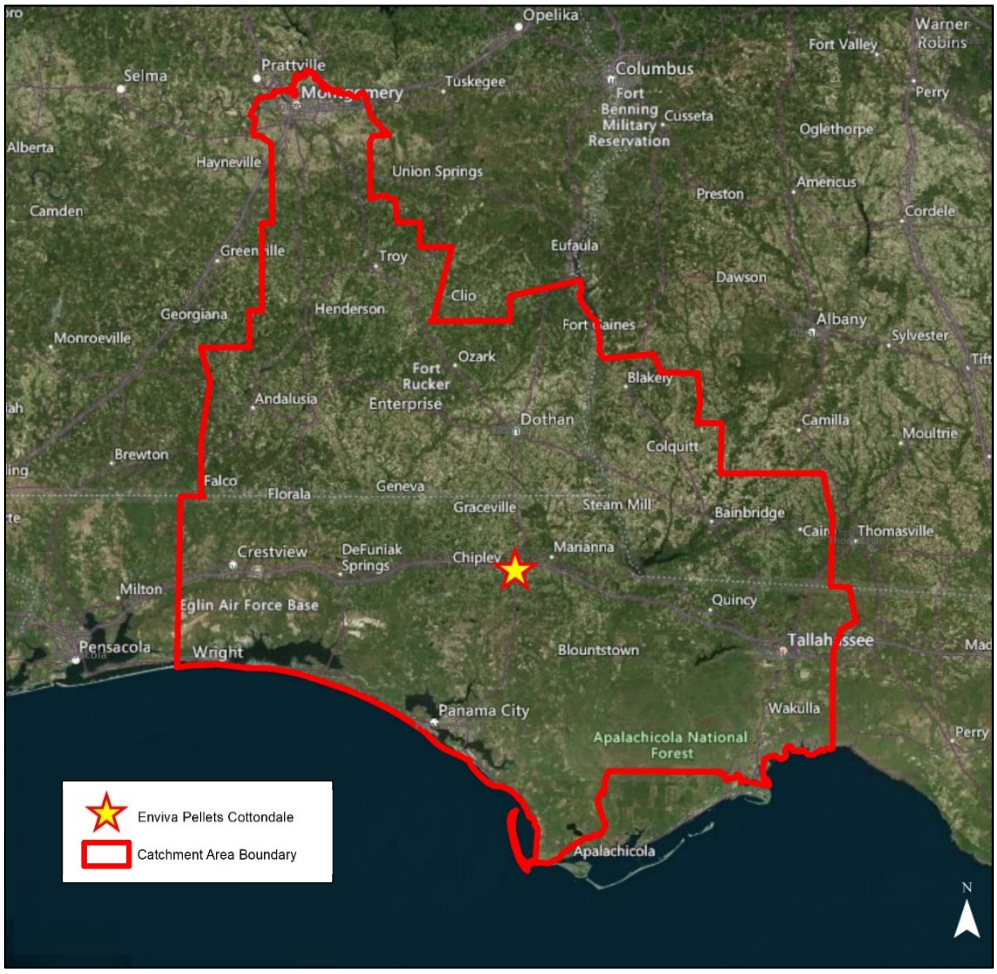


***Table 1**. Enviva Cottondale Catchment Area – County List*

State	County	State	County	State	County	State	County
AL	Coffee	AL	Montgomery	FL	Jackson	GA	Decatur
AL	Covington	AL	Pike	FL	Leon	GA	Early
AL	Crenshaw	FL	Bay	FL	Liberty	GA	Grady
AL	Dale	FL	Calhoun	FL	Okaloosa	GA	Miller
AL	Geneva	FL	Gadsden	FL	Wakulla	GA	Seminole
AL	Henry	FL	Gulf	FL	Walton		
AL	Houston	FL	Holmes	FL	Washington		

3. Market Profile & Resource Assessment

The following section provides a current market profile of the Enviva Cottondale 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

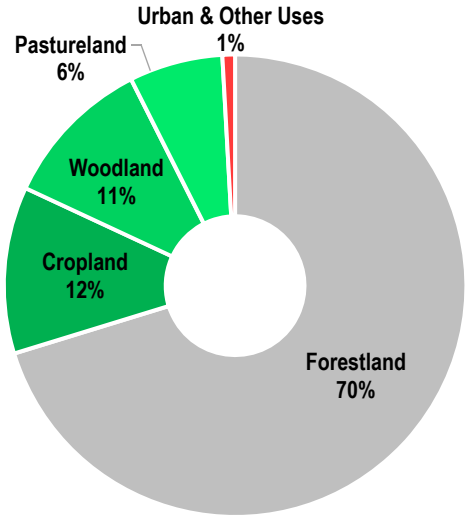
According to the US Department of Agriculture (USDA), the Enviva Cottondale catchment area totals approximately 4,296,373 hectares in size. Approximately 70% (3,018,616 hectares) of the total land area is classified as forestland, 29% (1,239,932 hectares) is farmland, and 1% (37,825 hectares) is urban areas or land that is classified as having other uses.

***Table 2**. Enviva Cottondale Catchment Area - Land Area by Land Classification & Use (2020)*

Land Classification / Use	Hectares	% of Total
Forestland	3,018,616	70%
Farmland:		
Cropland	501,661	12%
Woodland	456,986	11%
Pastureland	281,285	6%
Total Farmland	1,239,932	29%
Urban & Other Uses	37,825	1%
Total	**4,296,373**	**100%**

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

***Figure 3**. Enviva Cottondale 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 3,018,616 hectares and constitutes 70% of the catchment area's total land area.

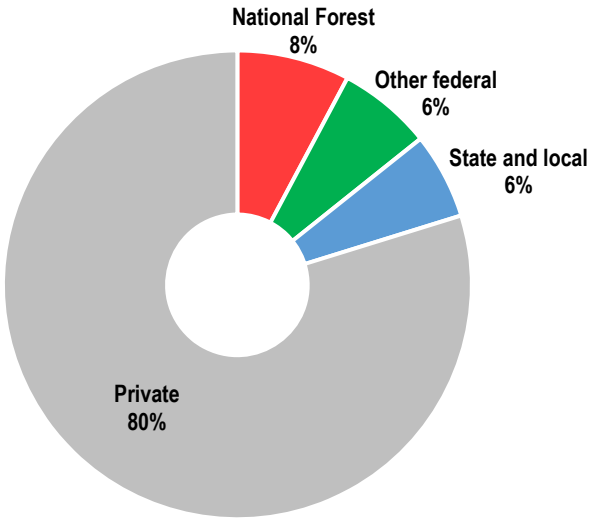
Ownership of forestland in the Georgia catchment area is predominantly privately owned. According to US Forest Service - Forest Inventory and Analysis (FIA) data from 2020, the latest available, privately-owned forestland constitutes 80% of total forestland and totals approximately 2,408,355 hectares. Public forestland constitutes 20% of total forestland in the catchment area, with National Forests totaling 234,809 hectares (8%), other federal forestland totaling 196,363 hectares (6%), and forestland owned by state and local authorities totaling 179,088 hectares (6%).

***Table 3**. Enviva Cottondale Catchment Area - Forestland Area by Ownership Group (2020)*

Ownership Group	Hectares	% of Total
National Forest	234,809	8%
Other Federal	196,363	6%
State and Local	179,088	6%
Private	2,408,355	80%
Total	**3,018,616**	**100%**

Source: USDA – US Forest Service

***Figure 4**. Enviva Cottondale 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 0.57 m^3 of industrial wood per year.

In the Enviva Cottondale catchment area, timberland constitutes 98% of total forestland and totals approximately 2,951,810 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.*

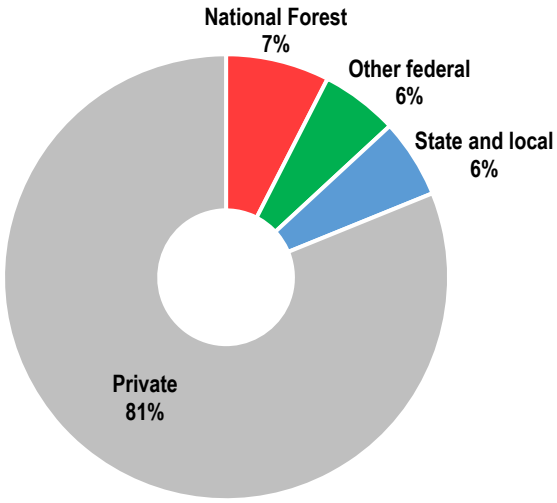
Ownership of timberland in the Enviva Cottondale catchment area is similar to that of forestland, with 81% (2,395,461 hectares) of total timberland privately owned, compared to 7% (222,052 hectares) National Forests, 6% (165,373 hectares) other federal, and 6% (168,924 hectares) owned by state and local authorities.

***Table 4**. Enviva Cottondale Catchment Area - Timberland Area by Ownership Group (2020)*

Ownership Group	Hectares	% of Total
National Forest	222,052	7%
Other Federal	165,373	6%
State and Local	168,924	6%
Private	2,395,461	81%
Total	**2,951,810**	**100%**

Source: USDA – US Forest Service

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



Age Class Distribution

According to US Forest Service data, of the 2,951,810 hectares of timberland in the catchment area, approximately 51% (1,508,554 hectares) is classified as softwood timberland, 37% (1,096,251 hectares) is classified as hardwood timberland, and 12% (347,005 hectares) is classified as mixed pine-hardwood timberland.

Distribution of timberland area by age class varies by forest type. However, note that a disproportionate percentage of timberland area falls within 0-5-year age class, as the timberland destroyed by Hurricane Michael in late-2018 was relegated to this youngest age class. *(For more details regarding Hurricane Michael, damage estimates associated with this storm, and its impact on the Cottondale catchment area, see Annex 1 on page 120.)*

Specifically, 78% of softwood timberland is 40 years of age or younger, with the average age of softwood timberland estimated at 26.7 years of age. However, excluding the 0-5-year age class, the average age is estimated at 33.6 years. In comparison, approximately 84% of hardwood timberland is 70 years of age or younger. However, in addition to the area destroyed by Hurricane Michael, the 0-5-year age class also includes transitional stands and those with low stocking levels that will likely not reach maturity. Excluding this youngest age class, approximately 50% of the remaining hardwood timberland is 36-70 years old, with the average age of hardwood timberland estimated at 50.0 years of age.

***Table 5**. Enviva Cottondale 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	333,599	22%	252,929	23%	64,850	19%	651,378	22%
6-10	81,257	5%	32,623	3%	22,383	6%	136,263	5%
11-15	97,760	6%	43,366	4%	19,527	6%	160,653	5%
16-20	139,111	9%	56,946	5%	5,754	2%	201,810	7%
21-25	175,633	12%	45,323	4%	15,193	4%	236,149	8%
26-30	162,770	11%	37,308	3%	24,799	7%	224,877	8%
31-35	113,152	8%	34,348	3%	25,430	7%	172,930	6%
36-40	78,723	5%	54,253	5%	20,530	6%	153,505	5%
41-45	49,881	3%	39,933	4%	18,969	5%	108,783	4%
46-50	42,511	3%	69,707	6%	22,847	7%	135,065	5%
51-55	38,930	3%	56,010	5%	18,656	5%	113,596	4%
56-60	31,071	2%	61,064	6%	24,073	7%	116,207	4%
61-65	31,684	2%	85,614	8%	10,511	3%	127,810	4%
66-70	26,456	2%	55,926	5%	23,411	7%	105,794	4%
71-75	39,242	3%	31,196	3%	12,021	3%	82,459	3%
76-80	25,777	2%	31,272	3%	11,722	3%	68,772	2%
81-85	20,725	1%	34,529	3%	1,919	1%	57,173	2%
86-90	10,365	1%	29,018	3%	2,378	1%	41,760	1%
91-95	1,801	0%	5,989	1%	0	0%	7,790	0%
96-100	4,091	0%	9,622	1%	1,016	0%	14,730	0%
100+	4,015	0%	29,275	3%	1,016	0%	34,306	1%
Total	**1,508,554**	**100%**	**1,096,251**	**100%**	**347,005**	**100%**	**2,951,810**	**100%**

Source: USDA - US Forest Service

***Figure 6**. Enviva Cottondale 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 65% (1,915,755 hectares) of total catchment area timberland is classified as naturally regenerated forests, compared to 35% (1,036,055 hectares) planted forests. However, stand origin area distribution varies widely by major forest type.

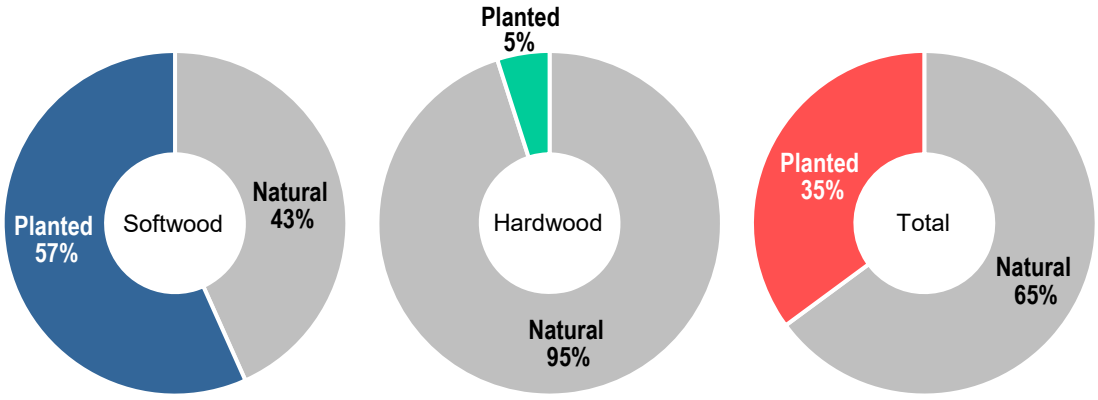
US Forest Service data shows 43% (744,722 hectares) of softwood timberland is naturally regenerated versus 57% (975,422 hectares) planted. In contrast, 95% (1,171,032 hectares) of hardwood timberland is naturally regenerated, compared to 5% (60,634 hectares) planted.

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

	Softwood		*Hardwood*		*Total*	
Stand Origin	**Hectares**	**Distribution**	**Hectares**	**Distribution**	**Hectares**	**Distribution**
Naturally Regenerated	744,722	43%	1,171,032	95%	1,915,755	65%
Planted	975,422	57%	60,634	5%	1,036,055	35%
Total	**1,720,144**	**100%**	**1,231,666**	**100%**	**2,951,810**	**100%**

Source: USDA - US Forest Service

***Figure 7**. Enviva Cottondale 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 54.

3.2.1 *Ownership Group*

Growing stock inventory on timberland in the Enviva Cottondale catchment area in 2020, the latest available, totaled an estimated 227 million m^3, of which approximately 80% (181 million m^3) is privately owned, 8% (19 million m^3) is National Forest, 7% (15 million m^3) is owned by state and local authorities, and 5% (12 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 10% of total softwood inventory but only 4% of hardwood inventory. Also, privately-owned timberland contains approximately 78% of total softwood inventory in the catchment area but 83% of total hardwood inventory. See Table 7 for details.

***Table 7**. Enviva Cottondale 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	16,027	2,662	18,689
Other Federal	8,722	3,313	12,035
State and Local	9,713	5,607	15,319
Private	123,234	58,134	181,368
Total	**157,695**	**69,715**	**227,410**

Source: USDA - US Forest Service

[1] US Forest Service-FIA data for those counties located in Florida and Georgia are only available through 2017 and 2019, respectively. Estimates through 2020 have been included and are based on historical trends and local area inventory models in each of these two states.

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 83% (130 million m^3) of total softwood growing stock inventory is 5- 17 inches in diameter, with 96% (152 million m^3) less than 23 inches in diameter. In comparison, 68% (47 million m^3) of total hardwood growing stock inventory is 5- 17 inches in diameter, with 86% (60 million m^3) less than 23 inches in diameter.

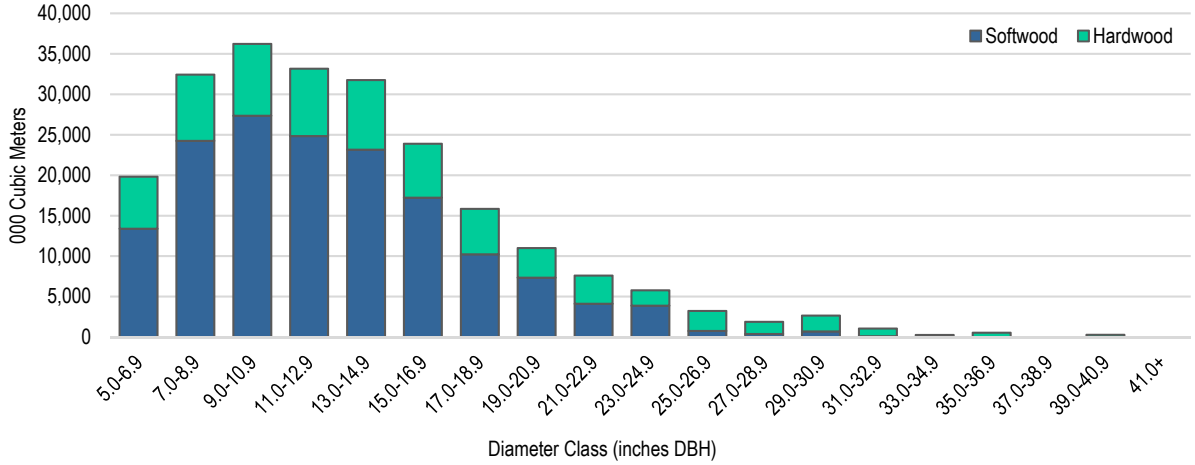
Based on these diameter class distributions, softwood growing stock inventory averages an estimated 12.8 inches in diameter, compared to 15.1 inches for hardwood growing stock inventory.

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

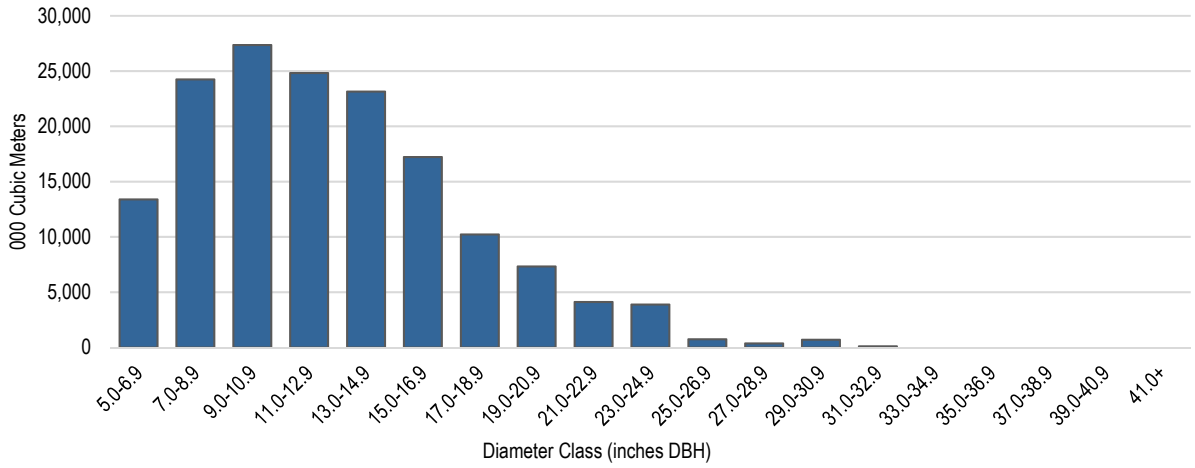
Diameter Class (inches DBH)		Softwood Volume (000 m^3)	Softwood Distribution		Hardwood Volume (000 m^3)	Hardwood Distribution	Total Volume (000 m^3)	Total Distribution
5.0-6.9	Pulpwood	13,388	8%	Pulpwood	6,424	9%	19,812	9%
7.0-8.9		24,245	15%		8,180	12%	32,425	14%
9.0-10.9	CNS	27,351	17%		8,875	13%	36,226	16%
11.0-12.9		24,830	16%		8,332	12%	33,162	15%
13.0-14.9	Sawtimber	23,149	15%	Sawtimber	8,611	12%	31,760	14%
15.0-16.9		17,232	11%		6,650	10%	23,881	11%
17.0-18.9		10,231	6%		5,601	8%	15,832	7%
19.0-20.9		7,332	5%		3,674	5%	11,005	5%
21.0-22.9		4,120	3%		3,484	5%	7,604	3%
23.0-24.9		3,882	2%		1,896	3%	5,778	3%
25.0-26.9		748	0%		2,486	4%	3,234	1%
27.0-28.9		373	0%		1,518	2%	1,891	1%
29.0-30.9		699	0%		1,956	3%	2,655	1%
31.0-32.9		102	0%		958	1%	1,060	0%
33.0-34.9		0	0%		260	0%	260	0%
35.0-36.9		0	0%		532	1%	532	0%
37.0-38.9		0	0%		0	0%	0	0%
39.0-40.9		0	0%		282	0%	282	0%
41.0+		0	0%		0	0%	0	0%
Total		**157,681**	**100%**		**69,721**	**100%**	**227,402**	**100%**

Source: USDA - US Forest Service

Figure 8. *Enviva Cottondale 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 83 million m^3 (36%) of total growing stock inventory is classified as pine sawtimber, compared to 38 million m^3 (17%) of pine chip-n-saw, 36 million m^3 (16%) of pine pulpwood, 41 million m^3 (18%) of hardwood sawtimber, and 28 million m^3 (12%) of hardwood pulpwood.

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

Product	Volume (000 m^3)	Distribution
Pine Sawtimber	82,877	36%
Pine Chip-n-saw	38,471	17%
Pine Pulpwood	36,333	16%
Hardwood Sawtimber	41,389	18%
Hardwood Pulpwood	28,332	12%
Total	**227,402**	**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 46% of total inventory 11-40 years of age and 38% of total inventory 46-80 years of age (see Figure 9 on the following page). However, this is explained by major species composition and its respective age class distribution.

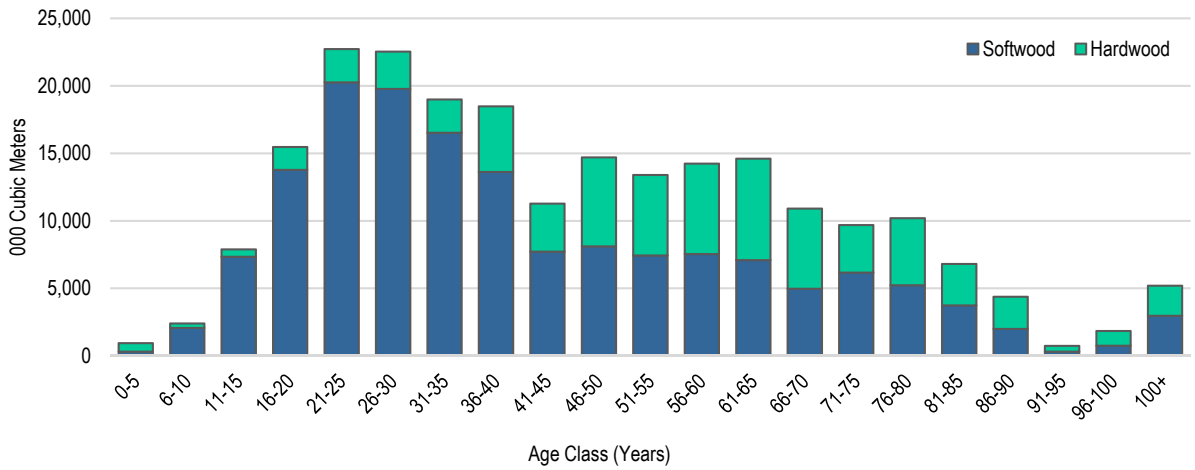
According to USFS estimates, softwood growing stock inventory averages an estimated 40.9 years of age, with 53% (84 million m^3) of total softwood inventory 16-40 years of age and 83% (132 million m^3) 65 years of age or younger. In contrast, hardwood inventory averages an estimated 56.6 years of age, with 71% (50 million m^3) of hardwood inventory 36-80 years of age and 92% (64 million m^3) 16-90 years of age.

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

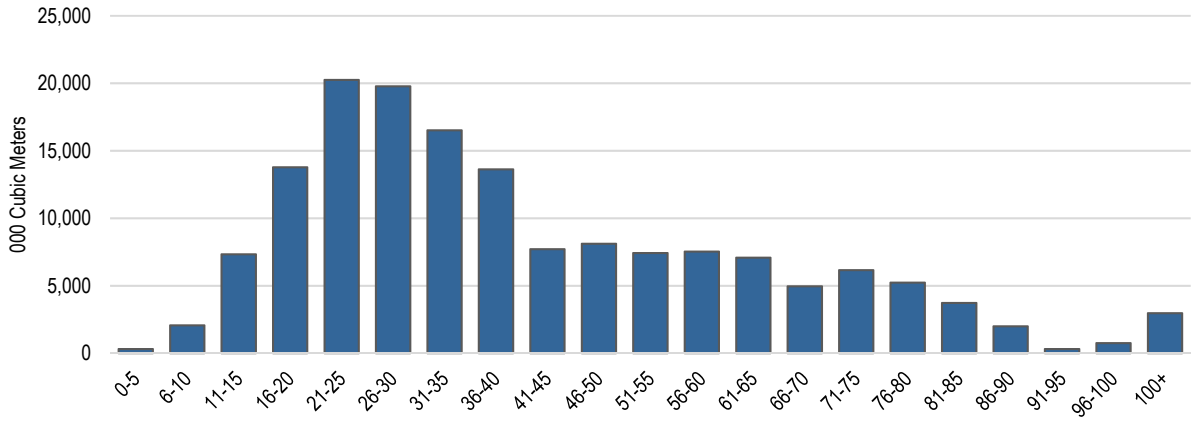
	Softwood		*Hardwood*		*Total*	
Age Class (Years)	**Volume** (000 m^3)	**Distribution**	**Volume** (000 m^3)	**Distribution**	**Volume** (000 m^3)	**Distribution**
0-5	311	0%	628	1%	939	0%
6-10	2,070	1%	322	0%	2,392	1%
11-15	7,334	5%	555	1%	7,889	3%
16-20	13,779	9%	1,695	2%	15,475	7%
21-25	20,256	13%	2,466	4%	22,722	10%
26-30	19,778	13%	2,762	4%	22,539	10%
31-35	16,523	10%	2,472	4%	18,995	8%
36-40	13,625	9%	4,852	7%	18,477	8%
41-45	7,715	5%	3,563	5%	11,278	5%
46-50	8,115	5%	6,591	9%	14,706	6%
51-55	7,430	5%	5,967	9%	13,397	6%
56-60	7,536	5%	6,701	10%	14,237	6%
61-65	7,085	4%	7,522	11%	14,607	6%
66-70	4,964	3%	5,941	9%	10,905	5%
71-75	6,163	4%	3,521	5%	9,684	4%
76-80	5,228	3%	4,964	7%	10,192	4%
81-85	3,734	2%	3,071	4%	6,805	3%
86-90	1,997	1%	2,382	3%	4,379	2%
91-95	313	0%	428	1%	741	0%
96-100	752	0%	1,091	2%	1,843	1%
100+	2,971	2%	2,227	3%	5,198	2%
Total	**157,681**	**100%**	**69,721**	**100%**	**227,402**	**100%**

Source: USDA - US Forest Service

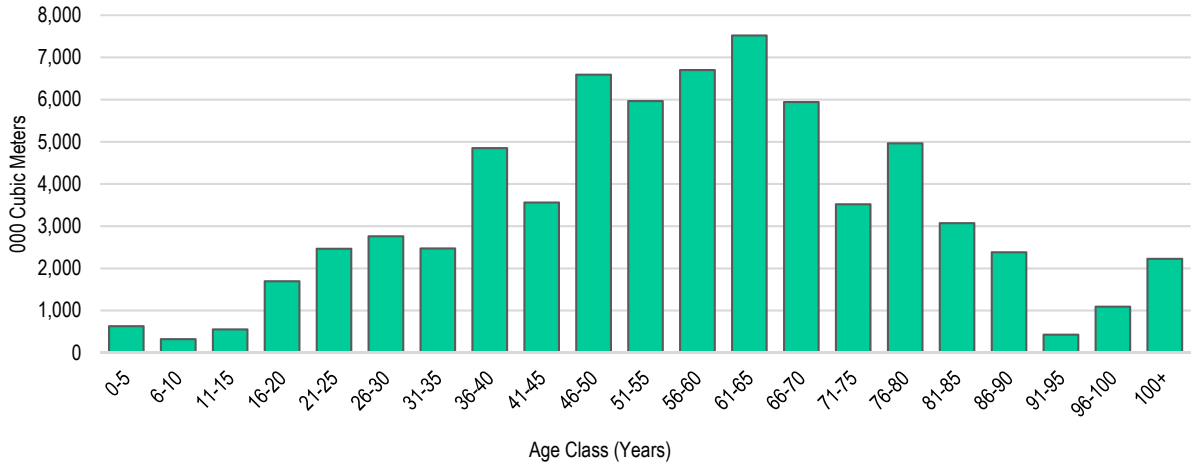
***Figure 9**. Enviva Cottondale Catchment Area - Distribution of Growing Stock Volume on Timberland by Age Class (2020)*



(a) Total Growing Stock Inventory



(b) Softwood Growing Stock Inventory



(c) Hardwood Growing Stock Inventory

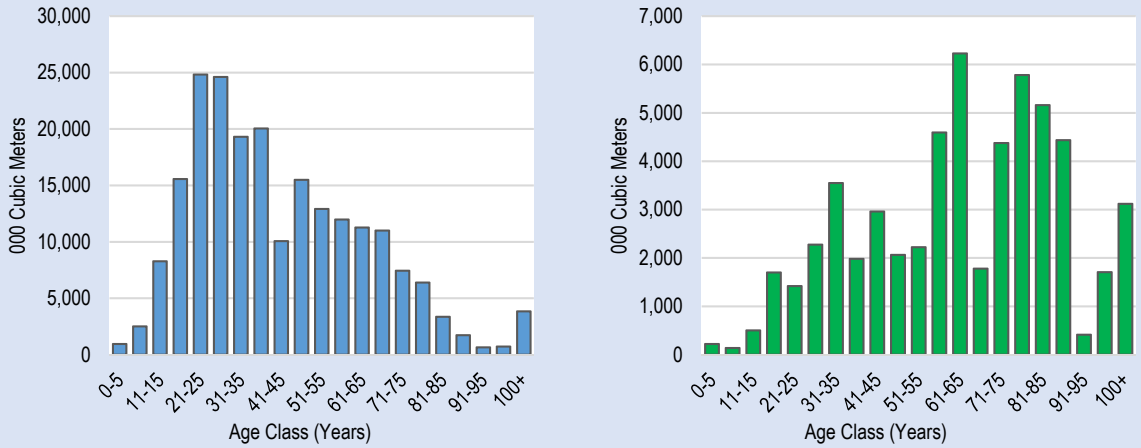
Growing Stock Inventory by Age Class & Ownership Group

Note that the bimodal distribution of total growing stock inventory by age class (see Figure 9 on pg. 28) is also influenced by the differing approaches to timber management (i.e. private versus public land management).

Figure 10 shows total growing stock inventory on timberland in the Enviva Cottondale catchment area by both age class and ownership group. According to USFS data, two-thirds of total growing stock inventory on privately-owned timberland is 50 years of age or younger. Specifically, looking at Figure 10(a) below, the high distribution of privately-owned timber inventory between 0 and 40 years of age is largely a reflection of the working forest area in the Enviva Cottondale catchment area, which is predominantly pine forest with shorter rotation lengths (typically less than 35 years).

On the other hand, 70% of growing stock inventory on public timberland is older than 50 years of age. Specifically, 57% of public timber inventory is 56-90 years of age (see Figure 10(b)). In general, the US Forest Service manages public timberland on a maximum sustained yield basis, which for softwood (pine) timber translates to rotation lengths in excess of 50 years. So, looking back at Figure 9 on page 28, the bimodal distribution of timber inventory (softwood inventory in particular) reflects not only the private working forest area but also publicly owned and managed forests in the Enviva Cottondale catchment area.

***Figure 10**. Enviva Cottondale Catchment Area - Distribution of Growing Stock Volume on Timberland by Age Class & Major Ownership Group (2020)*



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 65% of total growing stock volume in the catchment area, or 148 million m^3, is naturally regenerated timber, compared to 35% (80 million m^3) planted. However, stand origin distribution varies widely by major species group.

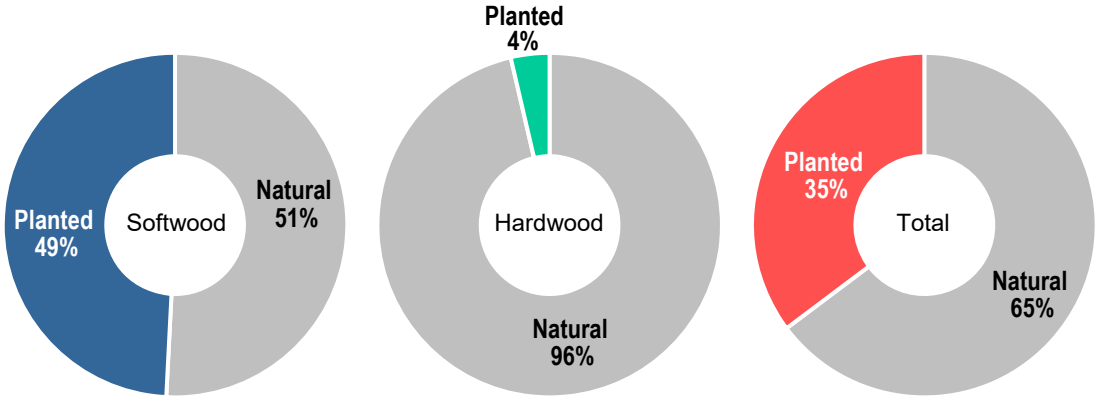
US Forest Service data shows approximately 51% (80 million m^3) of softwood growing stock inventory is naturally regenerated versus 49% (77 million m^3) planted. In contrast, approximately 96% (67 million m^3) of hardwood inventory is naturally regenerated, compared to 4% (3 million m^3) planted.

***Table 11**. Enviva Cottondale 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	80,417	51%	66,932	96%	147,811	65%
Planted	77,264	49%	2,789	4%	79,591	35%
Total	**157,681**	**100%**	**69,721**	**100%**	**227,402**	**100%**

Source: USDA - US Forest Service

***Figure 11**. Enviva Cottondale 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 Cottondale catchment area totaled an estimated 11.8 million m^3 in 2020, the latest available. Specifically, 81% (9.6 million m^3) of total growth was attributed to softwood species compared to 19% (2.2 million m^3) hardwood species.

Annual growth was highest for pine pulpwood, totaling 3.9 million m^3 and accounting for 33% of total volume growth, followed by pine sawtimber at 3.0 million m^3 (26%), pine chip-n-saw at 2.7 million m^3 (22%), hardwood pulpwood at 1.4 million m^3 (12%), and hardwood sawtimber at 0.8 million m^3 (7%).

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

Product	Volume Growth (000 m^3)	% of Total Growth
Pine Sawtimber	3,032	26%
Pine Chip-n-saw	2,650	22%
Pine Pulpwood	3,943	33%
Hardwood Sawtimber	832	7%
Hardwood Pulpwood	1,382	12%
Total	**11,839**	**100%**

Source: USDA - US Forest Service

3.3.2 *Timber Removals*

According to the USFS, timber removals in the catchment area totaled 8.7 million m^3 in 2020, of which approximately 89% (7.8 million m^3) was softwood timber and 11% (0.9 million m^3) was hardwood timber.

Of the five major timber products, removals were highest for pine pulpwood, totaling 3.1 million m^3 and accounting for 36% of total removals, followed by pine sawtimber at 2.4 million m^3 (27%), pine chip-n-saw at 2.3 million m^3 (26%), hardwood sawtimber at 0.5 million m^3 (6%), and hardwood pulpwood at 0.4 million m^3 (5%).

***Table 13**. Enviva Cottondale Catchment Area - Timber Removals by Major Timber Product (2020)*

Product	Removals (000 m^3)	% of Total Removals
Pine Sawtimber	2,364	27%
Pine Chip-n-saw	2,303	26%
Pine Pulpwood	3,137	36%
Hardwood Sawtimber	511	6%
Hardwood Pulpwood	404	5%
Total	**8,718**	**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 11.8 million m^3, compared to total removals of 8.7 million m^3, or a growth-to-removals ratio of 1.36. The growth-to-removal ratio for softwood species was 1.23 versus 2.42 for hardwood species.

Growth-to-removals ratios by species and individual timber product in 2020 were as follows: pine sawtimber=1.28, pine chip-n-saw=1.15, pine pulpwood=1.26, hardwood sawtimber=1.63, and hardwood pulpwood=3.42[2]. 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**. Enviva Cottondale 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	3,032	2,364	1.28
Pine Chip-n-saw	2,650	2,303	1.15
Pine Pulpwood	3,943	3,137	1.26
Softwood (Pine) Total	**9,625**	**7,804**	**1.23**

Hardwood	Growth (000 m^3)	Removals (000 m^3)	G:R Ratio
Hardwood Sawtimber	832	511	1.63
Hardwood Pulpwood	1,382	404	3.42
Hardwood Total	**2,214**	**915**	**2.42**

Product	Growth (000 m^3)	Removals (000 m^3)	G:R Ratio
Sawtimber	6,514	5,178	1.26
Pulpwood	5,326	3,541	1.50
Total	**11,839**	**8,718**	**1.36**

Source: USDA - US Forest Service

[2] Note that the harvest of hardwood pulpwood is limited because much of the hardwood in this catchment area is located alongside rivers, creeks, and streams (in SMZs). Also, some of these hardwood areas, particularly in Florida, are under conservation protection. Consumption of hardwood pulpwood could be increased to a certain extent, but these limitations/restrictions make it difficult for hardwood pulpwood consumption (by either the pulp/paper or bioenergy industries) to be drastically increased in the catchment area.

4. Wood Demand & Raw Material Cost Assessment

4.1 Mill Capacity & Wood Demand

According to TimberMart-South's mill database, as of May 2021, there were 100 wood-consuming mills operating in or around the Enviva Cottondale catchment area (within roughly 275 kilometers of the Cottondale mill). This includes 46 lumber mills (41 softwood mills and 5 hardwood mills), 17 pulp/paper mills, 21 panel (plywood/OSB) mills, 11 chip mills, and 5 pellet mills.

Total production capacity associated with these 100 mills translates to over 62 million metric tons of roundwood per year. However, not all wood consumed by these mills are procured from within the Enviva Cottondale catchment area. Based on the relative location of these mills to this catchment area, total annual wood demand allocated to the Enviva Cottondale catchment area by these mills is estimated at approximately 13,300,000 metric tons of roundwood.

