Catchment Area Analysis of Forest Management and Market Trends:

Amite BioEnergy

(UK metric version)

Prepared for:

Drax Group plc

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Executive Summary

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. In accordance with Drax's initiative to monitor its sourcing regions and the catchment areas in which its mills operate, this report, specifically, examines the fiber catchment area for Drax's Amite BioEnergy pellet mill located in Gloster, Mississippi.

The Amite BioEnergy catchment area analysis is broken down into five sections:

1. Market Profile & Resource Assessment – includes catchment area-specific details regarding land and forest area, timber inventory, timber growth, and timber removals.

2. Wood Demand & Raw Material Cost Assessment – identifies all mills (sources of wood demand) that procure wood from within the Amite BioEnergy fiber catchment area; provides details regarding annual wood demand and current raw material costs (timber prices) within the catchment area.

3. Forest Management Practices Assessment – includes a market study and logger survey that examines how forest management practices have changed in the catchment area since Amite BioEnergy commenced production.

4. Market Trends, Analysis, & Outlook – identifies trends and changes in land and forest area, timber inventory, growth, harvest removals, wood demand, and raw material prices since 2010; identifies and details any links between bioenergy-related wood demand and the aforementioned items. This section also includes a market outlook that details anticipated changes in wood demand and raw material costs for the Amite BioEnergy pellet mill through the year 2022.

5. Analysis Summary & Findings – provides a summary of the Amite BioEnergy catchment area analysis and details the report's findings.

Ultimately, the focus of this report is to assess and identify the impact the Drax pellet mill and bioenergy-related wood demand has had on this market since the Amite BioEnergy pellet mill commenced production in late 2014. A summary of the report's key findings has been provided on the following pages.

Is there any evidence that bioenergy demand has caused the following:	Analysis Findings
Deforestation?	**No.** US Forest Service data shows the opposite. Total timberland acreage has increased 1% since Amite BioEnergy commenced production in late 2014.
A change in management practices (rotation lengths, thinnings, conversion from hardwood to pine)?	**No / Inconclusive.** Changes in management practices have occurred in the catchment area over the last 5-10 years, but there is little evidence to suggest bioenergy demand has caused these changes. Market research shows thinnings have declined in this catchment area since 2014 (when Amite BioEnergy commenced production). However, local loggers identify poor markets conditions for the decrease in thinnings, not increased bioenergy demand. The primary focus of timber management in this area is the production of sawtimber grade timber, and rotation lengths of managed forests have remained unchanged (between 25-35 years of age) despite increases in bioenergy demand. Increased bioenergy demand, however, has benefited landowners in this catchment area, providing additional outlets for pulpwood removed from thinnings – a management activity necessary for sawtimber production. Conversion from naturally regenerated hardwood to planted pine has occurred in the catchment area. From 2014 through 2017, the latest available, planted pine acreage increased 7% while naturally generated hardwood timberland acreage decreased 5%. However, it is inconclusive as to whether bioenergy demand caused this change. Conversion from naturally regenerated timber to planted pine is typical in this market. As less productive naturally regenerated timber stands are harvested, these stands are replaced with more productive planted pine (improved genetics that offer better growth, improved form, reduced susceptibility to disease, and improved financial returns) to be managed for sawtimber production.
Diversion from other markets?	**No.** Since 2014, softwood pulpwood demand not attributed to bioenergy has increased 8% while demand for softwood sawlogs and hardwood pulpwood has increased 53% and 5%, respectively. Demand for hardwood sawlogs is down an estimated 24% since 2014; however, hardwood sawlog demand has been increasing since 2017.
An abnormal increase in wood prices?	**No.** Prices for delivered pine pulpwood (the primary raw material consumed by Amite BioEnergy) have rather decreased 12% since the pellet mill commenced production in 2014. And while prices for pine sawmill residuals and in-woods chips (the other two raw materials consumed by Amite BioEnergy) are both up 3% compared to 2014 levels, prices have declined each of the last two years for pine sawmill residuals and each of the last three years for in-woods chips.
A reduction in growing stock timber?	**No / Inconclusive.** Total growing stock inventory in the catchment area increased 5% from 2014 through 2017, the latest available. Specifically, pine sawtimber inventory increased 13%, pine chip-n-saw inventory increased 24%, and pine pulpwood inventory decreased 12% over this period. There is little evidence to suggest that increased bioenergy demand has caused this reduction in pine pulpwood inventory. Rather, the increase in total in timber inventory (including both pine sawtimber and chip-n-saw inventory) along with the decrease in pine pulpwood inventory is indicative of an aging forest. It also suggests the forest is in a state of transition, with pine pulpwood moving up in product class (to chip-n-saw).

Is there any evidence that bioenergy demand has caused the following:	Analysis Findings
A reduction in the sequestration rate of carbon?	**No.** US Forest Service data shows the average annual growth rate of growing stock timber has decreased slightly since 2014, and a slower timber growth rate essentially represents a reduction in the sequestration rate of carbon. However, the reduced growth rate and subsequent reduction in the sequestration rate of carbon is due to the aging of the forest (changes in timber age class distribution), not to increases in bioenergy demand.
An increase in harvesting above the sustainable yield capacity of the forest area?	**No.** Growth-to-removals ratios, which compare annual timber growth to annual harvests, provides a measure of market demand relative to supply as well as a gauge of market sustainability. In 2017, the latest available, the growth-to-removals ratio for pine pulpwood equaled 1.80 (a value greater than 1.0 indicates sustainable harvest levels). Even with the increased harvesting required to satisfy bioenergy demand, harvest levels remain well below the sustainable yield capacity of the catchment forest area.

Impact of bioenergy demand on:	Analysis Findings
Timber growing stock inventory	**Neutral.** Total wood demand (from biomass and other solid wood products) is up more than 35% compared to 2014 levels. Intuitively, increased demand means more timber is harvested, which reduces total growing stock inventory. However, in this catchment area, inventories are so substantial that increases in demand from bioenergy, as well as from other sources, have not been great enough to offset annual timber growth, and, as such, total growing stock inventory has continued to increase – an average of 2% per year since 2014 (when Amite BioEnergy commenced production).
Timber growth rates	**Neutral.** Timber growth rates have declined since 2014; however, evidence suggests the reduction in growth rates is more a product of an aging forest and not due to changes in bioenergy demand. Additionally, young planted pine stands are actually growing at a faster rate than ever before – due to the continued improvement of seedling genetics. And, as timber is harvested and these stands are replanted in pine (as has historically occurred in the catchment area), over the long term, the average timber growth rate is likely to increase.
Forest area	**Positive / Neutral.** Total forest **(timberland)** area in the catchment area increased m**ore than 5,200 hectares** from 2014 through 2017, the latest available. And while our analysis of biomass demand and forest area found a moderately strong relationship between the two, findings are inconclusive as to whether the increase in timberland acreage can be attributed to increases in biomass demand.
Wood prices	**Neutral.** Despite the additional wood demand placed on this market by Amite BioEnergy, since 2014, prices for delivered pine pulpwood (the primary raw material consumed by Amite BioEnergy) have decreased 12% in the catchment area. Prices for pine sawmill residuals and in-woods chips (the other two raw materials consumed by Amite BioEnergy) have also declined over the last several years – down 3% since 2016 for pine sawmill residuals and down 3% since 2015 for in-woods chips. According to the laws of supply and demand, for price to decrease despite an increase in demand, an even larger increase in supply must occur. And that's what we've seen in this catchment area. Increases in bioenergy

Impact of bioenergy demand on:	Analysis Findings
	demand have been matched with decreases in raw material prices, and it's the increase in wood supply that's driven prices downward, not increases in bioenergy demand.
Markets for solid wood products	**Positive / Neutral.** In the Amite BioEnergy catchment area, demand for softwood sawlogs to produce lumber has increased more than 50% since 2014. A by-product of the sawmilling process is sawmill residuals – a material utilized by Amite BioEnergy to produce wood pellets. With the increase in softwood lumber production has come an increase in sawmill residuals, some of which has been consumed by Amite BioEnergy. Not only has Amite BioEnergy benefited from the greater availability of this by-product, but lumber producers have also benefited, as Amite BioEnergy has provided an additional outlet for these producers and their by-products. The impact of bioenergy demand on hardwood markets, however, has been neutral. Amite BioEnergy utilizes no hardwood in its production of wood pellets, and there is no strong evidence to suggest bioenergy demand has had any significant impact on hardwood markets in the catchment area.

1. Report Background

Drax Group is a British electrical power generation and supply company that runs Europe's biggest biomass-fueled power station – the UK's largest decarbonization project - 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 in the markets in which its pellet mills operate, this report focuses specifically on the Amite BioEnergy pellet mill in Gloster, Mississippi, and its fiber catchment area.

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 Amite BioEnergy catchment area since 2010. It also includes an assessment of long-term market sustainability and provides a market outlook through 2022.

1.1 About Hood Consulting

The following catchment area analysis was conducted by Hood Consulting and in partnership with TimberMart-South, an industry-leading reporting service that has provided high quality price and market information on Southern timber markets since 1976.

Hood Consulting provides professional forest industry advisory and consulting services to both private and corporate landowners and investors, as well as to forest product companies, manufacturers, natural resource firms, and state and local economic development authorities. We incorporate advanced analytical techniques and applications, in-depth market research, and nearly 50 years of combined experience to provide innovative and strategic solutions for our clients and their specific needs.

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.

HOOD CONSULTING | TimberMart-South

2. Market Profile & Resource Assessment

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. Amite BioEnergy's catchment area, whose shape was derived by georeferencing site-specific data from Drax's primary feedstock supplies to the mill, extends as far out as 80 kilometers from the mill's location in Gloster, Mississippi, and includes areas located within nine different counties in southwest Mississippi and two different parishes in Louisiana (see Figure 1).

Since information and data pertaining to land classification, timber inventory, growth, and removals is provided at the individual county level, geospatial analysis software (Esri ArcGIS) was used to identify the proportion of each county located within the catchment area (see Table 1).

***Figure 1**. Amite BioEnergy Catchment Area Boundary (as defined by Drax Biomass)*

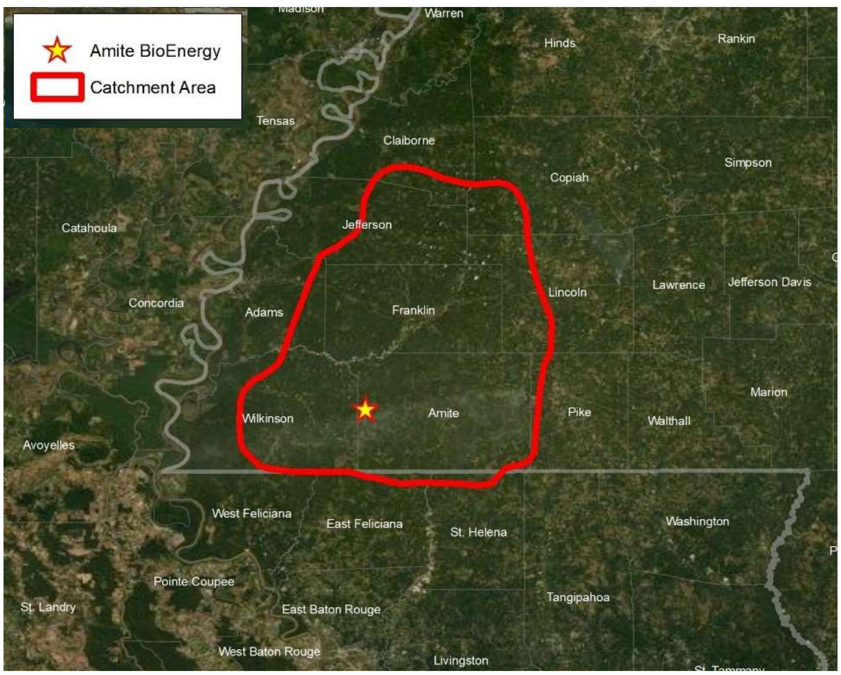


***Table 1**. County List & Catchment Area Allocation (%)*

County / Parish	State	Catchment Area Allocation (%)
Adams	MS	17%
Amite	MS	99%
Claiborne	MS	15%
Copiah	MS	13%
Franklin	MS	100%
Jefferson	MS	55%
Lincoln	MS	34%
Pike	MS	7%
Wilkinson	MS	65%
East Feliciana	LA	5%
St. Helena	LA	7%

2.1 Land Area

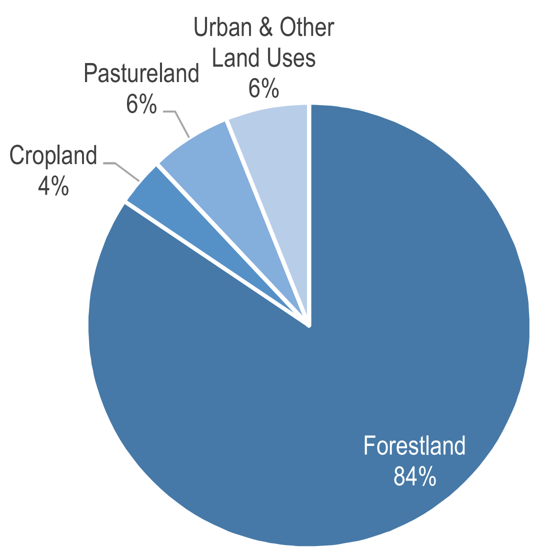
Geospatial analysis of the Amite BioEnergy catchment area calculates total land area at approximately 659,979 hectares. According to most current estimates published by the US Department of Agriculture (USDA), approximately 84% (557,206 hectares) of the total land area is classified as forestland, 4% (23,356 hectares) is cropland, 6% (39,377 hectares) is pastureland, and 6% (40,040 hectares) is urban areas or land that is classified as having other land uses.

Table 2*. Amite BioEnergy Catchment Area - Land Area by Land Classification & Use (2017)*

Land Classification	Hectares	% of Total
Forestland	557,206	84%
Cropland	23,356	4%
Pastureland	39,377	6%
Urban & Other Land Uses	40,040	6%
Total Land Area	**659,979**	**100%**

Source: USDA – US Forest Service; USDA Census of Agriculture (2017)

Figure 2*. Amite BioEnergy Catchment Area – Land Area Distribution by Land Classification & Use (2017)*



2.1.1 *Timberland*

Forestland, defined by the USDA as land at least 10% stock with trees of any kind, totals approximately 557,206 hectares and constitutes 84% of the catchment area's total land area.

Timberland, or forestland that is capable of producing at least 0.5 m^3 of industrial wood per year, constitutes over 99% of total forestland in the catchment area and totals approximately 554,176 hectares. (Note that not all forestland is capable of commercial timber production, but in this catchment area, 99% of all forestland is considered commercially productive. Also note that the following analysis will focus on and include timber inventory, growth, and removals data from timberland only).

2.1.1.1 *By Ownership Group*

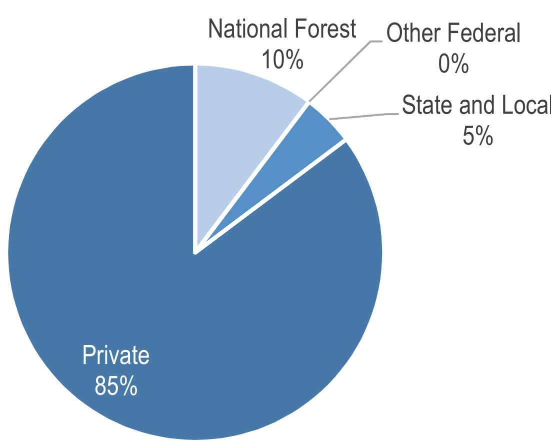
Ownership of timberland in the Amite BioEnergy catchment area is predominantly privately owned. According to US Forest Service - Forest Inventory and Analysis (FIA) data from 2017, the latest available, privately-owned timberland totaled approximately 472,305 hectares (85%), compared to 57,081 hectares (10%) of National Forest, 24,776 hectares (5%) owned by state and local authorities, and 15 hectares (<1%) owned by other federal authorities.