***Table 15**. Enviva Cottondale 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	46	19,742,459	4,787,994
Pulp / Paper	17	28,788,366	4,761,513
Plywood / OSB	21	7,426,358	1,914,860
Chip	11	2,588,063	588,345
Pellet	5	4,055,117	1,237,265
Total	**100**	**62,600,363**	**13,289,977**

*Roundwood equivalent volume

Source: TimberMart-South; Hood Consulting

***Table 16**. Enviva Cottondale Catchment Area - Mill List (2021)*

Mill Name / Company	City	County	State	Capacity	Units	Demand
		Softwood Sawmill				
Millry Mill	Millry	Washington	AL	14	MM Bf	110,180
Thomasville Lumber	Thomasville	Clarke	AL	17	MM Bf	133,790
Swift Lumber	Atmore	Escambia	AL	25	MM Bf	196,750
Hubert Moore Lumber	Alapaha	Berrien	GA	25	MM Bf	196,750
Great South Timber and Lumber	Lake City	Columbia	FL	29	MM Bf	228,230
Dudley Lumber	Salem	Lee	AL	30	MM Bf	236,100
Abbeville Fiber	Abbeville	Henry	AL	50	MM Bf	230,500
Phenix Lumber	Phenix City	Russell	AL	53	MM Bf	244,330
Cross City Lumber	Cross City	Dixie	FL	60	MM Bf	258,600
Griffin Lumber	Cordele	Crisp	GA	63	MM Bf	290,430
Canfor	Thomasville	Thomas	GA	65	MM Bf	299,650
East Alabama Lumber	Lafayette	Chambers	AL	66	MM Bf	304,260
Canfor	Moultrie	Colquitt	GA	71	MM Bf	327,310
Coastal Forest Resources	Chapman	Butler	AL	71	MM Bf	327,310
Hood Industries	Metcalf	Thomas	GA	75	MM Bf	345,750
West Fraser	McDavid	Escambia	FL	76	MM Bf	350,360
Georgia-Pacific	Monroeville	Monroe	AL	91	MM Bf	419,510
Rex Lumber	Bristol	Liberty	FL	95	MM Bf	437,950
West Fraser	Fitzgerald	Ben Hill	GA	98	MM Bf	451,780
West Fraser	Dudley	Laurens	GA	100	MM Bf	431,000
Rex Lumber	Graceville	Jackson	FL	104	MM Bf	448,240
West Fraser	Maplesville	Chilton	AL	107	MM Bf	461,170
T.R. Miller Mill	Brewton	Escambia	AL	108	MM Bf	465,480
Harrigan Lumber	Monroeville	Monroe	AL	109	MM Bf	469,790
M.C. Dixon Lumber	Eufaula	Barbour	AL	110	MM Bf	474,100
West Fraser	Perry	Taylor	FL	113	MM Bf	487,030
Spanish Trail Lumber	Cypress	Jackson	FL	119	MM Bf	512,890
Canfor	Jackson	Clarke	AL	120	MM Bf	517,200
Jordan Lumber and Supply	Barnesville	Lamar	GA	120	MM Bf	517,200
Langdale Forest Products	Valdosta	Lowndes	GA	135	MM Bf	581,850
Interfor	Perry	Houston	GA	142	MM Bf	612,020
Canfor	Mobile	Mobile	AL	147	MM Bf	633,570
WestRock	Cottonton	Russell	AL	153	MM Bf	659,430
Resolute Forest Products	Cross City	Dixie	FL	155	MM Bf	668,050
Interfor	Thomaston	Upson	GA	170	MM Bf	732,700
West Fraser	Opelika	Lee	AL	170	MM Bf	783,700
Canfor	Fulton	Clarke	AL	171	MM Bf	737,010
Interfor	Preston	Webster	GA	223	MM Bf	961,130
Rex Lumber	Troy	Pike	AL	240	MM Bf	1,034,400
Georgia-Pacific	Albany	Dougherty	GA	300	MM bf	1,293,000
Binderholz	Live Oak	Suwannee	FL	350	MM Bf	1,508,500
		Hardwood Sawmill				
Big River Cypress and Hardwood	Blountstown	Calhoun	FL	10	MM Bf	71,700
Oak Crest Lumber	Buena Vista	Marion	GA	14	MM Bf	100,380
Southern Forest Industries	Smarr	Monroe	GA	38	MM Bf	257,640
Thompson Hardwoods	Hazlehurst	Jeff Davis	GA	43	MM Bf	308,310
Beasley Forest Products	Hazlehurst	Jeff Davis	GA	90	MM Bf	645,300
		Plywood/Panel Mill				
Langboard Inc.	Willacoochee	Atkinson	GA	-	MM SqFt	-
Chattahoochee Veneer	Eufaula	Barbour	AL	25	MM SqFt	48,750
Browder Veneer Works	Montgomery	Montgomery	AL	25	MM SqFt	48,750
Browder Veneer Co.	Camden	Wilcox	AL	25	MM SqFt	48,750
Browder & Son Veneer Co.	Thomasville	Clarke	AL	25	MM SqFt	48,750
Cross City Veneer Co.	Cross City	Dixie	FL	25	MM SqFt	48,750
Howell Plywood Corp	Dothan	Houston	AL	25	MM SqFt	-

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

Mill Name / Company	City	County	State	Capacity	Units	Demand
		Plywood/Panel Mill (cont.)				
H.E. Browder Veneer Co.	Petrey	Crenshaw	AL	25	MM SqFt	48,750
Capital Veneer Works	Montgomery	Montgomery	AL	25	MM SqFt	48,750
Scotch Plywood	Fulton	Clarke	AL	50	MM SqFt	97,500
Southern Veneer Products	Fitzgerald	Ben Hill	GA	66	MM SqFt	127,969
Boise Cascade	Thorsby	Chilton	AL	125	MM SqFt	243,750
Sierra Pine	Adel	Cook	GA	138	MM SqFt	-
Coastal Lumber Co.	Havana	Gadsden	FL	215	MM SqFt	419,250
Langboard Inc.	Quitman	Brooks	GA	275	MM SqFt	503,250
Coastal Forest Resources	Chapman	Butler	AL	304	MM SqFt	593,531
Scotch Plywood	Beatrice	Monroe	AL	359	MM SqFt	699,563
Georgia-Pacific	Warm Springs	Meriwether	GA	406	MM SqFt	790,969
Georgia-Pacific	Hosford	Liberty	FL	598	MM SqFt	1,093,425
Louisiana-Pacific	Thomasville	Clarke	AL	750	MM SqFt	1,372,500
West Frazer	Cordele	Crisp	GA	1,040	MM SqFt	1,903,200
		Pulp/Paper Mill				
International Paper	Oglethorpe	Macon	GA	350	M tons	1,256,500
Georgia-Pacific	Perdue Hill	Monroe	AL	432	M tons	1,550,880
Georgia-Pacific	Brewton	Escambia	AL	464	M tons	-
Packaging Corporation of America	Jackson	Clarke	AL	469	M tons	1,683,710
International Paper	Cantonment	Escambia	FL	500	M tons	1,795,000
Georgia-Pacific	Perry	Taylor	FL	510	M tons	1,830,900
Graphic Packaging	Macon	Bibb	GA	548	M tons	1,967,320
WestRock	Dublin	Laurens	GA	585	M tons	2,100,150
International Paper	Selma	Dallas	AL	600	M tons	2,154,000
Packaging Corporation of America	Valdosta	Lowndes	GA	604	M tons	2168,360
WestRock	Panama City	Bay	FL	645	M tons	2,315,550
International Paper	Pine Hill	Wilcox	AL	870	M tons	3,123,300
International Paper	Prattville	Autauga	AL	1,051	M tons	3,773,090
WestRock	Phenix City	Russell	AL	1,066	M tons	3,826,940
Georgia-Pacific	Cedar Springs	Early	GA	1,185	M tons	4,254,150
Georgia-Pacific	Perdue Hill	Monroe	AL	1,253	M tons	4,498,270
		Chip Mill				
Green Valley Chipping	Brundidge	Pike	AL	-	M tons	-
Macon Chips Inc.	Macon	Bibb	GA	-	M tons	-
Shuler Bros. Chip Co.	Opp	Covington	AL	-	M tons	-
Georgia-Pacific	Jackson's Gap	Tallapoosa	AL	-	M tons	-
Price Industries	Valdosta	Lowndes	GA	-	M tons	-
Reynolds Wood Products	Maplesville	Chilton	AL	17	M tons	17,850
American Wood Fibre	Montgomery	Montgomery	AL	150	M tons	157,500
Southern Wood Suppliers	Oglethorpe	Macon	GA	200	M tons	210,000
Georgia-Pacific	Elba	Coffee	AL	250	M tons	262,500
Price Industries	Cairo	Grady	GA	300	M tons	315,000
Rayonier Advanced Materials	Eastman	Dodge	GA	350	M tons	367,500
Rayonier Advanced Materials	Barnesville	Lamar	GA	350	M tons	367,500
Price Industries	Abbeville	Henry	AL	375	M tons	393,750
Price Industries	Brewton	Escambia	AL	1,100	M tons	1,155,000
		Pellet Mill				
Rockwood Pellets	The Rock	Upson	GA	15	M tons	-
Zilkha Biomass Energy	Selma	Dallas	AL	275	M tons	550,000
Fram Renewable Fuels	Hazlehurst	Jeff Davis	GA	550	M tons	1,100,000
Enviva Biomass	Cottondale	Jackson	FL	660	M tons	1,320,000
Enviva Biomass	Waycross	Ware	GA	750	M tons	1,500,000

***Figure 12**. Enviva Cottondale Catchment Area - Mill Map (2021)*

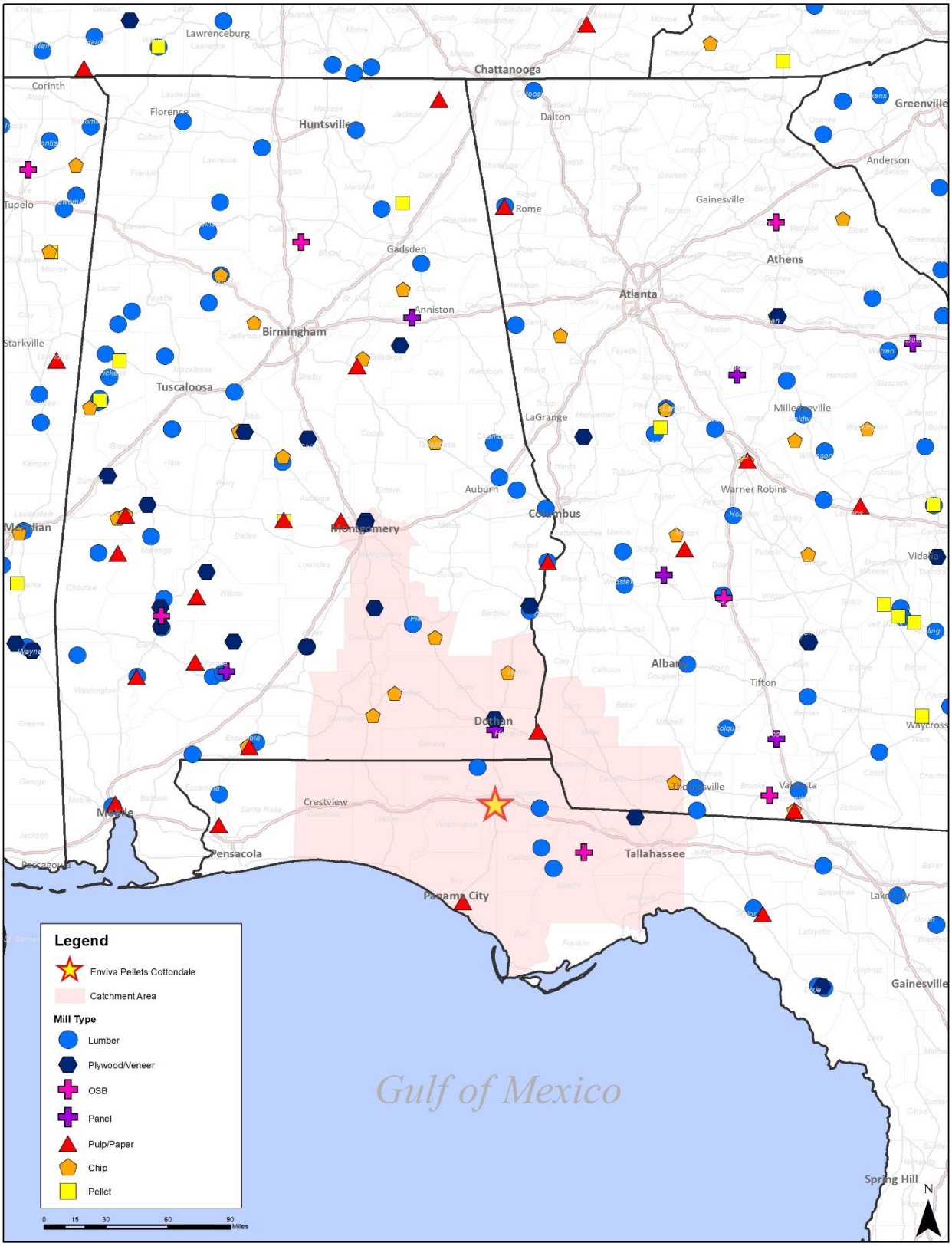


***Figure 13**. Enviva Cottondale Catchment Area - Lumber Mills (2021)*

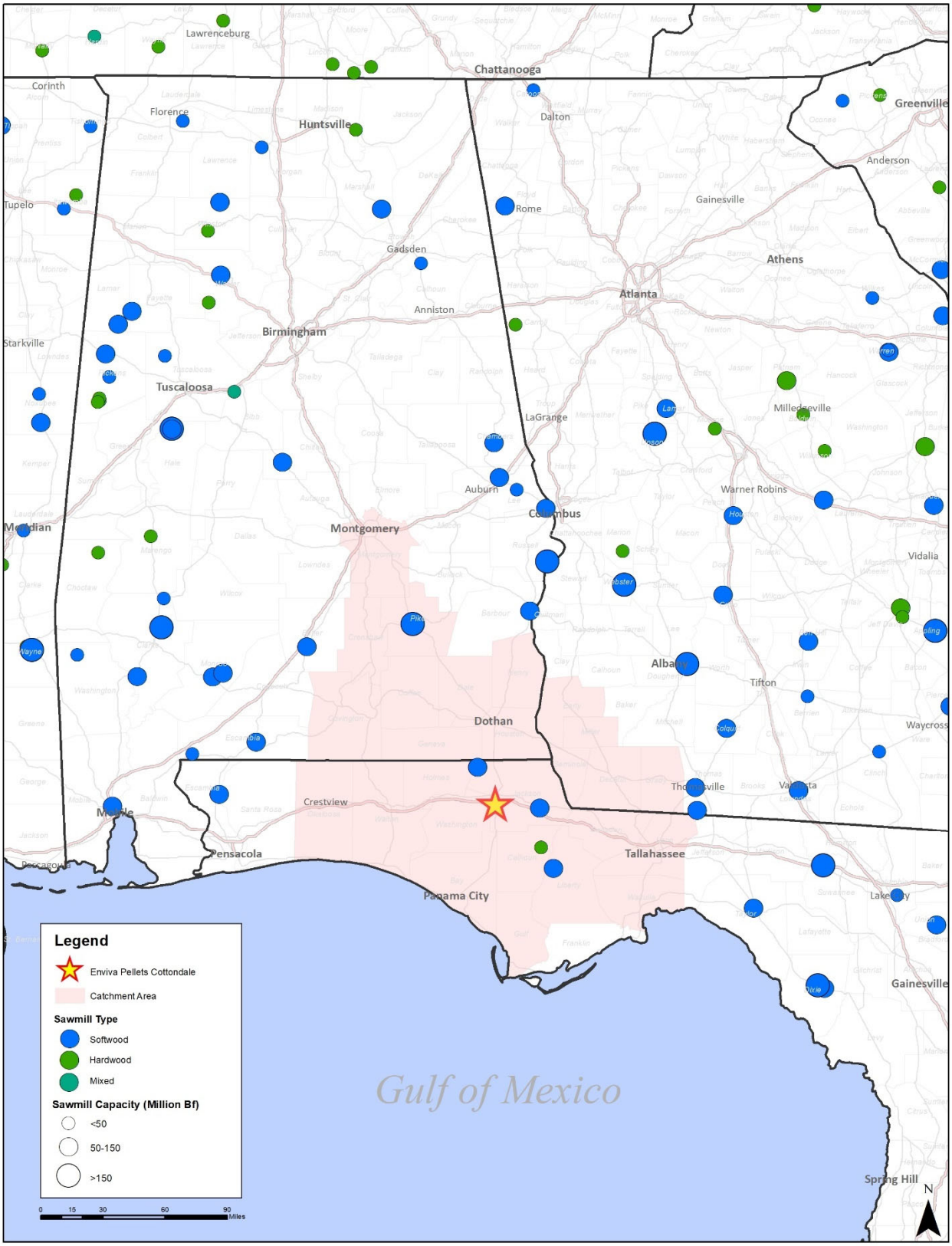


***Figure 14**. Enviva Cottondale Catchment Area - Panel Mills (2021)*

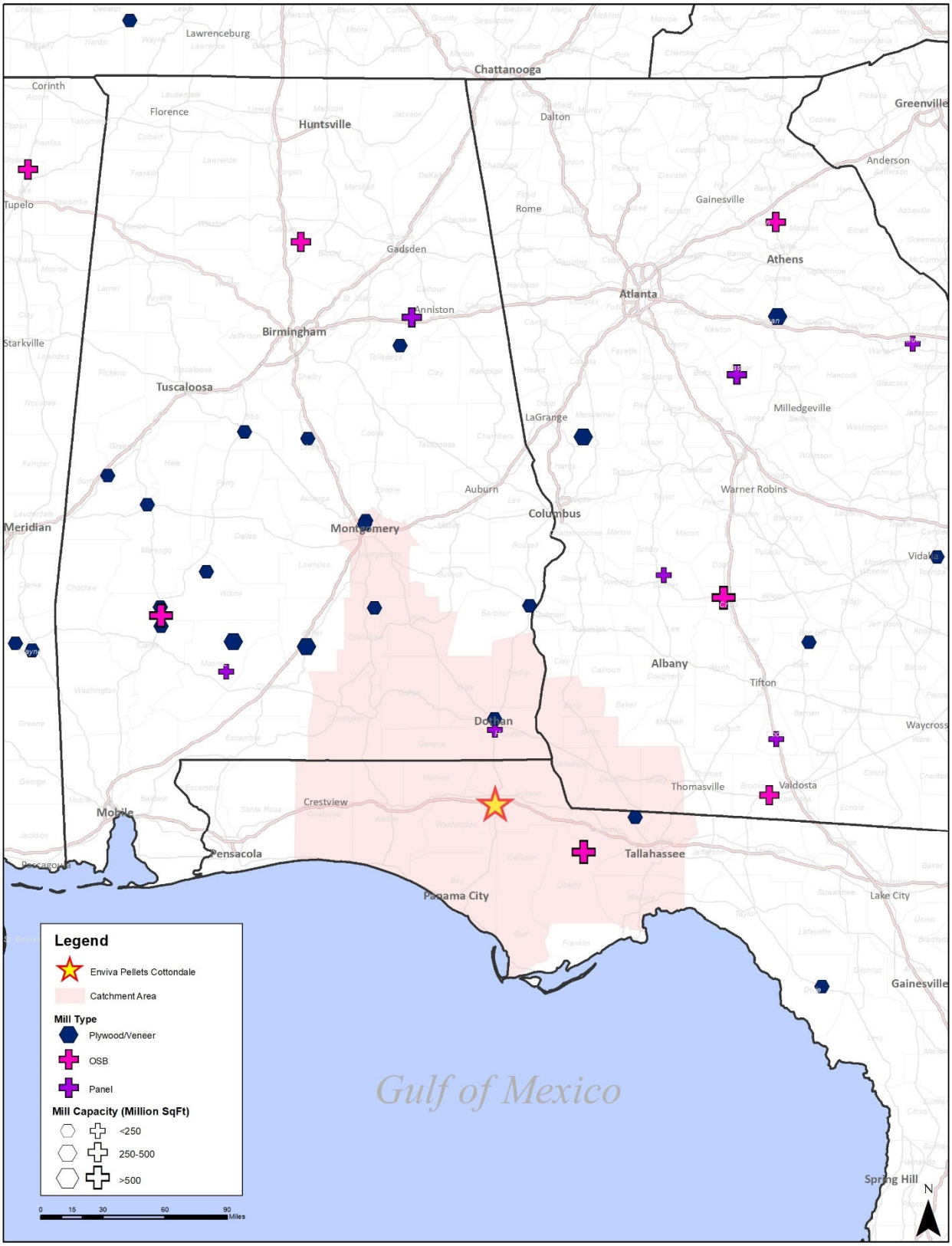
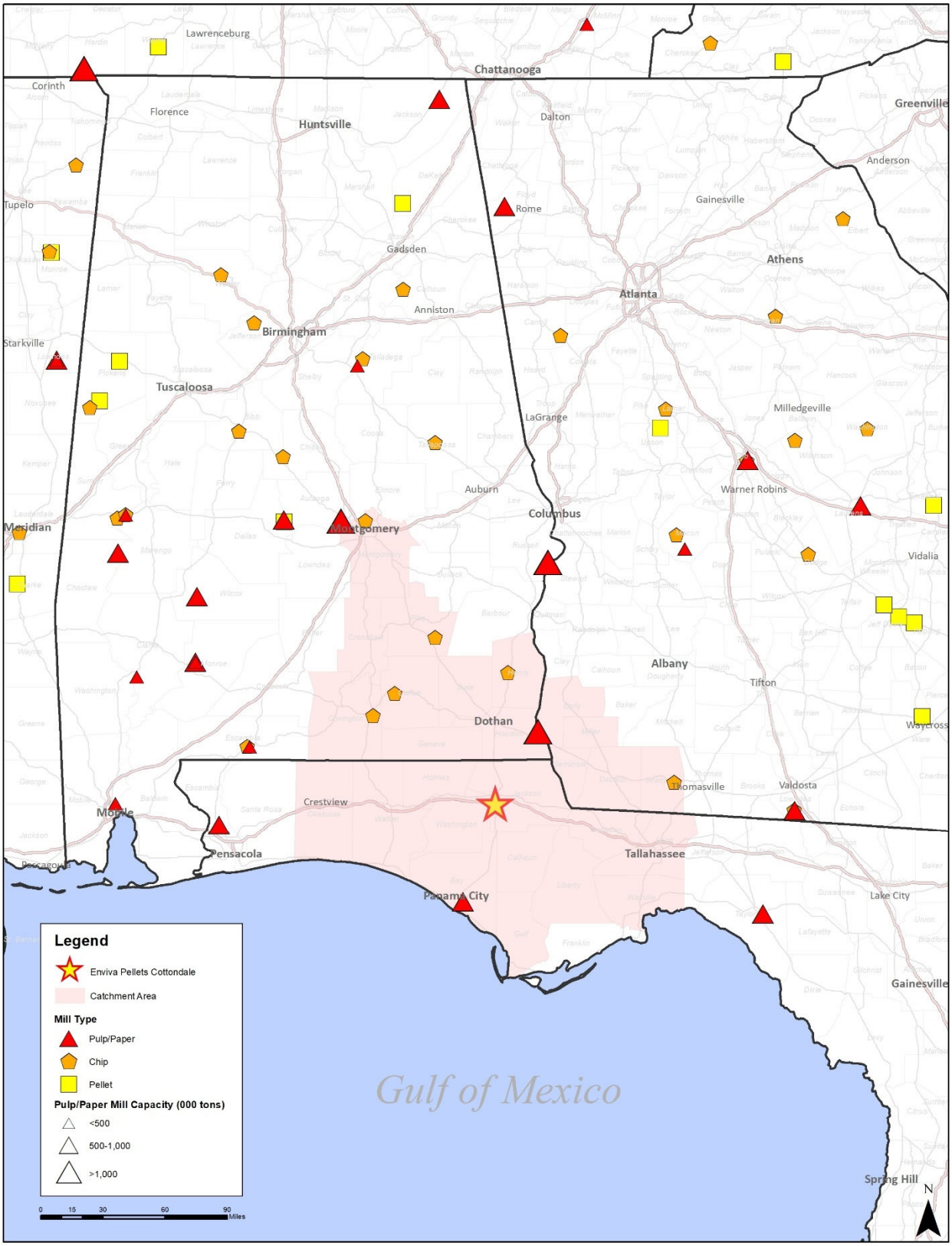


***Figure 15**. Enviva Cottondale Catchment Area - Pulp/Paper, Pellet, & Chip Mills (2021)*



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 13.3 million metric tons annually, actual wood demand[3] in the Enviva Cottondale catchment area in 2020, the latest available, was estimated at 10.1 million metric tons.

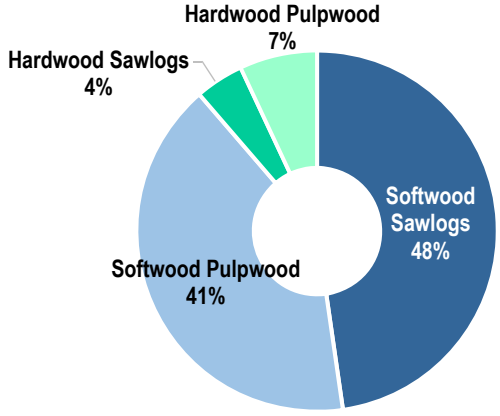
Distribution of total wood demand by major species in 2020 included 89% (9.0 million metric tons) softwood versus 11% (1.1 million metric tons) hardwood. Specifically, 46% of total softwood demand was attributed to softwood pulpwood compared to 54% softwood sawlogs. Conversely, of total hardwood demand, 62% was attributed to hardwood pulpwood versus 38% hardwood sawlogs.

***Table 17**. Enviva Cottondale Catchment Area - Wood Demand (2020)*

Major Species / Product	Demand (Metric Tons)	% of Total
Softwood:		
Sawlogs	4,823,678	48%
Pulpwood	4,142,500	41%
Softwood Total	*8,966,178*	*89%*
Hardwood:		
Sawlogs	440,643	4%
Pulpwood	703,974	7%
Hardwood Total	*1,144,616*	*11%*
Total	**10,110,794**	**100%**

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

***Figure 16**. Enviva Cottondale Catchment Area - Distribution of Wood Demand by Major Species & Product (2020)*



[3] Wood demand estimates for the Enviva Cottondale 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 780,615 metric tons in 2020, the latest available, accounting for approximately 16% of total pulpwood demand (and 8% of total wood demand) in the catchment area. Non-bioenergy related pulpwood demand, almost entirely attributed to the pulp/paper industry, accounted for approximately 84% of total pulpwood demand in the catchment area.

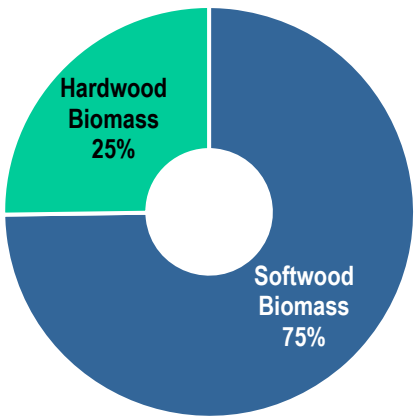
Note that not all wood consumed by a pellet mill or other bioenergy facility is encompassed in biomass demand. Wood consumption (demand) at pellet and other bioenergy facilities generally includes a combination of roundwood, wood chips, and sawmill residuals. However, sawmill residuals are a by-product 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**. Enviva Cottondale Catchment Area - Biomass Demand & Total Pulpwood Demand (2020)*

Product	Demand (Metric Tons)	% of Total
Softwood Pulpwood:		
Biomass	583,761	12%
Other Pulpwood	3,558,739	73%
Softwood Pulpwood Total	*4,142,500*	*85%*
Hardwood Pulpwood:		
Biomass	196,854	4%
Other Pulpwood	507,120	10%
Hardwood Pulpwood Total	*703,974*	*15%*
Total Pulpwood	**4,846,473**	**100%**

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

***Figure 17**. Enviva Cottondale 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 Enviva Cottondale 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.

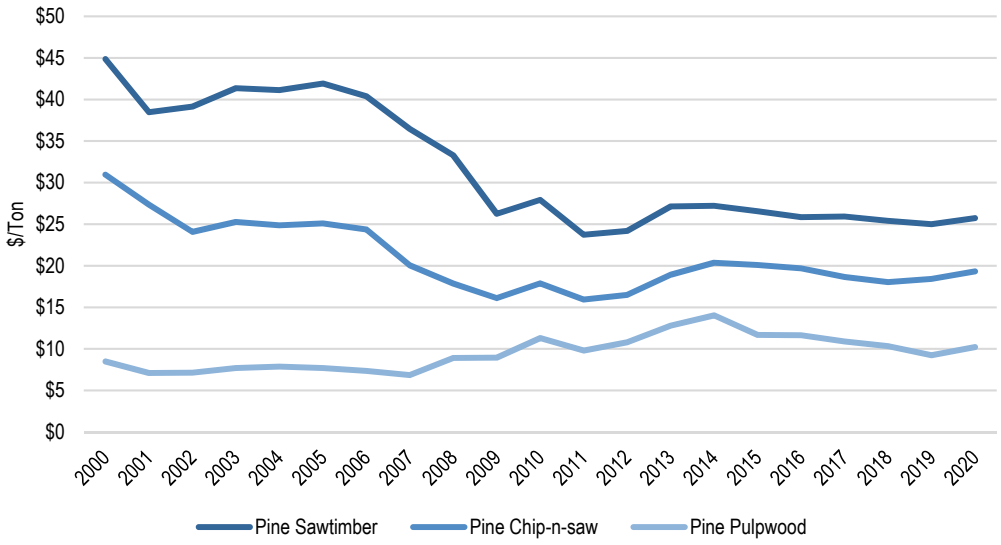
Table 19 below provides annual average stumpage prices in the Enviva Cottondale catchment area for each of the five major timber products since 2000. Prices are also shown graphically in Figure 18 on the following page. For a detailed assessment of these prices and historic trends, see the *Market Trends, Analysis, & Outlook* section beginning on page 54.

***Table 19**. Enviva Cottondale Catchment Area – Annual Stumpage Prices ($/Ton)*

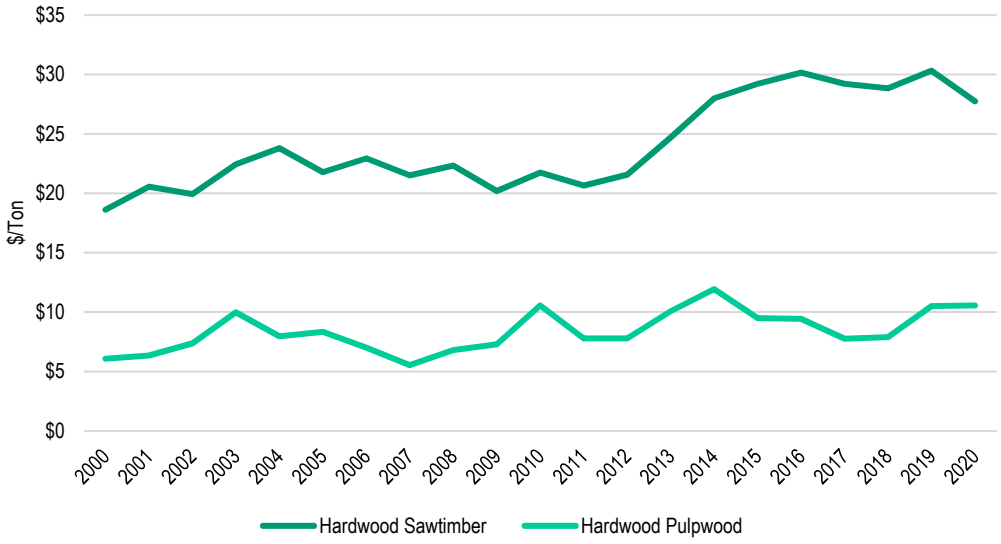
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
			($/Ton)		
2000	$44.86	$30.96	$8.49	$18.62	$6.07
2001	$38.46	$27.34	$7.10	$20.55	$6.34
2002	$39.15	$24.07	$7.13	$19.93	$7.37
2003	$41.35	$25.26	$7.69	$22.44	$9.97
2004	$41.12	$24.87	$7.88	$23.79	$7.95
2005	$41.93	$25.09	$7.69	$21.78	$8.34
2006	$40.37	$24.36	$7.35	$22.94	$6.99
2007	$36.44	$20.06	$6.85	$21.51	$5.53
2008	$33.28	$17.87	$8.91	$22.33	$6.80
2009	$26.25	$16.10	$8.95	$20.20	$7.28
2010	$27.92	$17.87	$11.31	$21.74	$10.56
2011	$23.73	$15.94	$9.79	$20.64	$7.79
2012	$24.20	$16.49	$10.80	$21.56	$7.78
2013	$27.13	$18.92	$12.79	$24.70	$10.08
2014	$27.21	$20.36	$14.03	$27.99	$11.93
2015	$26.55	$20.09	$11.69	$29.22	$9.49
2016	$25.84	$19.70	$11.65	$30.16	$9.42
2017	$25.92	$18.65	$10.89	$29.21	$7.76
2018	$25.41	$18.03	$10.33	$28.84	$7.89
2019	$25.00	$18.42	$9.23	$30.32	$10.50
2020	$25.73	$19.32	$10.22	$27.75	$10.55

Source: TimberMart-South

***Figure 18**. Enviva Cottondale 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.

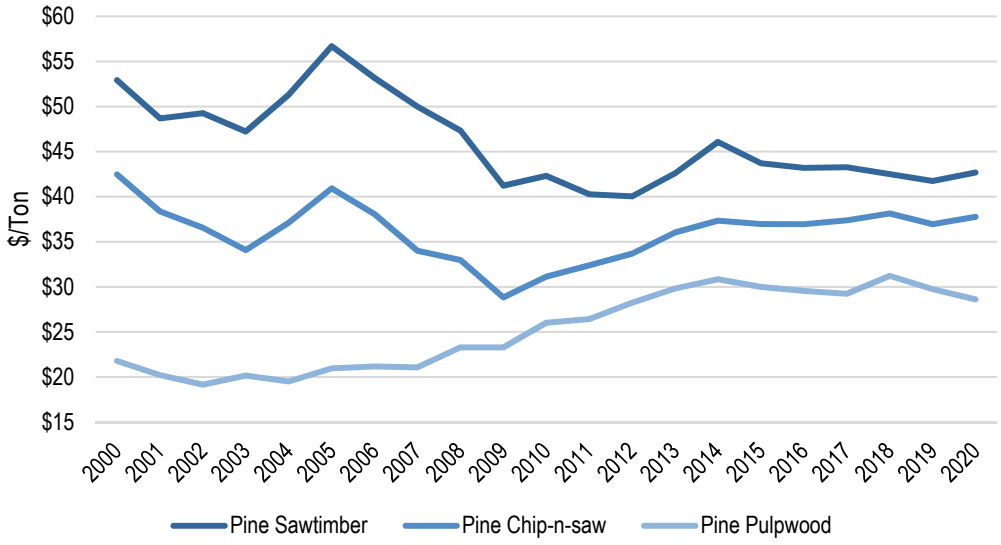
Table 20 below provides annual average delivered timber prices in the Enviva Cottondale catchment area for each of the five major timber products since 2000. Prices are also shown graphically in Figure 19 on the following page. For a detailed assessment of these prices and historic trends, see the *Market Trends, Analysis, & Outlook* section beginning on page 54.

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

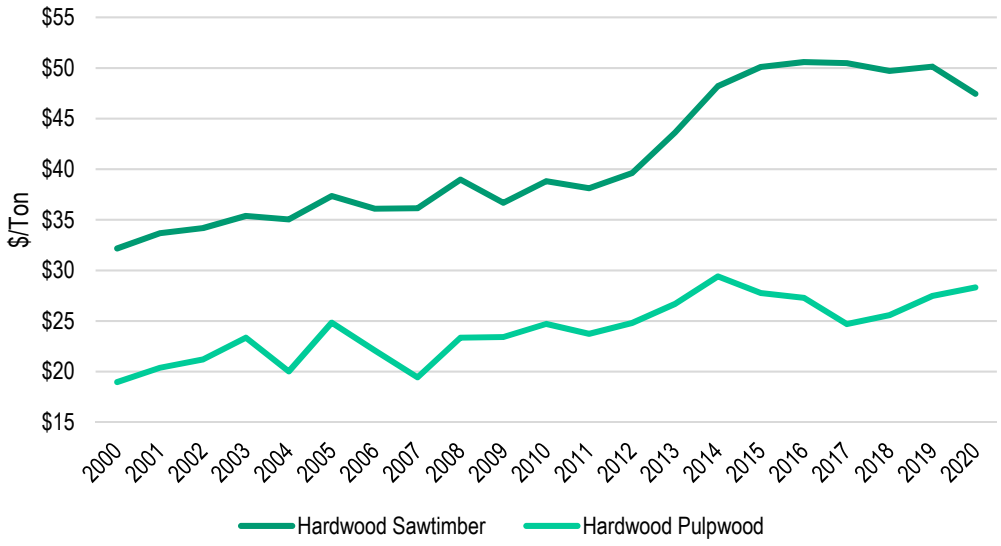
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
			($/Ton)		
2000	$52.91	$42.46	$21.78	$32.17	$18.97
2001	$48.67	$38.37	$20.21	$33.68	$20.38
2002	$49.26	$36.55	$19.16	$34.18	$21.20
2003	$47.23	$34.08	$20.16	$35.39	$23.36
2004	$51.30	$37.10	$19.51	$35.04	$20.02
2005	$56.69	$40.92	$20.97	$37.34	$24.84
2006	$53.17	$38.07	$21.17	$36.09	$22.10
2007	$49.99	$34.00	$21.06	$36.15	$19.43
2008	$47.32	$32.97	$23.29	$38.98	$23.36
2009	$41.22	$28.83	$23.29	$36.68	$23.42
2010	$42.32	$31.14	$26.02	$38.81	$24.71
2011	$40.26	$32.39	$26.43	$38.12	$23.73
2012	$40.03	$33.68	$28.24	$39.62	$24.81
2013	$42.59	$36.03	$29.82	$43.62	$26.69
2014	$46.07	$37.34	$30.85	$48.21	$29.41
2015	$43.71	$36.96	$29.99	$50.10	$27.77
2016	$43.19	$36.94	$29.54	$50.58	$27.30
2017	$43.27	$37.37	$29.24	$50.49	$24.69
2018	$42.51	$38.13	$31.22	$49.71	$25.58
2019	$41.75	$36.95	$29.74	$50.14	$27.49
2020	$42.69	$37.77	$28.62	$47.45	$28.33

Source: TimberMart-South

***Figure 19**. Enviva Cottondale 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.

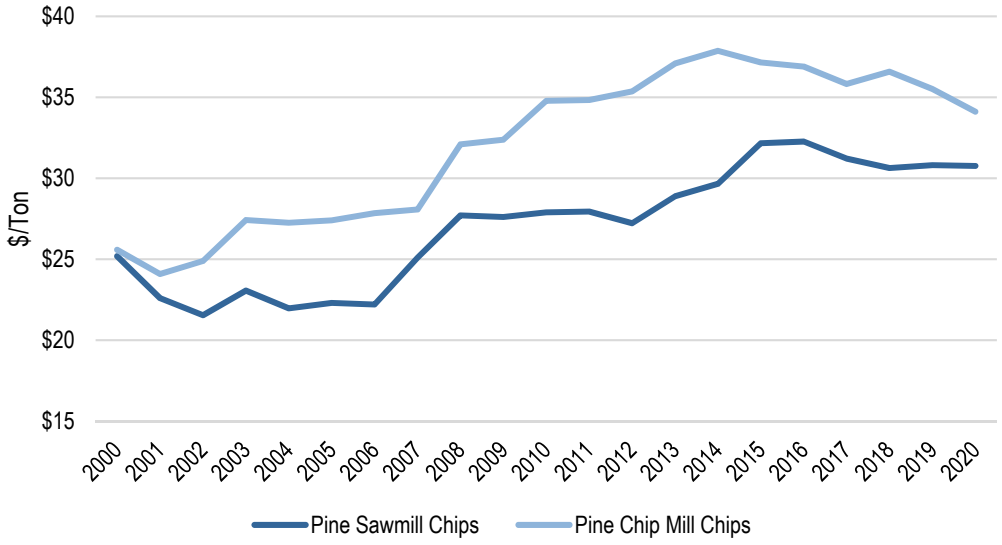
Table 21 below provides annual average pulp quality chip prices in the Enviva Cottondale catchment area since 2000. Prices are also shown graphically in Figure 20 on the following page. For a detailed assessment of these prices and historic trends, see the *Market Trends, Analysis, & Outlook* section beginning on page 54.

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

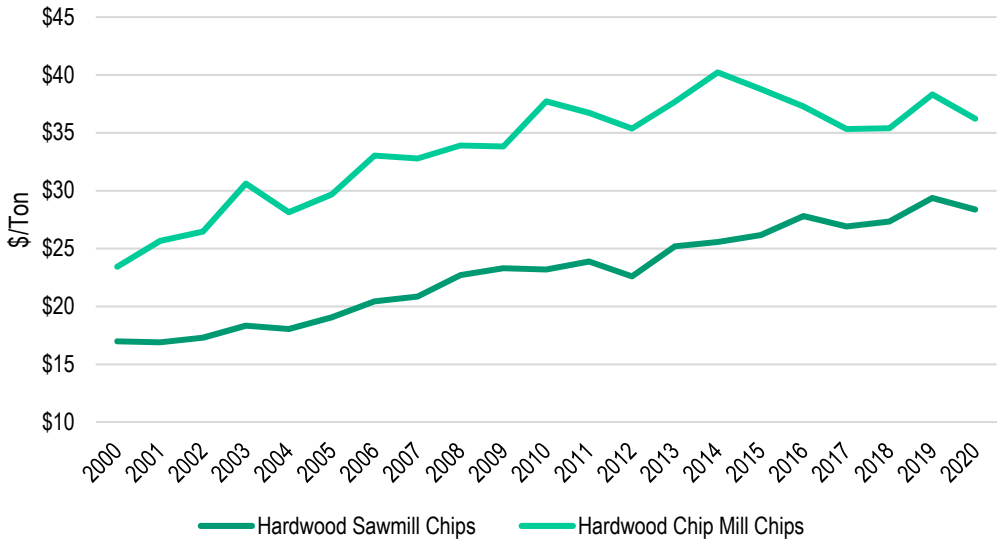
Year	Pine Sawmill Chips	Hardwood Sawmill Chips	Pine Chip Mill Chips	Hardwood Chip Mill Chips
		($/Ton – FOB point of production)		
2000	$25.19	$16.98	$25.58	$23.44
2001	$22.60	$16.90	$24.09	$25.66
2002	$21.54	$17.31	$24.89	$26.48
2003	$23.07	$18.34	$27.42	$30.62
2004	$21.97	$18.05	$27.26	$28.15
2005	$22.30	$19.06	$27.40	$29.68
2006	$22.20	$20.45	$27.84	$33.04
2007	$25.10	$20.85	$28.07	$32.79
2008	$27.71	$22.71	$32.10	$33.91
2009	$27.61	$23.31	$32.39	$33.83
2010	$27.90	$23.20	$34.79	$37.73
2011	$27.94	$23.89	$34.84	$36.73
2012	$27.22	$22.60	$35.36	$35.37
2013	$28.89	$25.20	$37.09	$37.69
2014	$29.65	$25.57	$37.87	$40.22
2015	$32.17	$26.16	$37.15	$38.78
2016	$32.27	$27.81	$36.90	$37.28
2017	$31.22	$26.92	$35.82	$35.33
2018	$30.63	$27.34	$36.58	$35.40
2019	$30.81	$29.37	$35.52	$38.32
2020	$30.76	$28.38	$34.11	$36.23

Source: TimberMart-South

***Figure 20**. Enviva Cottondale Catchment Area – Annual Pulp Quality Chip Prices (2000-2020)*



(a) Pine Chip Prices

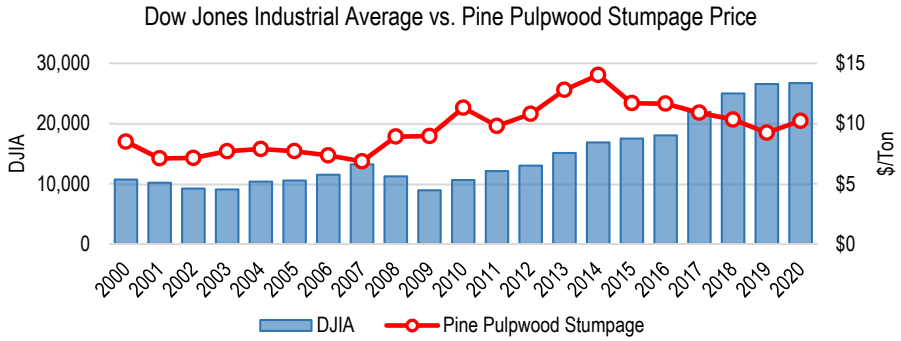


(b) Hardwood Chip Prices

4.2.4 *Timber Price Drivers*

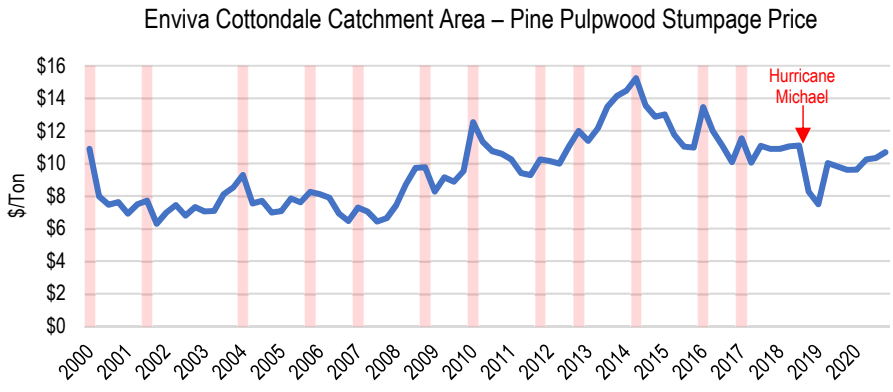
A detailed assessment of raw material prices and price trends is provided in the *Market Trends, Analysis, & Outlook* section beginning on page 54. However, we would like to point out and highlight some of the major price drivers of pine pulpwood – the predominant roundwood product consumed by the bioenergy sector in the Enviva Cottondale catchment area.

- Domestic Economy. The state of the domestic economy, historically, has been a strong indicator of timber prices in both the Enviva Cottondale catchment area and across the South. Financial markets generally reflect economic conditions, and the figure below shows that pine pulpwood stumpage prices in the catchment area have generally tracked the Dow Jones Industrial Average (DJIA) since 2000. However, pine pulpwood prices and the DJIA have deviated from one another slightly over the last several years, as both Hurricane Michael and the COVID-19 pandemic have had an impact on this particular pulpwood market.



Source: US Federal Reserve Bank, TimberMart-South

- 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. And, 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. In turn, with supply no longer an issue, timber prices decline in the short term (typically during the 2nd or 3rd quarter of the year).



Source: TimberMart-South

The Enviva Cottondale catchment area is also impacted periodically by hurricanes and tropical storms, with hurricane season typically occurring between July and October (3rd and 4th quarters of the year). These storms can bring heavy rainfall that constrain wood supply, driving prices upward in the short term. However, tropical storms with extremely high winds can also cause extensive forest damage, resulting in short-term oversupply from wood salvage and driving prices downward.

The figure on the proceeding page shows quarterly average pine pulpwood stumpage prices in the Cottondale catchment from 1Q 2000 through 4Q 2020, with seasonal weather-related price spikes highlighted in red. Note that of the 10 of the 12 seasonal spikes (83%) identified in this figure occurred in either the 1st or 4th quarter of the year. However, also note the impact of Hurricane Michael, whose destruction resulted in a roughly 30% decrease in pine pulpwood stumpage prices in the two quarters that directly followed this major storm.

- Competition. In the Cottondale 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 15 pine pulpwood-consuming pulp/paper mills located within roughly 250 kilometers of the Enviva Cottondale mill that together consume more than 23 million metrictons 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 Georgia catchment area and surrounding markets have changed since 2000. Specifically, we examined trends related to total sale volume, sale area (i.e. 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.

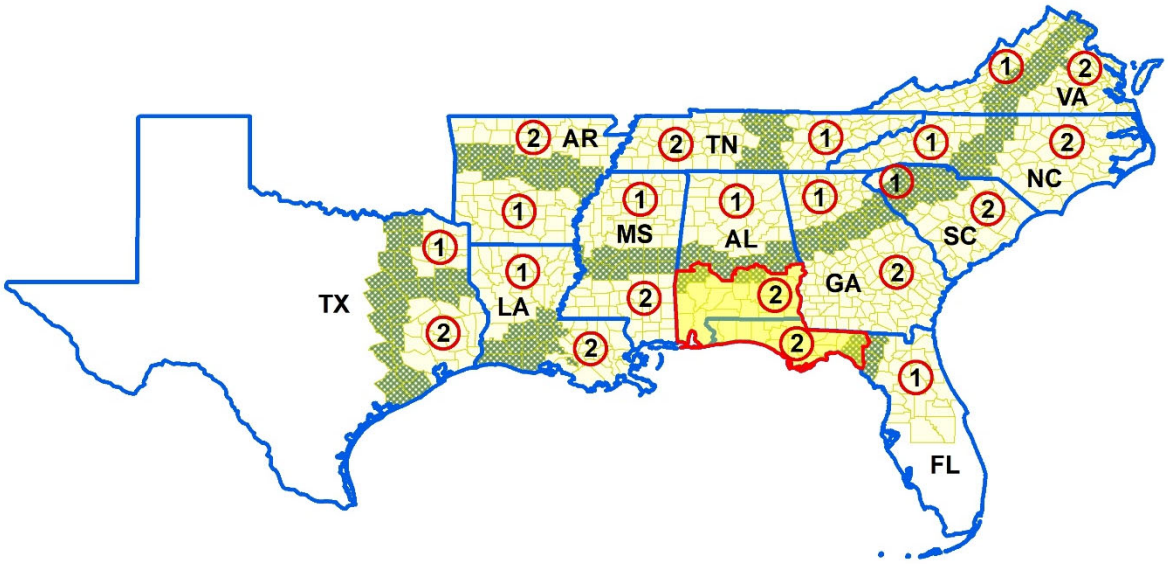
5.1 TimberMart-South Harvest Trends

The TimberMart-South (TMS) sales database includes over 115,000 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 Enviva Cottondale catchment area is located in two different TMS regions: Alabama Region 2 and Florida Region 2 (see highlighted portion in Figure 21 below). Data and trends for this 2-region area (denoted 'Cottondale 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 45 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 21**. TimberMart-South Region Map*



5.1.1 *Total Sale Area*

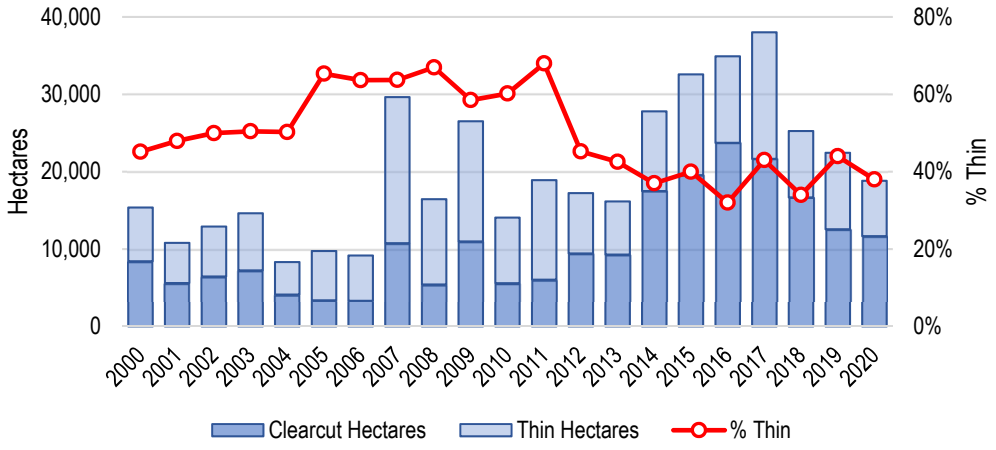
In the Cottondale market, the total area of all timber sales reported to TMS has averaged roughly 20,000 hectares per year since 2000 (see Figure 22). However, more importantly, TMS data shows a shift in the distribution of reported sale area by harvest type (clearcut vs. thinning) in comparing trends from 2000-2011 versus those from 2012-2020.

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 Cottondale market, thinnings constituted a majority of the total reported harvest area through the 2000s. Specifically, thinnings accounted for 58% of total reported harvest area from 2000-2011 but only 39% since 2012.

This market is unique in that pine sawtimber and pine pulpwood markets, historically, have both been strong (most other markets are typically driven by one of the two, but usually not both). In the 2000s, the strength of pine sawtimber markets led many landowners to focus on sawtimber production, which utilizes thinnings for timber reach sawtimber grade. But with the bursting of the US housing bubble and Great Recession that followed, sawtimber markets took a major hit. However, at the same time, pulpwood markets were strengthening rapidly, and these concurrent conditions led many landowners to shift their management focus to short pulpwood rotations (to take advantage of improving pulpwood prices).

The reduction of thinnings (relative to clearcuts) since 2012 speaks to the relative weakness of sawtimber markets in this area. When pine sawtimber prices were strong, thinnings were more prevalent – to promote sawtimber production. However, since pulpwood markets have strengthened (and sawtimber markets weakened), the focus appears to have shifted to short rotation timber management with less thinnings.

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



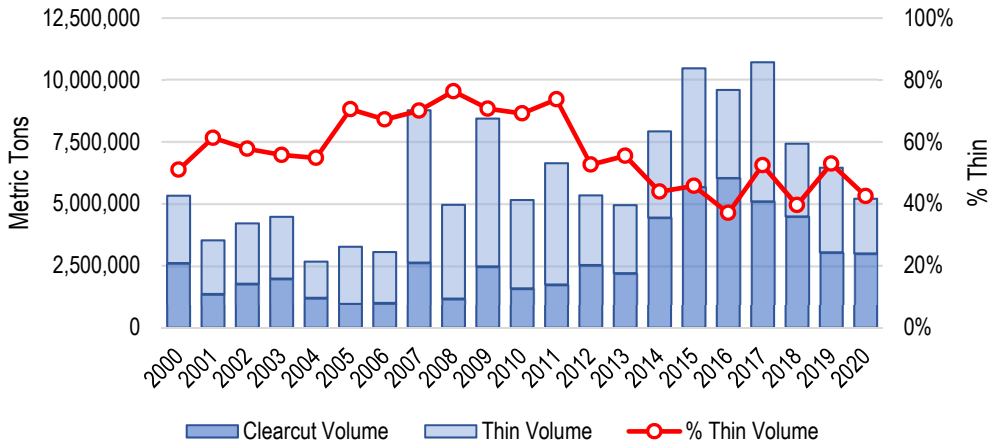
**Please note that these values do not represent the actual area of all timber harvested in this market, but rather the total number of hectares reported to TimberMart-South by its contributing reporters.*

5.1.2 *Total Sale Volume*

In the Cottondale market, the total volume of all timber sales reported to TMS has averaged approximately 6.1 million metric tons per year since 2000 (see Figure 23). 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 decreased substantially from 2011-2014. Specifically, thinnings accounted for 66% of total reported harvest volume in this market from 2000-2011, compared to 45% since 2014. Note that the increased distribution of volume thinned (relative to volume clearcut) in the 2000s coincided with strong sawtimber markets. Specifically, pine sawtimber stumpage price averaged more than $40 per ton in this market from 2000-2007, and this high price led many landowners to focus on sawtimber production (which utilizes thinnings). However, since 2009, pine sawtimber stumpage prices have averaged less than $26 per ton in this market, down more than 35% from 2000-2007 levels. So, given these relatively weak pine sawtimber prices, the focus shifted more towards short pulpwood rotations – a type of timber management that generally does not utilize thinnings.

***Figure 23**. Total Reported Sale Volume by Harvest Type (2000-2020)*



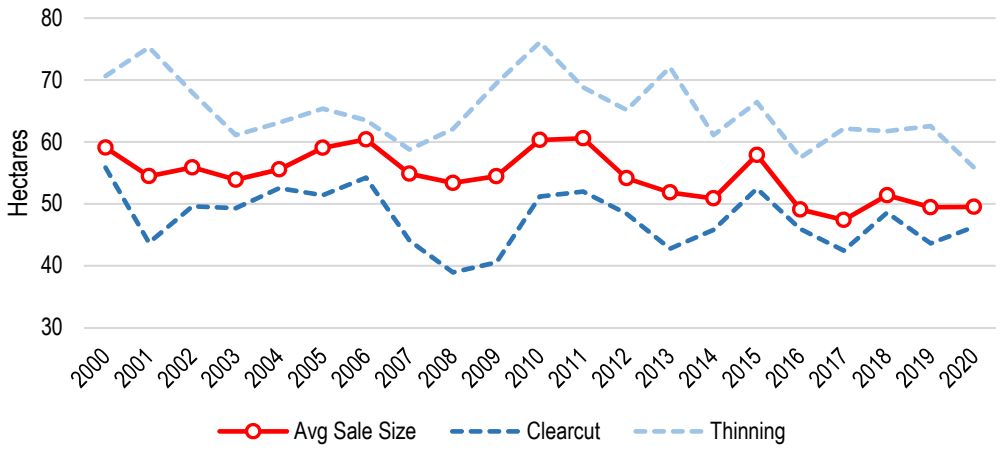
**Please note that these values do not represent the actual volume of all timber harvested in this market, but rather the total volume of harvested timber reported to TimberMart-South by its contributing reporters.*

5.1.3 *Average Sale Size*

The average size of timber sales reported to TMS in the Cottondale market averaged approximately 54 hectares from 2000-2020. TimberMart-South data also shows that thinnings have averaged 37% (+17 hectares) larger than clearcuts since 2000, with thinnings averaging 65 hectares in size compared to 48 hectares for clearcuts. However, we'd like to note that the gap between average clearcut size and average thinning size has also narrowed in this market since 2013. Specifically, thinnings averaged 51% (+23 hectares) larger than clearcuts from 2008-2013 but only 31% (+15 hectares) larger than clearcuts since 2013.

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 50-hectare tract to be clearcut or a 75-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 50 hectares or less.

***Figure 24**. Average Reported Sale Size by Harvest Type (2000-2020)*



6. Market Trends, Analysis, & Outlook

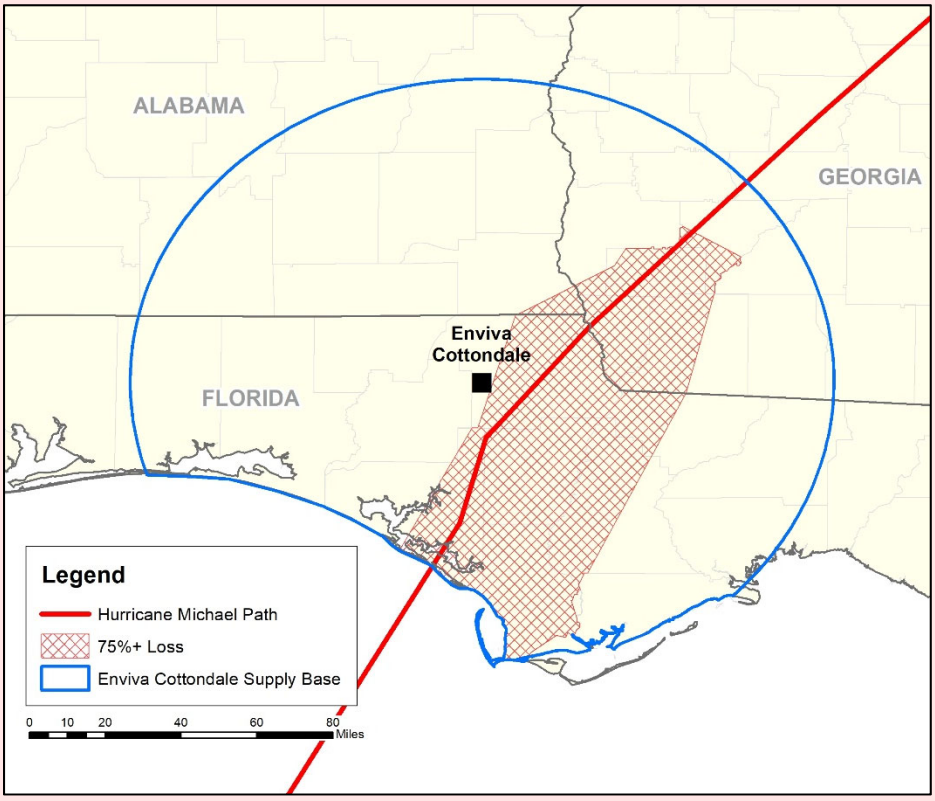
The following section provides an examination and assessment of forest market trends in the Enviva Cottondale catchment area since 2000. It also includes a market outlook through 2023 which details anticipated changes in wood demand and how these changes are likely to impact this market over the next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

However, before moving forward, we'd like to make special note and provide details on Hurricane Michael, a major storm that directly impacted the Cottondale catchment area in late-2018.

Hurricane Michael

Hurricane Michael was a Category 5 hurricane that directly impacted the Florida panhandle in October 2018 before moving inland and through the Cottondale catchment area. Based on damage reports released by the Florida Forest Service, an estimated 140,400 hectares of forestland experienced catastrophic damage (95% loss), 422,000 hectares experienced severe damage (75% loss), and 459,500 hectares experienced moderate damage (15% loss). In total, this translates to an estimated 518,800 hectares of forestland that was destroyed by the hurricane (100% loss), all of which is located within the Cottondale catchment area.

In terms of Hurricane Michael's impact on this catchment area, the destruction of 0.5 million hectares of forestland resulted in the estimated loss of 42 million m^3 of timber inventory, or an approximate 16% decrease compared to pre-hurricane levels. Additionally, the salvage wood ensuing from this storm resulted in a 30% increase in timber removals compared to 2017 levels.



6.1 Market Trends & Analysis

6.1.1 *Wood Demand*

Annual wood demand[4] in the Enviva Cottondale catchment area held relatively steady through the 2000s, averaging 8.3 million metric tons per year from 2000-2010 before increasing an average of 3.6% per year (+28% total) over the seven years that followed, to 10.8 million metric tons in 2017. In 2018, total demand increased to over 12.1 million metric tons, up 12% (+1.3 million metric tons) from 2017. However, note that this increase was due to Hurricane Michael, a Category 5 hurricane that directly struck the Florida panhandle and caused catastrophic damage to roughly 520,000 hectares of timberland in the Enviva Cottondale catchment area.

***Table 22**. Enviva Cottondale Catchment Area - Annual Wood Demand (2000-2020)*

Year	Softwood Sawlogs	Softwood Pulpwood	Hardwood Sawlogs	Hardwood Pulpwood	Total Wood Demand
			(Metric Tons)		
2000	3,270,258	3,362,486	830,217	1,097,003	8,559,964
2001	3,367,853	3,357,954	791,773	1,064,315	8,581,896
2002	3,465,449	3,353,423	753,329	1,031,627	8,603,828
2003	3,563,044	3,348,891	714,885	998,939	8,625,759
2004	3,346,043	3,252,111	622,527	829,602	8,050,283
2005	3,554,587	2,908,052	738,839	731,350	7,932,829
2006	3,595,842	2,855,359	606,633	762,918	7,820,752
2007	3,994,056	2,953,537	579,978	846,263	8,373,833
2008	3,934,636	3,042,614	602,730	807,505	8,387,485
2009	3,569,165	3,136,986	549,968	743,985	8,000,104
2010	3,687,284	3,358,100	548,438	842,953	8,436,775
2011	3,815,062	3,663,423	671,392	911,842	9,061,719
2012	3,927,915	3,644,803	545,702	866,864	8,985,284
2013	4,326,588	4,097,803	542,057	886,886	9,853,334
2014	4,149,862	4,242,405	507,124	812,795	9,712,187
2015	4,311,483	4,209,295	616,579	792,995	9,930,353
2016	4,830,524	4,196,541	504,548	828,421	10,360,034
2017	5,338,529	4,196,813	488,130	804,844	10,828,316
2018	6,062,423	4,743,953	476,696	830,450	12,113,523
2019	5,244,614	4,005,463	431,642	715,482	10,397,200
2020	4,823,678	4,142,500	440,643	703,974	10,110,794

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

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

***Figure 25**. Enviva Cottondale Catchment Area – Total Annual Wood Demand (2000-2020)*

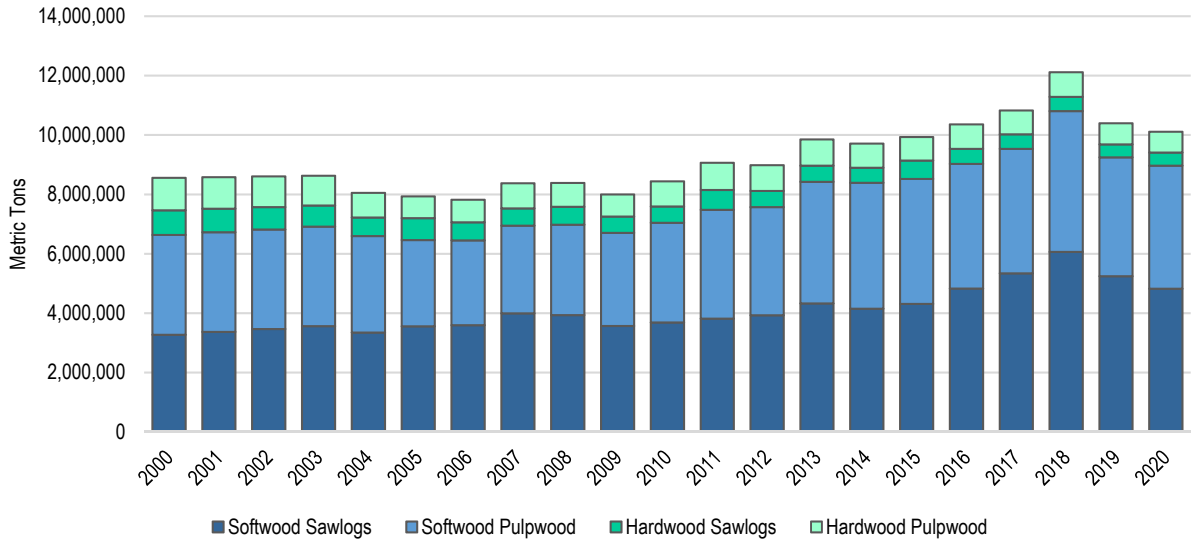
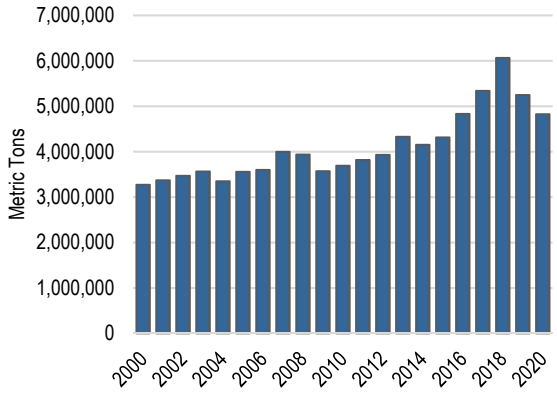
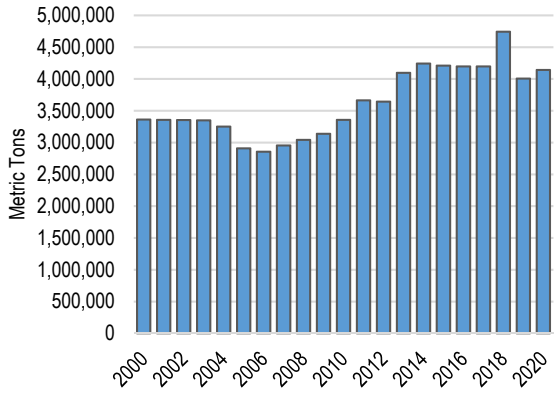


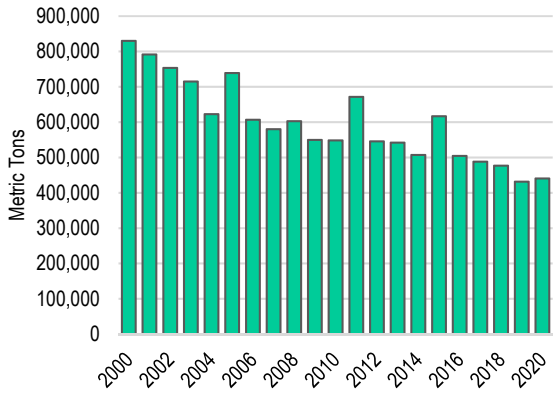
***Figure 26**. Enviva Cottondale Catchment Area – Annual Wood Demand by Major Species & Product (2000-2020)*



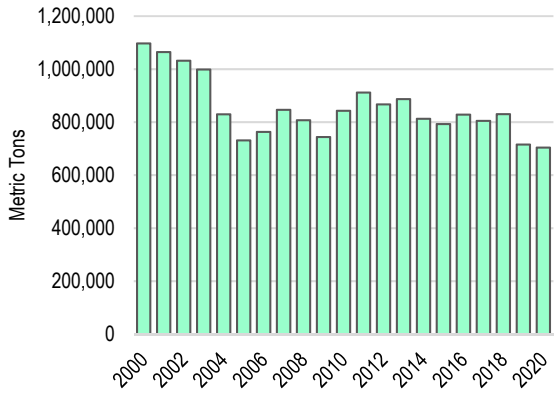
(a) Softwood Sawlogs



(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, Enviva Cottondale is the only major wood pellet mill operating within the catchment area. This mill was commissioned by Green Circle Bioenergy in 2008 and later acquired by Enviva in 2015. In addition to the Cottondale mill, there are several other pellet mills operating within relative proximity to the catchment area. However, these mills are located roughly 240-280 kilometers from the Cottondale mill and do not procure substantial amounts of wood from the catchment area.

Total biomass demand in the catchment area totaled roughly 205,000 metric tons in 2008, increasing each of the next five years and to nearly 1.1 million metric tons in 2013. However, biomass demand has steadily come down since (as lumber production has increased and pellet mills have utilized more sawmill residuals) and in 2020 totaled roughly 780,000 metric tons.

Note that biomass demand is predominantly softwood (pine), with softwood biomass demand accounting for 84% of total biomass demand in the catchment area since 2008 (compared to 16% hardwood biomass demand). Also, biomass-related pulpwood demand has accounted for 17% of total pulpwood demand in the catchment area since 2008. For a detailed breakdown of biomass and non-biomass-related pulpwood demand in the catchment area since 2000, see Table 23 below.

***Table 23**. Enviva Cottondale 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	-	-	-	3,362,486	1,097,003	4,459,489	3,362,486	1,097,003	4,459,489
2001	-	-	-	3,357,954	1,064,315	4,422,269	3,357,954	1,064,315	4,422,269
2002	-	-	-	3,353,423	1,031,627	4,385,050	3,353,423	1,031,627	4,385,050
2003	-	-	-	3,348,891	998,939	4,347,830	3,348,891	998,939	4,347,830
2004	-	-	-	3,252,111	829,602	4,081,713	3,252,111	829,602	4,081,713
2005	-	-	-	2,908,052	731,350	3,639,403	2,908,052	731,350	3,639,403
2006	-	-	-	2,855,359	762,918	3,618,277	2,855,359	762,918	3,618,277
2007	-	-	-	2,953,537	846,263	3,799,800	2,953,537	846,263	3,799,800
2008	204,832	-	204,832	2,837,783	807,505	3,645,288	3,042,614	807,505	3,850,119
2009	667,070	-	667,070	2,469,915	743,985	3,213,900	3,136,986	743,985	3,880,971
2010	737,961	2,661	740,622	2,620,139	840,292	3,460,431	3,358,100	842,953	4,201,053
2011	738,963	31,685	770,648	2,924,460	880,157	3,804,618	3,663,423	911,842	4,575,265
2012	866,795	44,362	911,157	2,778,008	822,502	3,600,510	3,644,803	866,864	4,511,667
2013	992,864	75,888	1,068,752	3,104,939	810,998	3,915,937	4,097,803	886,886	4,984,689
2014	903,463	132,952	1,036,415	3,338,942	679,844	4,018,786	4,242,405	812,795	5,055,201
2015	818,181	192,801	1,010,982	3,391,114	600,194	3,991,308	4,209,295	792,995	5,002,290
2016	603,835	239,074	842,909	3,592,707	589,347	4,182,053	4,196,541	828,421	5,024,962
2017	476,355	335,575	811,929	3,720,458	469,269	4,189,727	4,196,813	804,844	5,001,657
2018	549,087	268,239	817,326	4,194,866	562,211	4,757,077	4,743,953	830,450	5,574,403
2019	669,706	196,621	866,328	3,335,757	518,861	3,854,617	4,005,463	715,482	4,720,945
2020	583,761	196,854	780,615	3,558,739	507,120	4,065,859	4,142,500	703,974	4,846,473

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

Figure 27. Enviva Cottondale Catchment Area – Softwood Pulpwood Demand (2000-2020)

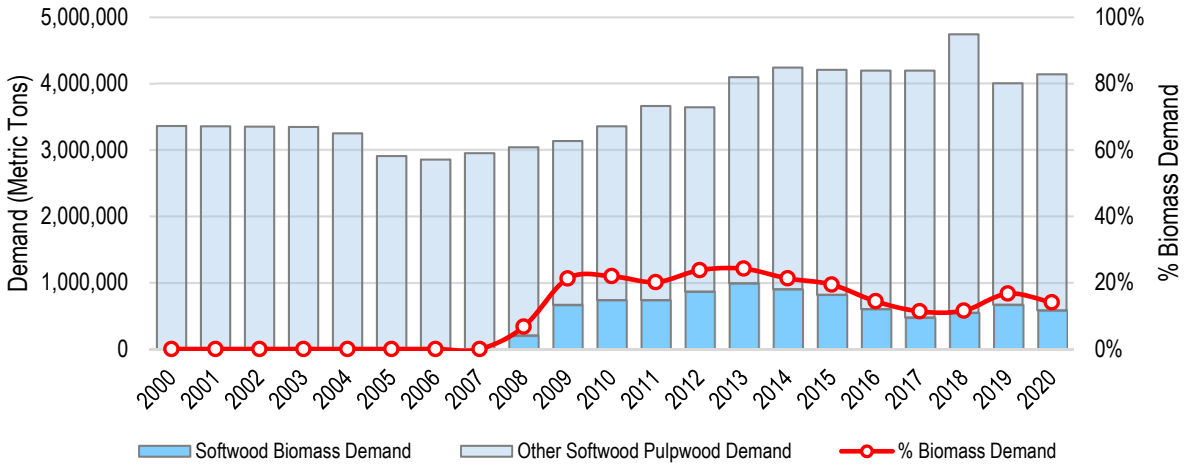


Figure 28. Enviva Cottondale Catchment Area – Hardwood Pulpwood Demand (2000-2020)

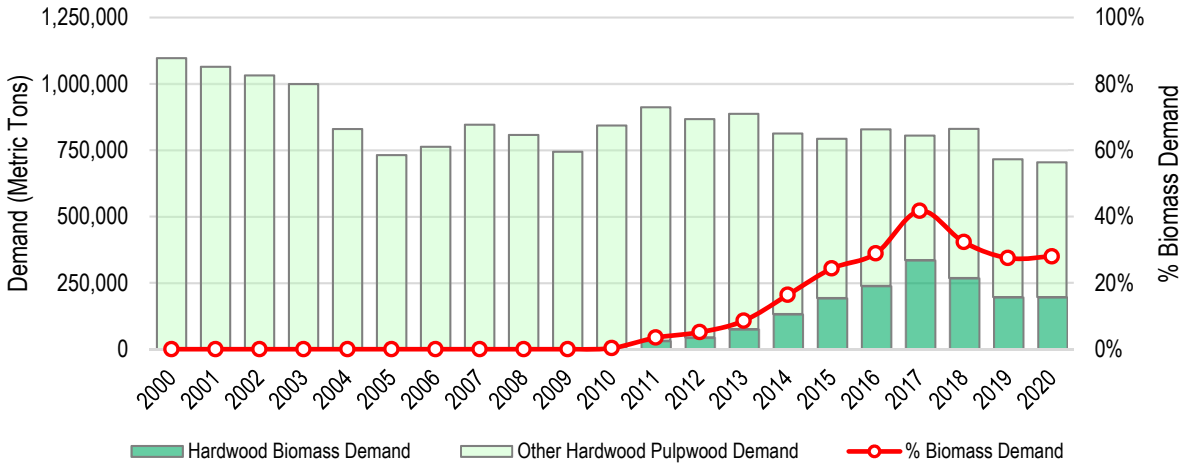
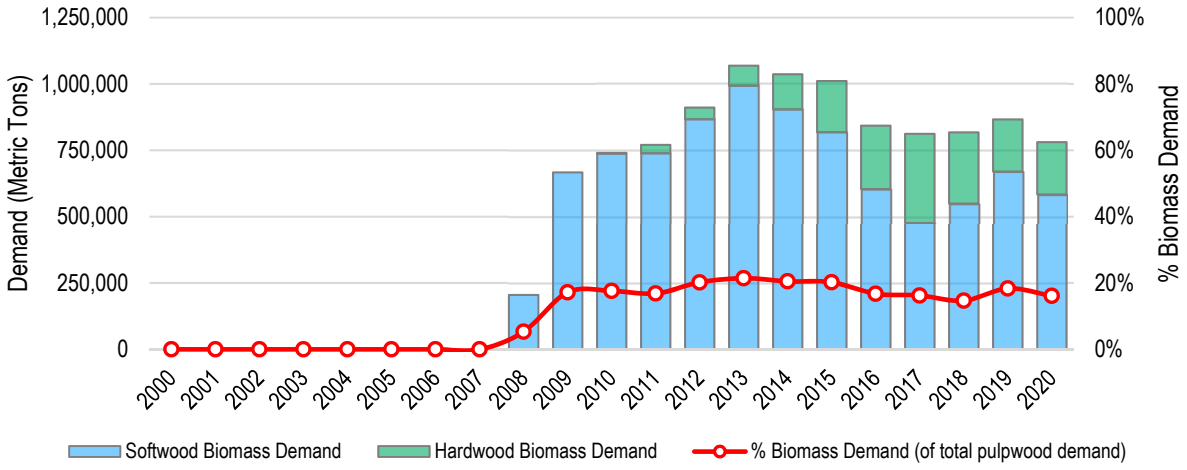


Figure 29. Enviva Cottondale Catchment Area – Total Biomass Demand (2000-2020)



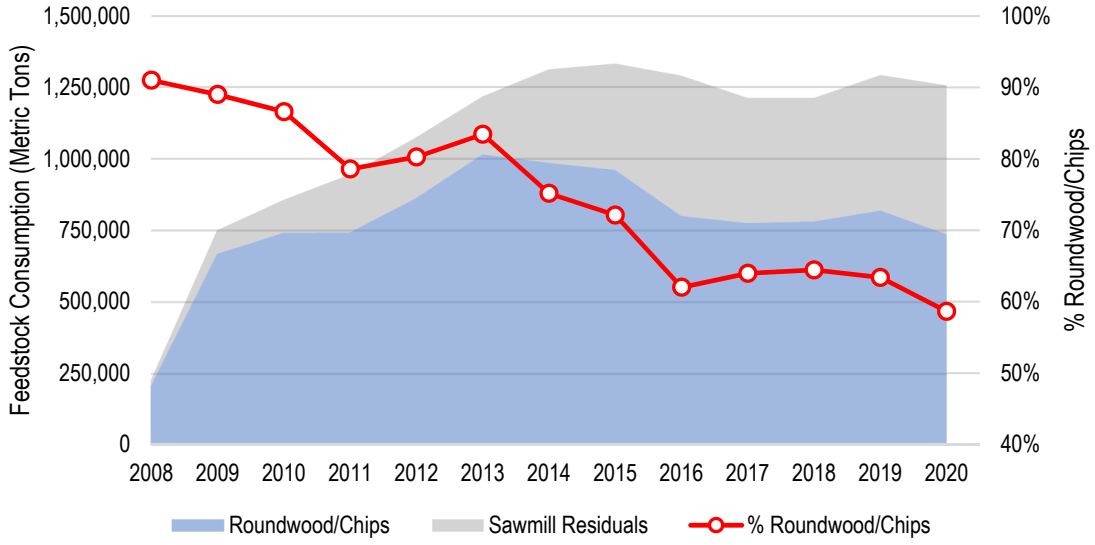
Changes in Bioenergy Feedstock Composition

For the Enviva Cottondale mill (which accounts for over 90% of total biomass-related wood demand in this catchment area), the raw materials utilized by the facility to produce wood pellets has historically included a combination of roundwood[5], in-woods chips, and pine sawmill residuals.