***Table 3**. Amite BioEnergy Catchment Area - Timberland Area by Ownership Group (2017)*

Ownership Group	Hectares	% of Total
National Forest	57,081	10%
Other Federal	15	0%
State and Local	24,776	5%
Private	472,305	85%
Total	**554,176**	**100%**

Source: USDA – US Forest Service

***Figure 3**. Amite BioEnergy Catchment Area - Distribution of Timberland Area by Ownership Group (2017)*



2.1.1.2 *By Forest Type and Age Class*

According to US Forest Service data, of the 554,176 hectares of timberland in the catchment area, approximately 53% (296,757 hectares) is pine, 37% (211,485 hectares) is hardwood, and 9% (45,933 hectares) is mixed pine-hardwood.

Distribution of timberland area by age class varies by forest type. Approximately 76% of pine timberland is 30 years of age or younger, with 50% 16-30 years of age. In contrast, approximately 65% of hardwood timberland area is 36-75 years of age, with 44% 51-75 years of age. Distribution of mixed pine-hardwood timberland by age class is a bit more wide-spread than that of both pine and hardwood timberland, with approximately 73% of mixed pine-hardwood timberland 26-80 years of age, with 53% 31-65 years of age.

Note that the age class distributions of both pine and hardwood timberland are in line with typical management regimes for these two species. In this market, timber management is focused on sawtimber production, and in general, pine reaches sawtimber grade in 25-30 years whereas hardwoods grow slower and typically don't reach sawtimber grade until around age 40-50.

***Figure 4**. Amite BioEnergy Catchment Area - Distribution of Timberland Area by Age Class (2017)*

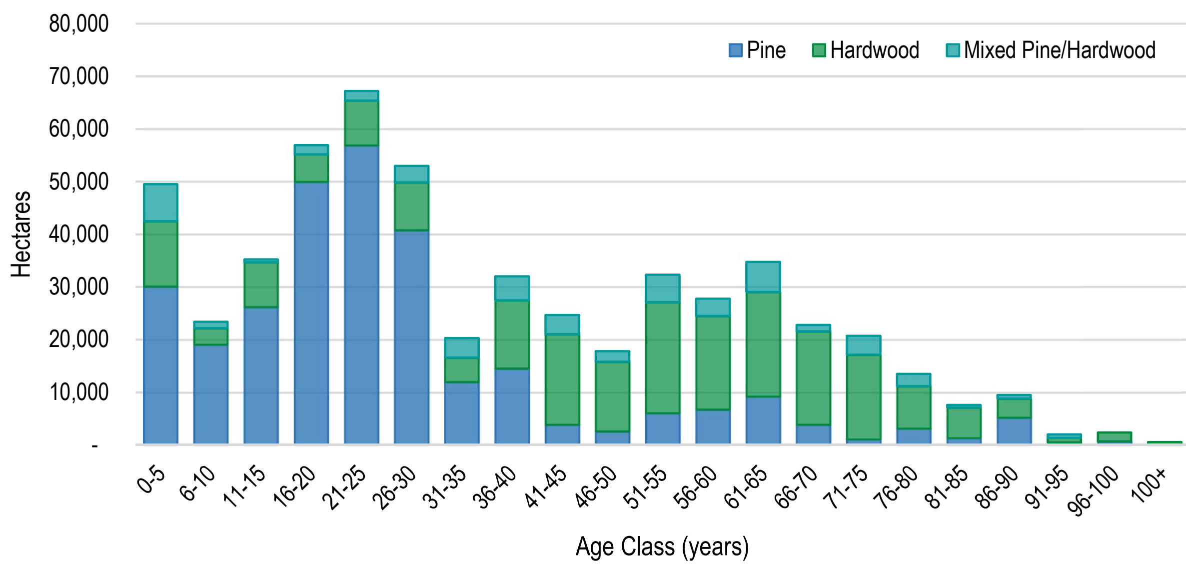
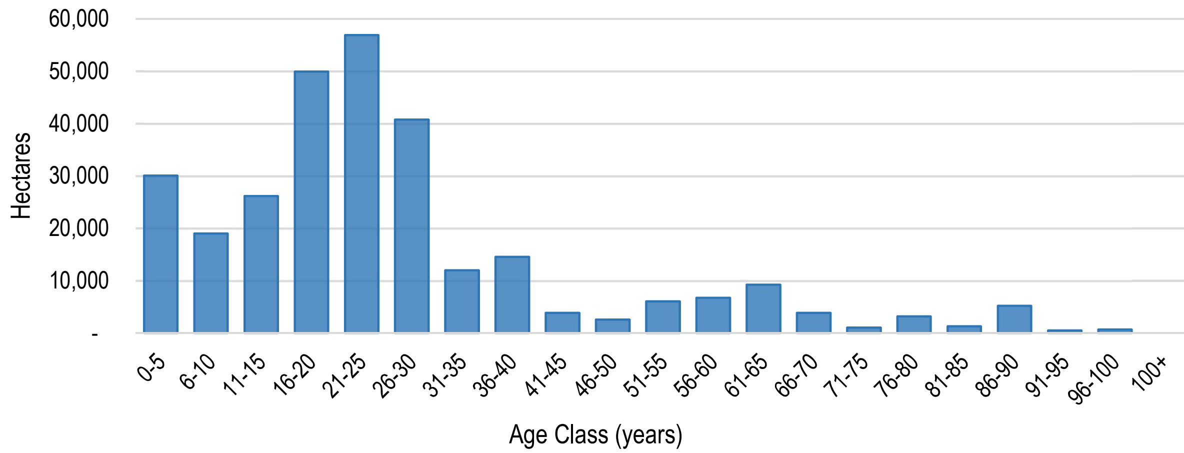
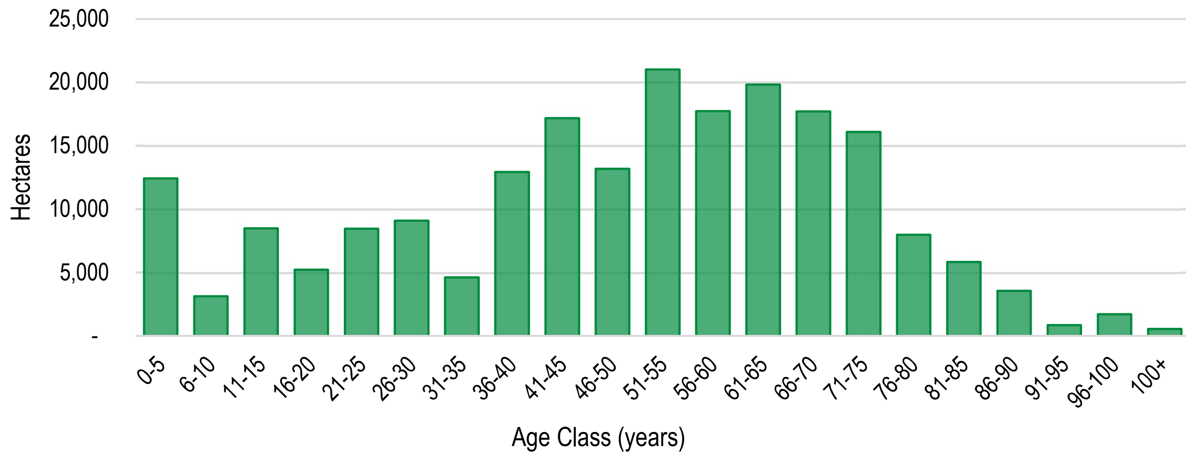


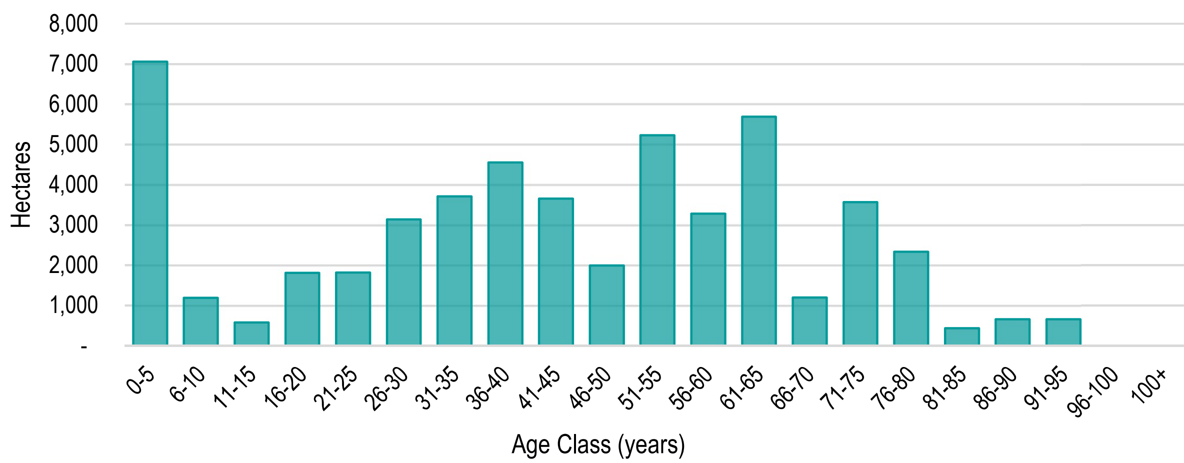
***Figure 5**. Amite BioEnergy Catchment Area - Distribution of Timberland Area by Age Class & Forest Type (2017)*



(a) Pine Timberland



(b) Hardwood Timberland



(c) Mixed Pine-Hardwood Timberland

2.2 Timber Inventory

Timber inventory data for the Amite BioEnergy 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 provides timber inventory details as of 2017[1], the most current available. Further analysis, including inventory projections through 2022, is provided in the *Market Analysis, Trends, & Outlook* section beginning on page 44.

2.2.1 *By Ownership Group*

Growing stock inventory on timberland in the Amite BioEnergy catchment area totals an estimated 89.6 million m^3, of which approximately 80% (71.9 million m^3) is privately owned, 17% (14.9 million m^3) is National Forest, 3% (2.7 million m^3) is owned by state and local authorities, and <1% (22,315 m^3) is owned by other federal authorities.

Distribution of total growing stock inventory by ownership group varies slightly by major species group (softwood vs. hardwood). According to the US Forest Service, inventory of softwood growing stock on timberland totals approximately 53.1 million m^3 (59% of total inventory), of which 77% (40.9 million m^3) is privately owned, 20% (10.8 million m^3) is National Forest, and 3% (1.4 million m^3) is owned by state and local authorities.

Hardwood growing stock inventory in the catchment area totals an estimated 36.6 million m^3 (41% of total inventory), with approximately 85% (31.1 million m^3) privately owned, 11% (4.2 million m^3) National Forest, 4% (1.3 million m^3) owned by state and local authorities, and <1% (22,315 m^3) owned by other federal authorities.

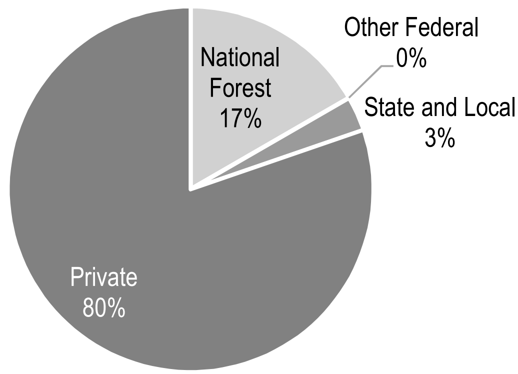
Table 4*. Amite BioEnergy Catchment Area - Growing Stock Volume on Timberland by Ownership Group and Major Species (2017)*

Ownership Group	Softwoods		Hardwoods		Total	
	(million m^3)	%	(million m^3)	%	(million m^3)	%
National Forest	10.8	20%	4.2	11%	14.9	17%
Other Federal	0	0%	0	0%	0	0%
State and Local	1.4	3%	1.3	4%	2.7	3%
Private	40.9	77%	31.1	85%	71.9	80%
Total	**53.1**	**100%**	**36.6**	**100%**	**89.6**	**100%**

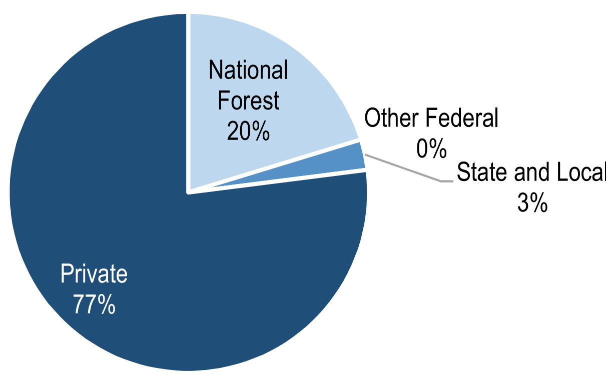
Source: USDA - US Forest Service

[1] US Forest Service FIA data for those areas located in Louisiana were only available through 2016. Estimates for 2017 have been included and are based on historical trends and a local area inventory model.

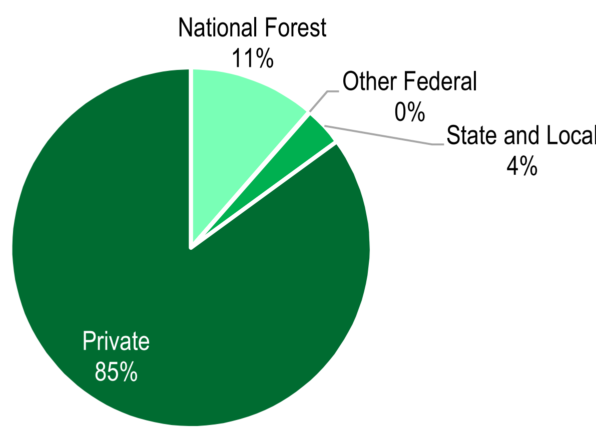
***Figure 6**. Amite BioEnergy Catchment Area - Distribution of Growing Stock Volume on Timberland by Ownership Group (2017)*



(a) Total Growing Stock



(b) Softwood Growing Stock



(c) Hardwood Growing Stock

2.2.2 *By Diameter Class Distribution*

Distribution of total growing stock inventory on timberland by diameter class varies by major species group. Based on the most current US Forest Service data, the distribution of softwood growing stock inventory shows that approximately 73% (38.9 million m^3) is less than 17 inches in diameter, with 59% (31.1 million m^3) of softwood inventory 7-15 inches in diameter.

In contrast, distribution of hardwood growing stock in the catchment area shows that 83% (30.3 million m^3) is 7-25 inches in diameter, with approximately 54% (19.6 million m^3) of hardwood inventory 11-21 inches in diameter.