From 2008 (the year this facility commenced operations) through 2013, roundwood and in-woods chips accounted for 83% of the total feedstock consumed by the Cottondale mill, with sawmill residuals (i.e. sawdust and shavings) accounting for the remaining 17%. However, utilization of sawmill residuals began to increase in the mid-2010s, and since 2016, sawmill residuals have accounted for 38% of the total feedstock consumed by the Cottondale mill (see Figure 30).

Note that the increased utilization of sawmill residuals at the Cottondale mill coincided with a 12% increase in softwood sawlog demand from 2013-2016. As softwood lumber production began to increase, so too did the production of sawmill residuals – a lower-cost feedstock (compared to both roundwood and in-woods chips) the Cottondale mill could utilize for wood pellet production.

***Figure 30**. Enviva Cottondale Feedstock Composition (2008-2020)*



[5] Includes dead wood in 2019 and 2020 from Hurricane Michael.

6.1.2 *Changes in Land Area & Use*

Notable changes in land use occurred in the Enviva Cottondale catchment area from 2000-2020, including a 1.3% increase in forestland and a 3.0% increase in land in farms (i.e. cropland, woodland, and pastureland).

According to the USDA, total catchment area forestland held relatively steady through the 2000s, decreasing slightly but averaging roughly 2,962,000 hectares from 2000-2009. However, total forestland increased more than 2% over the five years that followed and since 2014 has averaged nearly 3,025,000 hectares. Overall, the total area of forestland increased from an estimated 2,980,944 hectares in 2000 to 3,018,616 hectares in 2020, or a net increase of 37,622 hectares (+1.3%) over this 20-year period.

Over this same period, total land in farms increased 35,715 hectares (+3.0%) in the Enviva Cottondale catchment area. In particular, pastureland increased an estimated 87,930 hectares (+45%) and woodland increased an estimated 17,440 hectares (+4.0%) from 2000-2020. However, cropland decreased an estimated 69,655 hectares (-12%) over this period. See Table 24 for details.

***Table 24**. Enviva Cottondale 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	2,913,402	67,592	2,980,994	571,316	439,546	193,355	1,204,217	111,163	4,296,373
2001	2,922,973	62,467	2,985,440	566,529	440,373	203,361	1,210,264	100,669	4,296,373
2002	2,915,648	59,336	2,974,984	561,742	441,201	213,368	1,216,311	105,078	4,296,373
2003	2,909,244	55,977	2,965,221	559,807	453,842	229,143	1,242,793	88,360	4,296,373
2004	2,899,852	52,884	2,952,735	557,872	466,482	244,919	1,269,274	74,364	4,296,373
2005	2,901,153	50,621	2,951,773	555,937	479,123	260,695	1,295,755	48,845	4,296,373
2006	2,900,769	52,308	2,953,078	547,334	485,844	273,142	1,306,320	36,976	4,296,373
2007	2,905,379	52,797	2,958,176	537,987	491,540	284,792	1,314,319	23,878	4,296,373
2008	2,896,644	51,904	2,948,548	533,436	491,251	290,210	1,314,897	32,928	4,296,373
2009	2,896,620	50,392	2,947,012	526,530	488,843	294,450	1,309,823	39,539	4,296,373
2010	2,923,144	48,267	2,971,411	514,354	481,538	295,732	1,291,624	33,339	4,296,373
2011	2,948,369	51,242	2,999,611	505,099	476,943	298,644	1,280,686	16,076	4,296,373
2012	2,957,873	38,770	2,996,642	500,586	476,865	304,438	1,281,889	17,842	4,296,373
2013	2,952,451	42,711	2,995,162	502,352	475,583	301,712	1,279,648	21,563	4,296,373
2014	2,974,402	53,888	3,028,290	495,084	465,788	293,610	1,254,482	13,601	4,296,373
2015	2,986,608	43,367	3,029,974	495,493	463,261	290,119	1,248,872	17,527	4,296,373
2016	2,974,815	57,371	3,032,186	495,901	460,734	286,628	1,243,263	20,925	4,296,373
2017	2,958,102	58,513	3,016,614	503,880	465,196	287,456	1,256,532	23,227	4,296,373
2018	2,958,871	66,390	3,025,262	501,856	461,290	284,679	1,247,825	23,286	4,296,373
2019	2,954,723	65,341	3,020,065	501,620	459,019	282,910	1,243,549	32,759	4,296,373
2020	2,951,810	66,805	3,018,616	501,661	456,986	281,285	1,239,932	37,825	4,296,373

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

6.1.3 *Changes in Forest Area (Timberland)*

According to the US Forest Service, the total area of timberland in the Enviva Cottondale catchment area experienced a net increase of 38,408 hectares (+1.3%) from 2000-2020, increasing from 2,913,402 to 2,951,810 hectares over this 20-year period. Specifically, total timberland held relatively steady through the 2000s, averaging roughly 2,906,000 hectares from 2000-2009 before increasing to nearly 2,958,000 hectares in 2012 and ultimately stabilizing and averaging roughly 2,956,000 hectares since 2017.

In particular, pine timberland (the predominant supplier of pine pulpwood consumed by the pulp/paper and bioenergy industries in this market) increased more than 57,000 hectares (+3.8%) from 2000 to 2020. However, note that nearly all of this increase can be attributed to increases in natural pine timberland. Specifically, over this period, natural pine timberland increased roughly 56,600 hectares, compared to an increase of roughly 500 hectares for planted pine timberland.

***Table 25**. Enviva Cottondale Catchment Area - Timberland Area by Stand Origin (2000-2020)*

	Planted		*Naturally Regenerated*			
Year	**Pine**	**Hardwood**	**Pine**	**Hardwood**	**Mixed Pine-Hardwood**	**Total**
			(Hectares)			
2000	974,936	57,807	537,898	1,097,991	244,770	2,913,402
2001	970,066	56,226	545,774	1,104,333	246,573	2,922,972
2002	1,006,939	53,558	528,144	1,086,463	240,543	2,915,648
2003	1,017,828	53,686	520,934	1,078,333	238,462	2,909,243
2004	1,029,364	53,356	520,288	1,068,606	228,236	2,899,850
2005	1,021,104	64,036	520,785	1,056,762	238,464	2,901,152
2006	1,036,695	58,523	509,784	1,050,360	245,408	2,900,769
2007	1,048,087	57,955	504,922	1,037,405	257,009	2,905,378
2008	1,031,231	59,871	516,823	1,028,541	260,178	2,896,644
2009	1,016,006	57,630	524,825	1,031,243	266,914	2,896,619
2010	1,020,433	54,580	529,995	1,026,864	291,271	2,923,143
2011	1,008,269	50,371	561,575	1,037,496	290,659	2,948,370
2012	1,002,623	35,867	602,823	1,032,602	283,957	2,957,873
2013	997,612	29,515	602,680	1,038,026	284,618	2,952,451
2014	1,021,324	24,019	594,122	1,040,636	294,300	2,974,402
2015	1,014,168	23,853	609,381	1,059,834	279,372	2,986,608
2016	1,006,204	27,709	607,962	1,047,550	285,390	2,974,816
2017	1,006,895	33,039	597,140	1,039,666	281,361	2,958,102
2018	987,953	38,665	614,576	1,040,585	277,093	2,958,872
2019	987,600	52,153	602,645	1,023,942	288,383	2,954,723
2020	975,422	60,634	594,461	1,020,771	300,522	2,951,810

Source: USDA-US Forest Service

***Figure 31**. Enviva Cottondale Catchment Area - Timberland Area by Year (2000-2020)*

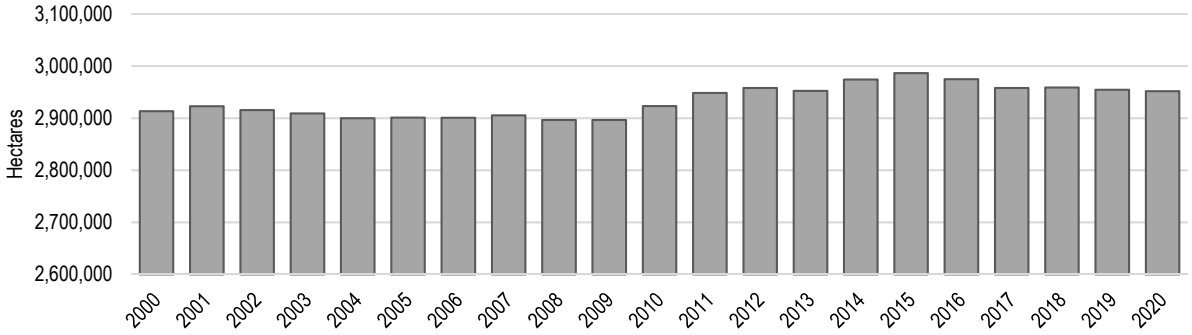
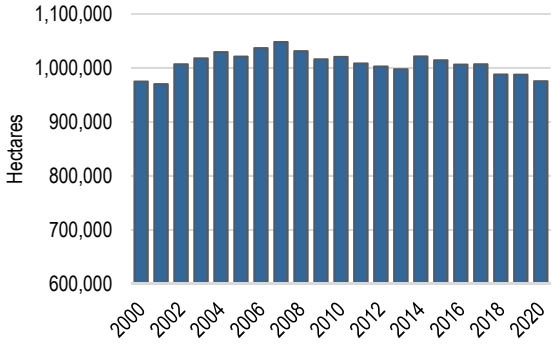
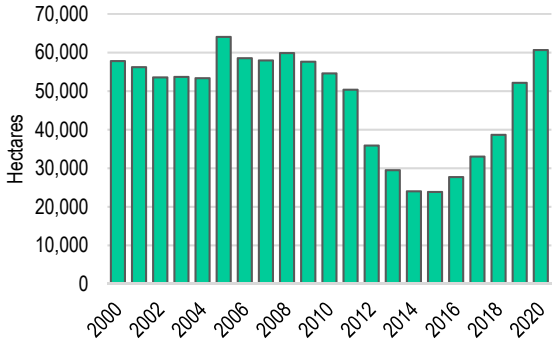


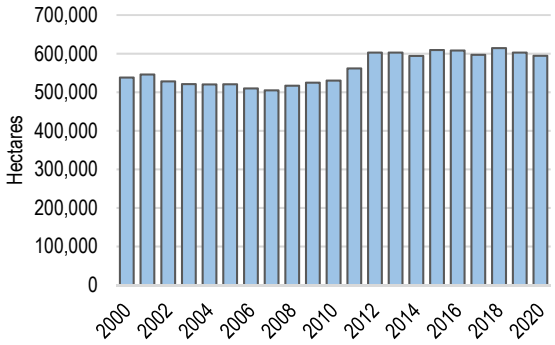
***Figure 32**. Enviva Cottondale Catchment Area – Timberland Area by Stand Origin (2000-2020)*



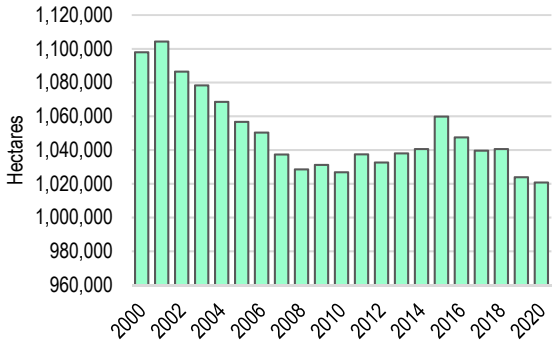
(a) Planted Pine



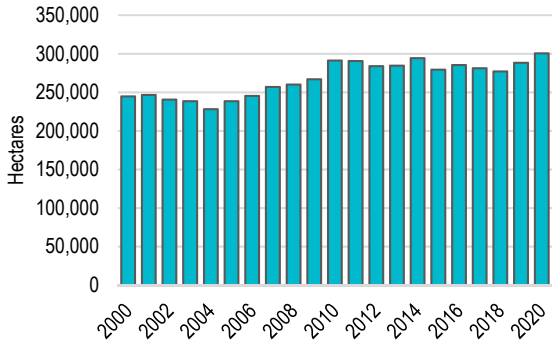
(b) Planted Hardwood



(c) Naturally Regenerated Pine



(d) Naturally Regenerated Hardwood



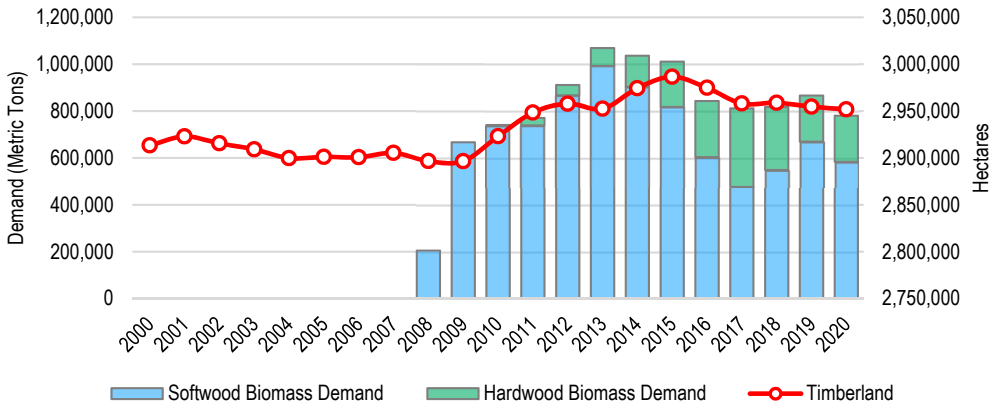
(e) Naturally Regenerated Mixed Pine-Hardwood

Correlation Analysis: *Biomass Demand vs. Timberland*

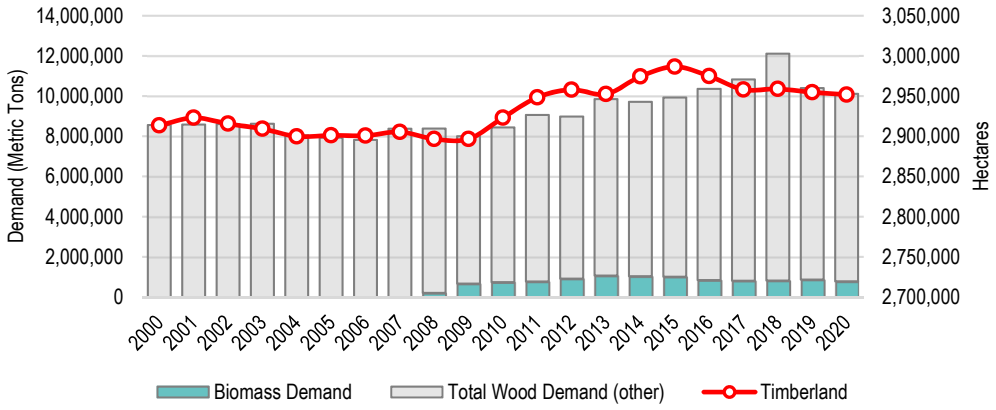
Figure 33 provides a side-by-side comparison of both biomass demand and total wood demand versus timberland hectares in the catchment area from 2000-2020. In comparing changes in biomass demand to changes in timberland area, a positive linear relationship appears evident. Total biomass demand increased rapidly following the startup of Enviva Cottondale in 2008 and peaked in 2013 before declining slightly and stabilizing from 2016-2020. Timberland area followed a similar pattern, also increasing through the mid-2010s before declining slightly and leveling off from 2017-2020.

Correlation analysis did identify a strong positive correlation (correlation coefficient=0.84) between total biomass demand and timberland area from 2000-2020. However, timberland area and total wood demand have also closely tracked one another, even prior to Enviva Cottondale's startup in 2008 (see Figure 33b). Correlation analysis confirmed this relationship, identifying a strong positive relationship (correlation coefficient=0.81) between total wood demand and timberland area from 2000-2020.

***Figure 33**. Enviva Cottondale Catchment Area – Biomass Demand & Total Wood Demand vs. Timberland Hectares (2000-2020)*



(a) Biomass Demand vs. Timberland Hectares



(b) Total Wood Demand vs. Timberland Hectares

Ultimately, there is evidence linking changes in timberland hectares to changes in overall wood demand. However, the importance of softwood pulpwood markets, in particular, is also evident. Specifically, a positive correlation was found between timberland area and pine pulpwood stumpage price (correlation coefficient=0.80). This finding is unique in that most timber markets across the US South are largely driven by pine sawtimber production, but, in the Cottondale catchment area, a strong negative relationship was found between timberland area and pine sawtimber price. So, in considering all this information in its entirety, the findings do suggest that the increase in catchment area timberland, particularly since the late 2000s, can be linked, to some degree, to increased softwood pulpwood demand from bioenergy.

However, 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=-0.83), which link the gains in timberland to losses in cropland.

(Note that the Cottondale market is different than most others across the US South due to the high concentration of pulp/paper mills located within relative proximity. Specifically, more than a dozen pulp/paper mills are located within roughly 300 kilometers of the Cottondale facility. Given such conditions, pulpwood constitutes approximately 50% of total wood demand in the Cottondale catchment area. In contrast, most other markets across the region are largely driven by sawtimber production, with sawlogs constituting anywhere from 65-80% of total wood demand.)

***Table 26**. Correlation Analysis –Biomass Demand, Pulpwood Demand & Timberland Hectares (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	-0.02	1			
Total Softwood Pulpwood Demand	0.67	0.73	1		
Pine Timberland	0.77	0.36	0.80	1	
Total Timberland	0.75	0.52	0.90	0.88	1

	Hardwood Biomass Demand	Other Hardwood Pulpwood Demand	Total Hardwood Pulpwood Demand	Hardwood Timberland	Total Timberland
Hardwood Biomass Demand	1				
Other Hardwood Pulpwood Demand	-0.83	1			
Total Hardwood Pulpwood Demand	-0.39	0.84	1		
Hardwood Timberland	-0.57	0.75	0.68	1	
Total Timberland	0.78	-0.57	-0.17	-0.61	1

	Softwood Biomass Demand	Hardwood Biomass Demand	Total Biomass Demand	Total Timberland
Softwood Biomass Demand	1			
Hardwood Biomass Demand	0.48	1		
Total Biomass Demand	0.98	0.66	1	
Total Timberland	0.75	0.78	0.84	1

6.1.4 *Changes in Timber Inventory*

Timber inventory data for the Enviva Cottondale catchment area was provided by the US Forest Service - Forest Inventory & Analysis (FIA) program from 2000 through 2020[6], the most current available. According to FIA estimates, total growing stock inventory on timberland in the Enviva Cottondale catchment area increased an average of 1.5% per year (+31% total) from 206 million m^3 in 2000 to 270 million m^3 in 2018. However, the destruction caused by Hurricane Michael in late-2018 resulted in the loss of more than 42 million m^3 of timber inventory in the catchment area. Ultimately, timber inventory totaled just over 227 million m^3 in 2020, up roughly 22 million m^3 (+11%) compared to 2000 levels.

Table 27 below (as well as Figures 34 and 35 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 both pine sawtimber and chip-n-saw over this period, despite the losses due to Hurricane Michael.

***Table 27**. Enviva Cottondale 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	53,021	26,798	41,010	46,908	38,033	205,769
2001	54,542	27,251	41,106	46,136	36,993	206,027
2002	56,065	28,399	42,983	45,402	35,590	208,440
2003	56,693	30,332	43,886	44,212	34,087	209,210
2004	57,534	31,826	43,759	43,166	32,796	209,081
2005	56,970	33,367	44,997	44,376	32,480	212,190
2006	57,964	34,456	46,466	45,770	32,494	217,149
2007	58,156	35,018	48,467	47,886	32,052	221,580
2008	60,216	36,182	48,444	48,475	32,250	225,568
2009	62,985	37,204	48,460	49,456	32,667	230,772
2010	66,542	39,290	48,606	51,106	32,842	238,385
2011	72,601	40,356	48,096	52,555	33,034	246,642
2012	75,169	41,787	49,088	51,485	32,306	249,835
2013	77,466	41,023	46,380	51,474	32,431	248,774
2014	81,952	43,931	46,160	52,437	32,554	257,035
2015	84,214	44,268	45,779	51,441	32,864	258,566
2016	86,725	45,586	45,811	49,692	32,525	260,339
2017	89,052	45,671	45,711	49,722	32,407	262,563
2018	94,474	46,416	46,741	49,097	32,811	269,540
2019	81,892	37,772	36,482	41,947	29,133	227,226
2020	82,877	38,471	36,333	41,389	28,332	227,402

Source: USDA - US Forest Service

[6] US Forest Service FIA data for those areas located in Florida and Georgia were only available through 2017 and through 2019, respectively. Estimates through 2020 have been included and are based on historical trends and local area inventory models for each respective state.

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

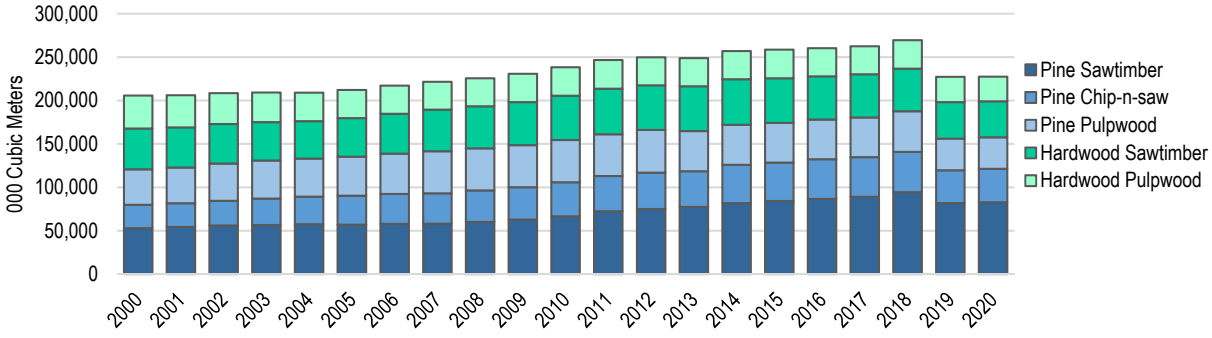
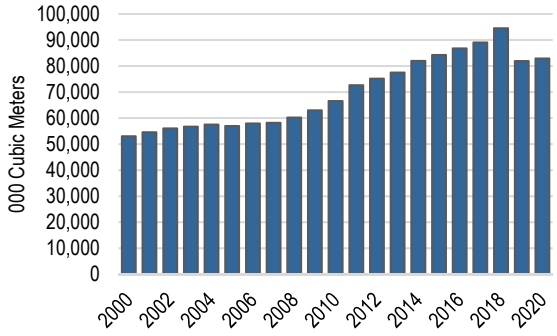
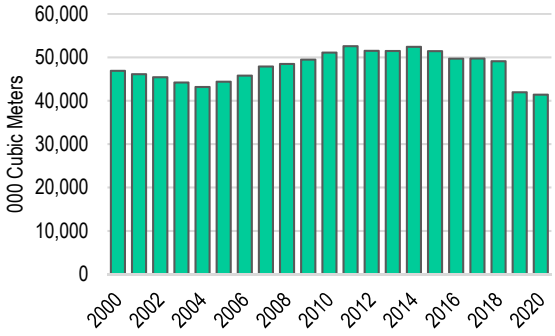


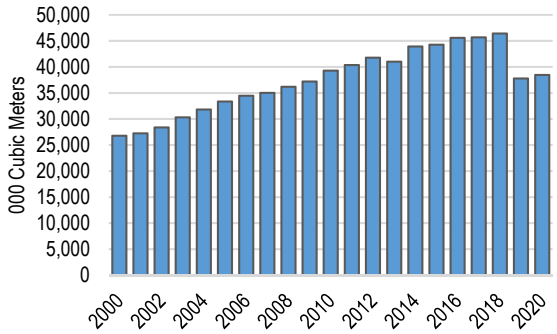
***Figure 35**. Enviva Cottondale Catchment Area - Timber Inventory by Major Timber Product (2000-2020)*



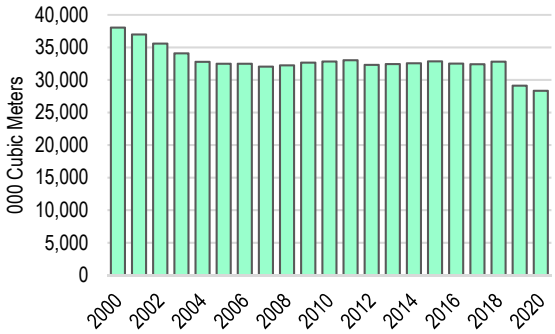
(a) Pine Sawtimber



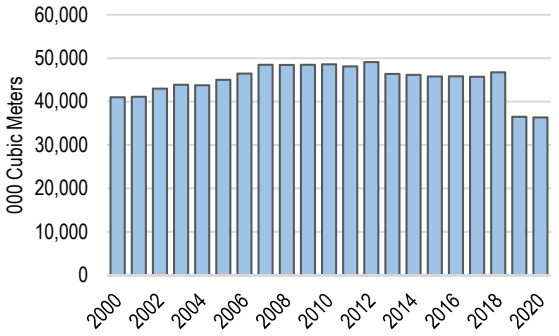
(d) Hardwood Sawtimber



(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 206 million m^3 in 2000 to 227 million m^3 in 2020, or a net increase of 22 million m^3 (+11%). There were also some minor changes in the distribution of growing stock inventory by diameter class, with softwood and hardwood growing stock inventory both increasing in average diameter over this period.

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 34% of softwood growing stock inventory was less than 9 inches in diameter (i.e. pulpwood classification), falling to 31% within these parameters in 2010 and to 24% in 2020. In terms of average diameter size, softwood inventory averaged 11.8 inches in diameter in 2000, 11.9 inches in diameter in 2010, and 12.8 inches in diameter in 2020.

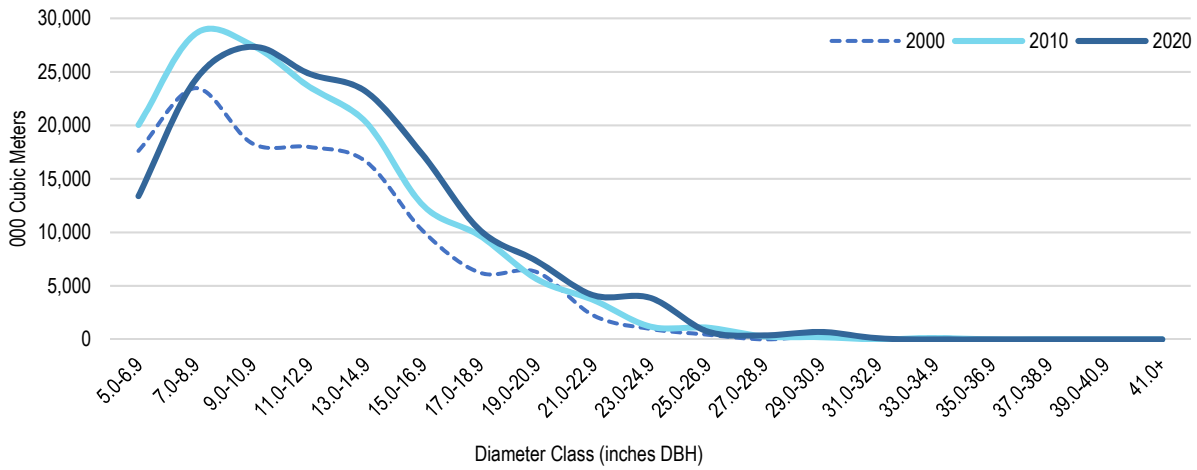
The historic distributions of hardwood growing stock inventory by diameter class show 77% of hardwood inventory was 12 inches in diameter or greater (i.e. sawtimber classification) in 2000, increasing to 81% within these same parameters in 2010 and decreasing slightly to 79% in 2020. Hardwood growing stock inventory averaged an estimated 14.2 inches in diameter in 2000, compared to 14.9 inches in 2010 and 15.1 inches in 2020.

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

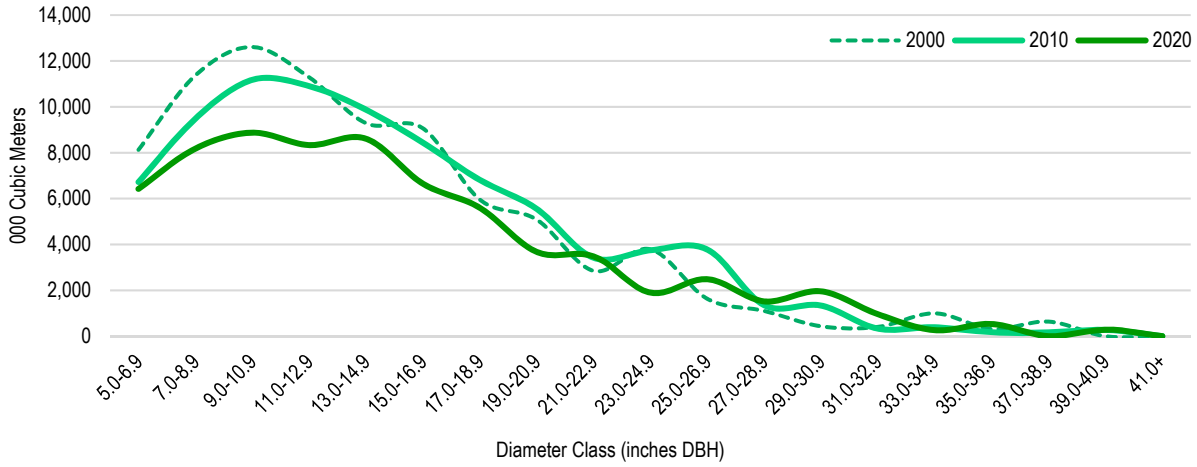
Diameter Class		*Softwood*				*Hardwood*			*Total*		
(inches DBH)		2000	2010	2020		2000	2010	2020	2000	2010	2020
						(000 Cubic Meters)					
5.0-6.9	Pulpwood	17,617	20,040	13,388	Pulpwood	8,128	6,723	6,424	25,745	26,763	19,812
7.0-8.9	Pulpwood	23,478	28,565	24,245	Pulpwood	11,371	9,486	8,180	34,849	38,052	32,425
9.0-10.9	CNS	18,313	27,481	27,351	Pulpwood	12,609	11,179	8,875	30,922	38,661	36,226
11.0-12.9	CNS	17,983	23,617	24,830	Pulpwood	11,290	10,907	8,332	29,273	34,524	33,162
13.0-14.9	Sawtimber	16,618	20,278	23,149	Sawtimber	9,288	9,877	8,611	25,906	30,155	31,760
15.0-16.9	Sawtimber	10,136	12,535	17,232	Sawtimber	9,065	8,438	6,650	19,201	20,973	23,881
17.0-18.9	Sawtimber	6,240	9,697	10,231	Sawtimber	5,958	6,816	5,601	12,197	16,513	15,832
19.0-20.9	Sawtimber	6,295	5,642	7,332	Sawtimber	5,084	5,555	3,674	11,380	11,197	11,005
21.0-22.9	Sawtimber	2,233	3,674	4,120	Sawtimber	2,848	3,419	3,484	5,080	7,093	7,604
23.0-24.9	Sawtimber	981	1,197	3,882	Sawtimber	3,791	3,749	1,896	4,772	4,946	5,778
25.0-26.9	Sawtimber	444	1,099	748	Sawtimber	1,630	3,780	2,486	2,074	4,880	3,234
27.0-28.9	Sawtimber	0	274	373	Sawtimber	1,101	1,352	1,518	1,101	1,627	1,891
29.0-30.9	Sawtimber	315	206	699	Sawtimber	432	1,336	1,956	747	1,542	2,655
31.0-32.9	Sawtimber	0	0	102	Sawtimber	404	329	958	404	329	1,060
33.0-34.9	Sawtimber	175	132	0	Sawtimber	996	391	260	1,171	523	260
35.0-36.9	Sawtimber	0	0	0	Sawtimber	310	170	532	310	170	532
37.0-38.9	Sawtimber	0	0	0	Sawtimber	635	164	0	635	164	0
39.0-40.9	Sawtimber	0	0	0	Sawtimber	0	276	282	0	276	282
41.0+	Sawtimber	0	0	0	Sawtimber	0	0	0	0	0	0
Total		**120,829**	**154,437**	**157,681**		**84,940**	**83,948**	**69,721**	**205,769**	**238,385**	**227,402**

Source: USDA - US Forest Service

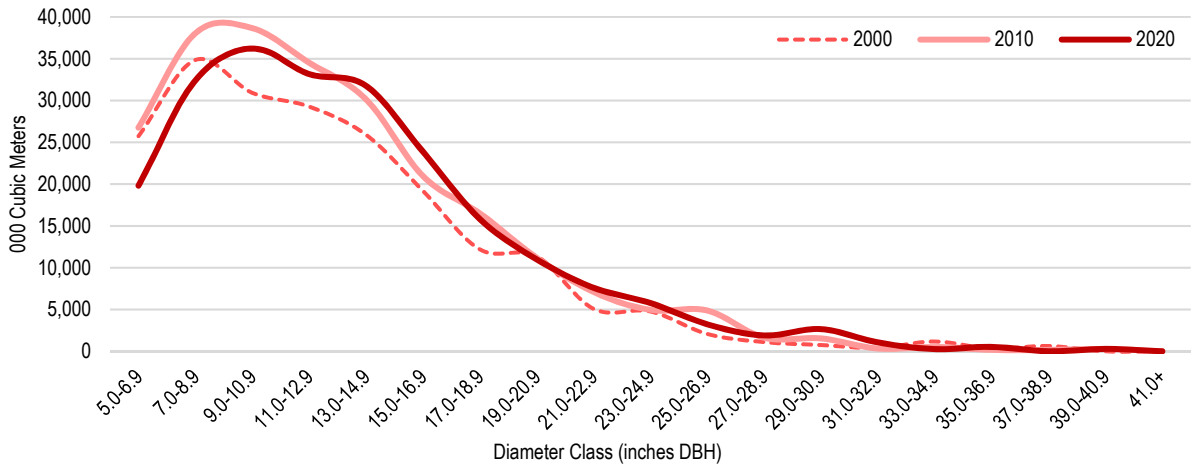
***Figure 36**. Enviva Cottondale Catchment Area - Timber Inventory by Major Species Group & Diameter Class (2000, 2010, & 2020)*



(a) Softwood Growing Stock Inventory



(b) Hardwood Growing Stock Inventory



(c) Total Growing Stock Inventory

6.1.4.2 *Age Class Distribution*

Changes in growing stock inventory by age class generally aligned with changes in diameter class distribution. Specifically, USFS data indicates the average age of softwood growing stock inventory increased from 38.9 years old in 2000 to 40.9 years old in 2020. Similarly, the average age of hardwood growing stock inventory also increased – from 48.8 to 56.6 years of age over this 20-year period.

The increase in the average age of both softwood and hardwood growing stock inventory is reflected in changes in age class distributions over this period. Specifically, the distribution of softwood growing stock inventory 50 years of age or younger decreased from 72% in both 2000 and 2010 to 69% in 2020. Similarly, the distribution of hardwood growing stock inventory 65 years of age or younger decreased from 79% to 73% and to 66% over these same three periods.

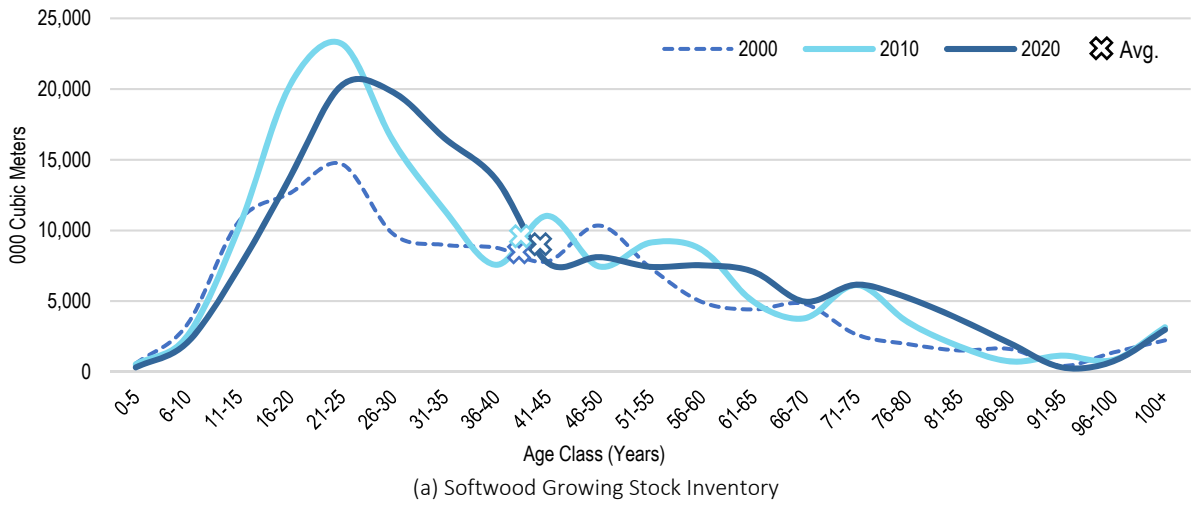
Table 29 below provides US Forest Service estimates of softwood and hardwood growing stock inventory by age class in 2000, 2010, and 2020. Corresponding values are shows graphically in Figure 37 on the following page.