In addition, FIA estimates of diameter class distribution by major species group allow us to break down volume estimates according to major timber product. Since pine constitutes greater than 98% of total softwood inventory in the catchment area (according to FIA data), for these calculations, all softwood inventory is considered pine. 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+

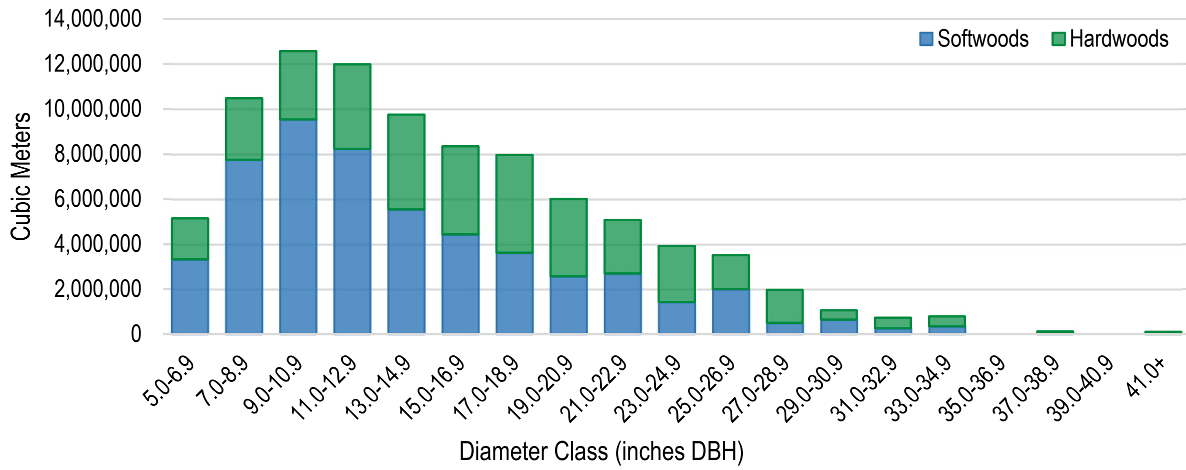
Based on these product specifications, approximately 28.3 million m^3 of total growing stock inventory is classified as pine sawtimber (32%), compared to 13.7 million m^3 of pine chip-n-saw (15%), 11.1 million m^3 of pine pulpwood (12%), 27.1 million m^3 of hardwood sawtimber (30%), and 9.5 million m^3 of hardwood pulpwood (11%).

***Table 5**. Amite BioEnergy Catchment Area - Distribution of Total Growing Stock Volume by Major Timber Product (2017)*

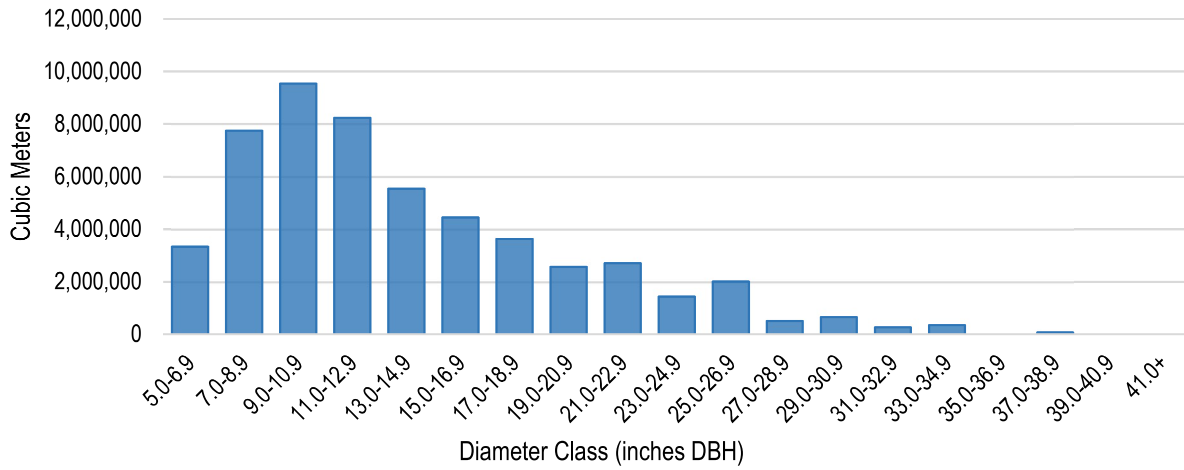
Product	Volume (Million m^3)	Distribution
Pine Sawtimber	28.3	32%
Pine Chip-n-saw	13.7	15%
Pine Pulpwood	11.1	12%
Hardwood Sawtimber	27.1	30%
Hardwood Pulpwood	9.5	11%
Total	**89.6**	**100%**

Source: USDA - US Forest Service

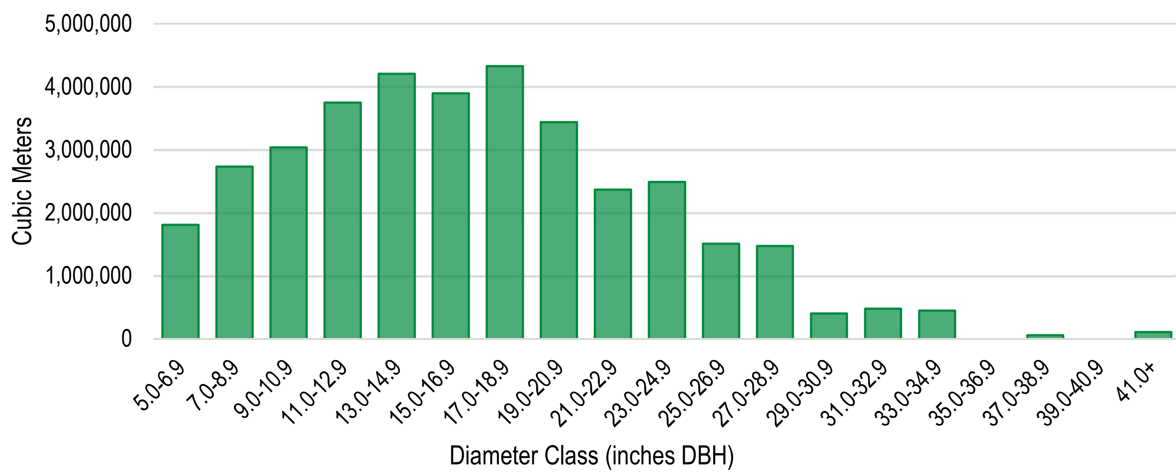
***Figure 7**. Amite BioEnergy Catchment Area - Distribution of Growing Stock Volume on Timberland by Diameter Class (2017)*



(a) Total Growing Stock



(b) Softwood Growing Stock



(c) Hardwood Growing Stock

2.2.3 *By Age Class Distribution*

Distribution of total growing stock volume on timberland by age class is bimodal, with approximately 34% of total inventory 16-30 years of age and 28% of total inventory 51-70 years of age (see Figure 8). This is explained by major species composition, as softwood growing stock averages roughly 36 years of age compared to 56 years of age for hardwood growing stock.

According to US Forest Service data, the distribution of softwood growing stock volume by age class shows that 66% (35.2 million m^3) is 11-40 years of age, with approximately 49% (26.1 million m^3) 16-30 years of age.

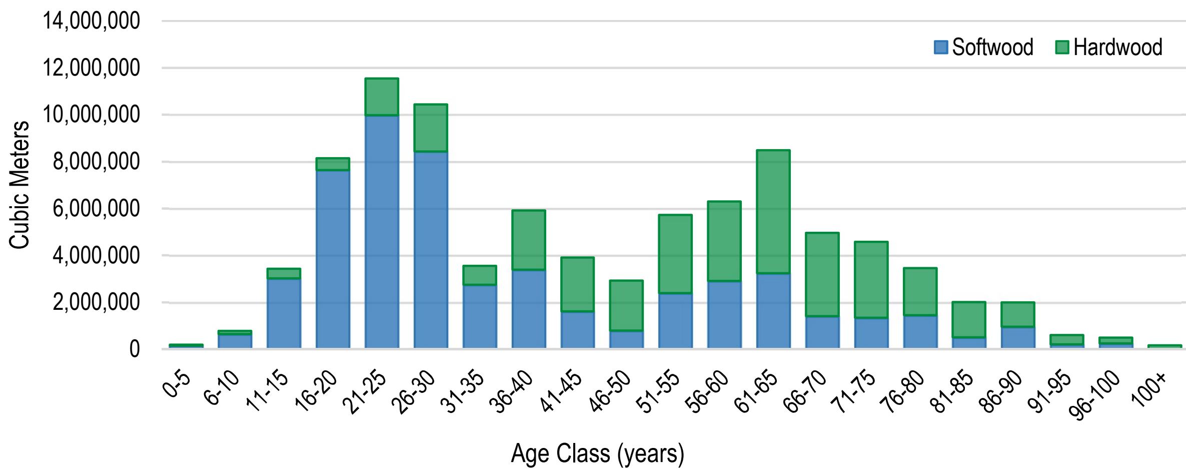
Distribution of hardwood growing stock in the catchment area by age class shows approximately 76% (27.7 million m^3) is 36-80 years of age, with 51% (18.8 million m^3) of hardwood growing stock volume 51-75 years of age.

***Table 6**. Distribution of Growing Stock Volume by Age Class & Major Species (2017)*

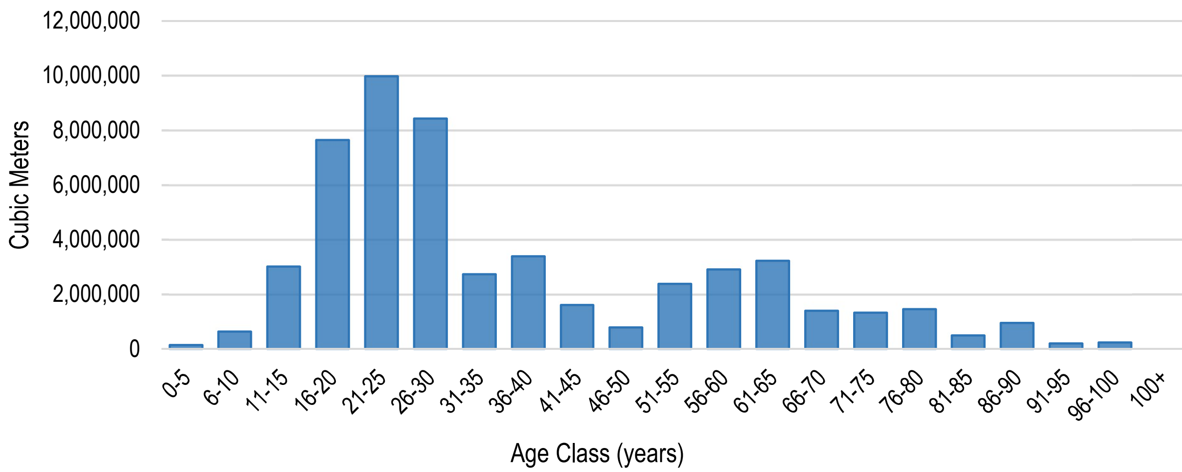
	Softwood		*Hardwood*		*Total*	
Age Class (Years)	**Volume** (m3)	**Distribution**	**Volume** (m3)	**Distribution**	**Volume** (m3)	**Distribution**
0-5	148,214	0%	48,040	0%	196,254	0%
6-10	638,025	1%	141,343	0%	779,368	1%
11-15	3,024,338	6%	405,302	1%	3,429,639	4%
16-20	7,643,562	14%	496,624	1%	8,140,186	9%
21-25	9,977,814	19%	1,569,437	4%	11,547,250	13%
26-30	8,430,079	16%	2,008,349	5%	10,438,428	12%
31-35	2,741,945	5%	807,076	2%	3,549,021	4%
36-40	3,389,620	6%	2,524,016	7%	5,913,636	7%
41-45	1,615,724	3%	2,299,918	6%	3,915,642	4%
46-50	798,242	2%	2,125,037	6%	2,923,278	3%
51-55	2,389,068	5%	3,343,261	9%	5,732,329	6%
56-60	2,913,527	5%	3,387,794	9%	6,301,320	7%
61-65	3,234,253	6%	5,258,002	14%	8,492,254	9%
66-70	1,407,489	3%	3,549,504	10%	4,956,994	6%
71-75	1,337,691	3%	3,248,405	9%	4,586,096	5%
76-80	1,456,266	3%	1,999,756	5%	3,456,022	4%
81-85	502,385	1%	1,503,872	4%	2,006,257	2%
86-90	963,351	2%	1,034,090	3%	1,997,440	2%
91-95	203,215	0%	393,324	1%	596,538	1%
96-100	242,191	0%	254,688	1%	496,878	1%
100+	0	0%	159,458	0%	159,458	0%
Total	**53,056,996**	**100%**	**36,557,295**	**100%**	**89,614,290**	**100%**

Source: USDA - US Forest Service

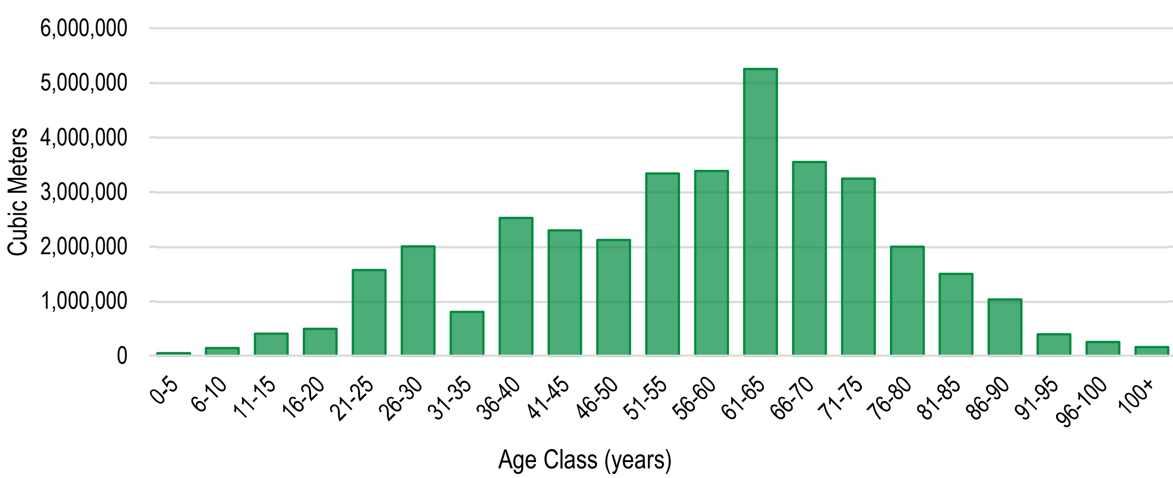
***Figure 8**. Amite BioEnergy Catchment Area - Distribution of Growing Stock Volume on Timberland by Age Class (2017)*



(a) Total Growing Stock



(b) Softwood Growing Stock



(c) Hardwood Growing Stock

2.2.4 *By Stand Origin*

US Forest Service data includes two classifications for stand origin: 1) naturally regenerated timber stands and 2) planted timber stands. Based on the most current US Forest Service FIA estimates, approximately 68% of total growing stock volume in the catchment area, or 61.0 million m^3, is of natural origin, compared to 32% (28.6 million m^3) that was planted. However, note that stand origin distribution varies widely by major species group.

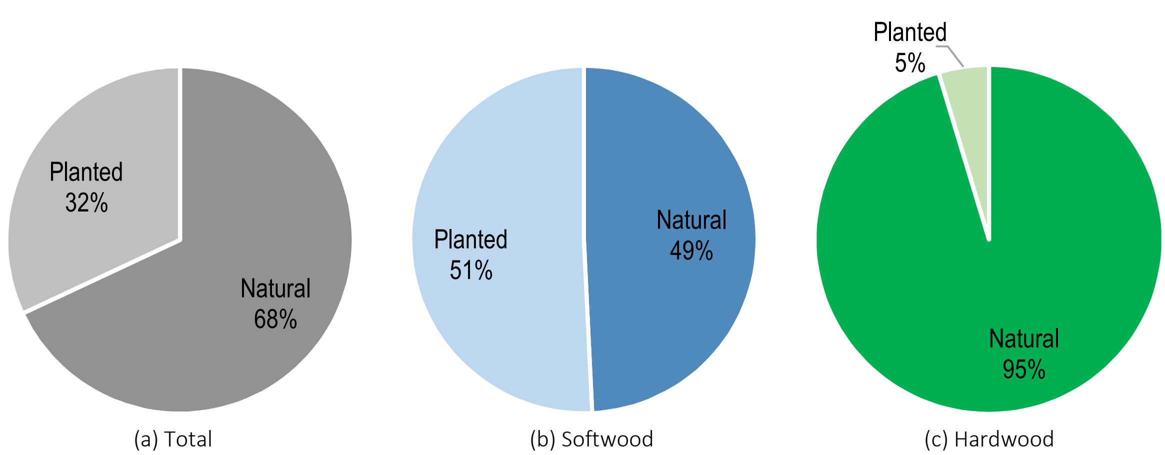
According to US Forest Service data, approximately 49% (26.1 million m^3) of softwood growing stock is naturally regenerated, whereas 51% (26.9 million m^3) is planted. In contrast, approximately 95% (34.8 million m^3) of hardwood inventory is naturally regenerated, compared to 5% (1.7 million m^3) planted.

***Table 7**. Amite BioEnergy Catchment Area - Growing Stock Volume on Timberland by Stand Origin & Major Species (2017)*

	Softwood		*Hardwood*		*Total*	
Stand Origin	**Volume** (million m3)	**Distribution**	**Volume** (million m3)	**Distribution**	**Volume** (million m3)	**Distribution**
Naturally Regenerated	26.1	49%	34.8	95%	61.0	68%
Planted	26.9	51%	1.7	5%	28.6	32%
Total	**53.1**	**100%**	**36.6**	**100%**	**89.6**	**100%**

Source: USDA - US Forest Service

***Figure 9**. Amite BioEnergy Catchment Area - Distribution of Growing Stock Volume on Timberland by Stand Origin (2017)*



2.2.5 *Commercially Available Timber Inventory*

Private landowners have the ability to sell their timber whenever and to whomever they decide, as such, all privately-owned timber inventory is considered commercially available. In the Amite BioEnergy catchment area, this totals an estimated 71.9 million m^3, or 80% of total growing stock volume. While only privately-owned timber is considered commercially available, note that a significant portion of National Forest and state and locally owned timberland is actively managed for timber production.

The US Forest Service (USFS) manages all National Forests and the overriding objective of the USFS's forest management program is to ensure that National Forests are managed in an ecologically sustainable manner. Other objectives include maintaining vegetation, restoring ecosystems, reducing hazards, and maintaining forest health. Timber harvests are a management tool the USFS utilizes to help meet these objectives. However, in accordance with the National Forest Management Act of 1976, the USFS must manage national forests on a maximum sustained yield basis. Ultimately, this translates to longer rotation lengths and a smaller percentage of National Forest timber that is harvested annually.

In Mississippi, much of the timberland owned by state and local authorities is 16th section land[2] that is managed by the Mississippi Forestry Commission under the direction of the Mississippi Secretary of State and in cooperation with local school districts. Like National Forests, state timberlands are also managed on a maximum sustained yield basis.

Conservatively, 40-60% of this timberland, or an additional 7-10 million m^3 of timber, is likely available. However, for this analysis, National Forests and state and locally owned timber is not considered commercially available.

***Table 8**. Amite BioEnergy Catchment Area - Commercially Available Inventory by Major Timber Product (2017)*

Product	Commercially Available Volume (Million m^3)
Pine Sawtimber	21.8
Pine Chip-n-saw	10.5
Pine Pulpwood	8.5
Hardwood Sawtimber	23.0
Hardwood Pulpwood	8.0
Total	**71.9**

[2] 16th section land is public school trust lands that leased by individual school districts to fund education in the State of Mississippi. (Source: Mississippi Secretary of State Office)

2.3 Timber Growth & Removals

2.3.1 *Timber Growth*

According to US Forest Service data, net annual growth of growing stock timber in the Amite BioEnergy catchment area totaled an estimated 5,109,497 m^3 in 2017, the latest available. Specifically, 79% (4,055,883 m^3) of total growth was attributed to softwood species, compared to 21% (1,053,614 m^3) hardwood species. Net annual growth by major timber product is provided below in Table 9.

***Table 9**. Amite Bioenergy Catchment Area - Net Growth of Growing Stock Timber by Major Timber Product (2017)*

Product	Volume Growth (m^3 / year)	% of Total Growth
Pine Sawtimber	1,300,327	25%
Pine Chip-n-saw	1,234,305	24%
Pine Pulpwood	1,521,250	30%
Hardwood Sawtimber	543,521	11%
Hardwood Pulpwood	510,093	10%
Total	**5,109,497**	**100%**

Source: USDA - US Forest Service

2.3.2 *Harvest Removals*

According to US Forest Service data, harvest removals in the catchment area totaled 2,410,970 m^3 in 2017, of which approximately 83% (2,003,171 m^3) was softwood timber and 17% (407,798 m^3) was hardwood timber. Of the five major timber products, harvest removals were highest for pine pulpwood, totaling 846,472 m^3 and accounting for 35% of total removals, followed by 663,956 m^3 of pine sawtimber (28% of total harvest removals), 492,744 m^3 of pine chip-n-saw (20%), 311,916 m^3 of hardwood sawtimber (13%), and 95,882 m^3 of hardwood pulpwood (4%).

***Table 10**. Amite BioEnergy Catchment Area - Harvest Removals by Major Timber Product (2017)*

Product	Harvest Removals (Cubic Meters)	% of Total Harvest Removals
Pine Sawtimber	663,956	28%
Pine Chip-n-saw	492,744	20%
Pine Pulpwood	846,472	35%
Hardwood Sawtimber	311,916	13%
Hardwood Pulpwood	95,882	4%
Total	**2,410,970**	**100%**

Source: USDA - US Forest Service

2.3.3 *Growth-to-Removal 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 2017, the latest available, overall inventory growth totaled 5.1 million m^3, compared to total harvest removals of 2.4 million m^3, or a growth-to-removals ratio of 2.12. The growth-to-removal ratio for softwood species was 2.02, compared to 2.58 for hardwood species.

Growth-to-removals ratios by species and individual timber product are as follows: pine sawtimber=1.96, pine chip-n-saw=2.50, pine pulpwood=1.80, hardwood sawtimber=1.74, and hardwood pulpwood=5.32. Note that growth-to-removal ratios for all five major timber products are well above 1.0, indicating sustainable market conditions as well as oversupply.

***Table 11**. Amite BioEnergy Catchment Area - Annual Growth, Removals, & Growth-to-Removal Ratios by Major Timber Product (2017)*

Softwood (Pine)	Growth (million m3)	Removals (million m3)	G:R Ratio
Pine Pulpwood	1.52	0.85	1.80
Pine Chip-n-saw	1.23	0.59	2.50
Pine Sawtimber	1.30	0.66	1.96
Softwood (Pine) Total	4.06	2.00	2.02

Hardwood	Growth (million m3)	Removals (million m3)	G:R Ratio
Hardwood Pulpwood	0.51	0.10	5.32
Hardwood Sawtimber	0.54	0.31	1.74
Hardwood Total	1.05	0.41	2.58

Product	Growth (million m3)	Removals (million m3)	G:R Ratio
Pulpwood	2.03	0.94	2.16
Sawtimber	3.08	1.47	2.10
Total	**5.11**	**2.41**	**2.12**

Source: USDA - US Forest Service

3. Wood Demand & Raw Material Cost Assessment

3.1 Mill Capacity & Wood Demand

According to TimberMart-South's mill database, as of June 2019, there were 44 major mills operating in and around the Amite BioEnergy catchment area (within a 160-kilometer radius of Drax's pellet mill in Gloster, Mississippi). This includes 26 lumber mills (14 softwood mills and 12 hardwood mills), five pulp/paper mills, five panel (plywood/OSB) mills, six chip mills, and two pellet mills (including Amite BioEnergy).

Total production capacity associated with these 44 mills translates to approximately 21.6 million tonnes of wood per year. However, not all wood procurement for these mills occurs within Amite BioEnergy's catchment area. Based on the relative location of these mills to Amite BioEnergy and its catchment area, we estimate the total allocated capacity of these mills to the BioEnergy catchment area at approximately 5,296,598 tonnes (Table 12).

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. Details regarding historic wood demand in the catchment area are provided in the *Market Trends, Analysis, & Outlook* section beginning on page 44.

***Table 12**. Number of Mills, Total Mill Capacity, & Catchment Area Allocated Mill Capacity (2019)*

Mill Type	No. Mills	Total Capacity (Tonnes*)	Catchment Area Allocation (Tonnes*)
Lumber	26	7,454,183	3,130,945
Pulp / Paper	5	8,539,322	716,663
Plywood / OSB	5	2,500,176	182,705
Chip	6	671,544	268,380
Pellet	2	2,449,402	997,904
Total	**44**	**21,614,627**	**5,296,598**

*Roundwood equivalent volume
Source: TimberMart-South; Hood Consulting

***Table 13**. Amite BioEnergy Catchment Area - Mill List (2019)*

Mill Name / Company	City	County	State	Capacity	Units	Demand†
		Softwood Sawmill				
Lincoln Lumber Co	Brookhaven	Lincoln	MS	8	MM Bf	62,960
Paul Davis Lumber Inc	Amite	Tangipahoa	LA	8	MM Bf	62,960
Bayou State Lumber	Jackson	East Feliciana	LA	10	MM Bf	78,700
J.M. Jones Lumber	Natchez	Adams	MS	16	MM Bf	125,920
Byrd Lumber	Fernwood	Pike	MS	21	MM Bf	165,270
Amite Lumber	Liberty	Amite	MS	28	MM Bf	220,360
Seago Lumber	McComb	Pike	MS	51	MM Bf	235,110
Canfor - Southern Lumber Co	Hermanville	Claiborne	MS	81	MM Bf	373,410
Rex Lumber	Brookhaven	Lincoln	MS	89	MM Bf	449,410
Vicksburg Forest Products	Vicksburg	Warren	MS	100	MM Bf	787,000
Hood Industries	Bogalusa	Washington	LA	150	MM Bf	646,500
Hood Industries	Silver Creek	Lawrence	MS	160	MM Bf	689,600
Weyerhaeuser Co - Holden Lumber	Holden	Livingston	LA	170	MM Bf	732,700
Weyerhaeuser Co - McComb	Magnolia	Pike	MS	240	MM Bf	1,034,400
		Hardwood Sawmill				
Wallace Lumber Co.	Summit	Amite	MS	10	MM Bf	71,700
Kitchens Bros. Manufacturing Co	Utica	Hinds	MS	15	MM Bf	107,550
Rutland Lumber Co	Collins	Covington	MS	18	MM Bf	129,060
Rives & Reynolds Lumber Co.	Natchez	Adams	MS	19	MM Bf	136,230
Monticello Tie & Timber	Monticello	Lawrence	MS	22	MM Bf	157,740
Kitchens Bros. Manufacturing Co	Hazlehurst	Copiah	MS	26	MM Bf	186,420
Jones Lumber Co	Hazlehurst	Copiah	MS	30	MM Bf	215,100
Netterville Lumber Co	Woodville	Wilkinson	MS	30	MM Bf	215,100
Jones Lumber Co	Sandy Hook	Walthall	MS	40	MM Bf	286,800
Jones Lumber Co	Gloster	Amite	MS	40	MM Bf	286,800
LeMoyen Mill & Timber	Le Moyen	Saint Landry	LA	46	MM Bf	329,820
Jones Lumber Co	Natchez	Adams	MS	60	MM Bf	430,200
		Pulp/Paper Mill				
Georgia-Pacific – Port Hudson*	Zachary	East Baton Rouge	LA	-	M tons	-
Hood Container Corporation	St Francisville	West Feliciana	LA	300	M tons	1,077,000
International Paper	Vicksburg	Warren	MS	571	M tons	2,049,890
International Paper	Bogalusa	Washington	LA	856	M tons	3,073,040
Georgia-Pacific - Monticello	Monticello	Lawrence	MS	895	M tons	3,213,050
		Panel Mill				
D & L Veneers Inc.	Collins	Covington	MS	25	MM SqFt	48,750
Hunt Forest Products	Pollock	Grant	LA	156	MM SqFt	304,688
Hunt Forest Products	Natalbany	Tangipahoa	LA	184	MM SqFt	359,531
Armstrong Hardwood Veneer	Vicksburg	Warren	MS	250	MM SqFt	487,500
Martco LP - OSB	Oakdale	Allen	LA	850	MM SqFt	1,555,500
		Chip Mill				
Gloster Chips	Gloster	Amite	MS	-	M tons	-
International Paper	Sandy Hook	Walthall	MS	-	M tons	-
International Paper	Columbia	Marion	MS	-	M tons	-
International Paper	Kentwood	Tangipahoa	LA	-	M tons	-
Jones Lumber	Sandy Hook	Walthall	MS	5	M tons	5,250
Georgia-Pacific	Bague Chitto	Lincoln	MS	700	M tons	735,000
		Pellet Mill				
Drax - Amite BioEnergy	Gloster	Amite	MS	450	M tons	1,100,000
Drax - LaSalle BioEnergy	Urania	LaSalle	LA	650	M tons	1,600,000

*GP continues to operate the consumer tissue and towel business operations at its Port Hudson mill; however, no roundwood is consumed at this facility.