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

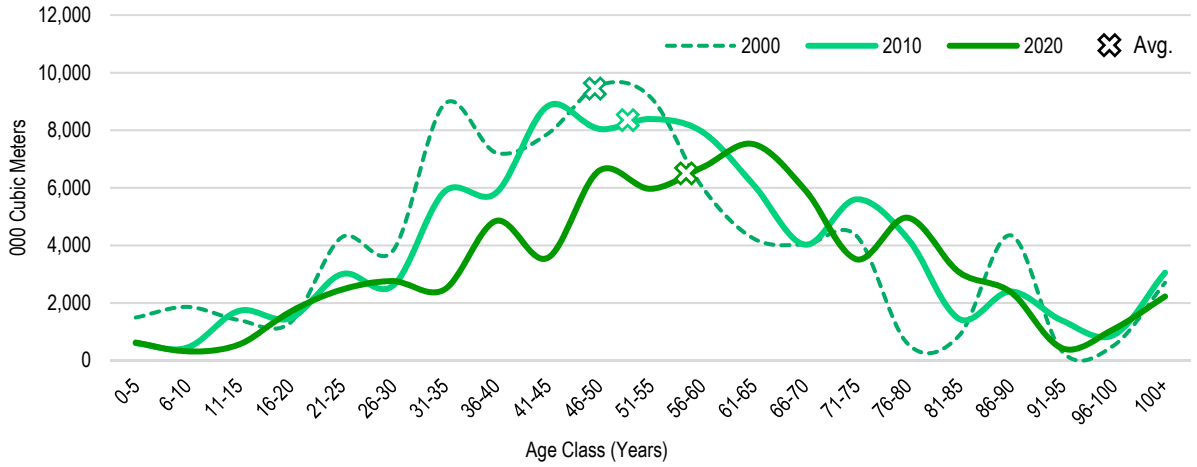
Age Class	Softwood			Hardwood			Total		
(years)	2000	2010	2020	2000	2010	2020	2000	2010	2020
				(000 Cubic Meters)					
0-5	583	531	311	1,496	603	628	2,079	1,134	939
6-10	3,349	2,538	2,070	1,867	450	322	5,216	2,988	2,392
11-15	10,630	10,157	7,334	1,409	1,726	555	12,039	11,883	7,889
16-20	12,640	20,297	13,779	1,316	1,467	1,695	13,956	21,765	15,475
21-25	14,699	23,209	20,256	4,282	3,007	2,466	18,980	26,216	22,722
26-30	9,753	16,332	19,778	3,823	2,603	2,762	13,576	18,935	22,539
31-35	8,976	11,442	16,523	8,914	5,868	2,472	17,890	17,311	18,995
36-40	8,777	7,568	13,625	7,223	5,821	4,852	16,000	13,389	18,477
41-45	7,813	11,029	7,715	7,872	8,835	3,563	15,685	19,864	11,278
46-50	10,351	7,459	8,115	9,556	8,047	6,591	19,907	15,506	14,706
51-55	7,359	9,132	7,430	9,156	8,393	5,967	16,515	17,525	13,397
56-60	4,941	8,633	7,536	6,047	7,958	6,701	10,988	16,591	14,237
61-65	4,412	4,966	7,085	4,246	6,117	7,522	8,658	11,084	14,607
66-70	4,800	3,795	4,964	4,037	4,028	5,941	8,837	7,823	10,905
71-75	2,646	6,142	6,163	4,343	5,602	3,521	6,989	11,744	9,684
76-80	1,966	3,524	5,228	586	4,240	4,964	2,552	7,763	10,192
81-85	1,510	1,805	3,734	869	1,445	3,071	2,379	3,251	6,805
86-90	1,604	733	1,997	4,354	2,403	2,382	5,957	3,136	4,379
91-95	423	1,148	313	317	1,391	428	740	2,539	741
96-100	1,373	843	752	522	887	1,091	1,896	1,730	1,843
100+	2,225	3,156	2,971	2,704	3,054	2,227	4,929	6,210	5,198
Total	**120,829**	**154,437**	**157,681**	**84,940**	**83,948**	**69,721**	**205,769**	**238,385**	**227,402**

Source: USDA - US Forest Service

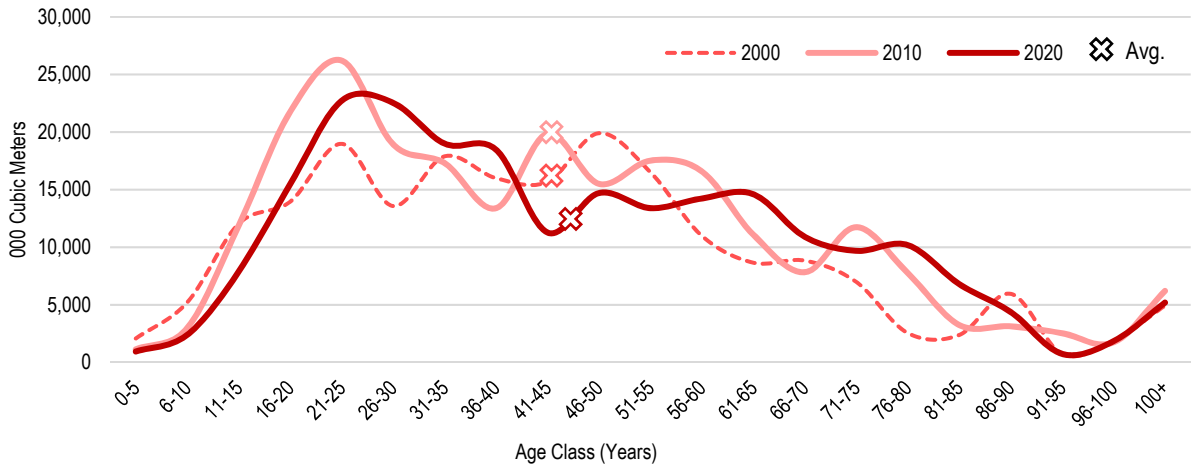
***Figure 37**. Enviva Cottondale Catchment Area - Timber Inventory by Major Species Group & Age Class (2000, 2010, & 2020)*



(a) Softwood Growing Stock Inventory



(b) Hardwood Growing Stock Inventory



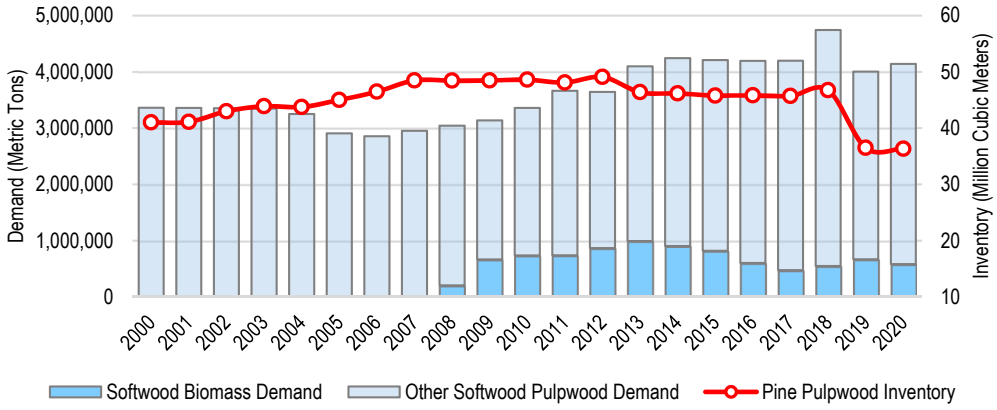
(c) Total Growing Stock Inventory

Correlation Analysis: *Biomass Demand vs. Timber Inventory*

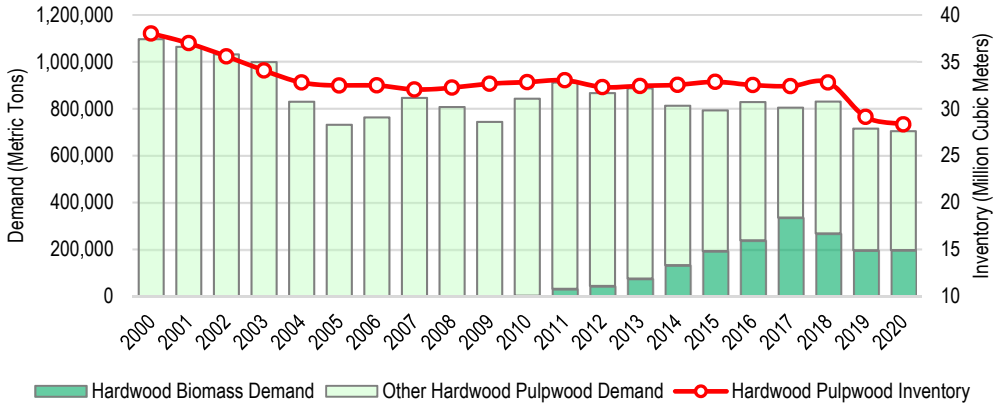
US Forest Service data shows that, even after accounting for the substantial losses due to Hurricane Michael in 2018, total timber inventory increased 11% (+0.5% per year average) in the Cottondale catchment area from 2000-2020. Intuitively, timber inventories can increase one of two ways: 1) through additional timberland gains or 2) through an environment in which annual growth outpaces annual removals. In this catchment area, both occurred over this period.

However, note that inventories of pine pulpwood – the predominant timber product utilized by the bioenergy industry – steadily increased through the early and mid-2000s before leveling off and holding relatively steady from 2007 up until Hurricane Michael impacted this catchment area in late-2018. In comparison, total softwood pulpwood demand dipped in the mid-2000s, increased through the late-2000s and early-2010s, but has more-or-less held steady since (see Figure 38a). Ultimately, correlation analysis identified a weak negative relationship between pine pulpwood inventory and pine pulpwood demand (correlation coefficient=-0.19) from 2000-2020 but no meaningful relationship (correlation coefficient=0.07) between pine pulpwood inventory and softwood biomass demand since the Cottondale mill's startup in 2008.

***Figure 38**. Enviva Cottondale Catchment Area – Biomass Demand & Total Pulpwood Demand vs. Pulpwood Inventory (2000-2020)*



(a) Softwood Pulpwood Demand vs. Pine Pulpwood Inventory



(b) Hardwood Biomass Demand vs. Hardwood Pulpwood Inventory

The negative correlation found between pine pulpwood inventory and softwood pulpwood demand indicates that these two move inversely to one another, which is what we'd expect to see. However, the correlation is extremely weak and does not provide adequate evidence to suggest causation. Ultimately, changes in pine pulpwood inventory can be more closely linked to changes in pine timberland area (i.e. hectares) as well as a reflection of trends in age class distribution.

***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	-0.02	1			
Total Softwood Pulpwood Demand	0.67	0.73	1		
Pine Pulpwood Inventory	0.21	-0.45	-0.19	1	
Total Pine Inventory	0.80	0.36	0.82	0.28	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	-0.83	1			
Total Hardwood Pulpwood Demand	-0.39	0.84	1		
Hardwood Pulpwood Inventory	-0.43	0.79	0.88	1	
Total Hardwood Inventory	-0.11	0.36	0.49	0.88	1

	Softwood Biomass Demand	*Hardwood Biomass Demand*	*Total Biomass Demand*	*Total Pulpwood Inventory*	*Total Inventory*
Softwood Biomass Demand	1				
Hardwood Biomass Demand	0.48	1			
Total Biomass Demand	0.98	0.66	1		
Total Pulpwood Inventory	-0.04	-0.39	-0.14	1	
Total Inventory	0.80	0.74	0.87	0.16	1

6.1.5 *Changes in Annual Timber Growth*

Timber growth data for the Enviva Cottondale catchment area was also provided by the US Forest Service - Forest Inventory & Analysis (FIA) program. However, note that FIA growth data for this catchment area is only available since 2003.

According to US Forest Service data, net annual growth of growing stock timber increased 18% from 11.4 million m^3 in 2003 to 13.5 million m^3 in 2009. Annual growth proceeded to hold relatively steady over the nine years that followed; however, the impact of Hurricane Michael was significant, as annual growth declined an estimated 14% from 2018 to 2019. Overall, annual growth totaled 11.8 million m^3 in 2020, representing a 3% increase from 2003 levels.

Table 31 below (as well as Figure 39 on the following page) provides a breakdown of annual timber growth by major timber product from 2003 through 2020. Note that even with the catastrophic losses due to Hurricane Michael, annual growth of pine sawtimber and pine chip-n-saw increased an estimated 69% and 51%, respectively, from 2003-2020. However, the affects were more strongly felt with pine pulpwood, with annual growth of pine pulpwood declining an estimated 27% over this period.

***Table 31**. Enviva Cottondale Catchment Area - Annual Growth by Major Timber Product (2003-2020)*

	Softwood			*Hardwood*		
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
			(000 Cubic Meters)			
2003	1,793	1,750	5,421	694	1,789	11,447
2004	1,724	1,914	5,462	811	1,736	11,647
2005	1,670	2,043	5,389	922	1,711	11,734
2006	1,789	2,175	5,548	1,257	1,810	12,579
2007	1,832	2,296	5,834	1,348	1,780	13,089
2008	2,036	2,343	5,622	1,503	1,756	13,260
2009	2,233	2,398	5,674	1,467	1,735	13,506
2010	2,430	2,554	5,165	1,499	1,763	13,411
2011	2,739	2,642	5,007	1,528	1,718	13,634
2012	2,900	2,649	5,056	1,446	1,662	13,713
2013	2,964	2,761	5,115	1,257	1,588	13,685
2014	3,020	2,929	4,973	1,219	1,540	13,681
2015	3,030	2,914	4,926	1,091	1,538	13,499
2016	3,047	3,003	4,863	974	1,515	13,402
2017	3,171	3,011	4,850	921	1,494	13,447
2018	3,402	3,030	5,016	856	1,495	13,798
2019	3,003	2,578	4,050	824	1,387	11,843
2020	3,032	2,650	3,943	832	1,382	11,839

Source: USDA-US Forest Service

***Figure 39**. Enviva Cottondale Catchment Area - Net Annual Growth of Growing Stock Timber on Timberland (2003-2020)*

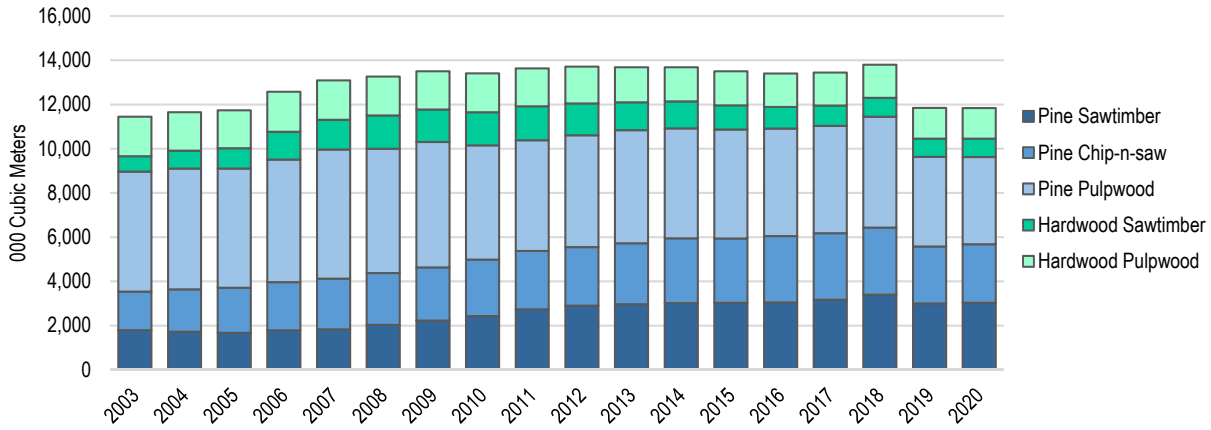
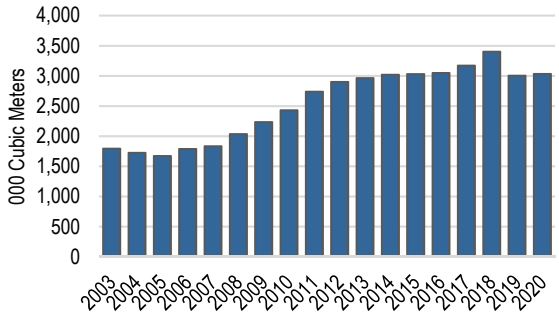
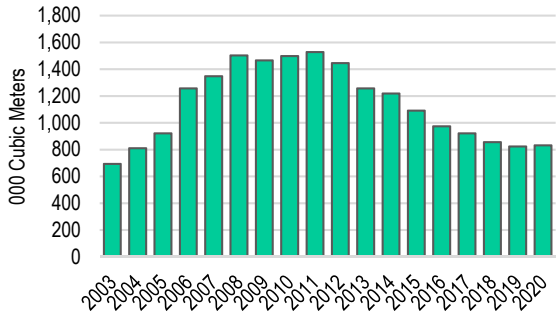


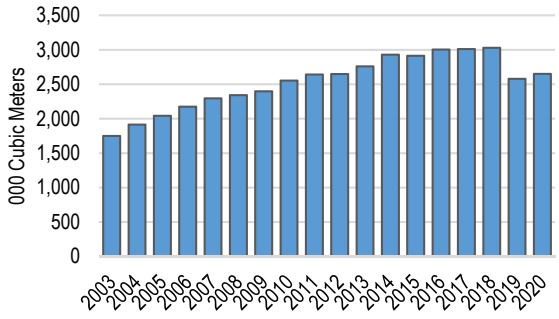
***Figure 40**. Enviva Cottondale Catchment Area - Net Annual Growth by Major Timber Product (2003-2020)*



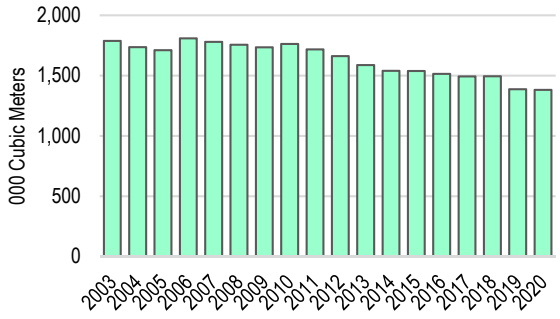
(a) Pine Sawtimber



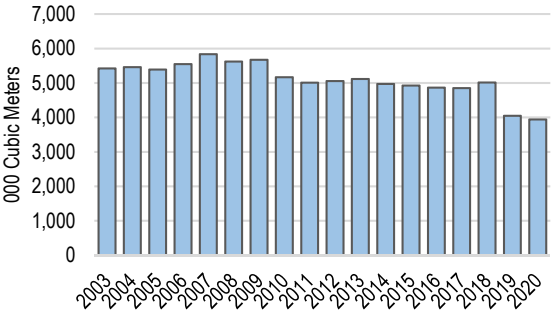
(d) Hardwood Sawtimber



(b) Pine Chip-n-saw



(e) Hardwood Pulpwood



(c) Pine Pulpwood

6.1.5.1 *Growth Rates & Per-Hectare Growth*

According to USFS data, average annual growth rates in the catchment area increased slightly from 5.5% in 2003 to 5.9% in 2007. However, this rate started to decline beginning in 2010 and steadily fell over the next seven years to 5.1% in 2017. Since 2017, growth rates have held steady and averaged 5.2% per year. Specifically, the average annual growth rate of pine pulpwood, the primary timber product consumed by the bioenergy sector, declined from 12.5% in 2003 to 10.6% in 2010 but since has held steady and averaged 10.6% per year. See Table 32 below for details.

***Table 32**. Enviva Cottondale Catchment Area - Average Annual Growth Rate by Major Timber Product (2003-2020)*

	Softwood			Hardwood		
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
			Annual Growth Rate (%)			
2003	3.2%	5.8%	12.4%	1.6%	5.2%	5.5%
2004	3.0%	6.0%	12.5%	1.9%	5.3%	5.6%
2005	2.9%	6.1%	12.0%	2.1%	5.3%	5.5%
2006	3.1%	6.3%	11.9%	2.7%	5.6%	5.8%
2007	3.2%	6.6%	12.0%	2.8%	5.6%	5.9%
2008	3.4%	6.5%	11.6%	3.1%	5.4%	5.9%
2009	3.5%	6.4%	11.7%	3.0%	5.3%	5.9%
2010	3.7%	6.5%	10.6%	2.9%	5.4%	5.6%
2011	3.8%	6.5%	10.4%	2.9%	5.2%	5.5%
2012	3.9%	6.3%	10.3%	2.8%	5.1%	5.5%
2013	3.8%	6.7%	11.0%	2.4%	4.9%	5.5%
2014	3.7%	6.7%	10.8%	2.3%	4.7%	5.3%
2015	3.6%	6.6%	10.8%	2.1%	4.7%	5.2%
2016	3.5%	6.6%	10.6%	2.0%	4.7%	5.1%
2017	3.6%	6.6%	10.6%	1.9%	4.6%	5.1%
2018	3.6%	6.5%	10.7%	1.7%	4.6%	5.1%
2019	3.7%	6.8%	11.1%	2.0%	4.8%	5.2%
2020	3.7%	6.9%	10.9%	2.0%	4.9%	5.2%

Source: USDA - US Forest Service

Furthermore, average per-hectare volume growth in the Enviva Cottondale catchment area increased from 3.93 m^3 in 2003 to 4.66 m^3 in 2009, and holding steady and averaging 4.60 m^3 per year from 2009-2018 before declining to 4.01 m^3 in 2019. However, note the recent decline in productivity is due to the loss of timber inventory (and associated growth) caused by Hurricane Michael. In terms of individual timber products, combined per-hectare growth of pine sawtimber and chip-n-saw nearly doubled from 2003-2018 while pine pulpwood per-hectare growth decreased slightly over this period (see Table 33 on the following page).

Ultimately, this data in its entirety is suggestive of two things: 1) the catchment area forest has become more productive and 2) the forest is in a state of transition where timber is moving up in product class (i.e. pulpwood is moving up to chip-n-saw and chip-n-saw is moving up to sawtimber). In general, growth rates decline as timber ages, so the decrease in pine pulpwood growth rate and simultaneous increase in pine chip-n-saw growth rate suggests pine pulpwood is moving up in classification to pine chip-n-saw. Pine pulpwood growth declines as it moves closer to chip-n-saw classification, and just the opposite

occurs with pine chip-n-saw – its growth rate increases due to the influx of younger timber into this new classification.

Moreover, note that the decline in pine pulpwood growth rate can also be linked to changes in forest composition (i.e. increased levels of natural pine – which have slower associated growth rates compared to plantation pine). Specifically, in the mid and late-2000s, planted pine constituted approximately 67% of total pine timberland, with natural pine accounting for the remaining 33%. However, in 2020, natural pine timberland accounted for 38% of total pine timberland, compared to 62% planted pine timberland.

***Table 33**. Enviva Cottondale Catchment Area - Average Per-Hectare Volume Growth by Major Timber Product (2003-2020)*

	Softwood			Hardwood		
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
			(Cubic Meters/Hectare/Year)			
2003	0.62	0.60	1.86	0.24	0.61	3.93
2004	0.59	0.66	1.88	0.28	0.60	4.02
2005	0.58	0.70	1.86	0.32	0.59	4.04
2006	0.62	0.75	1.91	0.43	0.62	4.34
2007	0.63	0.79	2.01	0.46	0.61	4.51
2008	0.70	0.81	1.94	0.52	0.61	4.58
2009	0.77	0.83	1.96	0.51	0.60	4.66
2010	0.83	0.87	1.77	0.51	0.60	4.59
2011	0.93	0.90	1.70	0.52	0.58	4.62
2012	0.98	0.90	1.71	0.49	0.56	4.64
2013	1.00	0.94	1.73	0.43	0.54	4.64
2014	1.02	0.98	1.67	0.41	0.52	4.60
2015	1.01	0.98	1.65	0.37	0.52	4.52
2016	1.02	1.01	1.63	0.33	0.51	4.51
2017	1.07	1.02	1.64	0.31	0.51	4.55
2018	1.15	1.02	1.70	0.29	0.51	4.66
2019	1.02	0.87	1.37	0.28	0.47	4.01
2020	1.03	0.90	1.34	0.28	0.47	4.01

Source: USDA - US Forest Service

***Figure 41**. Enviva Cottondale Catchment Area – Average Timber Growth Rate & Total Per-Hectare Volume Growth (2003-2020)*

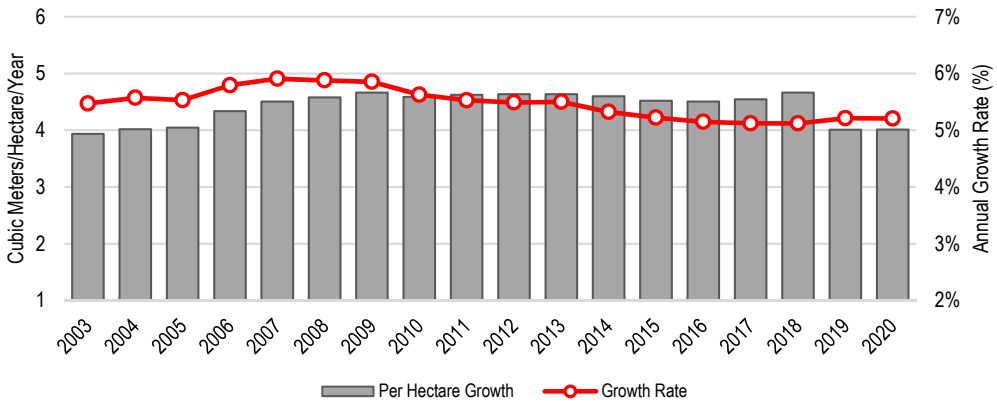
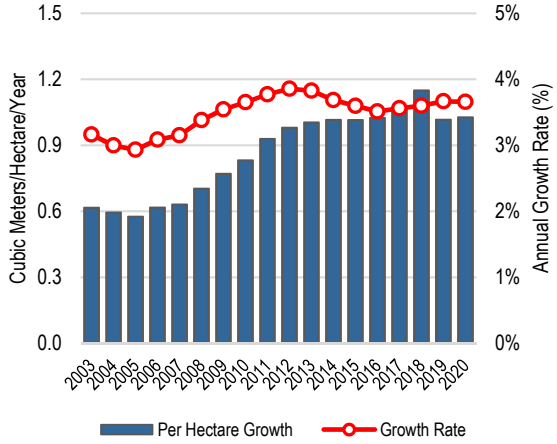
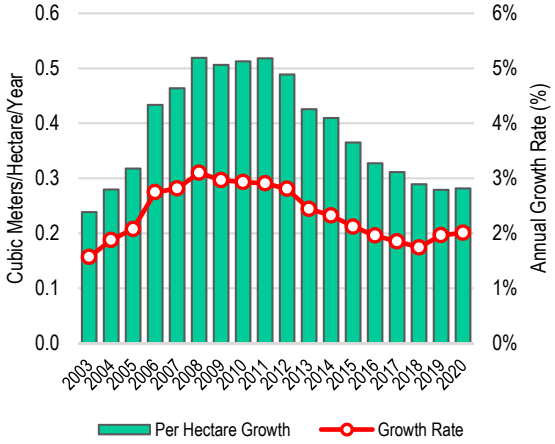


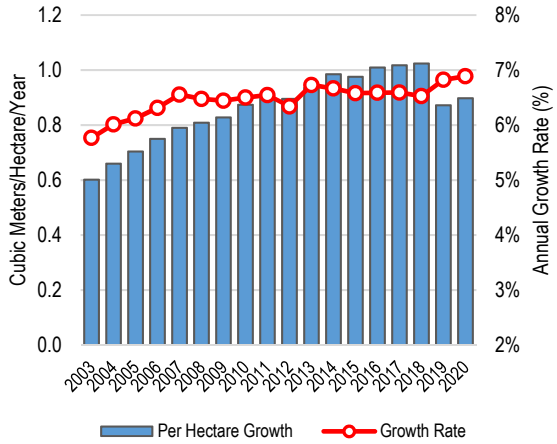
***Figure 42**. Enviva Cottondale Catchment Area - Annual Growth Rates & Per-Hectare Growth by Major Timber Product (2003-2020)*



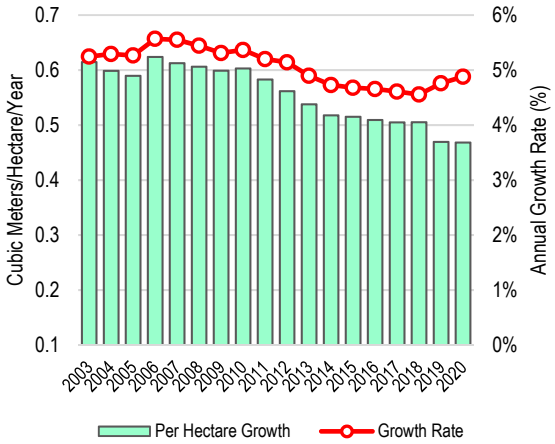
(a) Pine Sawtimber



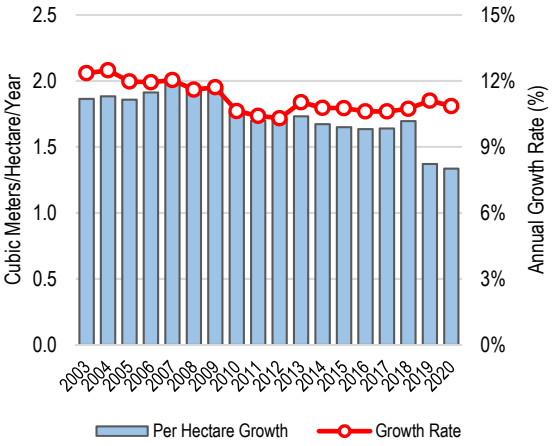
(d) Hardwood Sawtimber



(b) Pine Chip-n-saw



(e) Hardwood Pulpwood



(c) Pine Pulpwood

Growth Rates, Age Class, & Diameter Class

As was noted on page 75, the decrease in pine pulpwood growth rate and subsequent increase in pine chip-n-saw growth rate suggests that softwood forests in the catchment area are transitioning, with a significant portion of softwood inventory moving up in product class (from pine pulpwood to pine chip-n-saw). To demonstrate and help further explain this transition – including how this impacts growth rates – let's look at a typical yield curve for a pine timber stand as well as the growth rate curve.

Figure 43, below, shows softwood growing stock inventory in the catchment area by age class in 2020, including an overlay of the yield curve for a typical pine timber stand. Looking at this figure, notice that the majority of softwood growing stock inventory is located along the yield curve in those age classes where gross volume increases at a rapid pace. Specifically, according to USFS data, 58% of softwood inventory is 11-40 years of age, which is within the age class range where pine pulpwood transitions to pine chip-n-saw and pine chip-n-saw transitions to pine sawtimber.

Going a bit further, Figure 44 on the following page shows softwood growing stock inventory in the catchment area by diameter class 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. What we want to draw your attention to is where the highest distributions are located within each highlighted product class. Specifically, a majority of pine pulpwood inventory (highlighted in green) is at the top end of its diameter class range (and the bottom end of its growth rate rage), whereas a majority of pine chip-n-saw inventory (highlighted in yellow) is at the bottom end of its diameter class range (and the top end of its growth rate range).

***Figure 43**. Distribution of Softwood Growing Stock Inventory by Age Class vs. Typical Pine Gross Yield Curve*

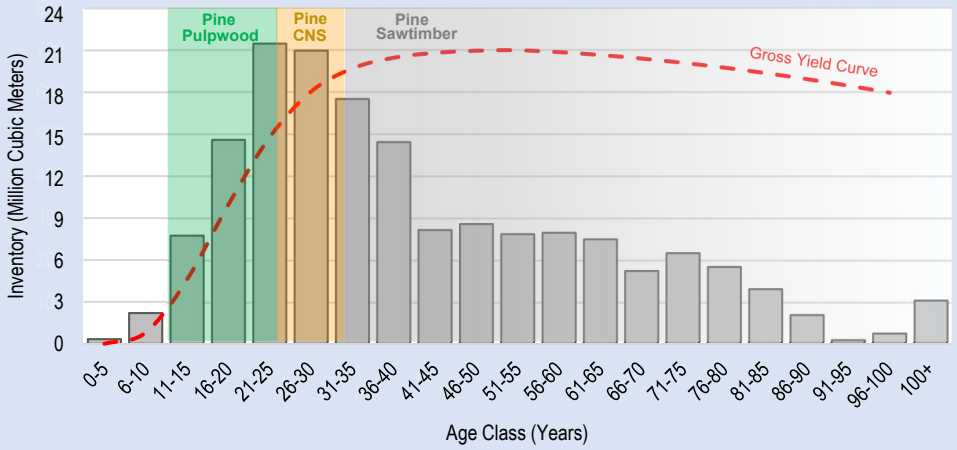
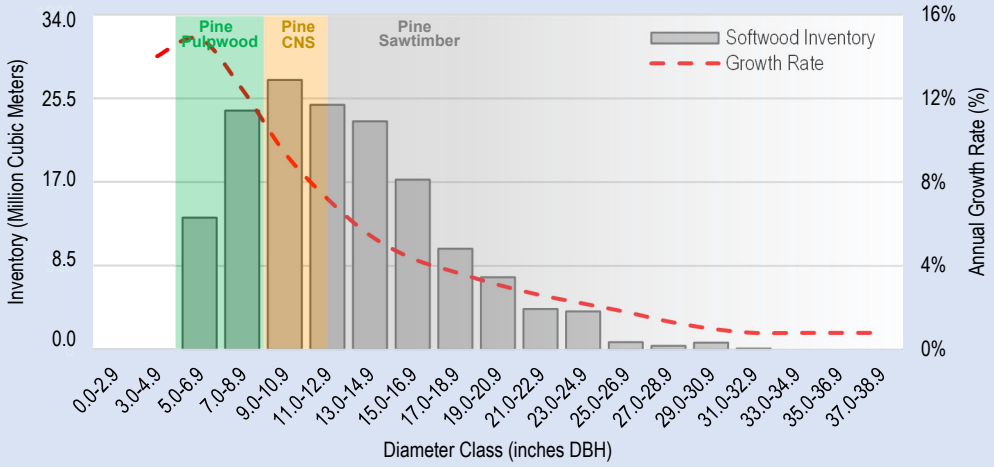


***Figure 44**. Distribution of Softwood Growing Stock Inventory by Diameter Class vs. Softwood Growth Rate Curve*



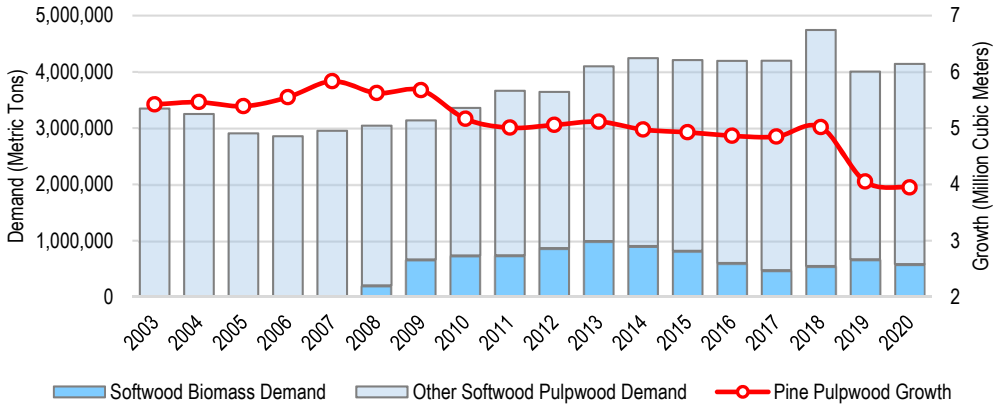
Ultimately, the decline in pine pulpwood growth rate and increase in pine chip-n-saw growth rate since the mid-2000s (as shown in Table 32 on pg. 75) indicate that the catchment area forest has been in a state of transition. And as these figures show/illustrate, this transition – and the change in growth rates – can be explained and better understood if we consider the natural growth cycle of timber and how this cycle impacts timber growth rates.

Correlation Analysis: *Biomass Demand vs. Timber Growth*

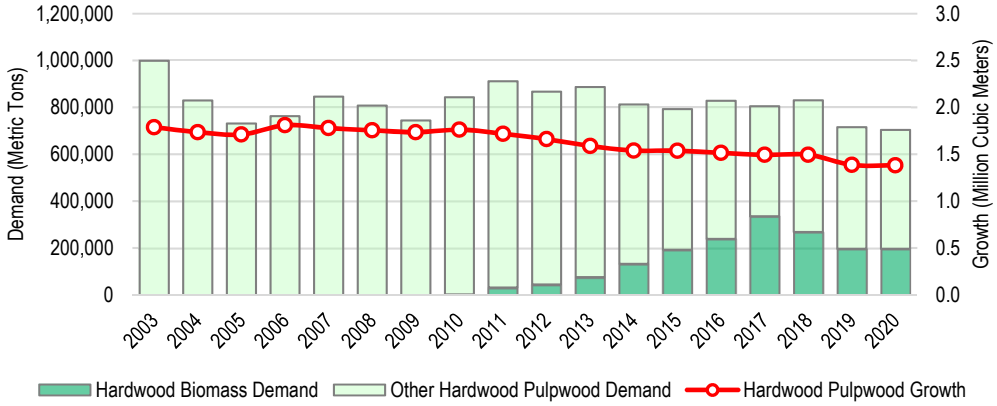
Figure 45 provides a side-by-side comparison of pulpwood demand (including biomass demand) and annual pulpwood growth in the catchment area from 2003-2020. In particular, Figure 45a shows that total softwood pulpwood demand and pine pulpwood growth, in general, have moved inversely to one another in the catchment area since 2003. Statistical analysis confirms this relationship, identifying a moderately strong negative correlation (correlation coefficient=-0.70) between these two variables from 2003-2020.

Intuitively, an inverse relationship is generally expected between demand and growth, and this is what the data shows in regards to softwood pulpwood demand and pine pulpwood growth in the Cottondale catchment area. However, there is little evidence suggesting that increased demand attributed to bioenergy, alone, is responsible for the decrease in pine pulpwood growth since the Cottondale mill commenced operations in 2008. Moreover, no identifiable relationship (correlation coefficient=-0.09) was found between softwood biomass demand and pine pulpwood growth from 2008-2020 – which provides further evidence that the decrease in pine pulpwood growth is more closely linked to increased softwood pulpwood demand from other sources.

***Figure 45**. Enviva Cottondale Catchment Area – Softwood Pulpwood Demand vs. Annual Pine Pulpwood Growth (2003-2020)*



(a) Softwood Pulpwood Demand vs. Pine Pulpwood Growth



(b) Hardwood Biomass Demand vs. Hardwood Pulpwood Growth

***Table 34**. Correlation Analysis –Biomass Demand, Pulpwood Demand & Annual Timber Growth (2003-2020)*

	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	0.06	1			
Total Softwood Pulpwood Demand	0.67	0.79	1		
Pine Pulpwood Growth	-0.51	-0.51	-0.70	1	
Total Pine Growth	0.71	0.37	0.71	-0.17	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	-0.88	1			
Total Hardwood Pulpwood Demand	-0.25	0.68	1		
Hardwood Pulpwood Growth	-0.88	0.87	0.42	1	
Total Hardwood Growth	-0.70	0.65	0.24	0.94	1

	Softwood Biomass Demand	*Hardwood Biomass Demand*	*Total Biomass Demand*	*Total Pulpwood Growth*	*Total Growth*
Softwood Biomass Demand	1				
Hardwood Biomass Demand	0.40	1			
Total Biomass Demand	0.97	0.62	1		
Total Pulpwood Growth	-0.52	-0.74	-0.65	1	
Total Growth	0.64	0.23	0.61	0.10	1

6.1.6 *Changes in Annual Removals*

According to the US Forest Service, annual removals of growing stock timber held relatively consistent in the catchment area through the 2000s, averaging 7.4 million m^3 per year from 2000-2009. However, since 2013, and excluding 2018 levels which were heavily impacted by Hurricane Michael, total removals have averaged 8.8 million m^3 per year, up 19% compared to 2000-2009 average levels.