†US green tons

__Figure 10__. Amite BioEnergy Catchment Area - Mill Map (2019)

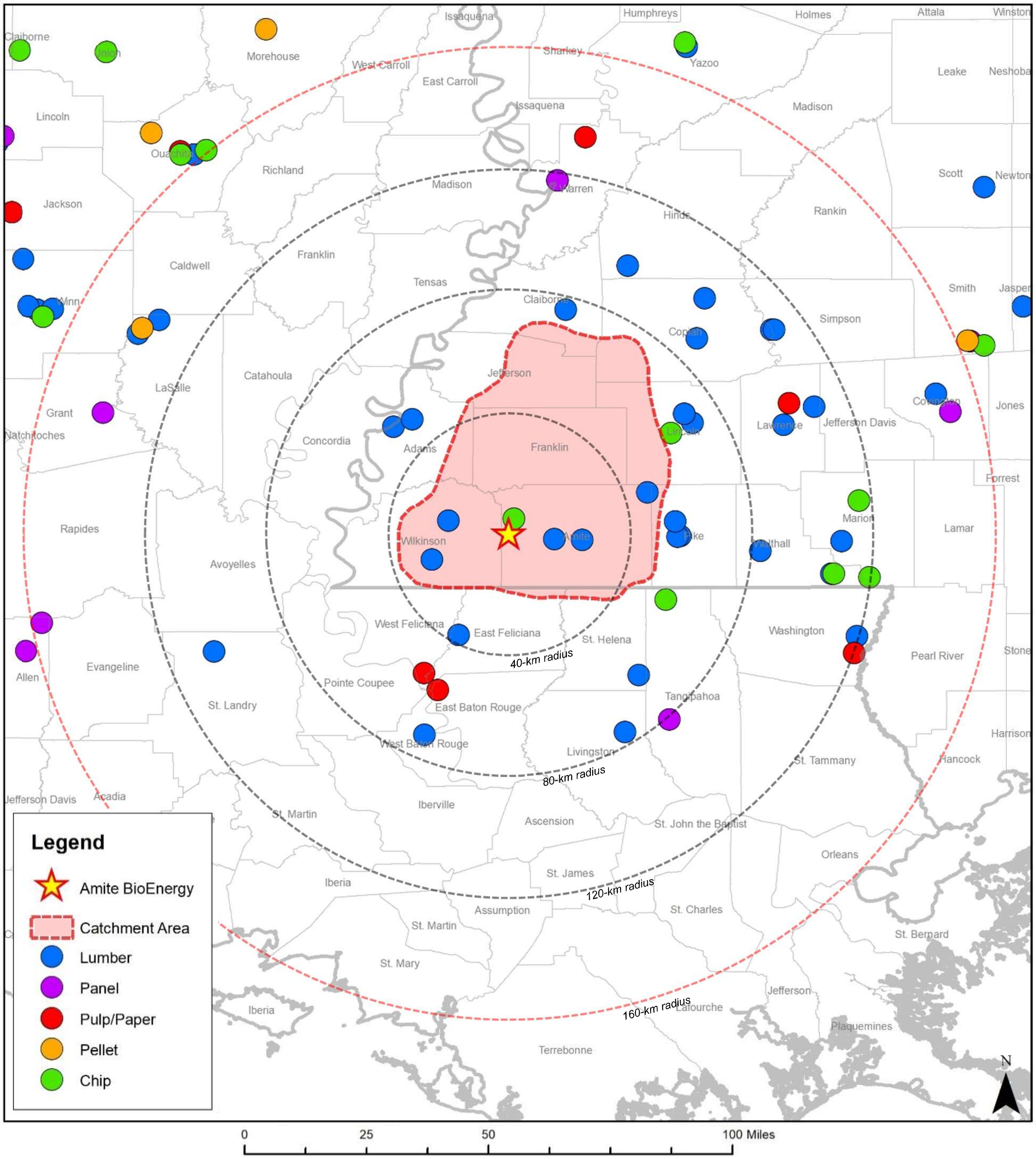


Figure 11. Lumber Mills (2019)

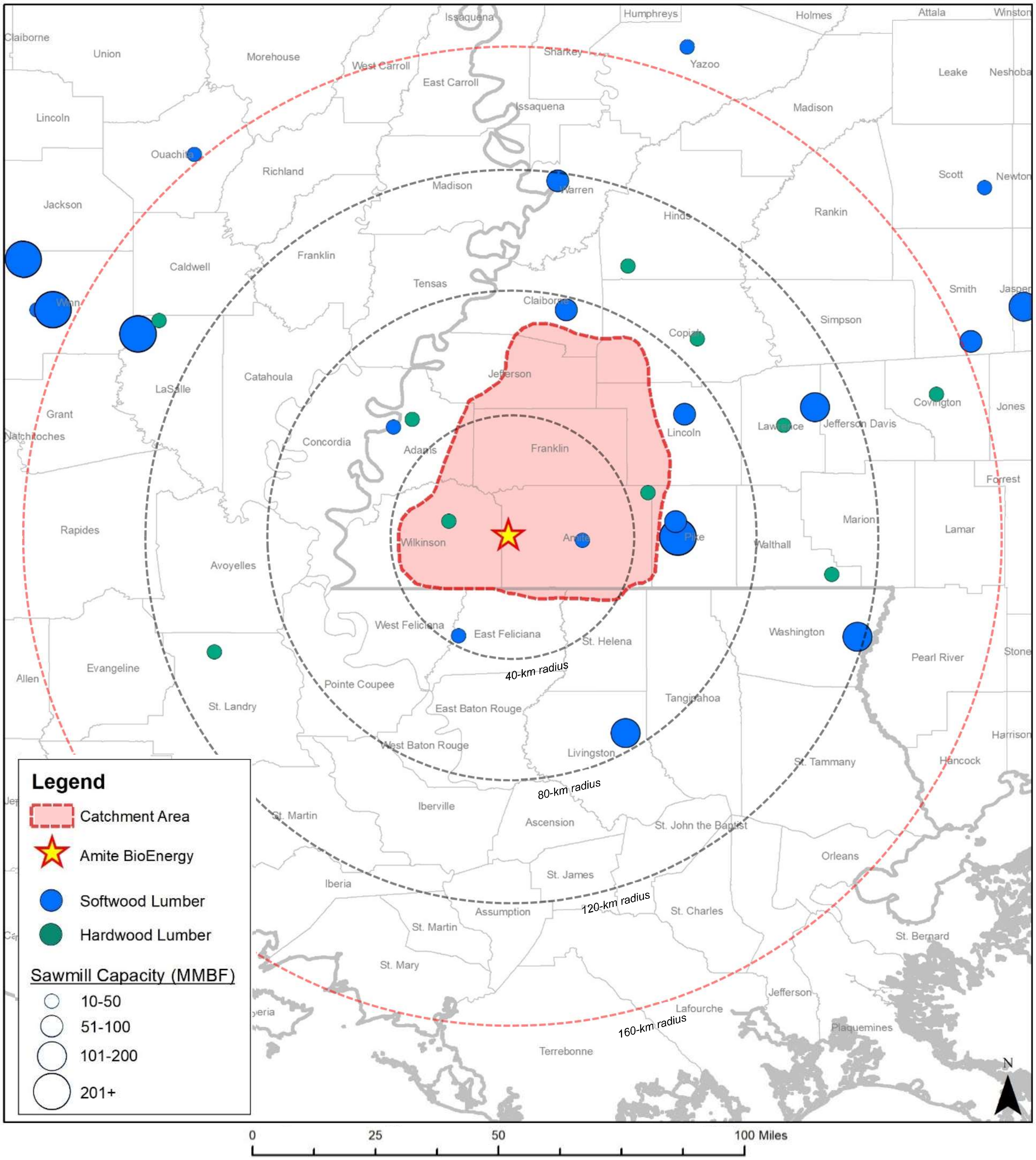
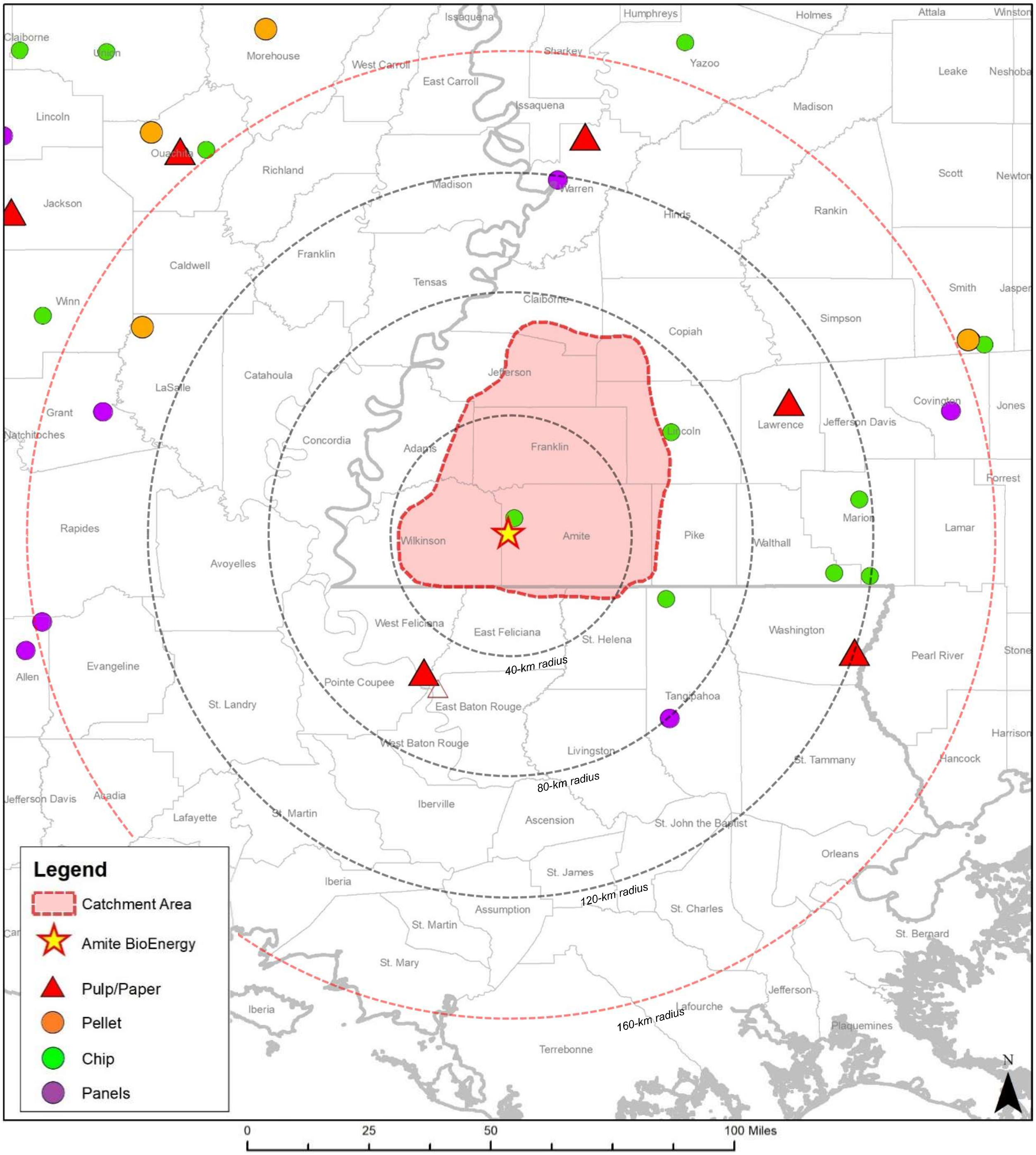


***Figure 12**. Pulp, Pellet, Chip, & Panel Mills (2019)*



3.2 Raw Material Costs

Current and historic prices for both stumpage and delivered timber as well as pulp quality chips and sawmill residuals have been provided by TimberMart-South (TMS). Note that these prices are specific to the Amite BioEnergy catchment area and are average market prices calculated from actual timber sales reported to TMS and occurring in the following Mississippi counties and Louisiana parishes: Adams, Amite, Claiborne, Copiah, Franklin, Jefferson, Lincoln, Pike, and Wilkinson (all in Mississippi), as well as East Feliciana, St. Helena, and West Feliciana (in Louisiana).

3.2.1 *Standing Timber (Stumpage) 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. In the 1st Quarter of 2019 in the Amite BioEnergy catchment area, stumpage prices for the five major timber products averaged as follows:

Timber Product	Stumpage $/Tonne
Pine Sawtimber	$27.70
Pine Chip-n-saw	$19.49
Pine Pulpwood	$8.17
Hardwood Sawtimber	$51.59
Hardwood Pulpwood	$15.81

Historic quarterly stumpage prices for the five major timber products from 1st Quarter 2010 through 1st Quarter 2019 are provided in Appendix A. See the *Market Trends, Analysis, & Outlook* section beginning on page 44 for a detailed assessment of raw material prices and price trends.

***Figure 13**. Amite BioEnergy Catchment Area – Pine Stumpage Prices (1Q 2010 – 1Q 2019)*

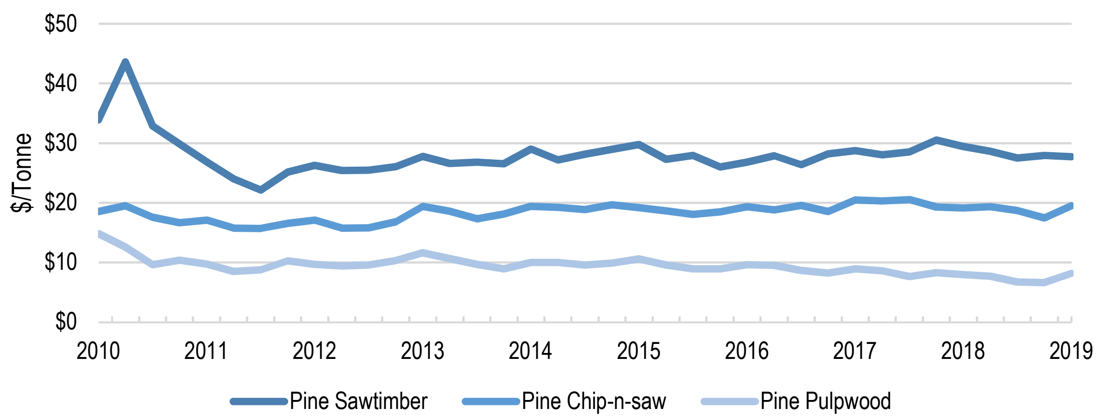
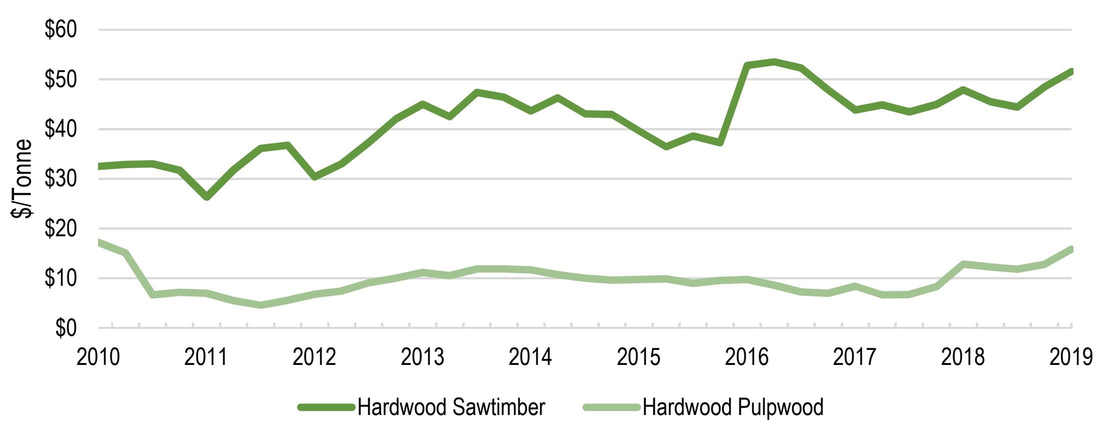


***Figure 14**. Amite BioEnergy Catchment Area – Hardwood Stumpage Prices (1Q 2010 – 1Q 2019)*



3.2.2 *Delivered Timber Prices*

Delivered prices are those paid for timber delivered to the mill. These prices include stumpage price plus any costs associated with cutting, loading, and hauling timber to the mill. In the 1st Quarter of 2019 in the Amite BioEnergy catchment area, delivered prices for the five major timber products averaged as follows:

Timber Product	Delivered $/Tonne
Pine Sawtimber	$47.44
Pine Chip-n-saw	$40.50
Pine Pulpwood	$30.36
Hardwood Sawtimber	$72.39
Hardwood Pulpwood	$35.77

Historic quarterly delivered prices for the five major timber products from 1st Quarter 2010 through 1st Quarter 2019 are provided in Appendix A. See the *Market Trends, Analysis, & Outlook* section beginning on page 44 for a detailed assessment of raw material prices and price trends.