Table 35 below provides a breakdown of annual removal estimates by major timber product in the Enviva Cottondale catchment area from 2000 through 2020. Annual removals of pine sawtimber and pine chip-n-saw (i.e. softwood sawlogs) held steady and averaged 3.4 million m^3 per year from 2000-2010 before increasing nearly 40% over the seven years that followed to 4.8 million m^3 in 2017. Softwood sawlog removals proceeded to increase an estimated 34% in 2018 (due to Hurricane Michael). However, excluding 2018, removals of softwood sawlogs have held relatively steadily and averaged 4.8 million m^3 per year since 2017.

Annual removals of pine pulpwood (the primary roundwood product consumed by the bioenergy sector) averaged 2.4 million m^3 per year from 2000-2010. However, since 2013 (and excluding 2018), pine pulpwood removals have averaged 3.1 million m^3 per year in the Cottondale catchment area, up nearly 30% compared to 2000-2010 levels.

***Table 35**. Enviva Cottondale 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	1,909	1,404	2,431	866	829	7,441
2001	2,065	1,328	2,466	834	827	7,521
2002	2,223	1,253	2,509	803	824	7,611
2003	2,385	1,178	2,568	773	821	7,724
2004	2,093	1,132	2,732	664	736	7,356
2005	2,274	1,182	2,533	825	728	7,542
2006	2,101	1,160	2,312	679	683	6,936
2007	2,259	1,293	2,297	671	708	7,228
2008	2,218	1,418	2,287	719	703	7,345
2009	1,881	1,421	2,284	671	667	6,925
2010	1,876	1,620	2,398	654	742	7,290
2011	1,740	1,958	2,623	798	776	7,895
2012	1,830	1,957	2,543	657	692	7,678
2013	1,961	2,303	3,104	673	694	8,735
2014	1,711	2,276	3,301	621	620	8,529
2015	1,863	2,318	3,270	735	616	8,802
2016	2,265	2,240	3,019	622	542	8,688
2017	2,502	2,293	3,048	579	561	8,982
2018	3,360	3,067	4,177	614	493	11,710
2019	2,743	2,318	3,006	531	416	9,013
2020	2,364	2,303	3,137	511	404	8,718

Source: USDA - US Forest Service

***Figure 46**. Enviva Cottondale Catchment Area - Annual Removals by Year (2000-2020)*

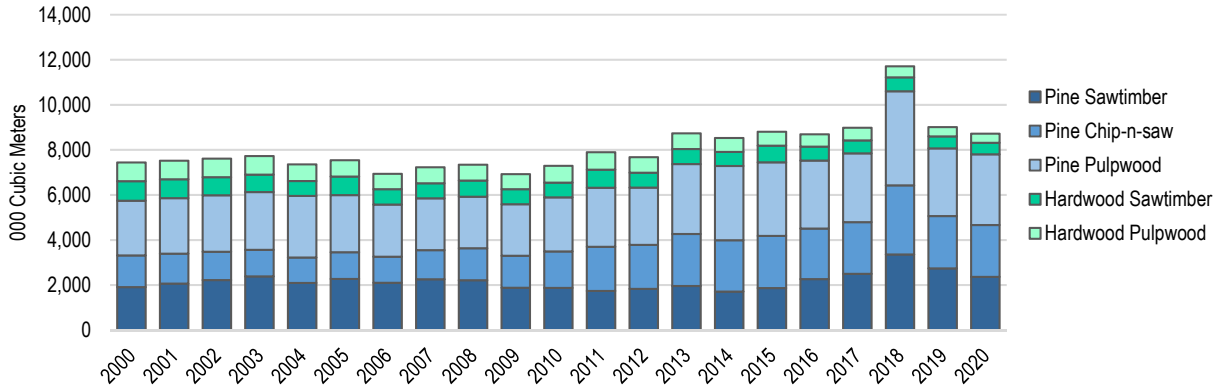
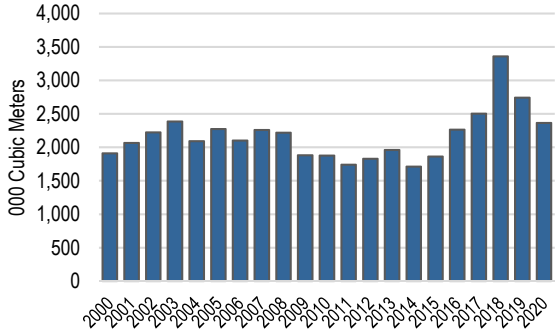
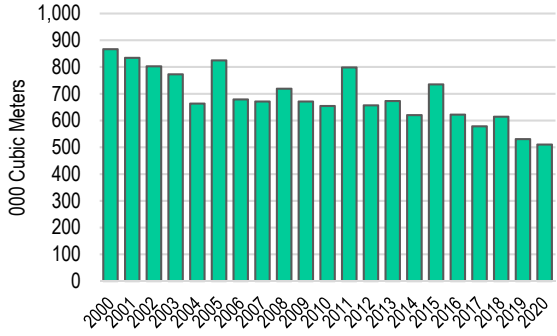


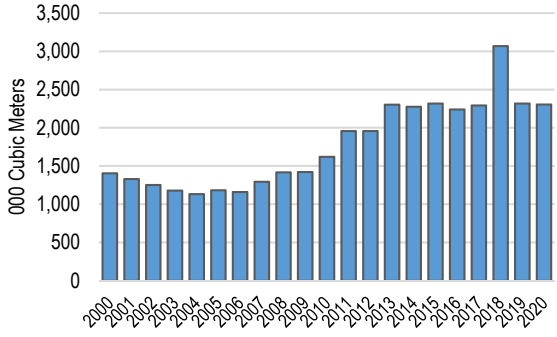
***Figure 47**. Enviva Cottondale Catchment Area - Annual Removals by Major Timber Product (2000-2020)*



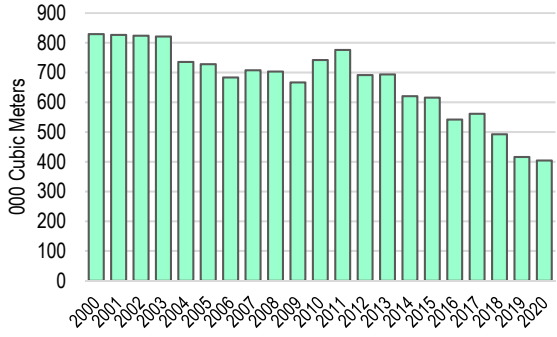
(a) Pine Sawtimber



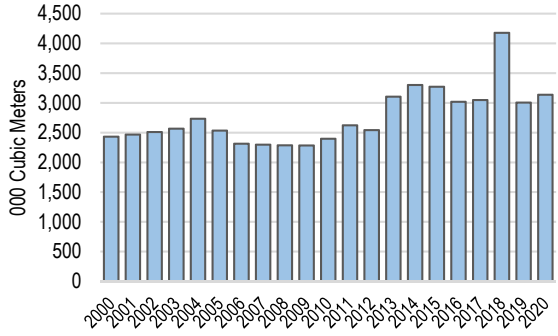
(d) Hardwood Sawtimber



(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 above 1.0 in the catchment area from 2003-2020, indicating that harvest levels remained below the sustainable yield capacity of the forest area over this period. Specifically, pine pulpwood G:R ratio averaged 2.47 from 2006-2009, steadily declining over the five years that followed but leveling out and averaging 1.55 from 2014-2017. However, as a result of the increased removals/salvage wood brought about by Hurricane Michael, the pine pulpwood G:R ratio fell to 1.20 in 2018 and has since averaged 1.27 in the Cottondale catchment area.

Note that unsustainable harvest levels persisted in the catchment area for both pine sawlogs (combined pine sawtimber and chip-n-saw) and hardwood sawtimber in the early 2000s. However, since 2004, pine and hardwood sawlog markets have both remained sustainable – with harvest levels remaining below the sustainable yield capacity of the forest area.

***Table 36**. Enviva Cottondale Catchment Area – Growth-to-Removals Ratios (2003-2020)*

	Softwood			*Hardwood*		
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
			(Growth-to-Removals Ratio)			
2003	0.75	1.49	2.11	0.90	2.18	1.48
2004	0.82	1.69	2.00	1.22	2.36	1.58
2005	0.73	1.73	2.13	1.12	2.35	1.56
2006	0.85	1.87	2.40	1.85	2.65	1.81
2007	0.81	1.77	2.54	2.01	2.51	1.81
2008	0.92	1.65	2.46	2.09	2.50	1.81
2009	1.19	1.69	2.48	2.19	2.60	1.95
2010	1.30	1.58	2.15	2.29	2.38	1.84
2011	1.57	1.35	1.91	1.91	2.21	1.73
2012	1.58	1.35	1.99	2.20	2.40	1.79
2013	1.51	1.20	1.65	1.87	2.29	1.57
2014	1.76	1.29	1.51	1.96	2.48	1.60
2015	1.63	1.26	1.51	1.48	2.50	1.53
2016	1.35	1.34	1.61	1.57	2.79	1.54
2017	1.27	1.31	1.59	1.59	2.66	1.50
2018	1.01	0.99	1.20	1.39	3.04	1.18
2019	1.09	1.11	1.35	1.55	3.33	1.31
2020	1.28	1.15	1.26	1.63	3.42	1.36

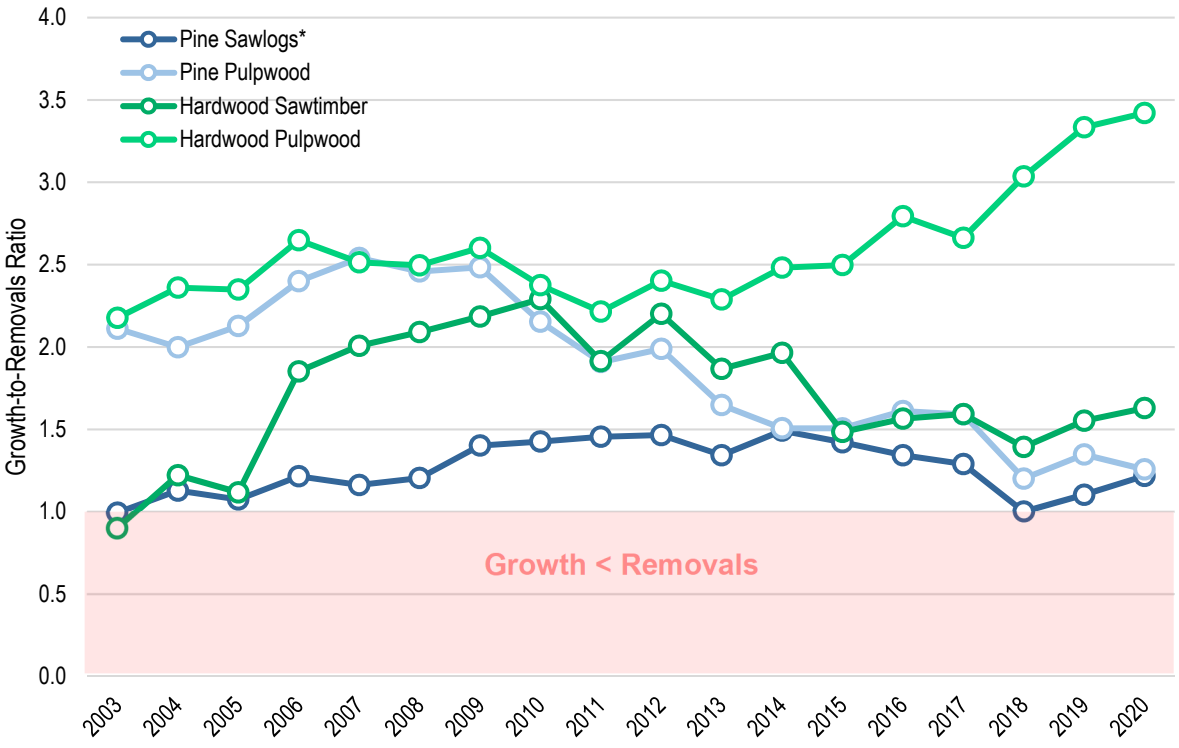
Source: USDA - US Forest Service

Figure 48, below, shows growth-to-removals ratios in the catchment area for the major timber products from 2003-2020. As this figure shows (and was noted on the previous page), the pine pulpwood G:R ratio steadily declined from 2009-2014. Note that this decline can ultimately be linked to both an increase in pine pulpwood removals and simultaneous decrease in pine sawtimber removals.

Specifically, the decrease in pine pulpwood growth coincided with reduced harvests of pine sawtimber, which resulted in a reduction in new reestablished pine stands, leading to reduced pine pulpwood inventory levels and ultimately reduced pine pulpwood growth. Furthermore, the increase in pine pulpwood removals can also be linked to reduced pine sawtimber production levels in the mid to late-2000s. Specifically, reduced pine sawtimber production resulted in a reduction of sawmill residuals (which are utilized by both the pulp/paper industry and bioenergy industry), which in turn led to an increase in pine pulpwood removals (to account for the loss of sawmill residues).

However, pine sawtimber production started to increase beginning in the early 2010s, resulting in an increase in sawmill residuals, and, as a result, pine pulpwood removals also begun to decrease. This ultimately resulted in the pine pulpwood G:R ratio leveling off and holding steady between 1.40 and 1.45 from 2011-2017. The pine pulpwood G:R ratio declined substantially in 2018. However, as was previously noted, this decrease can be attributed to Hurricane Michael and the 31% year-over-year increase in pine pulpwood removals (due to increased levels of salvage wood).

***Figure 48**. Enviva Cottondale Catchment Area – Growth-to-Removals Ratios by Major Timber Product (2003-2020)*



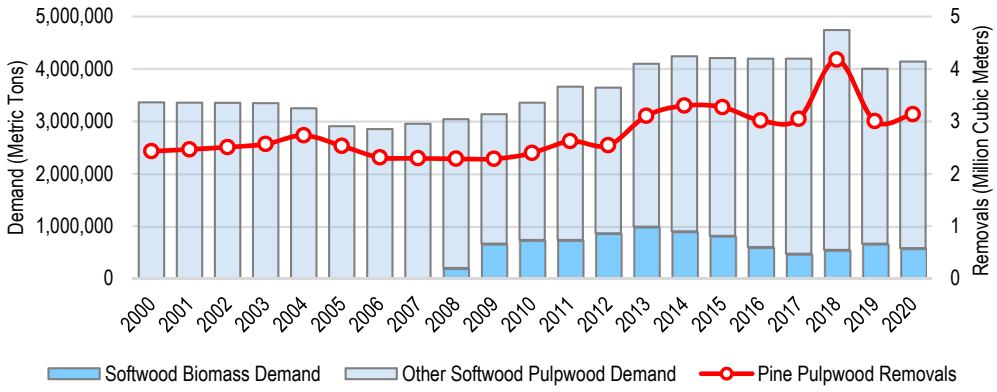
*Pine sawlogs includes pine sawtimber and pine chip-n-saw

Correlation Analysis: *Biomass Demand vs. Timber Removals*

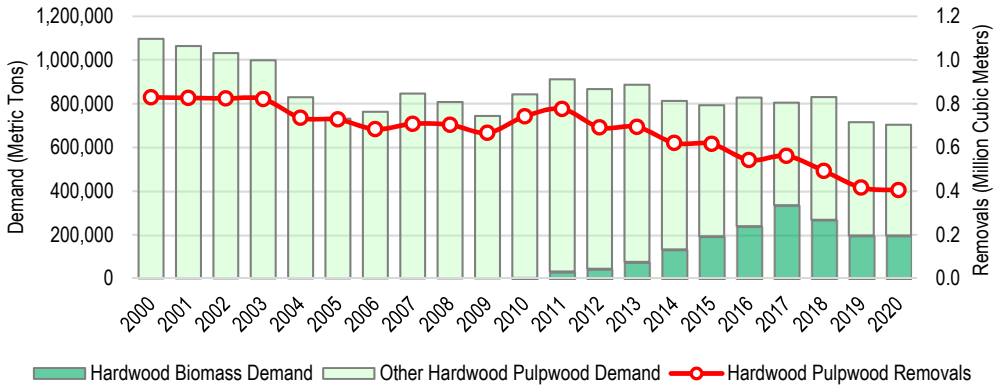
Figure 49 provides a side-by-side comparison of biomass demand and total pulpwood demand versus pulpwood removals in the catchment area from 2000-2020. Since pulpwood removals, in general, should be representative of pulpwood demand, we'd expected these two to be very strongly (positively) correlated, and that's exactly what we see in Figure 49. Statistical analysis confirms this relationship, identifying a strong positive correlation between softwood pulpwood demand and pine pulpwood removals (correlation coefficient=0.92) as well as a moderately strong positive correlation between hardwood pulpwood demand and hardwood pulpwood removals (correlation coefficient=0.73) in the catchment area from 2000-2020.

Looking specifically at Figure 49(a), we also see that softwood biomass demand has only loosely tracked pine pulpwood removals since the Enviva Cottondale mill commenced operations in 2008. Furthermore, statistical analysis failed to identify any meaningful relationship between the two from 2008-2020 (correlation coefficient=0.13). Ultimately, softwood biomass, which accounted for only 17% of total softwood pulpwood demand in the catchment area from 2008-2020, has had an impact on the total level of pine pulpwood removals in the Cottondale catchment area. However, demand from other sources (i.e. pulp/paper) is the primary driver of pine pulpwood removals in this catchment area.

***Figure 49**. Enviva Cottondale Catchment Area –Pulpwood Demand vs. Annual Pulpwood Removals (2000-2020)*



(a) Softwood Pulpwood Demand vs. Pine 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	-0.02	1			
Total Softwood Pulpwood Demand	0.67	0.73	1		
Pine Pulpwood Removals	0.48	0.79	0.92	1	
Total Pine Removals	0.47	0.78	0.90	0.95	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	-0.83	1			
Total Hardwood Pulpwood Demand	-0.39	0.84	1		
Hardwood Pulpwood Removals	-0.82	0.93	0.73	1	
Total Hardwood Removals	-0.77	0.91	0.75	0.96	1

	Softwood Biomass Demand	*Hardwood Biomass Demand*	*Total Biomass Demand*	*Total Pulpwood Removals*	*Total Removals*
Softwood Biomass Demand	1				
Hardwood Biomass Demand	0.48	1			
Total Biomass Demand	0.98	0.66	1		
Total Pulpwood Removals	0.41	0.69	0.53	1	
Total Removals	0.43	0.82	0.57	0.92	1

***Table 38**. Enviva Cottondale 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	82,883	38,482	36,330	41,399	28,345	227,410
	2019	81,892	37,774	36,472	41,937	29,138	227,212
	2018	94,464	46,411	46,751	49,101	32,819	269,546
	2017	89,056	45,675	45,703	49,724	32,394	262,551
	2016	86,734	45,590	45,816	49,696	32,536	260,343
	2015	84,214	44,259	45,788	51,451	32,876	258,559
	2014	81,948	43,919	46,156	52,442	32,564	257,030
	2013	77,474	41,031	46,383	51,480	32,422	248,761
	2012	75,181	41,795	49,101	51,480	32,309	249,837
	2011	72,604	40,351	48,110	52,556	33,045	246,637
	2010	66,544	39,303	48,620	51,111	32,847	238,397
	2009	62,976	37,208	48,450	49,469	32,677	230,780
	2008	60,229	36,189	48,450	48,478	32,253	225,570
	2007	58,162	35,028	48,478	47,883	32,054	221,577
	2006	57,964	34,461	46,468	45,760	32,507	217,160
	2005	56,973	33,357	44,995	44,372	32,479	212,176
	2004	57,539	31,828	43,749	43,154	32,791	209,090
Growth	2020	3,030	2,662	3,936	821	1,388	11,836
	2019	3,002	2,577	4,049	821	1,388	11,836
	2018	3,398	3,030	5,012	849	1,501	13,790
	2017	3,171	3,002	4,842	934	1,501	13,450
	2016	3,058	3,002	4,870	963	1,501	13,394
	2015	3,030	2,917	4,927	1,104	1,529	13,507
	2014	3,030	2,917	4,984	1,218	1,529	13,677
	2013	2,973	2,775	5,125	1,246	1,586	13,677
	2012	2,888	2,662	5,069	1,444	1,671	13,705
	2011	2,747	2,633	5,012	1,529	1,727	13,620
	2010	2,435	2,548	5,154	1,501	1,756	13,422
	2009	2,237	2,407	5,663	1,472	1,727	13,507
	2008	2,039	2,350	5,635	1,501	1,756	13,252
	2007	1,841	2,294	5,833	1,359	1,784	13,082
	2006	1,784	2,180	5,550	1,246	1,812	12,573
	2005	1,671	2,039	5,380	934	1,699	11,723
	2004	1,727	1,926	5,465	821	1,727	11,638
Removals	2020	2,152	2,095	2,860	340	283	7,759
	2019	2,492	2,124	2,775	340	283	8,014
	2018	2,718	2,407	3,087	396	368	8,948
	2017	2,350	2,237	2,917	368	425	8,325
	2016	2,124	2,180	2,888	396	425	7,985
	2015	1,727	2,237	3,143	538	481	8,127
	2014	1,586	2,209	3,200	425	510	7,900
	2013	1,841	2,237	3,002	510	595	8,155
	2012	1,699	1,897	2,435	510	595	7,136
	2011	1,614	1,897	2,520	680	680	7,391
	2010	1,727	1,557	2,294	566	651	6,768
	2009	1,756	1,359	2,180	566	566	6,428
	2008	2,095	1,359	2,209	595	595	6,853
	2007	2,152	1,246	2,209	510	595	6,711
	2006	1,982	1,104	2,237	538	566	6,428
	2005	2,180	1,133	2,435	680	595	7,023
	2004	2,010	1,076	2,662	510	595	6,853
Mortality	2020	510	255	368	425	368	1,954
	2019	510	255	368	425	368	1,926
	2018	425	198	340	481	368	1,812
	2017	425	170	340	453	368	1,727
	2016	396	170	340	425	368	1,727
	2015	396	170	368	396	368	1,699
	2014	396	170	368	368	340	1,671
	2013	396	170	368	368	340	1,642
	2012	396	170	368	340	311	1,614
	2011	453	198	340	311	311	1,586
	2010	481	198	311	255	283	1,557
	2009	453	198	311	311	283	1,586
	2008	425	170	311	368	311	1,586
	2007	396	198	283	453	368	1,671
	2006	368	198	283	425	368	1,642
	2005	340	198	283	453	396	1,642
	2004	311	198	283	481	396	1,642

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 Enviva Cottondale plant has included a combination of pulpwood (roundwood), pulp quality chips, and 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 Enviva Cottondale catchment area. Also, historic quarterly raw material prices are provided in tabular form in Appendix A.

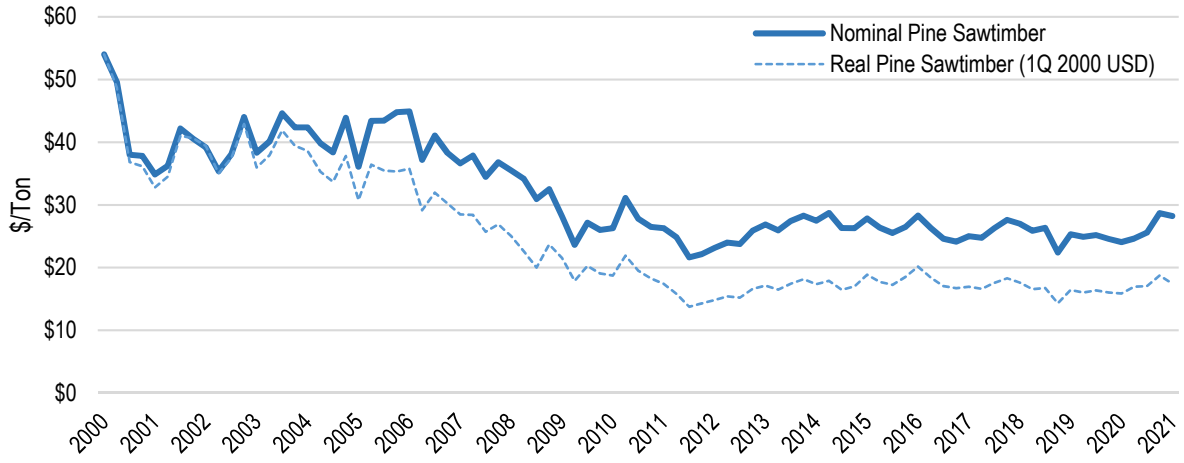
6.1.7.1 *Stumpage Prices*

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

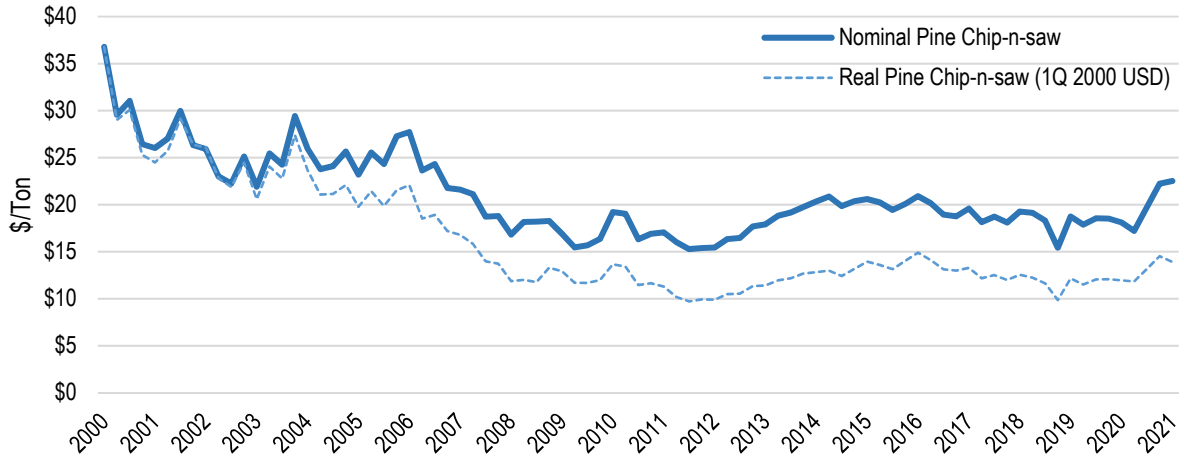
- Pine Sawtimber Stumpage. Pine sawtimber (PST) stumpage prices held relatively steady and averaged more than $41 per ton from 1Q 2000-1Q 2006. However, PST stumpage prices proceeded to decline more than 50% over the five years that followed, bottoming out at $21.63 per ton in 3Q 2011. Prices rebounded a bit but over the two years that followed but since 2013 have held more-or-less flat and remained between $24 and $29 per ton.
- Pine Chip-n-saw Stumpage. Pine chip-n-saw (CNS) stumpage prices in the Enviva Cottondale catchment area trended very similarly to those of pine sawtimber, holding relatively steady through the mid-2000s before declining 45% from 1Q 2006 to 3Q 2011. Prices rebounded modestly over the next several years, increasing from $15.28 per ton in 3Q 2011 to $20.87 per ton in 2Q 2014 – and remaining between roughly $18 and $21 per ton through 3Q 2020. However, since 3Q 2020, CNS prices have increased 13% and averaged approximately $22.40 per ton, which is still down 14% from the 2000-2006 average of roughly $26 per ton.
- Pine Pulpwood Stumpage. Pine pulpwood (PPW) stumpage prices held steady and averaged roughly $7.50 per ton from 2000-2007. However, PPW prices more than doubled over the seven years that followed, increasing to approximately $15.25 per ton in 2Q 2014. But since peaking in 2Q 2014, PPW prices have trended downwards, falling 30% to $10.75 per ton in 1Q 2021.
- Hardwood Sawtimber Stumpage. Hardwood sawtimber (HST) stumpage prices trended flat overall from 2000-2011, averaging $21.37 per ton over this period. However, HST prices proceeded to increase nearly 40% over the two-plus years that followed, to $29.36 per ton in 2Q 2014. And since that time, HST prices have held steady and averaged $29.22 per ton in the Enviva Cottondale catchment area.
- Hardwood Pulpwood Stumpage. Hardwood pulpwood (HPW) stumpage prices, although somewhat volatile, trended flat overall from 2000 through 2016. However, since the start of 2017, HPW prices have trended upwards, increasing to $11.60 per ton in 1Q 2021, which was up 41% from the 2000-2016 average of $8.22 per ton.

See Figures 50 and 51 for nominal and real quarterly average stumpage prices in the Enviva Cottondale catchment area for the five major timber products from 1Q 2000 – 1Q 2021. Corresponding prices are provided in tabular form in Appendix A.

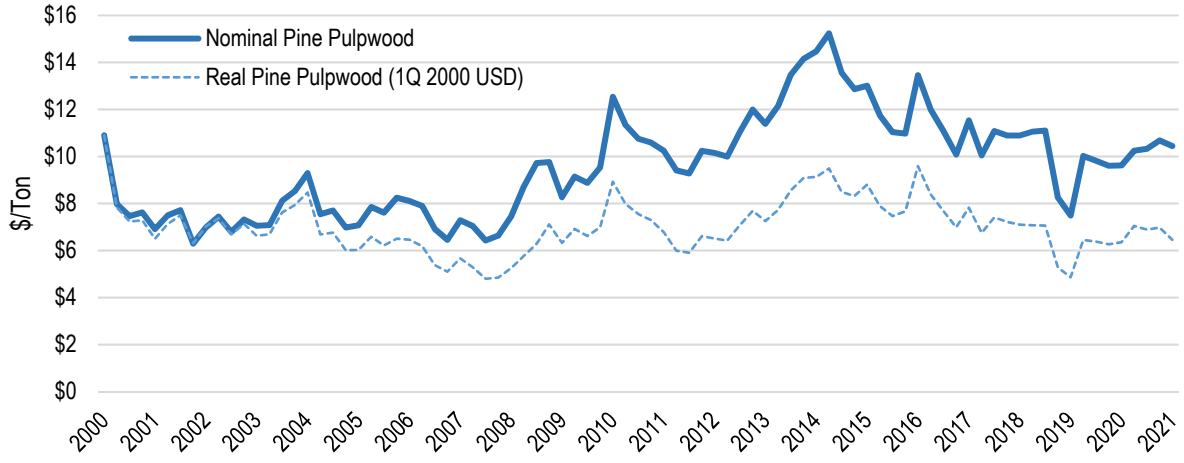
***Figure 50**. Enviva Cottondale Catchment Area – Nominal & Real Quarterly Pine Stumpage Prices ($/Ton)*



(a) Pine Sawtimber Stumpage

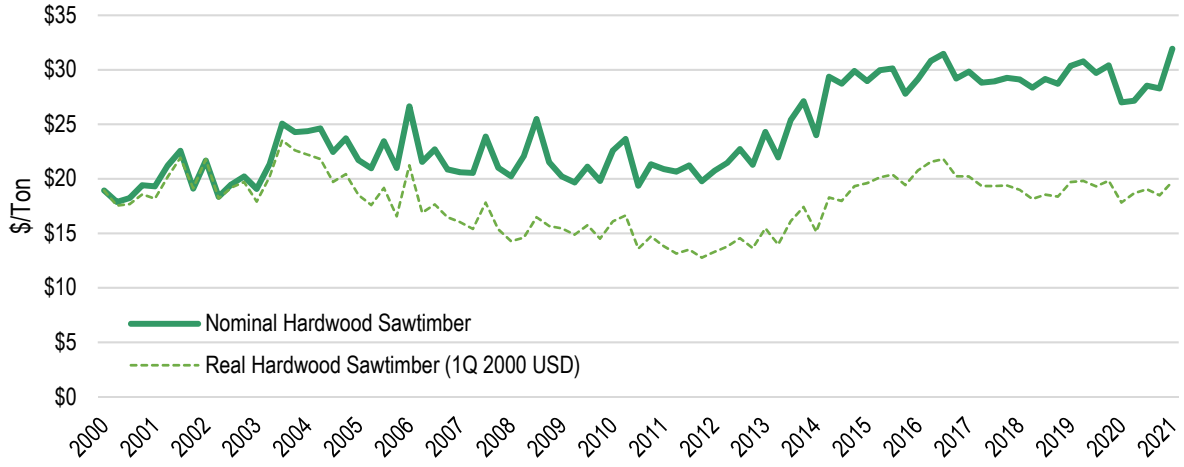


(b) Pine Chip-n-saw Stumpage

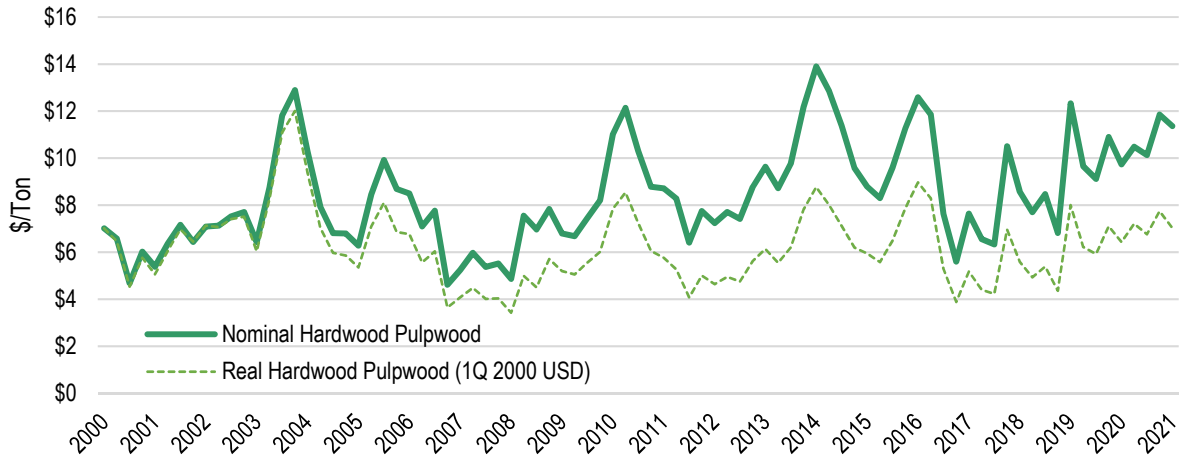


(c) Pine Pulpwood Stumpage

***Figure 51**. Enviva Cottondale Catchment Area – Nominal & Real Quarterly Hardwood Stumpage Prices ($/Ton)*



(a) Hardwood Sawtimber Stumpage



(b) Hardwood Pulpwood Stumpage

5.1.7.2 *Delivered Timber Prices*

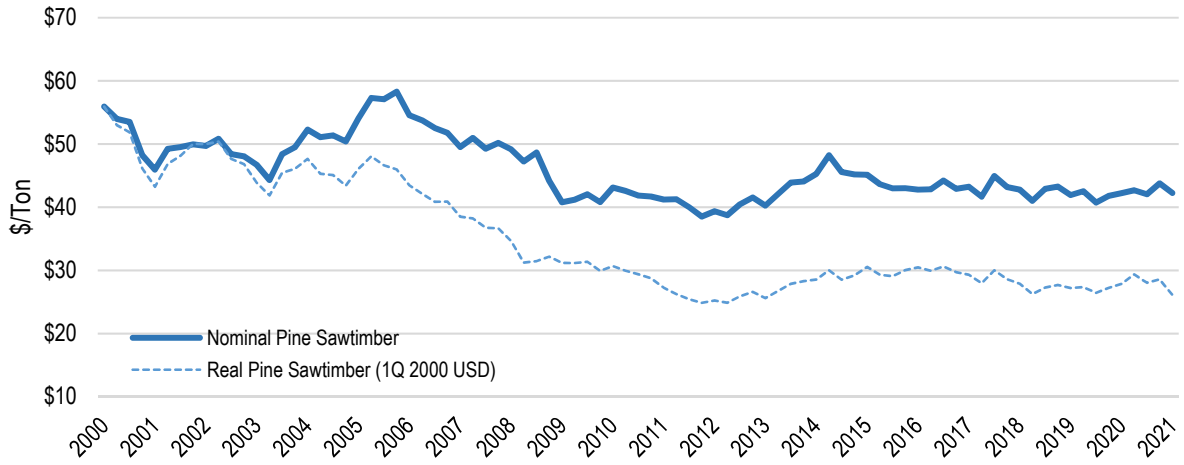
Delivered prices are those paid for timber delivered to the mill. These prices include stumpage (standing timber) price plus any costs associated with cutting, loading, and hauling timber to the mill.

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

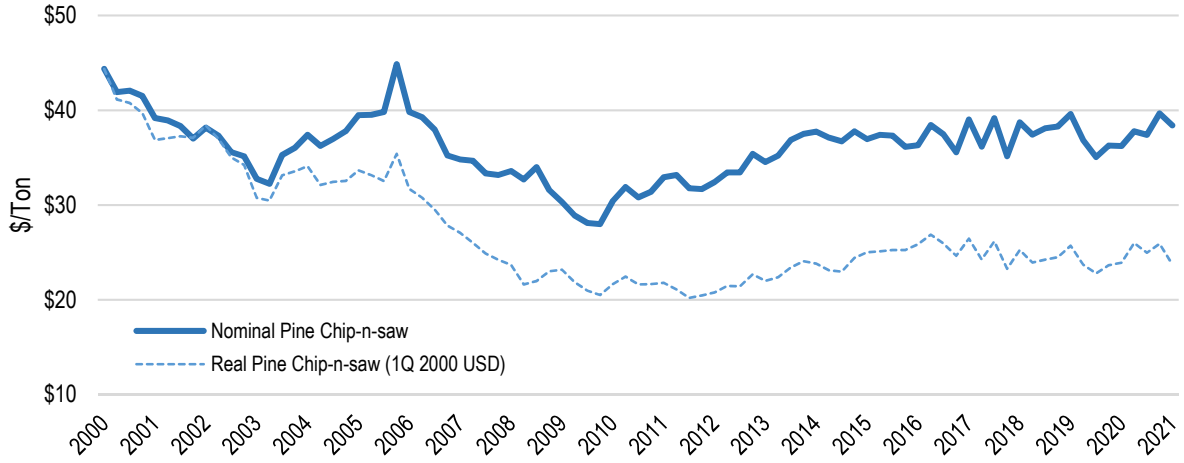
- Delivered Pine Sawtimber. Delivered pine sawtimber (PST) prices were up and down in the early and mid-2000s but ultimately peaked at $58.29 per ton in 4Q 2005. However, prices fell 30% over the three years that followed before stabilizing at roughly $41 per ton from 1Q 2009 – 1Q 2013. Delivered PST prices rebounded a bit but since 2015 have held steady and averaged $42.83 per ton in the Enviva Cottondale catchment area.
- Delivered Pine Chip-n-saw. Delivered pine chip-n-saw (CNS) prices were also up and down in the early and mid-2000s, peaking at nearly $45 per ton in 4Q 2005. However, delivered CNS prices declined 38% over the four years that followed, falling to just below $28 per ton in 4Q 2009. Prices rebounded over the next four years but since 2014 have stabilized and averaged $37.40 per ton in the Enviva Cottondale catchment area.
- Delivered Pine Pulpwood. Delivered pine pulpwood (PPW) prices declined slightly in the early 2000s but proceeded to increase an average of 4.4% per year (+66% total) over the next 12 years, from $18.77 per ton in 4Q 2002 to $31.23 per ton in 3Q 2014. Delivered PPW prices held steady relatively steady over the four years that followed. However, since 4Q 2018, prices have trended downwards, falling 14% to $27.69 per ton in 1Q 2021.
- Delivered Hardwood Sawtimber. Delivered hardwood sawtimber (HST) prices had been on steady upward climb through the 2000s and early 2010s, increasing an average of 1.8% per year (+25% total) from $31.46 per ton in 1Q 2000 to $39.48 per ton in 4Q 2012. However, delivered HST prices increased 20% over the four quarters that followed, to $47.41 per ton in 4Q 2013, but since have held steady and averaged $49.36 per ton in the Enviva Cottondale catchment area.
- Delivered Hardwood Pulpwood. Delivered hardwood pulpwood (HPW) prices, although a bit volatile, increased at an average rate of 2.8% per year (+57% total) from $19.00 per ton in 1Q 2000 to $29.84 per ton in 1Q 2016. Prices declined 20% over the six quarters that followed, falling to approximately $24 per ton in 3Q 2017. However, delivered HPW prices are up more than 22% since, averaging $29.42 per ton in 1Q 2021.

See Figures 52 and 53 for nominal and real quarterly average delivered prices in the Enviva Cottondale catchment area for the five major timber products from 1Q 2000 – 1Q 2021. Corresponding prices are provided in tabular form in Appendix A.

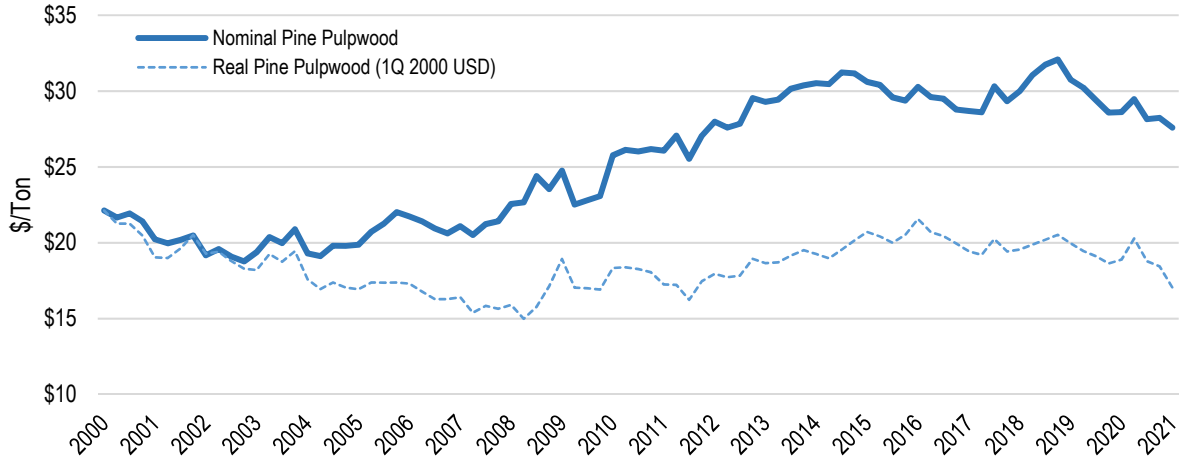
***Figure 52**. Enviva Cottondale Catchment Area - Nominal & Real Quarterly Delivered Pine Prices ($/Ton)*



(a) Delivered Pine Sawtimber

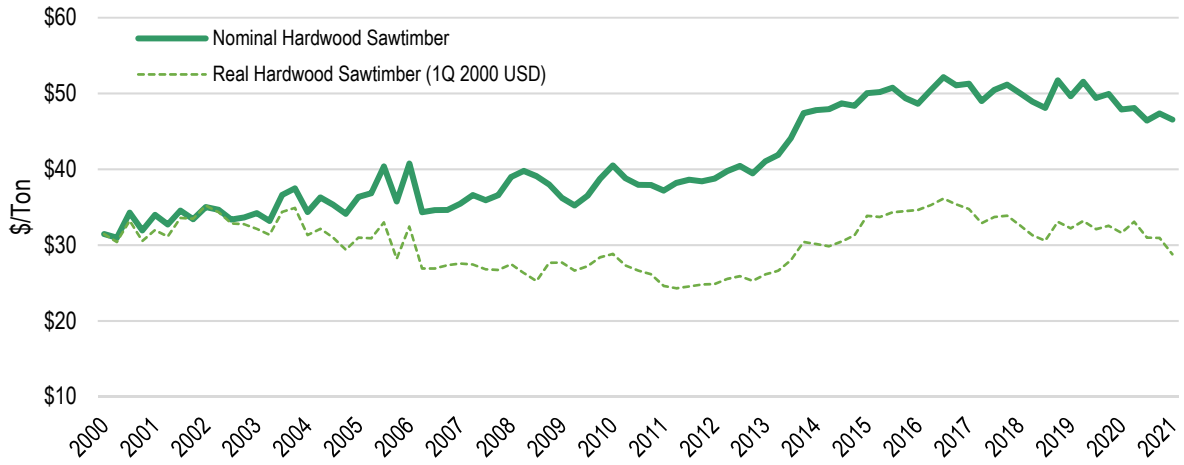


(b) Delivered Pine Chip-n-saw

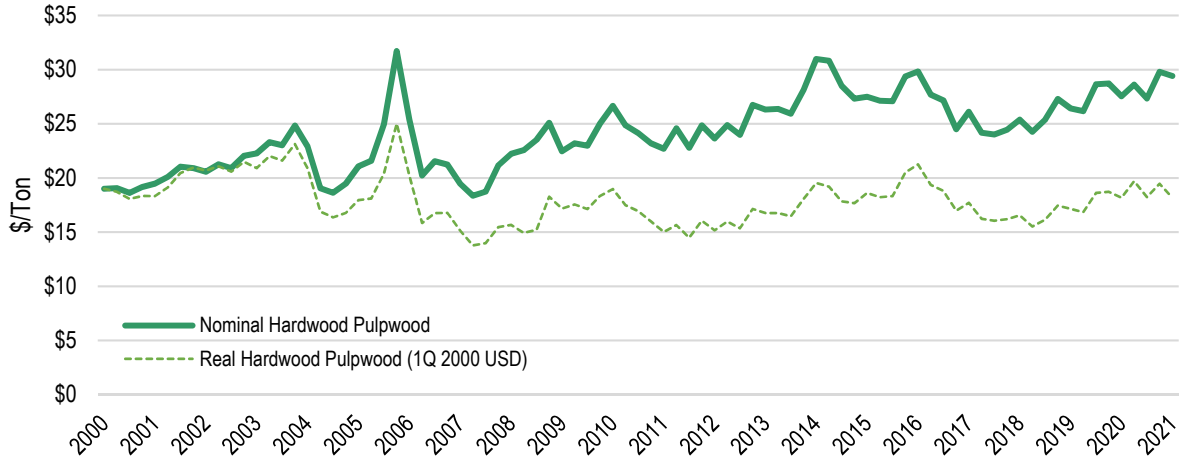


(c) Delivered Pine Pulpwood

***Figure 53**. Enviva Cottondale 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*

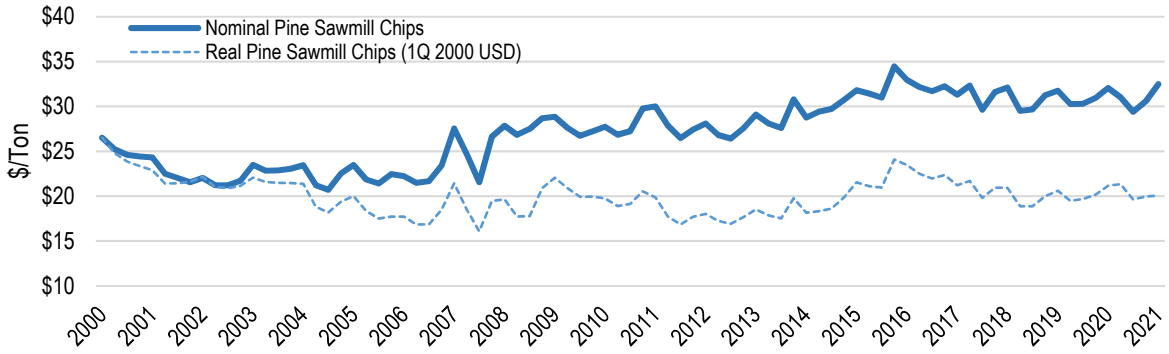
Pulpwood quality chips (FOB point of production) include both pine and hardwood sawmill chips (sawmill residuals) and pine and hardwood chip mill chips. Trends/changes with nominal chip and sawmill residual prices since 2000 are as follows:

- Pine Sawmill Chips (Sawmill Residuals). Pine sawmill chip prices were down slightly in the early 2000s but held steady and averaged approximately $22 per ton from 2Q 2001 – 3Q 2006 before increasing an average of 4.9% per year (+57% total) to $34.46 per ton in 4Q 2015. Prices have since come down slightly but since 2016 have averaged more than $31 per ton in the Enviva Cottondale catchment area.
- Pine Chip Mill Chips. Pine chip mill chip prices increased an average of 2.5% per year (+45% total) from roughly $26.50 per ton in 1Q 2000 to $38.50 per ton in 4Q 2014. However, prices have stabilized since, decreasing slightly but averaging $35.73 per ton in the Enviva Cottondale catchment area since 1Q 2016.
- 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 2.4% per year (+64% total) from $17.13 per ton in 1Q 2000 to $28.15 per ton in 1Q 2021.
- Hardwood Chip Mill Chips. Hardwood chip mill chip prices increased 63% (+4.6% per year average) from $23.80 per ton in 1Q 2000 to $38.77 per ton in 4Q 2010. However, prices have trended overall flat since and averaged just over $37 per ton over the last 10 years.

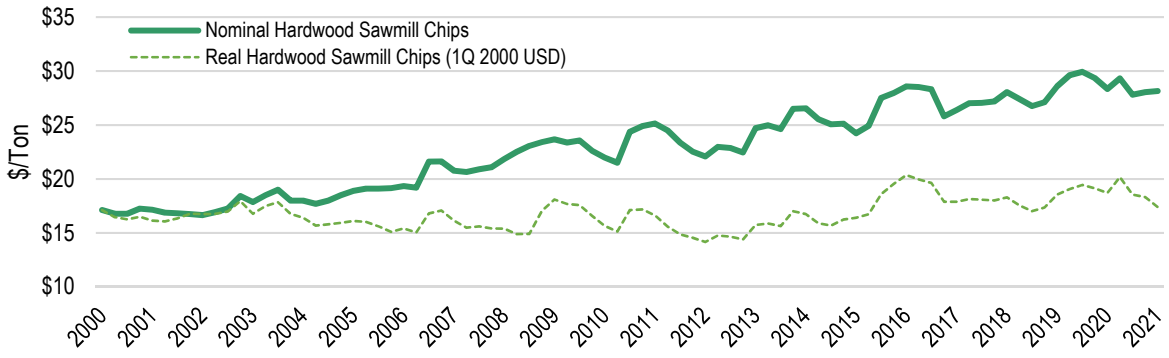
  In addition, we'd like to note that chip mill chip prices have historically remained above sawmill chip prices, with pine and hardwood chip mill chip prices averaging a 18% and 47% premium, respectively, over pine and hardwood sawmill chip prices since 2000.

See Figure 54 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 Enviva Cottondale catchment area from 1Q 2000 – 1Q 2021. Corresponding prices are provided in tabular form in Appendix A.

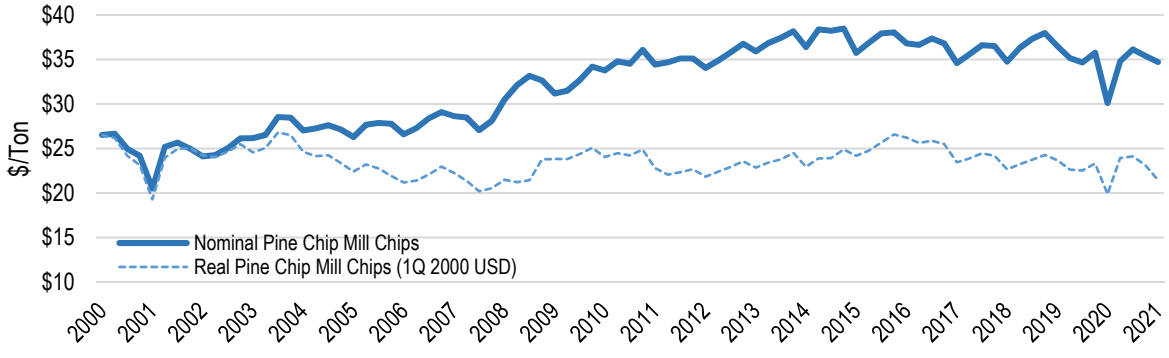
***Figure 54**. Enviva Cottondale Catchment Area - Nominal & Real Quarterly Pulp Quality Chip Prices ($/Ton)*



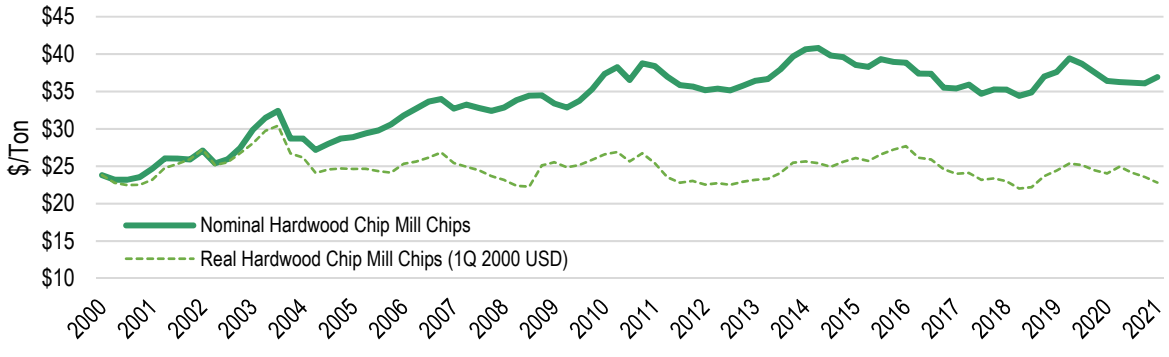
(a) Pine Sawmill Chips



(b) Hardwood Sawmill Chips



(c) Pine Chip Mill Chips



(d) Hardwood Chip Mill Chips

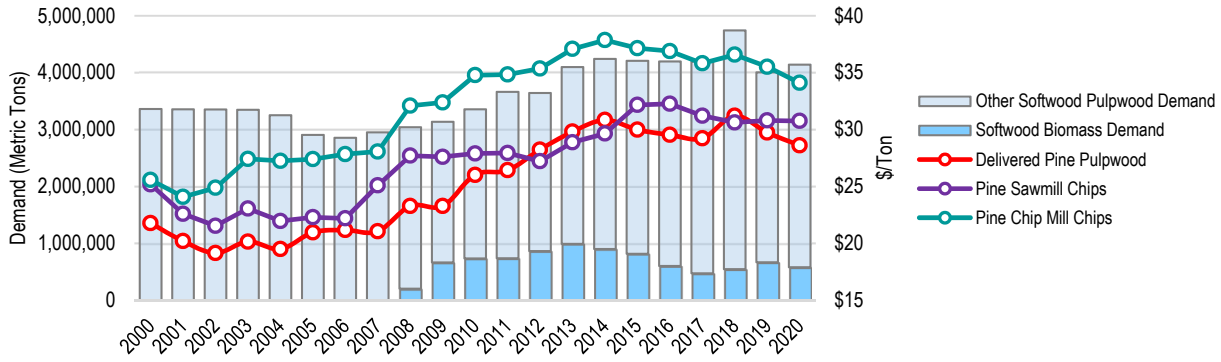
Correlation Analysis: *Biomass Demand vs. Raw Material Costs*

Historically, raw material purchases at Enviva Cottondale mill have included a combination of predominantly softwood pulpwood (roundwood), pulp quality chips, and sawmill residuals. Specifically, softwood roundwood and residuals have constituted 88% of all raw materials consumed by this mill since 2008, compared to 12% for hardwood roundwood and residuals.

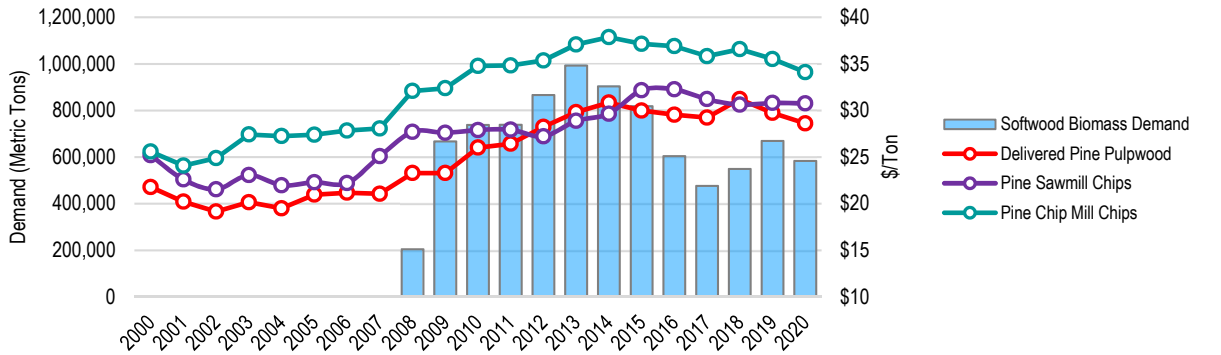
Figure 55 provides a side-by-side comparison of softwood biomass demand and total softwood pulpwood demand versus delivered pine pulpwood, pine sawmill chip, and pine chip mill chip prices in the catchment area from 2000-2020. Intuitively, we'd expect to see prices and demand moving in the same direction, 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). However, the relationship between softwood biomass demand and these raw material prices was much weaker. Specifically, only a weak positive relationship was found between softwood biomass demand and both delivered pine pulpwood price and pine chip mill chip price since Enviva Cottondale's startup in 2008; no identifiable relationship was found between softwood biomass demand and pine sawmill chip price.

Ultimately, there is some evidence linking the increase in these pine raw material prices to increased demand attributed to bioenergy. However, these price increases since 2008 were driven to much larger degree by increased softwood pulpwood demand from non-bioenergy sources.

***Figure 55**. Enviva Cottondale 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



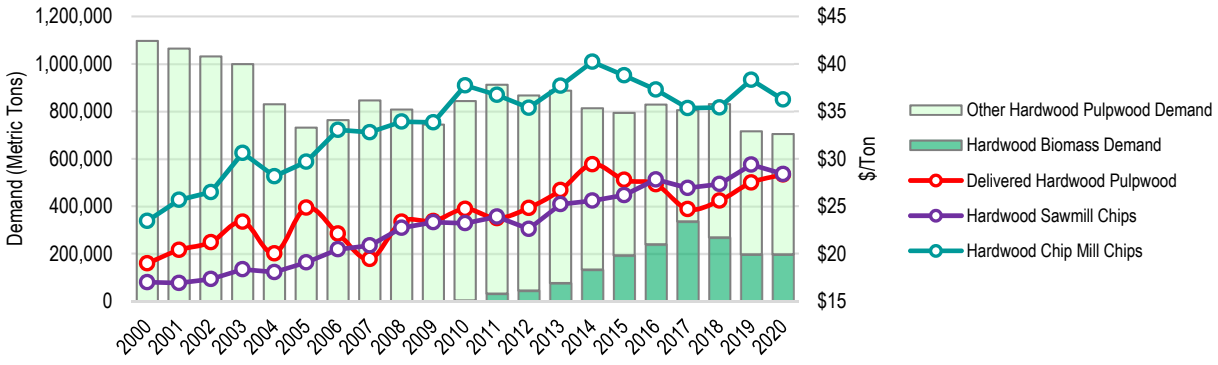
(b) Softwood Biomass Demand vs. Delivered Pine Pulpwood & Pine Chip Prices

Hardwood Pulpwood & Hardwood Chip Prices

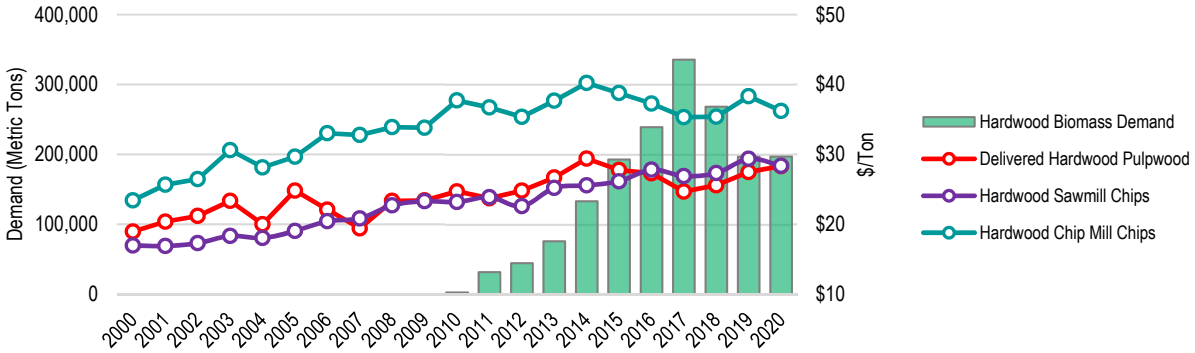
Figure 56 provides a side-by-side comparison of hardwood pulpwood demand and hardwood raw material prices in the catchment area since 2000. As this figure shows, hardwood raw material costs have steadily increased in the catchment area despite demand for hardwood pulpwood holding relatively steady since the mid-2000s. 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 both found to have a moderately strong positive correlation to hardwood biomass demand since the Cottondale mill commenced operations in 2008.

These moderately 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 one-third of total hardwood pulpwood demand in the Cottondale catchment area. Furthermore, the increase in these hardwood raw material prices can be more closely linked to a decrease in hardwood timberland and limited hardwood pulpwood supply in the Cottondale catchment area.

***Figure 56**. Enviva Cottondale 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 57 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 2008. 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 up until the mid-2010s (see Figure 58). However, we'd like to note that this relationship has fallen apart since 2014 (due to a growing imbalance between supply and demand). Specifically, delivered pine sawtimber and chip-n-saw prices have generally held flat despite demand for softwood sawlogs increasing since 2014.

***Figure 57**. Enviva Cottondale Catchment Area – Biomass Demand vs. Delivered Pine Sawtimber, Pine Chip-n-saw, & Hardwood Sawtimber Prices (2000-2020)*

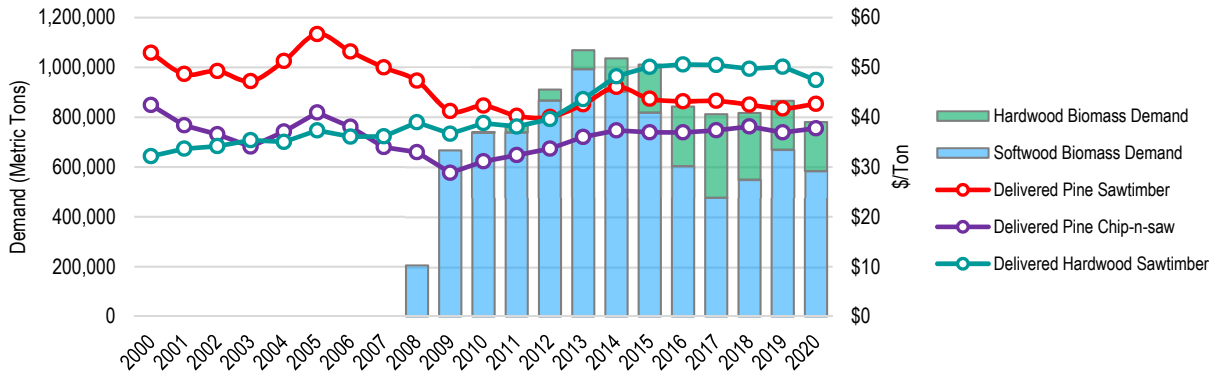


***Figure 58**. Enviva Cottondale Catchment Area – Sawlog Demand vs. Delivered Pine Sawtimber, Pine Chip-n-saw, & Hardwood Sawtimber Prices (2000-2020)*

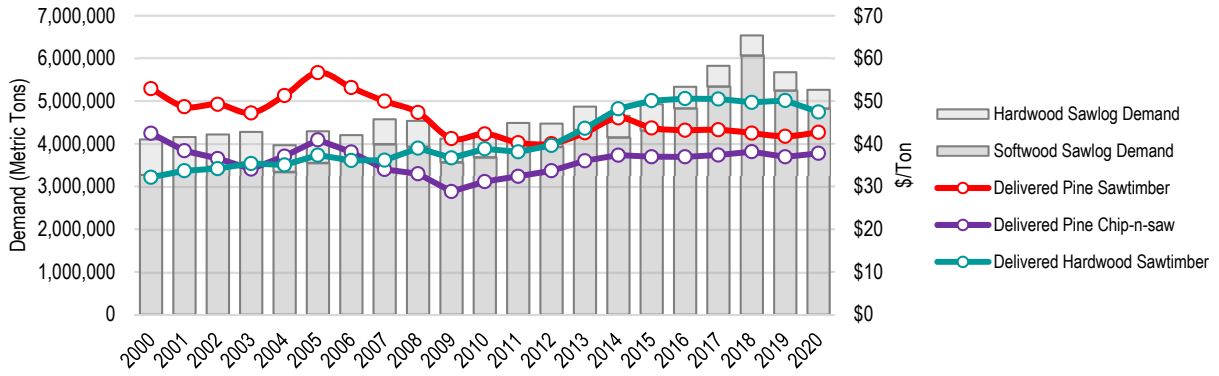


***Table 39**. Correlation Analysis – Softwood Biomass Demand, Delivered Pine Pulpwood Price, Pine Sawmill Chip Price & Pine Chip Mill Chip Price (2000-2020)*

	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	-0.02	1				
Total Softwood Pulpwood Demand	0.67	0.73	1			
Delivered Pine Pulpwood Price	0.88	0.38	0.88	1		
Pine Sawmill Chip Price	0.80	0.34	0.80	0.93	1	
Pine Chip Mill Chip Price	0.92	0.17	0.76	0.95	0.91	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	-0.83	1				
Total Hardwood Pulpwood Demand	-0.39	0.84	1			
Delivered Hardwood Pulpwood Price	0.65	-0.74	-0.58	1		
Hardwood Sawmill Chip Price	0.82	-0.88	-0.65	0.83	1	
Hardwood Chip Mill Chip Price	0.55	-0.72	-0.65	0.84	0.87	1

***Table 41**. Correlation Analysis – Biomass Demand & Delivered Sawtimber Prices (2008-2020)*

	Softwood Biomass Demand	Hardwood Biomass Demand	Total Biomass Demand	Delivered Pine Sawtimber	Delivered Pine Chip-n-saw	Delivered Hardwood Sawtimber
Softwood Biomass Demand	1					
Hardwood Biomass Demand	-0.17	1				
Total Biomass Demand	0.86	0.36	1			
Delivered Pine Sawtimber	-0.41	0.09	-0.34	1		
Delivered Pine Chip-n-saw	0.03	0.85	0.47	0.28	1	
Delivered Hardwood Sawtimber	-0.02	0.93	0.47	0.25	0.92	1

***Table 42**. 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	-0.76	1				
Total Sawlog Demand	0.99	-0.68	1			
Delivered Pine Sawtimber	-0.53	0.64	-0.49	1		
Delivered Pine Chip-n-saw	0.13	0.27	0.19	0.57	1	
Delivered Hardwood Sawtimber	0.88	-0.78	0.86	-0.57	0.11	1

5.2 Market Outlook: 2021-2023

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

- Binder Beteiligungs AG (Binderholz) announced in 3Q 2020 that it had won the bid for the Klausner Lumber One, LLC sawmill in Live Oak FL. The mill and assets were offered at auction as part of bankruptcy proceedings after the owners filed for Chapter 11 protection in April 2020. The mill, which was restarted in early-2021, has an annual production capacity of 350 million board feet (bf) of lumber. The mill restart is expected to increase wood demand in the Enviva Cottondale catchment area by an estimated 100,000-125,000 tons in 2021 and by an additional 50,000-100,000 tons per year beginning in 2022.
- Enviva ceased announced in 1Q 2021 plans to invest $50 million in new expansion projects to de-bottleneck manufacturing processes, improve efficiencies, and increase production capacity at its facilities located in Cottondale FL, Hamlet NC, and Sampson NC. Project completion is expected by the end of 2022, subject to receiving the necessary permits. The expansion project is expected to increase production capacity at the Cottondale mill from 760,000 to roughly 900,000 metric tons of wood pellets annually and increase annual wood demand in the Enviva Cottondale catchment area by an estimated 250,000-300,000 tons per year beginning in 2023.
- Interfor's Phase 2 capital projects remain underway, which includes upgrades to its Thomaston GA sawmill. The expansion project is scheduled to be complete by the end of 2022 and is expected to add 25,000-40,000 tons per year of additional roundwood demand on the Enviva Cottondale catchment area beginning in 2023.
- International Paper (IP) began ramping up containerboard production at its Riverdale mill in Selma AL in October 2020 following the conversion of one of the two uncoated freesheet machines at the facility. The completion of this conversion is expected to increase wood demand in the Enviva Cottondale catchment area by an estimated 10,000-25,000 tons per year beginning in 2021.
- 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 700,000 tons, with the conversion taking place in a phased approach over the next 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 have only a marginal impact on roundwood demand attributed to the Enviva Cottondale catchment area in 2022 and 2023 but add an estimated 20,000-40,000 tons annually to catchment area demand beginning in 2024.
- Renewable Biomass Group 1 ceased announced in 2020 plans to build a new wood pellet plant in Adel GA. Target annual pellet capacity is 450,000 tons, with startup planned for 1Q 2022. The startup of this new pellet mill is expected to increase wood demand in the Enviva Cottondale catchment area by an estimated 75,000-100,000 tons in 2022 and by an additional 50,000-75,000 ton in 2023.
- Westervelt commenced production at its new 250 million bf pine lumber mill in Thomasville AL in March 2021. The new mill is expected to increase wood demand in the Enviva Cottondale catchment area by an estimated 30,000-40,000 tons in 2021 and by an additional 20,000-30,000 tons in 2022 and thereafter.

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 Enviva Cottondale catchment area to increase an estimated 12.8% from 2020 to 2023.

In particular, biomass demand is projected to increase from 860,480 tons in 2020 to 1,293,237 tons in 2023, or a roughly 50% over this period. Note that this expected increase is due to the anticipated startup of the Renewable Biomass Group 1 pellet mill in Adel GA and expanded production capacity at the Enviva Cottondale mill.

***Table 43**. Enviva Cottondale Catchment Area - Projected Wood Demand (2020-2023)*

Product	2020	2021	2022	2023
	Catchment Area – Annual Wood Demand (Metric Tons)			
Sawlogs:				
Softwood	4,823,678	5,121,493	5,297,001	5,412,717
Hardwood	440,642	452,980	461,588	467,126
Total Sawlogs	5,264,320	5,574,473	5,758,589	5,879,843
Pulpwood:				
Softwood	4,142,500	4,285,525	4,440,826	4,715,402
Hardwood	703,974	717,604	747,979	810,891
Total Pulpwood	4,846,473	5,003,129	5,188,805	5,526,293
Total	**10,110,794**	**10,577,602**	**10,947,394**	**11,406,137**

**projected*

***Table 44**. Enviva Cottondale Catchment Area – Projected Biomass & Total Pulpwood Demand (2020-2023)*

Product	2020	2021	2022	2023
	Catchment Area – Pulpwood Demand (Metric Tons)			
Biomass Demand:				
Softwood Biomass	583,761	594,676	665,343	894,747
Hardwood Biomass	196,854	200,650	224,367	278,458
Total Biomass	**780,615**	**795,326**	**889,710**	**1,173,205**
Other Pulpwood Demand:				
Other Softwood Pulpwood	3,558,739	3,690,849	3,775,483	3,820,655
Other Hardwood Pulpwood	507,120	516,954	523,613	532,433
Total Other Pulpwood	**4,065,859**	**4,207,803**	**4,299,095**	**4,353,088**
Total Pulpwood Demand:				
Total Softwood Pulpwood	4,142,500	4,285,525	4,440,826	4,715,402
Total Hardwood Pulpwood	703,974	717,604	747,979	810,891
Total Pulpwood	**4,846,473**	**5,003,129**	**5,188,805**	**5,526,293**

**projected*

***Figure 59**. Enviva Cottondale Catchment Area - Projected Wood Demand (2020 – 2023)*

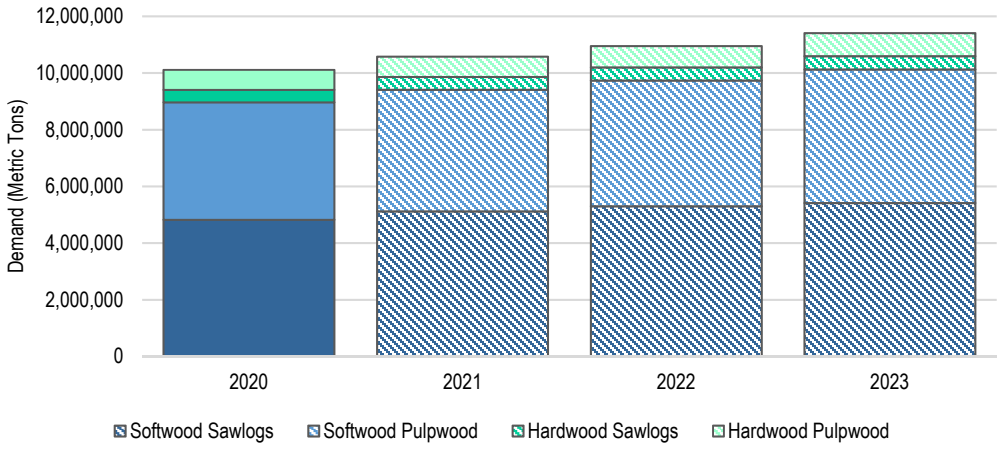
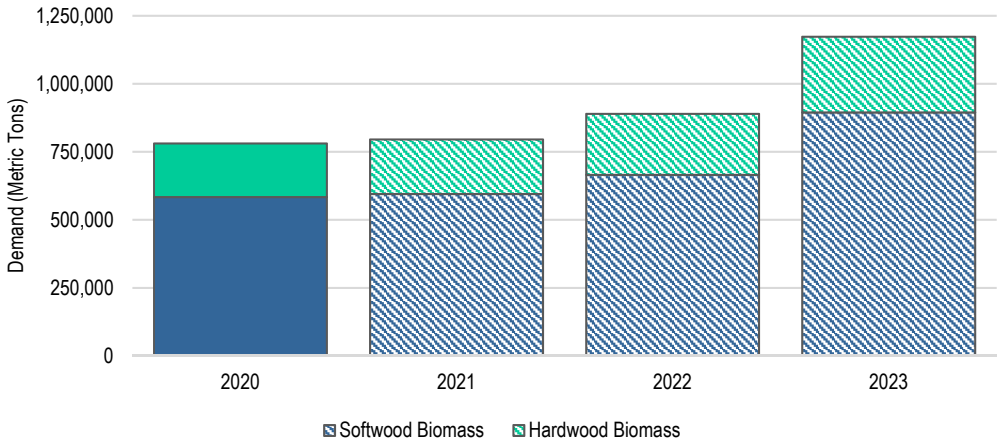


***Figure 60**. Enviva Cottondale Catchment Area - Projected Biomass Demand (2020 – 2023)*



5.2.2 *Raw Material Price Outlook*

Historically, raw material purchases for the Enviva Cottondale mill have predominantly included a mix of pine pulpwood (roundwood), pine chips, and pine sawmill residuals. Specifically, pine pulpwood constituted 43% of the total raw material purchases in 2020, with pine chips and secondary pine residuals accounting for an additional 41% of total purchases (84% total). Hardwood pulpwood, hardwood chips, and secondary hardwood residuals accounted for the remaining 16% of raw material purchases.

Given that pine pulpwood and pine chips constitute an overwhelming majority of the raw materials purchased by the Enviva Cottondale mill, and that these specific raw materials are expected to account for a majority of the raw materials purchased by this mill over the next several years, our price forecasts focus specifically on these 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 11% increase in delivered pine pulpwood (PPW) price from 2020 through 2023. Specifically, delivered PPW price is forecasted increase an average of 2.6% per year from 2000-2022 before increasing 5.4% Y/Y in 2023 due in large part to increased demand from Enviva Cottondale following its expansion project. Overall, delivered PPW prices are forecasted to average $30.40 per ton from 2020-2023, up 6.2% (+$1.79 per ton) from the 2020 average of $28.62 per ton.
- Pine Sawmill Chips. Pine sawmill chip prices are forecasted to increase an average of 1.5% per year from 2020-2022 before increasing 3.7% Y/Y in 2023. Overall, pine sawmill chip prices are forecasted to average $31.93 per ton from 2020-2023, up 3.8% (+$1.17 per ton) from the 2020 average.
- Pine Chip Mill Chips. As with pine pulpwood and pine sawmill chips, pine chip mill chip prices are also forecasted to increase over the next three years. Specifically, pine chip mill chip prices are forecasted to increase an average of 1.3% per year from 2020-2022 before increasing 3.4% Y/Y in 2023.Overall, pine chip mill chip prices are forecasted to average $35.26 per ton from 2020-2022, up 3.6% (+$1.15 per ton) from the 2020 average.