***Figure 15**. Amite BioEnergy Catchment Area – Delivered Pine Prices (1Q 2010 – 1Q 2019)*

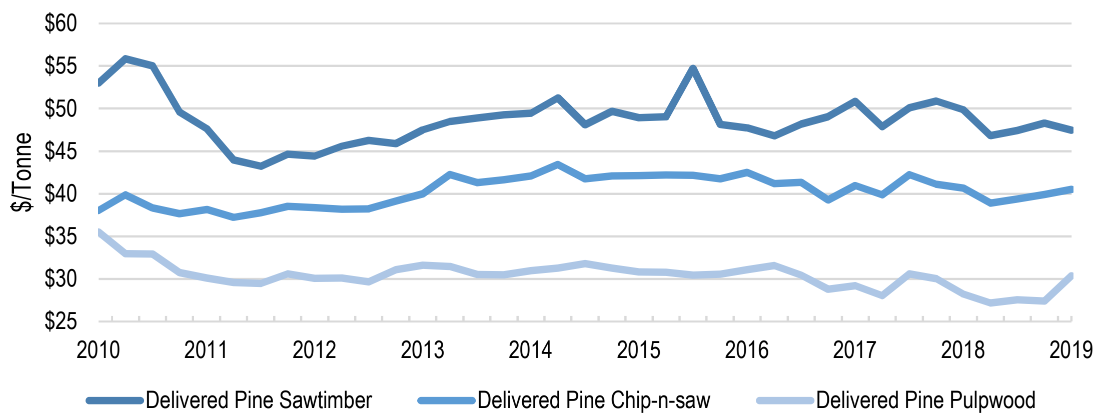
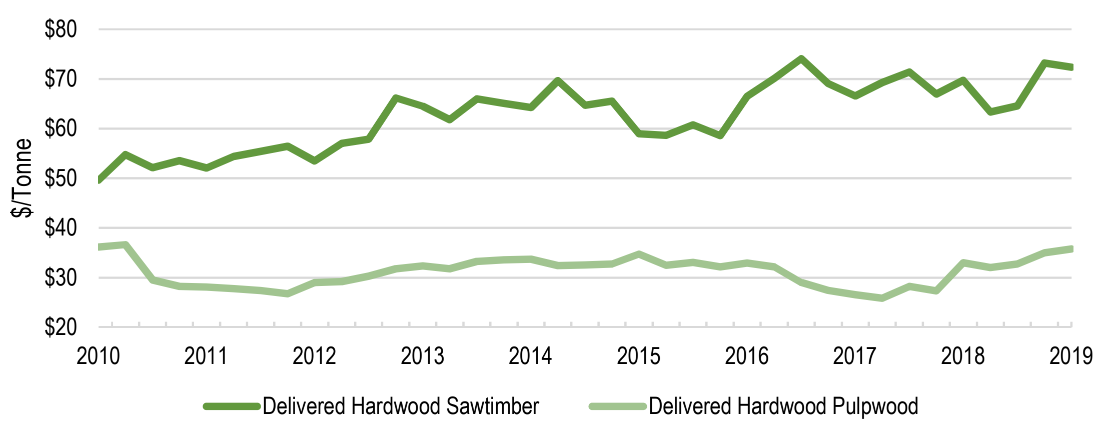


***Figure 16**. Amite BioEnergy Catchment Area – Delivered Hardwood Prices (1Q 2010 – 1Q 2019)*



3.2.3 *Sawmill Residuals & Pulp Quality Chip Prices*

In the 1st Quarter of 2019, pine and hardwood pulp quality chip prices (FOB point of production) averaged as follows in the Amite BioEnergy catchment area:

Product	Average $/Tonne
Pine Sawmill Chips	$31.36
Pine Chip Mill Chips	$37.00
In-Wood Debarked Pine Chips	$35.92
Hardwood Sawmill Chips	$31.68
Hardwood Chip Mill Chips	$46.50

Historic quarterly sawmill residual and chip prices from 1st Quarter 2010 through 1st Quarter 2019 are provided in Appendix A. See the *Market Trends, Analysis, & Outlook* section beginning on page 44 for a detailed assessment of raw material prices and price trends.

***Figure 17**. Amite BioEnergy Catchment Area - Quarterly Pine Pulp Quality Chip Prices (1Q 2010 – 1Q 2019)*

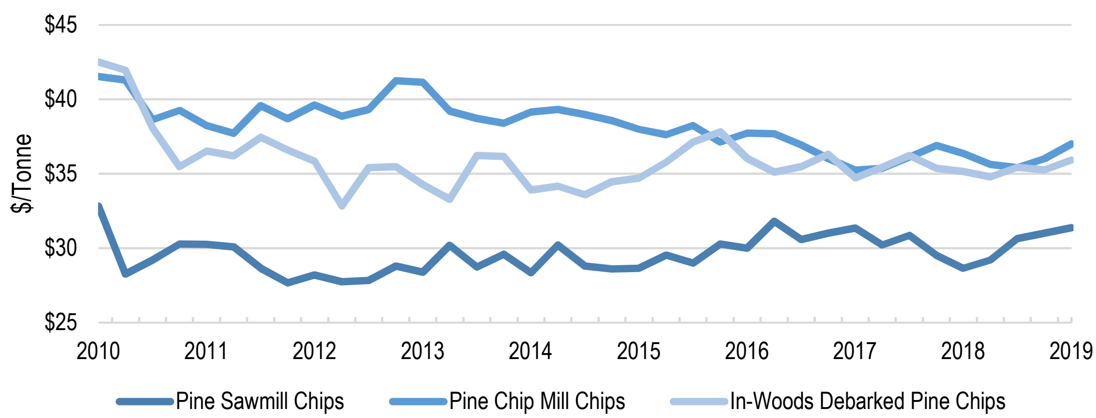
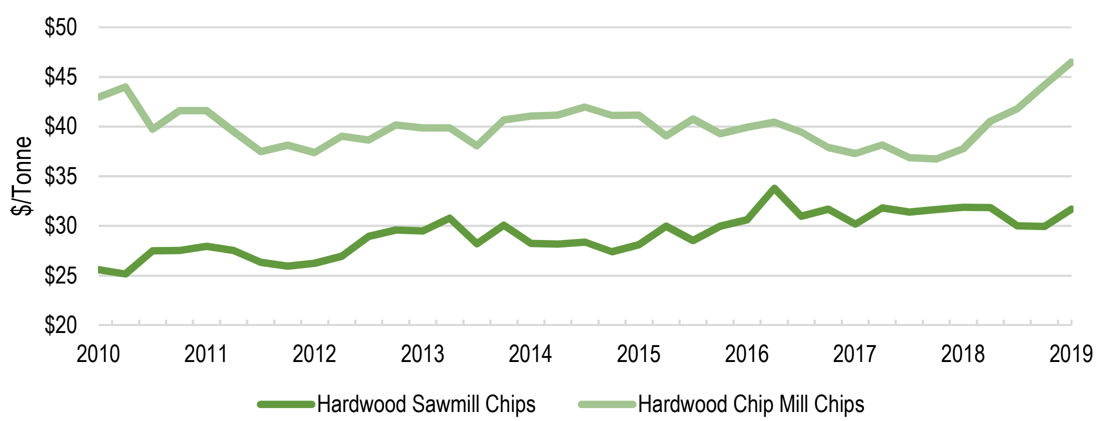


***Figure 18**. Amite BioEnergy Catchment Area - Quarterly Hardwood Chip Prices (1Q 2010 – 1Q 2019)*

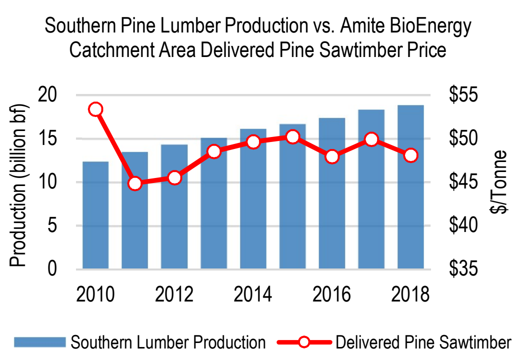


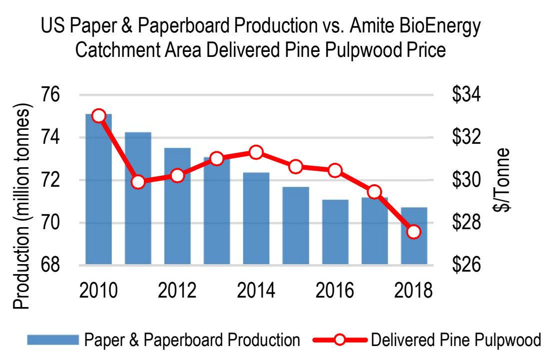
3.2.4 *Timber Price Drivers*

A detailed assessment of raw material prices and price trends is provided in the *Market Trends, Analysis, & Outlook* section beginning on page 44. However, we would like to point out and highlight some of the major price drivers and indicators.

- Production. Production levels for forest products are representative of wood demand and have historically been a strong indicator of timber price. The figure below (left) shows annual Southern pine lumber production and annual average delivered pine sawtimber prices in the Amite BioEnergy catchment area from 2010-2018. Looking at this figure, pine sawtimber price has generally tracked lumber production, particularly from 2011-2015. Over this period, production increased 24% and pine sawtimber price increased 12%. However, we'd like to note that the recent divergence of lumber production and pine sawtimber price (since 2015) is largely due to increases in wood supply, which is documented in detail in subsequent sections of this report.

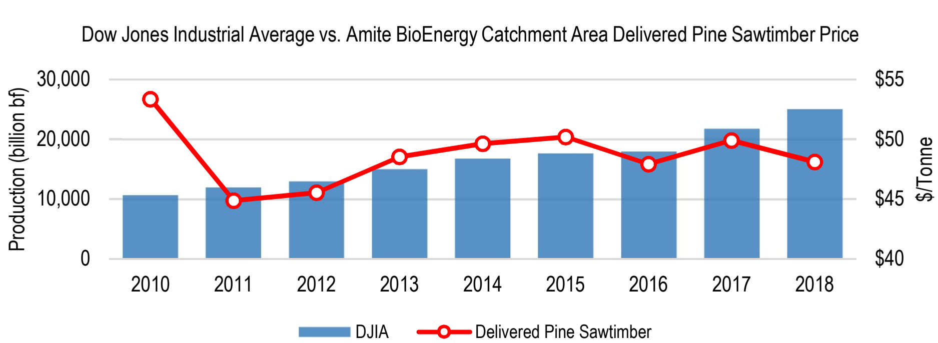
  Similarly, US paper and paperboard production has historically been a strong indicator of pine pulpwood price (see figure below (right) of annual US paper and paperboard production and catchment area delivered pine pulpwood prices from 2010-2018).





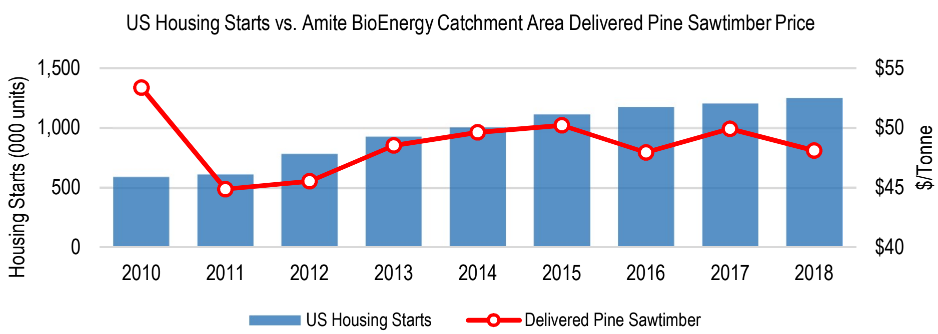
Source: Southern Forest Products Association, American Forest & Paper Association, TimberMart-South

- Domestic Economy. The state of the domestic economy drives changes in timber prices both locally and across the Southern region. Specifically, financial markets have historically been a strong indicator of price. Over the long term, timber prices, specifically pine sawtimber price, have generally tracked both the Dow Jones Industrial Average (DJIA) and S&P 500 (see figure below of the DJIA and catchment area delivered pine sawtimber prices from 2010-2018).



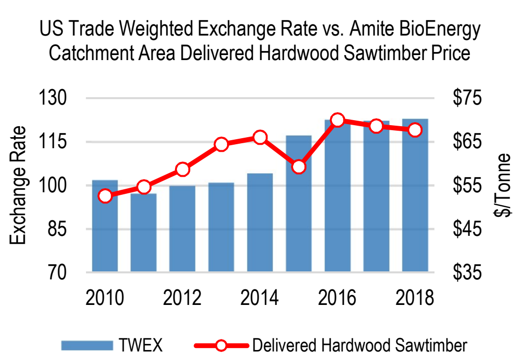
Source: US Federal Reserve Bank, TimberMart-South

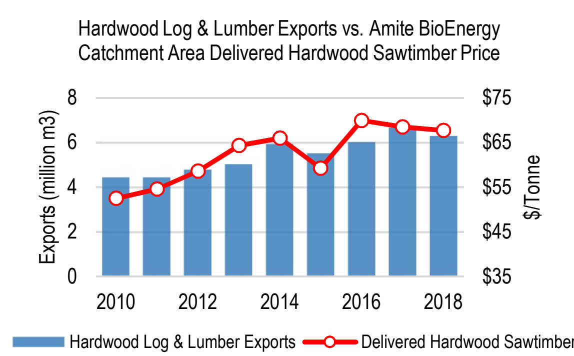
- Housing Starts. US residential building construction is a principal driver of the wood products industry and, historically, domestic housing starts have been a major indicator of sawtimber price. For instance, US housing starts totaled just over 600,000 units in 2011, increasing to over 1.1 million units in 2015. Delivered pine sawtimber prices closely tracked housing starts over this period, increasing 12% from 2011-2015 (see figure below). But while housing starts have continued to increase since 2015 (to nearly 1.3 million units in 2018), delivered pine sawtimber prices have remained relatively flat. As we saw with pine sawtimber price and lumber production, pine sawtimber price and housing starts have also diverged since 2015 – largely due to wood oversupply.



Source: US Census Bureau, TimberMart-South

- International Trade. International trade and foreign trade policy also drives changes in timber prices, particularly changes in hardwood sawtimber price. Hardwood log and lumber exports, specifically, constitute around 65-75% of total US log and lumber exports, and these exports are driven largely by exchange rates. For instance, the US trade weighted exchange rate (TWEX) increased from 97 in 2011 to 122 in 2016 (a value greater than 100 is indicative of a strong US dollar), and, over this same period, delivered hardwood sawtimber prices in the catchment area increased nearly 30% (see figure below (left)). However, trade policies enacted by the current US President since then have slowed growth in US exports and consequently hardwood sawtimber prices have held relatively flat since 2016.

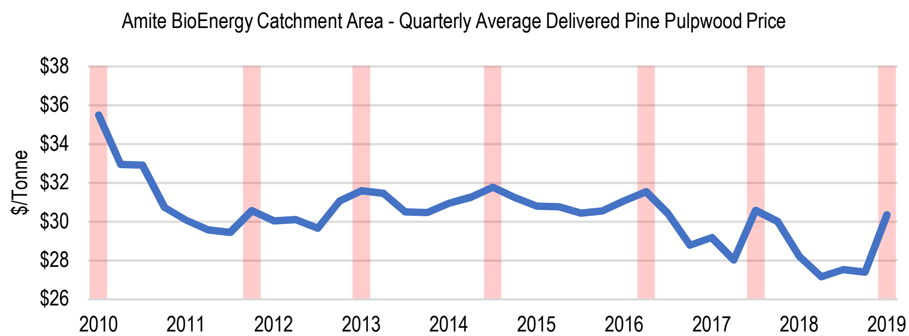




Source: US Federal Reserve Bank, US Department of Agriculture, TimberMart-South

- Weather. Weather trends also impact timber prices; 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 1st and 4th 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).