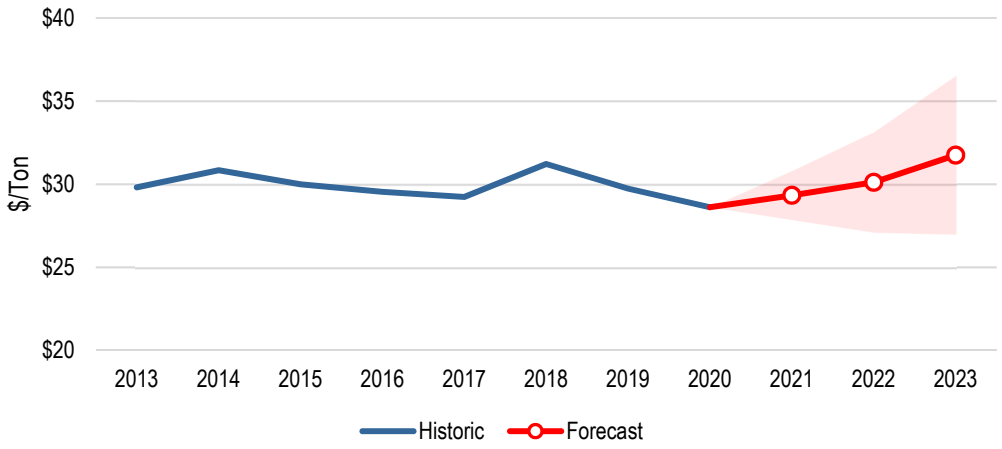
***Table 45**. Enviva Cottondale Catchment Area - Forecasted Delivered Pine Pulpwood, Pine Sawmill Chip, & Pine Chip Mill Chip Prices (2021-2023)*

Year	Delivered Pine Pulpwood	Pine Sawmill Chips	Pine Chip Mill Chips
		($/Ton)	
2000	$21.78	$25.19	$25.58
2001	$20.21	$22.60	$24.09
2002	$19.16	$21.54	$24.89
2003	$20.16	$23.07	$27.42
2004	$19.51	$21.97	$27.26
2005	$20.97	$22.30	$27.40
2006	$21.17	$22.20	$27.84
2007	$21.06	$25.10	$28.07
2008	$23.29	$27.71	$32.10
2009	$23.29	$27.61	$32.39
2010	$26.02	$27.90	$34.79
2011	$26.43	$27.94	$34.84
2012	$28.24	$27.22	$35.36
2013	$29.82	$28.89	$37.09
2014	$30.85	$29.65	$37.87
2015	$29.99	$32.17	$37.15
2016	$29.54	$32.27	$36.90
2017	$29.24	$31.22	$35.82
2018	$31.22	$30.63	$36.58
2019	$29.74	$30.81	$35.52
2020	$28.62	$30.76	$34.11
2021	$29.48	$31.39	$34.77
2022	$30.41	$32.07	$35.50
2023	$32.06	$33.26	$36.77

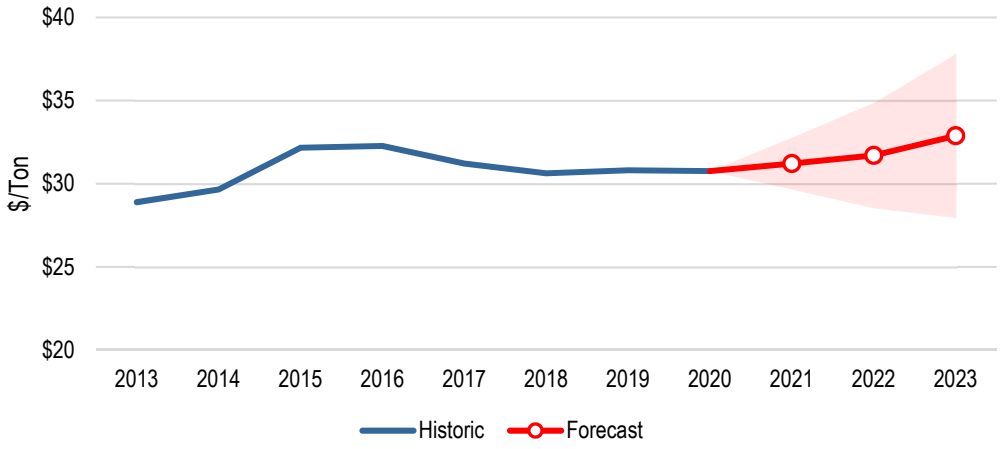
**Forecasted values*

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

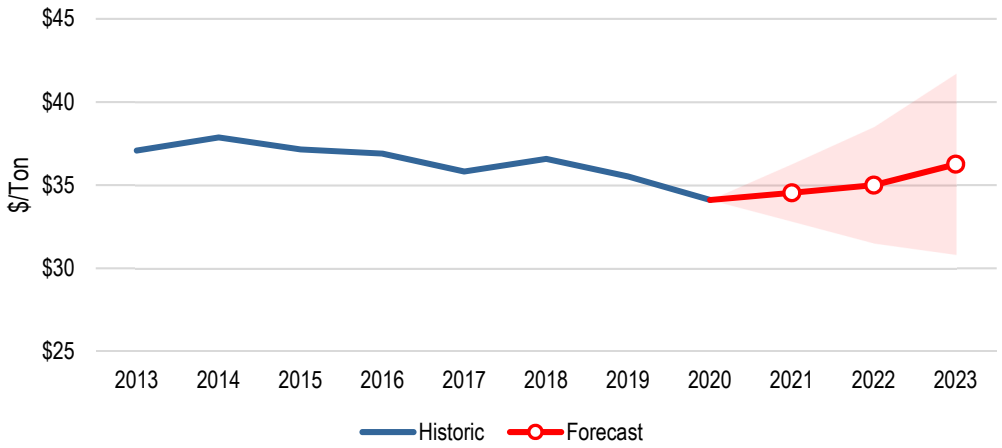
***Figure 61**. Enviva Cottondale Catchment Area Price Forecasts: Delivered Pine Pulpwood, Pine Sawmill Chips, & Pine Chip Mill Chips (2021-2023)*



(a) Delivered Pine Pulpwood



(b) Pine Sawmill Chips



(c) Pine Chip Mill Chips

Table 46 provides a cost index (2020=100) of historic and forecasted per-unit pine raw material costs for the Enviva Cottondale mill from 2013 through 2023. These index values are based on the actual distribution of pine pulpwood, pine sawmill chips, and pine chip mill chips purchases by the Cottondale mill, as well as respective product prices, and 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 Enviva Cottondale but rather based on average market prices in the Cottondale catchment area.

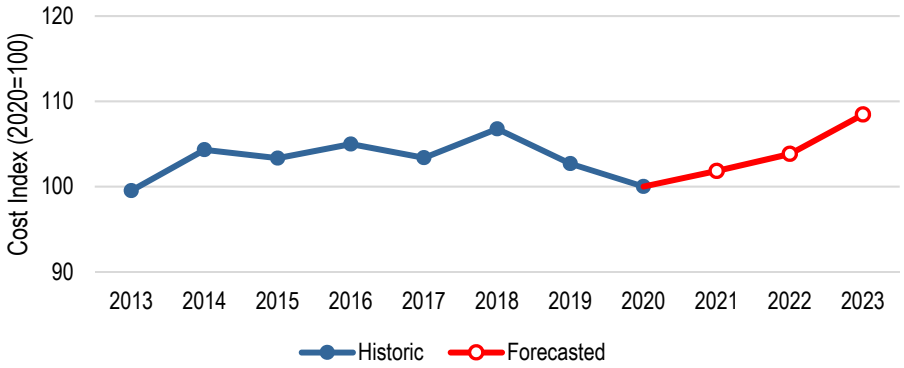
Average per-unit pine costs for a pellet mill in the Enviva Cottondale catchment area increased an estimated 7% from 2013-2018. However, from 2018-2020, average per-unit costs declined 6% in large part due to increased salvage brought about by Hurricane Michael. Based on our forecasts and anticipated changes in product mix consumption, average per-unit pine raw material costs are projected to increase in the Cottondale catchment area over the next three years, with the 2020-2022 average up 4.7% compared to 2020 levels.

***Table 46**. Enviva Cottondale Catchment Area – Pine Raw Material Per-Unit Cost Index (2020=100)*

Year	Pine Raw Material Cost Index (2020 = 100)
2013	100
2014	104
2015	103
2016	105
2017	103
2018	107
2019	103
2020	100
2021	102
2022	104
2023	108

**Forecasted*

***Figure 62**. 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 Enviva Cottondale catchment area as well as our professional expertise and market knowledge.

- Changes in Forest Area

  According to the US Forest Service (USFS), total timberland in the Enviva Cottondale catchment area experienced a net increase of 38,408 hectares (+1.3%) from 2000-2020, increasing from 2,913,402 to 2,951,810 hectares over this 20-year period. However, much of this increase took place between 2009 and 2012. Specifically, the total area of timberland held relatively steady through the 2000s, decreasing slightly but averaging roughly 2,906,200 hectares from 2000-2009. However, total catchment area timberland increased to 2,957,873 hectares in 2012 (and later peaking at 2,986,608 hectares in 2015) but more-or-less stabilizing and averaging approximately 2,963,300 hectares from 2012-2020.

  The composition of timberland in the catchment area has also undergone changes over the last two decades. Pine timberland (the predominant supplier of pine pulpwood consumed by the pulp/paper and bioenergy industries in this market) increased an estimated 57,049 hectares (+3.8%) from 2000-2020. However, nearly all of that increase can be attributed to natural pine timberland, which increased an estimated 56,563 hectares (+10.5%) over this 20-year period. In comparison, planted pine timberland increased only 486 hectares (<0.1%) from 2000-2020.

  Furthermore, we'd like to note that, since 2007, planted pine timberland has decreased nearly 72,700 hectares (-6.9%) compared to a more than 89,500-hectare increase (+18%) in natural pine timberland. The simultaneous decrease in planted pine timberland and increase in natural pine timberland suggests that much of the planted pine timberland lost during this period was replaced by naturally regenerated pine – presumably due to the weakening of pine sawtimber markets and the diminished returns associated with plantation pine management.

  Ultimately, not only has pine timberland increased in the catchment area since 2000 (and since Enviva Cottondale's startup in 2008), but it has also 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 both the bioenergy industry and pulp/paper industry (bioenergy's primary roundwood competitor) over the next several years, adequate wood supply is expected to remain in the Cottondale catchment area (at least over the short to mid-term).

  Note: Hurricane Michael destroyed nearly 520,000 hectares of timberland in the Cottondale catchment area in late-2018, of which more than 291,000 hectares was classified as pine timberland. Much of this destroyed pine timberland has already been reestablished or is in the process of being reestablished (either through plantings or natural regeneration) and is expected to provide elevated supplies of pine pulpwood in the next 10-15 years as this timber reaches merchantability.

- Changes in Timber Inventory, Growth, & Removals

According to USFS estimates, total growing stock inventory on timberland in the Enviva Cottondale catchment area increased from 206 million m^3 in 2000 to more than 227 million m^3 in 2020, or a net increase of nearly 22 million m^3 (+11%) over this period. However, this considers the 16% decrease in in total inventory from 2018 to 2019 due to Hurricane Michael. Prior to Hurricane Michael in 2018, growing stock inventory totaled an estimated at 270 million m^3, which was up nearly 64 million m^3 (+31%) from 2000.

Inventories of pine pulpwood, specifically, had held steady in the catchment area since the mid-2000s, averaging nearly 47 million m^3 from 2006-2018. However, losses due to Hurricane Michael resulted in pine pulpwood inventory levels decreasing an estimated 22% Y/Y and to just under 37 million m^3 in 2020, which was down an estimated 4.7 million m^3 (-11%) compared to 2000 levels. Note that this decrease in pine pulpwood inventory was matched by a simultaneously 30 million m^3-increase in pine sawtimber inventory as well as a 12 million m^3-increase in pine chip-n-saw inventory. This, along with observed changes in diameter class distribution, particularly since the mid-2000s, provide evidence of a catchment area forest that is aging.

The increase in total timber inventory reflected both trends in growth and removals in the catchment area, as total annual timber growth has outpaced total annual removals every year since 2003 – the first year that growth estimates were made available by the USFS. Specifically, total annual growth of growing stock timber increased through the mid-2000s before stabilizing and averaging 13.6 million m^3 per year from 2009-2018. However, the overall losses in timber inventory due to Hurricane Michael were reflected in annual growth, which declined to an estimated 11.8 million m^3 in 2019, or a 14% decrease Y/Y. In comparison, total annual removals averaged 7.4 million m^3 per year through the 2000s before increasing and stabilizing at roughly 8.8 million m^3 per year from 2013-2020 (excluding 2018, when removals increased to an estimated 11.7 million m^3 due to increased levels of salvage wood created by Hurricane Michael).

More specifically, inventories of pine pulpwood had held steady from the mid-to-late-2000s through 2018, and this reflected both growth and removal trends as well as general forest trends. Annual growth and annual removals of pine pulpwood had both held steady in the catchment area throughout this period, with growth exceeding removals (which would typically result in increased inventory levels). However, this net gain was counterbalanced by inventories of pine pulpwood moving up in product class to pine chip-n-saw, resulting in pine pulpwood inventory holding steady.

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 Cottondale catchment area since 2003. (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 1.57 from 2013-2017 before abruptly dropping to 1.20 in 2018 (due to the substantial amount of salvage wood created by Hurricane Michael). Ultimately, the losses due to Hurricane Michael tightened up this market, so the anticipated increases in softwood pulpwood demand associated with the Cottondale mill's upcoming expansion will place additional pressure on an already tight growth-to-removals ratio. However, inventories of pine pulpwood remain adequate (to support that increase in demand) 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 Cottondale catchment area held steady and averaged 8.3 million metric tons per year from 2000-2010 but proceeded to increase an average of 3.6% per year (+28% total) to 10.8 million metric tons in 2017. With the increase in salvage wood created by Hurricane Michael, total wood demand increased to over 12.1 million metric tons in 2018 before falling to 10.1 million metric tons in 2020, which was still up 18% compared to 2000 levels.

Specifically, demand for softwood sawlogs, which accounts for nearly 50% of total wood demand in the catchment area, held relatively steady and averaged 3.6 million metric tons per year from 2000-2010 before increasing more than 30% to 4.8 million metric tons in 2020. Note that this increase in softwood sawlog demand was due in large part to improved market conditions coming off the heels of the Great Recession.

Demand for softwood pulpwood, which accounts for over 40% of total wood demand in the catchment area, increased 40% from less than 3.0 million metric tons in 2007 – the year prior to Enviva Cottondale's startup – to 4.1 million metric tons in 2020. Note that the increase in softwood pulpwood demand was due to increased demand from both bioenergy (i.e. Enviva Cottondale) and the pulp/paper industry. Specifically, biomass-related softwood (pine) pulpwood demand increased more than 580,000 metric tons from 2007-2020 while non-biomass-related softwood pulpwood demand increased more than 605,000 metric tons over this period.

In terms of the short-term outlook, demand for pine pulpwood is projected to increase 14% in the Cottondale catchment area from 2020-2023, and this anticipated increase is due to increased demand from both bioenergy and the pulp/paper industry. Specifically, biomass-related softwood pulpwood demand is projected to increase to roughly 895,000 metric tons in 2023 (+53% compared to 2020 levels) with the startup of Renewable Biomass Group 1's pellet mill in Adel GA and following the completion of Enviva Cottondale's expansion project.

Changes in Raw Material Prices

Raw material purchases for the Enviva Cottondale pellet mill include a combination of roundwood, chips, and secondary wood residues. Specifically, pine pulpwood (roundwood) and pine in-woods chips have accounted for approximately 58% of total raw material purchases by this mill since 2010, with other secondary pine residuals accounting for 29% of total purchases (hardwood roundwood and hardwood chips account for the remaining 13%).

In the Cottondale catchment area, the price of delivered pine pulpwood (PPW) – the predominant raw material purchased by the Cottondale mill since its startup – increased from $21.06 per ton in 2007 (the year prior to Enviva Cottondale's startup) to $29.82 per ton in 2013, or a 42% increase over this 6-year period. However, since 2013, delivered pine pulpwood prices have more-or-less stabilized and averaged $29.88 per ton in the catchment area. Similarly, pine chip mill chip prices experienced an 32% increase from $28.07 per ton in 2007 to $37.09 per ton in 2013. However, pine chip mill chip prices have trended downwards since 2014, falling an average of 1.7% per year and to $34.11 per ton in 2020.

Ultimately, our analysis identified a positive relationship between softwood biomass demand and both delivered PPW price and pine chip mill chip price, suggesting that the increases in these raw material prices, to some degree, can be attributed to increased softwood pulpwood demand from bioenergy. However, increased demand from bioenergy, alone, is not responsible for increased raw material prices in the Cottondale catchment area. Furthermore, the relationships between these raw material prices and non-biomass-related softwood pulpwood demand were found to be stronger than those associated with softwood biomass demand, suggesting that these prices are impacted to a larger degree by PPW demand from non-biomass sources (which accounts for over 85% of total softwood pulpwood demand in the catchment area).

In terms of the short-term outlook, delivered PPW and pine chip prices are projected to increase alongside increased demand from both bioenergy and the pulp/paper industry. Specifically, delivered PPW prices are forecasted to increase more than 10% from 2020-2023 while pine chip prices are forecasted to increase 6-7% over this period.

- 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 a notable shift in the distribution of hectares clearcut versus hectares thinned in the Florida panhandle/south Alabama market in the early-2010s. Specifically, thinnings accounted for 60-70% of total (annual) reported harvest area in this market from 2005-2011. However, a shift occurred in 2012, with thinnings accounting for only 35-45% of the total (annual) reported harvest area in this market over the last eight years.

Specifically, the decreased prevalence of thinning since 2012 can be linked to the strengthening of pine pulpwood markets and concurrent weakening of pine sawtimber markets that begun in the mid-2000s. Prior to the bursting of the US housing bubble in 2006, timber management in this market was largely driven by pine sawtimber production. Pine sawtimber (PST) stumpage prices averaged around $40-45 per ton in the early and mid-2000s. However, challenging market conditions led to PST prices falling 35-40% in just a 3-4-year period (and remaining between $23 and $27 per ton in this market since 2009). On the other hand, pine pulpwood markets started to strengthen beginning in the mid-2000s, with pine pulpwood (PPW) stumpage prices increasing more than 50% from 2006-2010.

When managing for pine sawtimber production, most private landowners utilize a two-thin management regime. For example, if we assume a 30-year rotation, a pine timber stand will undergo a 1st thinning at around age 15, a 2nd thinning at around age 22, and final harvest at age 30. So, if we assume a regulated forest (i.e. even age class distribution), each year roughly two-thirds (67%) of the total area harvested would be attributed to thinnings and one-third (33%) would be attributed to clearcuts – and this aligns with TMS data trends prior to 2012 (with

thinnings accounting for 60-70% of reported harvest area). But, with PST markets weakening and PPW markets strengthening, as the data suggests, many private landowners opted to shift from pine sawtimber production to pine pulpwood production, which generally requires no thinnings. TMS data supports this change, with thinnings accounting for 35-45% of total reported harvest area in this market annually since 2012.

- 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 Enviva Cottondale started up in 2008.

Specifically, the startup of Enviva Cottondale added more than 900,000 metric tons of softwood pulpwood demand to the catchment area from 2008-2013, and this increase in demand coincided with a 28% increase in delivered pine pulpwood (PPW) price and a 16% increase in pine chip prices over this period. However, delivered PPW prices have held flat since 2013, despite biomass-related softwood pulpwood demand falling to an average of roughly 577,000 metric tons per year from 2016-2020, down more than 40% compared to 2013 peak levels. (Note the decrease in roundwood consumption was due to a higher utilization of secondary residuals). It's also important to point out that the roughly 410,000-metric ton decrease in softwood biomass demand from 2013 to 2020 was offset by a roughly 455,000-metric ton increase in softwood pulpwood demand from other sources (i.e. pulp/paper).

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 83% of total pine pulpwood demand in the catchment area since 2008. 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 – 1Q 2021)

Enviva Cottondale Catchment Area - Quarterly Stumpage Prices ($/Ton)

Year	Quarter	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
2000	1	54.00	36.78	10.90	18.93	7.02
2000	2	49.61	29.56	7.98	17.88	6.58
2000	3	38.01	31.04	7.46	18.24	4.68
2000	4	37.82	26.44	7.62	19.42	6.02
2001	1	34.86	26.03	6.91	19.31	5.38
2001	2	36.25	27.04	7.49	21.22	6.36
2001	3	42.19	29.98	7.71	22.57	7.17
2001	4	40.56	26.33	6.29	19.10	6.44
2002	1	39.17	25.92	6.98	21.67	7.09
2002	2	35.36	23.00	7.44	18.36	7.13
2002	3	38.05	22.24	6.79	19.49	7.53
2002	4	44.03	25.12	7.32	20.22	7.71
2003	1	38.33	21.91	7.05	19.07	6.43
2003	2	40.12	25.45	7.08	21.33	8.75
2003	3	44.60	24.25	8.11	25.06	11.81
2003	4	42.36	29.42	8.53	24.29	12.89
2004	1	42.37	25.95	9.29	24.37	10.28
2004	2	39.83	23.78	7.54	24.63	7.93
2004	3	38.37	24.10	7.70	22.46	6.81
2004	4	43.90	25.65	6.98	23.72	6.80
2005	1	36.08	23.20	7.07	21.72	6.28
2005	2	43.40	25.55	7.85	20.96	8.46
2005	3	43.44	24.33	7.61	23.45	9.92
2005	4	44.78	27.29	8.24	21.00	8.69
2006	1	44.91	27.73	8.11	26.65	8.50
2006	2	37.18	23.64	7.90	21.55	7.10
2006	3	41.07	24.32	6.92	22.70	7.76
2006	4	38.30	21.77	6.46	20.86	4.62
2007	1	36.62	21.60	7.29	20.60	5.25
2007	2	37.87	21.12	7.04	20.54	5.98
2007	3	34.47	18.73	6.43	23.87	5.38
2007	4	36.81	18.79	6.64	21.02	5.52
2008	1	35.50	16.83	7.45	20.24	4.86
2008	2	34.18	18.16	8.71	22.07	7.55
2008	3	30.93	18.21	9.72	25.49	6.97
2008	4	32.51	18.28	9.76	21.52	7.84
2009	1	28.17	16.91	8.27	20.21	6.80
2009	2	23.65	15.46	9.14	19.66	6.68
2009	3	27.16	15.68	8.88	21.11	7.46
2009	4	26.01	16.37	9.53	19.81	8.21
2010	1	26.29	19.21	12.54	22.60	11.02

Year	Quarter	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
2010	2	31.11	19.04	11.34	23.65	12.14
2010	3	27.78	16.33	10.76	19.37	10.30
2010	4	26.50	16.90	10.59	21.33	8.78
2011	1	26.29	17.06	10.24	20.89	8.71
2011	2	24.85	16.02	9.41	20.66	8.28
2011	3	21.63	15.28	9.28	21.24	6.41
2011	4	22.15	15.39	10.24	19.78	7.75
2012	1	23.14	15.44	10.15	20.75	7.24
2012	2	23.98	16.34	9.99	21.47	7.71
2012	3	23.76	16.47	11.05	22.73	7.41
2012	4	25.91	17.69	12.00	21.30	8.77
2013	1	26.89	17.92	11.39	24.30	9.64
2013	2	25.93	18.82	12.15	21.97	8.72
2013	3	27.44	19.17	13.47	25.40	9.77
2013	4	28.27	19.77	14.15	27.11	12.18
2014	1	27.50	20.34	14.47	24.00	13.90
2014	2	28.72	20.87	15.24	29.36	12.86
2014	3	26.32	19.85	13.56	28.73	11.37
2014	4	26.29	20.37	12.87	29.89	9.58
2015	1	27.86	20.60	13.01	28.97	8.79
2015	2	26.37	20.24	11.75	29.97	8.30
2015	3	25.51	19.44	11.03	30.13	9.60
2015	4	26.47	20.09	10.97	27.80	11.27
2016	1	28.30	20.91	13.45	29.16	12.59
2016	2	26.32	20.16	11.99	30.82	11.86
2016	3	24.60	18.94	11.08	31.47	7.64
2016	4	24.13	18.76	10.08	29.20	5.60
2017	1	25.00	19.60	11.54	29.83	7.64
2017	2	24.77	18.15	10.05	28.81	6.56
2017	3	26.29	18.74	11.08	28.94	6.33
2017	4	27.61	18.10	10.89	29.26	10.50
2018	1	27.01	19.26	10.89	29.12	8.58
2018	2	25.89	19.14	11.05	28.37	7.70
2018	3	26.33	18.29	11.10	29.16	8.47
2018	4	22.40	15.43	8.26	28.71	6.82
2019	1	25.31	18.74	7.49	30.36	12.33
2019	2	24.91	17.88	10.02	30.78	9.66
2019	3	25.19	18.55	9.82	29.72	9.12
2019	4	24.58	18.52	9.60	30.41	10.90
2020	1	24.06	18.11	9.62	27.01	9.74
2020	2	24.64	17.21	10.24	27.16	10.48
2020	3	25.56	19.74	10.33	28.55	10.13
2020	4	28.68	22.24	10.68	28.30	11.85
2021	1	28.23	22.57	10.75	28.06	11.60

Source: TimberMart-South

Enviva Cottondale Catchment Area - Quarterly Delivered Timber Prices ($/Ton)

Year	Quarter	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
2000	1	55.92	44.37	22.12	31.46	19.00
2000	2	53.99	41.91	21.66	30.98	19.07
2000	3	53.51	42.07	21.94	34.29	18.63
2000	4	48.23	41.51	21.42	31.94	19.17
2001	1	45.96	39.18	20.23	33.99	19.48
2001	2	49.25	38.93	19.96	32.73	20.11
2001	3	49.53	38.34	20.18	34.56	21.04
2001	4	49.95	37.02	20.48	33.43	20.91
2002	1	49.71	38.18	19.17	35.02	20.57
2002	2	50.84	37.31	19.59	34.67	21.26
2002	3	48.41	35.58	19.09	33.38	20.91
2002	4	48.06	35.15	18.77	33.65	22.06
2003	1	46.71	32.76	19.39	34.23	22.27
2003	2	44.30	32.24	20.38	33.20	23.30
2003	3	48.41	35.29	19.97	36.63	23.02
2003	4	49.49	36.04	20.89	37.50	24.84
2004	1	52.28	37.40	19.30	34.38	22.91
2004	2	51.11	36.25	19.12	36.29	19.06
2004	3	51.38	36.96	19.81	35.34	18.64
2004	4	50.42	37.80	19.79	34.14	19.48
2005	1	54.06	39.49	19.87	36.36	21.07
2005	2	57.30	39.52	20.72	36.85	21.59
2005	3	57.09	39.83	21.26	40.40	24.96
2005	4	58.29	44.86	22.02	35.76	31.71
2006	1	54.58	39.82	21.73	40.76	25.39
2006	2	53.75	39.27	21.41	34.34	20.23
2006	3	52.55	37.95	20.94	34.63	21.55
2006	4	51.79	35.24	20.61	34.65	21.24
2007	1	49.53	34.80	21.10	35.46	19.46
2007	2	50.98	34.68	20.51	36.61	18.36
2007	3	49.27	33.33	21.23	35.93	18.73
2007	4	50.19	33.17	21.42	36.61	21.16
2008	1	49.18	33.59	22.56	38.99	22.23
2008	2	47.24	32.70	22.66	39.81	22.57
2008	3	48.68	34.00	24.40	39.10	23.53
2008	4	44.19	31.59	23.54	38.01	25.09
2009	1	40.80	30.31	24.75	36.22	22.47
2009	2	41.20	28.90	22.52	35.23	23.21
2009	3	42.07	28.11	22.81	36.51	22.98
2009	4	40.83	27.99	23.08	38.75	25.03
2010	1	43.12	30.43	25.76	40.51	26.66
2010	2	42.59	31.90	26.12	38.83	24.86
2010	3	41.86	30.80	26.02	37.95	24.12
2010	4	41.70	31.41	26.18	37.94	23.19
2011	1	41.23	32.93	26.07	37.20	22.70

Year	Quarter	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
2011	2	41.27	33.17	27.07	38.21	24.59
2011	3	40.02	31.77	25.53	38.63	22.79
2011	4	38.53	31.68	27.05	38.43	24.86
2012	1	39.38	32.42	27.99	38.79	23.65
2012	2	38.75	33.44	27.59	39.78	24.88
2012	3	40.46	33.45	27.84	40.45	23.98
2012	4	41.54	35.40	29.55	39.48	26.75
2013	1	40.25	34.54	29.29	41.06	26.32
2013	2	42.12	35.21	29.44	41.90	26.38
2013	3	43.90	36.87	30.16	44.11	25.94
2013	4	44.08	37.51	30.38	47.41	28.13
2014	1	45.26	37.75	30.52	47.81	30.98
2014	2	48.24	37.11	30.46	47.94	30.83
2014	3	45.59	36.72	31.23	48.70	28.50
2014	4	45.19	37.78	31.17	48.39	27.32
2015	1	45.15	36.96	30.61	50.04	27.50
2015	2	43.65	37.41	30.41	50.20	27.13
2015	3	43.00	37.33	29.58	50.76	27.08
2015	4	43.02	36.15	29.37	49.39	29.37
2016	1	42.80	36.31	30.29	48.65	29.84
2016	2	42.83	38.43	29.61	50.45	27.69
2016	3	44.22	37.46	29.50	52.16	27.16
2016	4	42.91	35.58	28.79	51.08	24.50
2017	1	43.26	39.02	28.68	51.30	26.11
2017	2	41.69	36.15	28.61	49.03	24.18
2017	3	44.94	39.17	30.32	50.47	24.02
2017	4	43.20	35.15	29.33	51.16	24.46
2018	1	42.80	38.73	29.99	50.08	25.38
2018	2	41.02	37.42	31.06	48.94	24.26
2018	3	42.92	38.10	31.74	48.10	25.38
2018	4	43.29	38.28	32.08	51.73	27.30
2019	1	41.94	39.60	30.76	49.65	26.42
2019	2	42.53	36.83	30.23	51.55	26.17
2019	3	40.73	35.07	29.40	49.41	28.64
2019	4	41.80	36.28	28.58	49.96	28.72
2020	1	42.23	36.23	28.61	47.90	27.55
2020	2	42.70	37.79	29.47	48.10	28.63
2020	3	42.05	37.41	28.15	46.44	27.33
2020	4	43.78	39.67	28.23	47.38	29.80
2021	1	42.26	38.41	27.69	46.58	29.42

Source: TimberMart-South

Enviva Cottondale 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	26.52	17.13	26.52	23.80
2000	2	25.23	16.78	26.67	23.20
2000	3	24.60	16.78	24.95	23.20
2000	4	24.42	17.25	24.19	23.55
2001	1	24.32	17.15	20.50	24.68
2001	2	22.50	16.88	25.20	26.05
2001	3	22.04	16.83	25.67	26.03
2001	4	21.56	16.75	24.98	25.90
2002	1	22.03	16.65	24.11	27.10
2002	2	21.22	16.92	24.26	25.40
2002	3	21.22	17.25	25.03	25.95
2002	4	21.71	18.43	26.15	27.46
2003	1	23.49	17.87	26.17	29.89
2003	2	22.84	18.50	26.53	31.48
2003	3	22.88	19.00	28.54	32.40
2003	4	23.05	18.00	28.47	28.70
2004	1	23.44	18.00	27.02	28.70
2004	2	21.21	17.70	27.26	27.20
2004	3	20.70	18.00	27.63	28.00
2004	4	22.53	18.50	27.13	28.70
2005	1	23.47	18.90	26.28	28.90
2005	2	21.86	19.10	27.67	29.40
2005	3	21.42	19.10	27.87	29.80
2005	4	22.46	19.15	27.77	30.60
2006	1	22.24	19.35	26.60	31.80
2006	2	21.48	19.20	27.30	32.70
2006	3	21.68	21.61	28.39	33.65
2006	4	23.42	21.63	29.08	34.00
2007	1	27.55	20.76	28.64	32.70
2007	2	24.67	20.65	28.48	33.25
2007	3	21.54	20.90	27.06	32.80
2007	4	26.64	21.10	28.10	32.40
2008	1	27.85	21.85	30.48	32.85
2008	2	26.82	22.52	32.09	33.85
2008	3	27.49	23.06	33.16	34.45
2008	4	28.69	23.43	32.65	34.48
2009	1	28.84	23.68	31.17	33.40
2009	2	27.63	23.37	31.48	32.86
2009	3	26.73	23.57	32.69	33.77
2009	4	27.23	22.60	34.20	35.29
2010	1	27.73	21.99	33.76	37.35
2010	2	26.84	21.52	34.78	38.25
2010	3	27.25	24.37	34.51	36.54
2010	4	29.78	24.91	36.09	38.77

Year	Quarter	Pine Sawmill Chips	Hardwood Sawmill Chips	Pine Chip Mill Chips	Hardwood Chip Mill Chips
2011	1	30.00	25.14	34.43	38.40
2011	2	27.86	24.51	34.68	36.98
2011	3	26.48	23.37	35.12	35.86
2011	4	27.42	22.53	35.12	35.67
2012	1	28.10	22.09	34.05	35.17
2012	2	26.82	22.98	34.86	35.39
2012	3	26.41	22.88	35.79	35.15
2012	4	27.56	22.47	36.76	35.77
2013	1	29.09	24.71	35.91	36.43
2013	2	28.09	24.98	36.84	36.67
2013	3	27.59	24.62	37.43	37.96
2013	4	30.78	26.50	38.16	39.69
2014	1	28.76	26.55	36.38	40.66
2014	2	29.41	25.55	38.39	40.82
2014	3	29.72	25.07	38.23	39.81
2014	4	30.71	25.12	38.47	39.59
2015	1	31.81	24.23	35.75	38.56
2015	2	31.42	24.93	36.88	38.29
2015	3	30.98	27.51	37.93	39.31
2015	4	34.46	27.98	38.05	38.97
2016	1	32.96	28.59	36.81	38.85
2016	2	32.17	28.53	36.65	37.39
2016	3	31.70	28.32	37.35	37.37
2016	4	32.25	25.81	36.79	35.51
2017	1	31.30	26.39	34.59	35.42
2017	2	32.32	27.02	35.58	35.92
2017	3	29.64	27.06	36.61	34.70
2017	4	31.61	27.20	36.52	35.28
2018	1	32.10	28.05	34.75	35.26
2018	2	29.50	27.42	36.30	34.42
2018	3	29.66	26.75	37.31	34.90
2018	4	31.26	27.12	37.96	37.01
2019	1	31.76	28.59	36.50	37.62
2019	2	30.27	29.62	35.14	39.42
2019	3	30.28	29.93	34.67	38.69
2019	4	30.93	29.35	35.76	37.56
2020	1	32.06	28.35	30.10	36.41
2020	2	31.02	29.32	34.80	36.26
2020	3	29.40	27.81	36.13	36.17
2020	4	30.57	28.05	35.40	36.09
2021	1	32.48	28.15	34.71	36.93

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

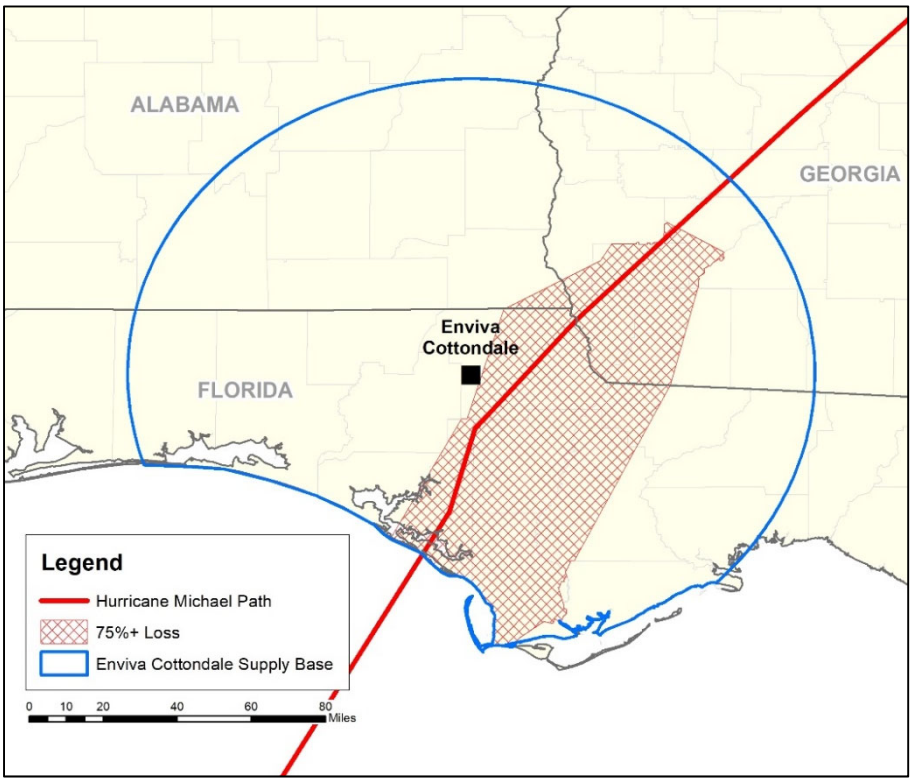
1 mile = 1.609 kilometers

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

Annex 1. Hurricane Michael's Impact on the Cottondale Catchment Area

Hurricane Michael was a Category 5 hurricane that directly impacted the Florida panhandle in October 2018 before moving inland and through the Cottondale catchment area. Based on damage reports released by the Florida Forest Service, an estimated 140,400 hectares of forestland experienced catastrophic damage (95% loss), 422,000 hectares experienced severe damage (75% loss), and 459,500 hectares experienced moderate damage (15% loss). In total, this translates to an estimated 518,900 hectares of forestland that was destroyed by the hurricane (100% loss), all of which is located within the Cottondale catchment area.

Also note that the damage caused by Hurricane Michael was not evenly distributed amongst the different forest types. Specifically, according to damage estimate reports, softwood (pine) represented approximately 57% of total damaged forests, compared to 25% mixed pine-hardwood forests and 18% bottomland hardwood forests.

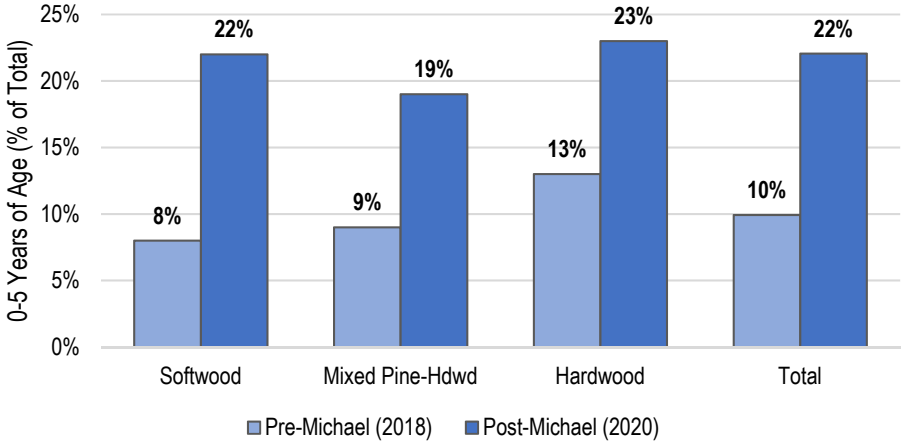


Change in Timberland Age Class Distribution

Furthermore, the damaged caused by Hurricane Michael resulted in an abrupt change in the distribution of timberland area by age class within the Cottondale catchment area. Specifically, the percentage of total timberland area within the 0-5-year age class increased from 10% directly prior to Hurricane Michael to 22% directly following Michael.

In particular, softwood (pine) timberland experienced the greatest change in age class distribution, as the percentage of total softwood timberland within the 0-5-year age class increased from 8% prior to Michael to 22% post-Michael. Regarding the other major forest types, the distribution of total area within the 0-5-year age class increased from 9% to 19% for mixed pine-hardwood timberland and from 13% to 23% for hardwood timberland.

Enviva Cottondale Catchment Area – Percentage of Timberland Area 0-5 Years of Age Prior to & Following Hurricane Michael by Forest Type



Timber Inventory Losses

In terms of Hurricane Michael's impact on timber inventory levels in the Cottondale catchment area, the destruction of nearly 520,000 hectares of forestland resulted in the estimated loss of 42 million m^3 of timber inventory, or an approximate 16% decrease compared to pre-hurricane levels. Additionally, the salvage wood ensuing from this storm resulted in a 30% year-over-year increase in the total volume of timber removed in the catchment area in 2018.

Enviva Cottondale Catchment Area – Timber Inventory by Major Product (2018 vs. 2019)

	Volume (000 m^3)		Δ	
Product	**2018**	**2019**	**000 m^3**	**%**
Pine Sawtimber	94,474	81,892	(12,582)	-13%
Pine Chip-n-saw	46,416	37,772	(8,645)	-19%
Pine Pulpwood	46,741	36,482	(10,260)	-22%
Hardwood Sawtimber	49,097	41,947	(7,149)	-15%
Hardwood Pulpwood	32,811	29,133	(3,678)	-11%
Total	**269,540**	**227,226**	**(42,313)**	**-16%**

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).

Hood Consulting
3100 Old Canton Road, Suite 200
Jackson, MS 39216

1-601-540-8602
hbhood@hoodconsultingllc.com