  The figure below shows quarterly average delivered pine pulpwood prices in the Amite BioEnergy catchment area since 2010. Looking at this figure you can see the seasonality in price movements (seasonal weather-related price spikes highlighted in light red). An example of a short-term, weather-driven price spike occurred in 1Q 2019, with delivered pine pulpwood price increasing 11% quarter-over-quarter due largely to wet conditions that persisted in this market from September 2018 through March 2019.



Source: TimberMart-South

4. Forest Management Practices Assessment

To assess how forest management practices in both the catchment area and other similar areas across the US South have changed since 2010, we examined historical timber sales reported to TimberMart-South as well as conducted interviews with multiple loggers who operate in and around the Amite BioEnergy catchment area.

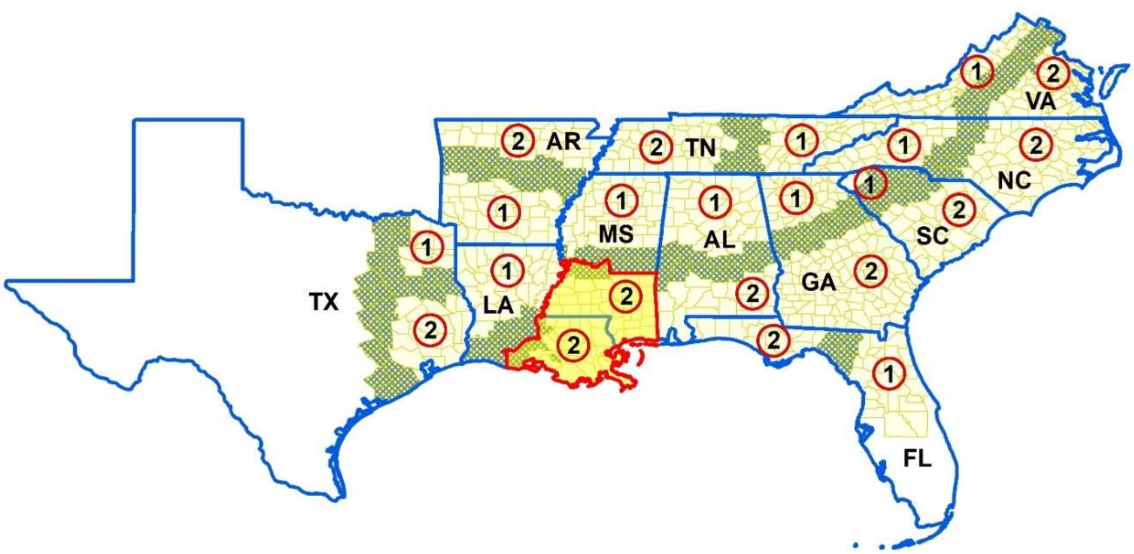
4.1 TimberMart-South Harvest Trends

The TimberMart-South (TMS) sales database includes over 46,000 unique timber sales that have occurred throughout the TMS 11-state region since 2010. 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 Amite BioEnergy catchment area is located in two different TMS regions: Mississippi Region 2 and Louisiana Region 2 (see highlighted portion Figure 19). So, in addition to providing region-wide information, data and trends for this 2-region area (denoted 'Amite BioEnergy market' hereafter) have been provided and are intended to be representative of the catchment area.

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

***Figure 19**. TimberMart-South Region Map*



4.1.1 *Total Sale Area*

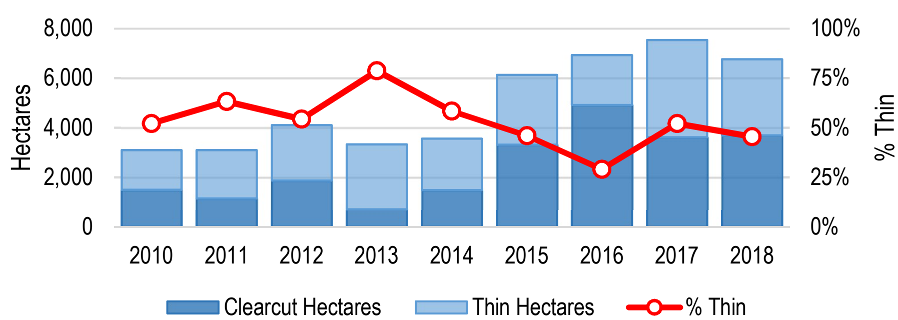
In the Amite BioEnergy market, total sale area that fell within the study's parameters averaged 3,435 hectares per year from 2010 through 2014, doubling and averaging 6,840 hectares per year since 2015. Note there is no evidence connecting this increase in sale area to increases in biomass demand, but rather this increase in total sale area is due to new reporters participating in TMS's market survey and an increase in the total number of reported sales that fell within the study's parameters.

More importantly, we want to focus on distribution of reported sale area by harvest type (clearcut vs. thinning). In the Amite BioEnergy market, thinned hectares as a percentage of total reported sale area peaked in 2013 at 79% but steadily declined over the three years that followed to 29% in 2016. However, that percentage has increased the last several years and in 2018 equaled 45%.

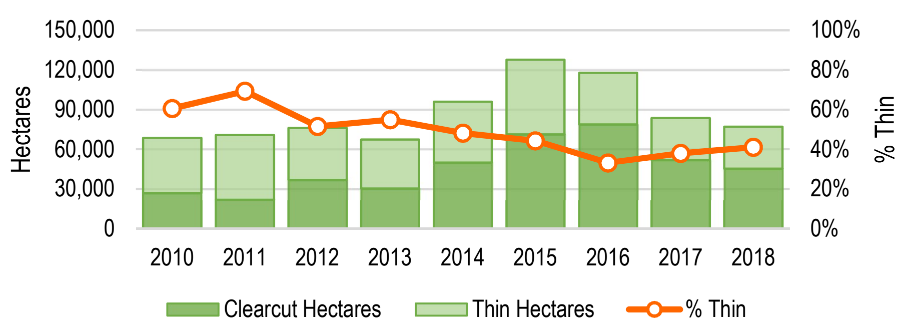
Comparing trends in the Amite BioEnergy market to South-wide market trends, thinned hectares as a percentage of total reported sale area for the TMS 11-state Southern region peaked in 2011 at 69%. However, the proportion of area thinned steadily declined over the five years that followed, falling to 33% in 2016. The distribution of thinned area has slowly increased since that time and in 2018 equaled 41%.

Ultimately, this study identified a decreasing trend in the percentage of area thinned in both the Amite BioEnergy market and across the Southern region as a whole, suggesting that thinnings decrease when markets are weak. Specifically, thinned area as a percentage of total reported sale area in the Amite BioEnergy market averaged 62% from 2010-2013 but 45% from 2014-2018. Similarly, the distribution of thinned area across the South averaged 59% from 2010-2013 and 41% from 2014-2018.

***Figure 20**. Total Reported Sale Area by Harvest Type (2010 - 2018)*



(a) Amite BioEnergy Market



(b) TMS South-wide Total

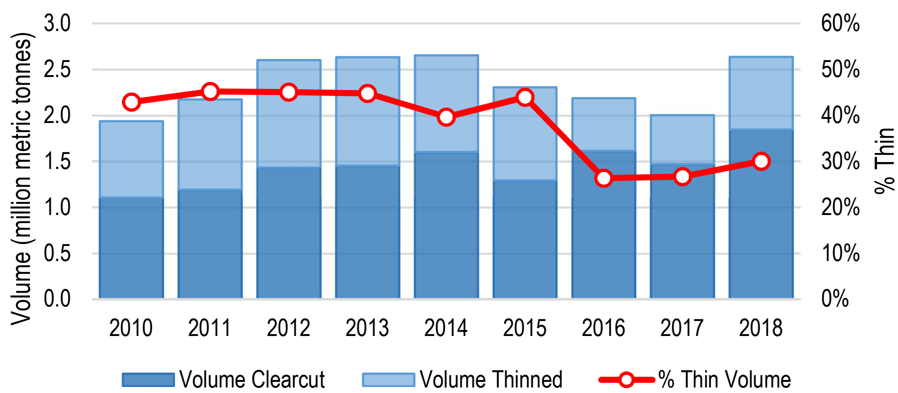
4.1.2 *Total Sale Volume*

In the Amite BioEnergy market, total reported sale volume has changed very little since 2010. However, as with total sale area, the distribution of total sale volume by harvest type shows the proportion of total volume attributed to thinnings decreasing since 2010. In the Amite BioEnergy market, volume thinned as a percentage of total reported sale volume trended downwards from 43% in 2010 to 26% in 2016 (and increasing slightly to 30% in 2018).

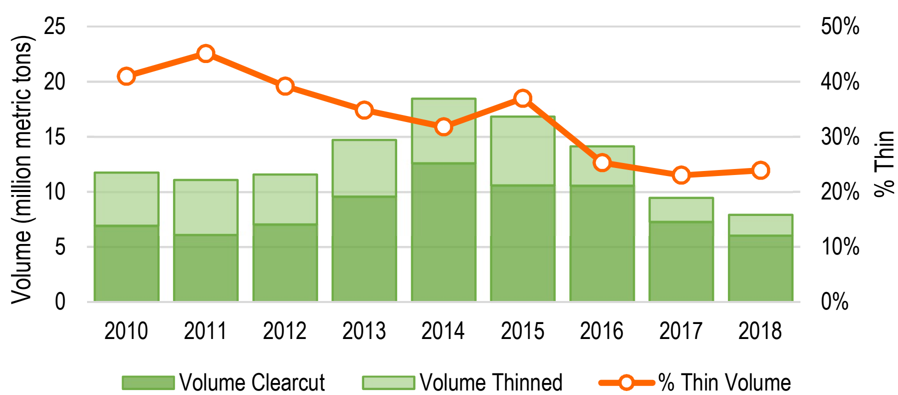
Similarly, the distribution of total sale volume by harvest type for the entire TMS 11-state region also shows the proportion of total volume attributed to thinnings declining over this period. Across the TMS 11-state region, volume thinned as a percentage of total reported sale volume decreased from 41% in 2010 to 23% in 2017 (and increasing slightly to 24% in 2018).

Note that the overall decreasing trend in thinning volume (as a percentage of total sale volume) is in line with what typically occurs when markets are weak. That is, when timber markets are weak, loggers tend to reduce the amount of thinnings they conduct because the profitability associated with thinnings is lower than that associated with clearcut harvests.

***Figure 21**. Total Reported Sale Volume by Harvest Type (2010 - 2018)*



(a) Amite BioEnergy Market



(b) TMS South-wide Total

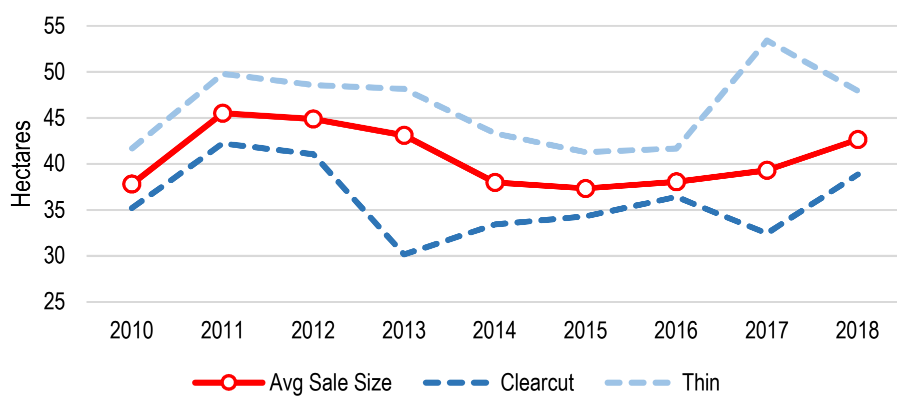
4.1.3 *Average Sale Size*

Average sale size in the Amite BioEnergy market has averaged 41 hectares in size since 2010. However, reported sales data shows that thinnings have averaged 28% larger (+10 hectares) than clearcuts, with thinnings averaging 46 hectares in size compared to 36 hectares for clearcuts.

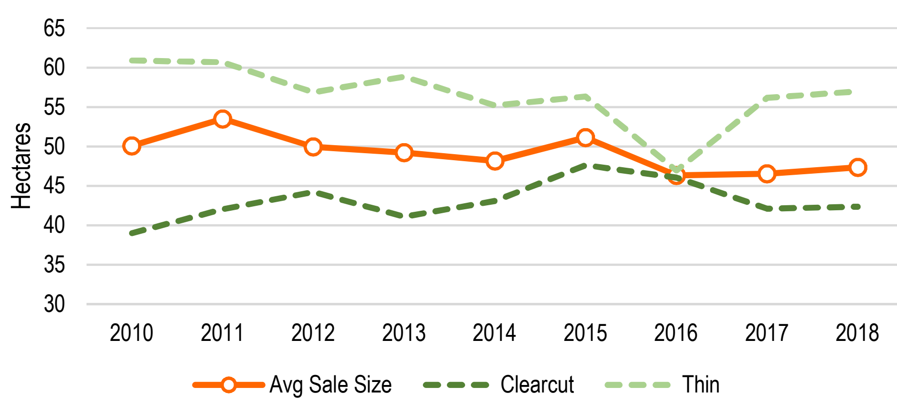
The average sale size has been slightly larger across the TMS 11-state region as a whole, averaging 49 hectares in size since 2010. However, average sale size by harvest type shows a similar relationship to what was observed between clearcuts and thinnings in the Amite BioEnergy market. Across the US South since 2010, thinnings have averaged 31% larger (+14 hectares) than clearcuts, with thinnings averaging 57 hectares in size compared to 43 hectares for clearcuts.

We'd like to note that clearcuts are typically smaller in size compared to thinnings due to capital requirements, as clearcuts generally remove more timber volume per acre than do thinnings. For example, given the same amount of capital, a wood buyer/logger can purchase a 35-hectare tract to be clear cut or a 50-hectare tract to be thinned. Also, loggers typically prefer larger tracts for thinning because it allows them to take advantage of economies of scale.

***Figure 22**. Average Reported Sale Size by Harvest Type (2010 - 2018)*



(a) Amite BioEnergy Market



(b) TMS South-wide Total

4.2 Logger Interviews/Survey

For this assessment, Hood Consulting also interviewed multiple loggers to provide first-hand accounts of how forest management practices, specifically harvest activities, have changed since 2010. Note that all professionals interviewed operate in and around the Amite BioEnergy catchment area.

The individuals interviewed include Dale Stephens, the southwest Mississippi regional forester for Charles Donald Pulpwood, Inc., John Coates, region manager of Good Hope Inc., and Lance Smith, owner of Lance Smith Logging Inc. Together, the three companies represented operate over 50 crews, deliver more than 85,000 loads per year, and have over 125 years of combined logging experience.

- **Charles Donald Pulpwood, Inc.**
  1024 Noble Road
  Port Gibson, MS 39150

  Charles Donald Pulpwood, Inc. was originally founded in 1946 and is based out of Port Gibson, Mississippi. Charles Donald Pulpwood operates four logging crews throughout central and south Mississippi, delivering an average of 1,200-1,300 loads per year.

- **Good Hope Inc.**
  209 State Street
  Natchez, MS 39120

  Good Hope Inc. was founded in 1982 and is based out of Natchez, Mississippi. Good Hope operated 40-50 logging crews and works throughout Mississippi, Louisiana, and in eastern Arkansas, delivering 75,000-80,000 loads per year.

- **Lance Smith Logging Inc.**
  1562 Zetus Road NW
  Brookhaven, MS 39601

  Lance Smith Logging Inc. was founded in 2002 and is based out of Brookhaven, Mississippi. Lance operates predominantly in southwest and south-central Mississippi, operating two logging crews and delivering 4,500-5,000 loads per year.

Each of the individuals interviewed were asked the following questions pertaining to the logging industry and harvesting practices. A summary of the interviewees' answers is provided on the following page.

1. How have forest management practices, specifically thinning practices, changed since 2010?
2. Have thinnings become more/less prevalent over the last 8-10 years?
3. Based on your experience, do thinnings decline (or pick up) when timber markets weaken?
4. How has forest certification and carbon sequestration affected logging and logging practices?
5. Based on your experience, what drives (or has driven) changes in logging and logging practices?
6. What are your expectations regarding changes in timber prices over the next 3-5 years?

***Table 14**. Logger Interview Questions & Reponses*

Question	Interviewee Responses
How have forest management practices, particularly thinning practices, changed since 2010?	All individuals interviewed stated that actual logging and thinning practices have not changed since 2010.
Have thinnings become more/less prevalent over the last 8-10 years?	Two of the interviewees stated that the proportion of their respective company's logging activities attributed to thinnings has decline since 2010, but even more so the last several years. Both pointed to weak market conditions for pine pulpwood, which is the predominant timber product removed (harvested) with 1st thinnings. The same two individuals also stated the reduction in thinnings was an internal company decision – to focus primarily on clearcut harvests, which provide improved profit margins over thinnings. One interviewee stated that his company focuses primarily on pulpwood production and logging, and that that proportion of his company's logging activites attributed to thinnings has essentially remained the same every year since 2010, despite changes in market conditions.
Based on your experience, do thinnings decline (or pick up) when timber markets weaken?	All three interviewees stated that thinnings typically decline when markets weaken, due in part to landowners' unwillingness to sell timber and because loggers intentionally reduce the amount of thinnings they perform (it becomes unprofitable for loggers when markets weaken and prices fall below a certain level).
How has forest certification and carbon sequestration affected logging and logging practices?	All three individuals interviewed stated that their companies' loggers are trained through Sustainable Forestry Initiative (SFI) programs. However, certification has not affected actual logging practices, noting just the additional time required to complete certification training programs. All three stated that carbon sequestration has had no effect on logging and logging practices.
Based on your experience, what drives (or has driven) changes in logging and logging practices?	Multiple drivers of change were identified by the interviewed individuals, including: – Efficiency of new machines/logging equipment (a single logging crew's production capabilities has doubled over the last 10 years, from 7-8 loads/day to 15-16 loads/day) – Mill closures (leads to farther haul distances and reduced logger margins) – Logger workforce (one individual stated that his company has started focusing on buying winter-accessible tracts (often paying premium prices) to ensure continued work for their loggers → so they don't lose experienced loggers due to downtime and lack of work)
What are your expectations regarding changes in timber prices over the next 3-5 years?	All three interviewees expressed concern, particularly regarding pine pulpwood markets with the recent shutdown that occurred at Georgia-Pacific's Port Hudson mill. Each of these individuals anticipate pine pulpwood prices holding flat (or even declining a bit) over the next several years. A common thought amongst these individuals is that conditions need to change, or more and more logger attrition will occur in this area. Increased equipment and insurance costs already make logging profitability difficult, and if timber prices remain at such low levels (and margins remained squeezed), they believe the logging industry will shrink further.

5. Market Trends, Analysis, & Outlook

The following section provides an examination and assessment of market trends in the Amite BioEnergy catchment area since 2010, including changes in forest area, timber inventory, growth, removals, wood demand, and raw material costs. This section also identifies and details any links between these variables and both biomass demand and total wood demand.

In addition, we have provided a market outlook through 2022. This outlook details anticipated changes in wood demand and how these anticipated changes are likely to impact raw material costs in the catchment area over the next several years.

5.1 Market Trends & Analysis

A key aspect of this analysis includes assessing and identifying any links or relationships between wood demand and other market changes (i.e. forest area, inventory, raw material prices, etc.) in the catchment area since 2010. As such, this section will begin with our analysis of wood demand.

5.1.1 *Wood Demand*

Total wood demand[3] in the Amite Bioenergy catchment area doubled from an estimated 2,502,954 tonnes in 2010 to 5,001,021 tonnes in 2018, or an average increase of 9.0% over this period. Softwood pulpwood demand, specifically, increased an estimated 1,027,178 tonnes over this same period, from 1,110,677 tonnes in 2010 to 2,137,855 tonnes in 2018 (+93% total; +8.5% per year average).

***Table 15**. Amite BioEnergy Catchment Area - Annual Wood Demand (Metric Tonnes): 2010-2018*

Year	Softwood Sawlogs	Hardwood Sawlogs	Softwood Pulpwood	Hardwood Pulpwood	Total Wood Demand
2010	662,110	369,754	1,110,677	360,414	2,502,954
2011	833,631	538,334	1,455,188	344,918	3,172,071
2012	942,892	495,021	1,387,456	461,697	3,287,066
2013	1,104,618	465,516	1,366,488	612,800	3,549,422
2014	1,290,903	392,157	1,382,752	555,282	3,621,095
2015	1,530,126	327,568	1,652,829	512,791	4,023,315
2016	1,639,985	300,112	1,858,210	546,131	4,344,438
2017	1,886,359	292,026	2,080,729	571,729	4,830,842
2018	1,980,676	299,326	2,137,855	583,164	5,001,021

**Projected*

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

[3] Wood demand estimates for the Amite BioEnergy catchment area are based on USDA Forest Service – Timber Products Output (TPO) data, which estimates industrial uses of roundwood via survey of all primary wood-using mills within each state, as well as TimberMart-South wood demand estimates and consumption data provided by Drax Group.

Specifically, for this analysis, biomass demand is defined as softwood pulpwood (roundwood) consumed by pellet or other bioenergy facilities. See Table 16 for annual estimates of biomass demand in the Amite BioEnergy catchment area from 2010-2018.

Note, however, that not all wood consumed by a pellet mill or other bioenergy facility is classified as biomass demand. Like with Amite BioEnergy, wood consumption (demand) at pellet and other bioenergy facilities generally includes a combination of wood chips and sawmill residuals. Keep in mind that 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 our determination of biomass demand.

***Table 16**. Amite BioEnergy Catchment Area - Biomass Demand & Total Softwood Pulpwood Demand (Tons): 2010-2018*

Year	Biomass Demand	Other Softwood Pulpwood Demand	Total Softwood Pulpwood Demand
2010	0	1,110,677	1,110,677
2011	0	1,455,188	1,455,188
2012	0	1,387,456	1,387,456
2013	0	1,366,488	1,366,488
2014	41,927	1,340,825	1,382,752
2015	361,130	1,291,699	1,652,829
2016	600,465	1,257,744	1,858,210
2017	709,705	1,371,024	2,080,729
2018	685,802	1,452,053	2,137,855

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

Figure 23. Amite BioEnergy Catchment Area - Annual Wood Demand (2010-2018)

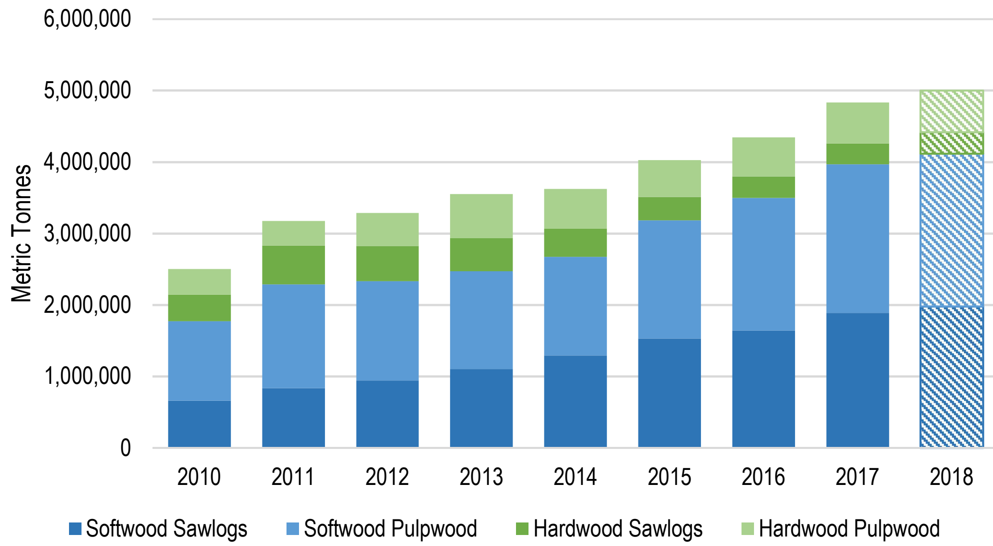
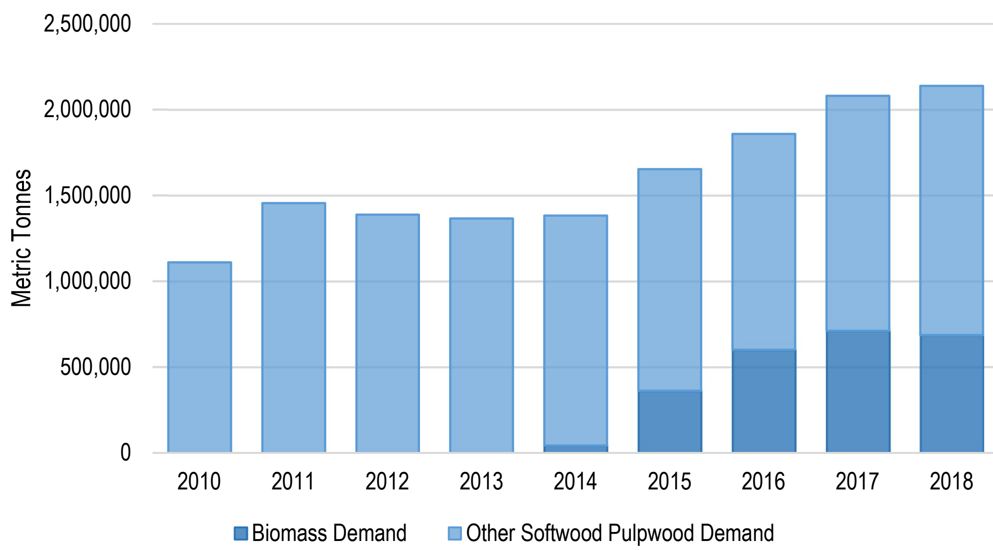


Figure 24. Amite BioEnergy Catchment Area - Biomass & Other Softwood Pulpwood Demand (2010-2018)



5.1.2 *Changes in Forest Area*

According to US Forest Service data, timberland area in the Amite BioEnergy catchment area experienced a net increase of 3,992 hectares (+0.7%) from 2010 to 2017, the latest available, increasing from 550,184 to 554,176 hectares over this 7-year period.

The composition of timberland in the catchment area has also undergone changes since 2010, as the trend has been for naturally regenerated pine and hardwood timber stands to be converted to planted pine. Specifically, planted pine area increased an estimated 15,305 hectares (+9%) from 2010-2017, while naturally regenerated pine and hardwood timberland decreased a combined 12,003 hectares (-4% combined). See Table 17 for details.

***Table 17**. Amite BioEnergy Catchment Area - Timberland Area, in Hectares, by Stand Origin (2010-2018*)*

	Planted		Naturally Regenerated			
Year	**Pine**	**Hardwood**	**Pine**	**Hardwood**	**Pine-Hardwood**	**Total**
2010	174,630	9,040	111,344	210,736	44,435	550,184
2011	173,581	9,114	107,018	212,839	45,868	548,420
2012	174,161	9,272	103,751	216,887	47,706	551,776
2013	176,383	9,936	103,825	215,785	45,156	551,086
2014	178,142	10,576	103,625	214,112	42,483	548,937
2015	180,099	9,920	105,369	210,260	42,800	548,448
2016	183,042	9,316	107,692	207,543	43,352	550,944
2017	189,935	8,231	106,823	203,255	45,933	554,176
2018	191,911	7,211	107,049	202,450	46,037	554,657

**Projected*
Source: USDA US Forest Service

***Figure 25**. Amite BioEnergy Catchment Area - Timberland Area by Year (2010 – 2018)*

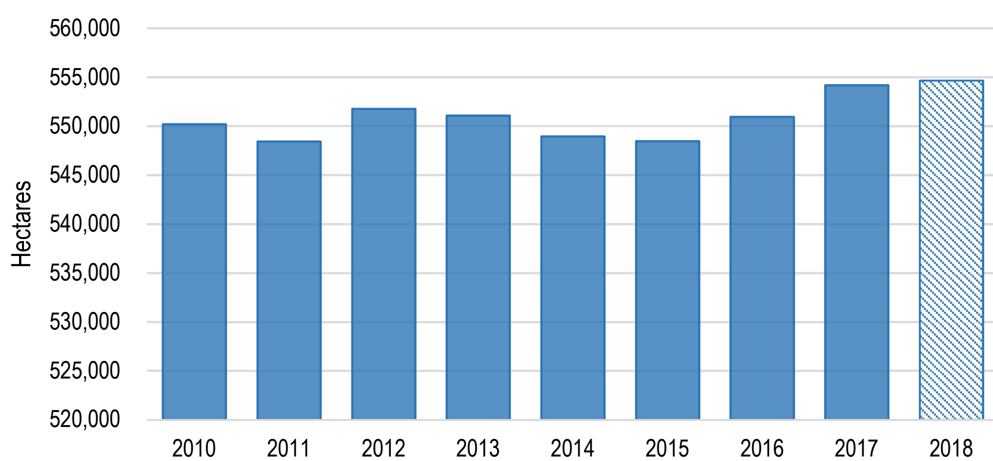
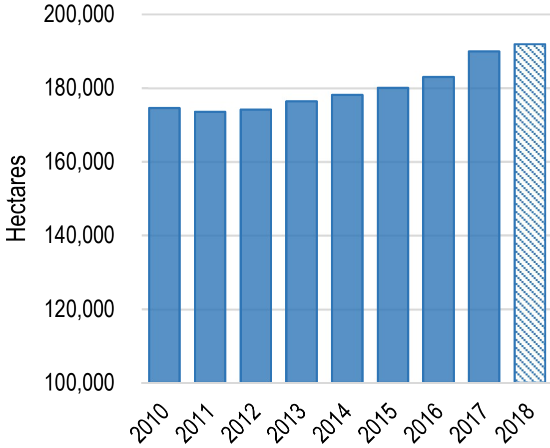
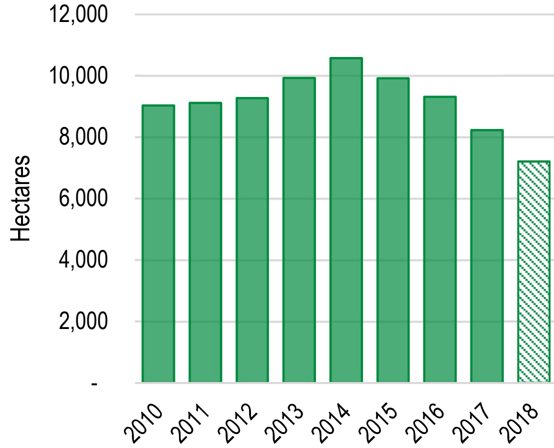


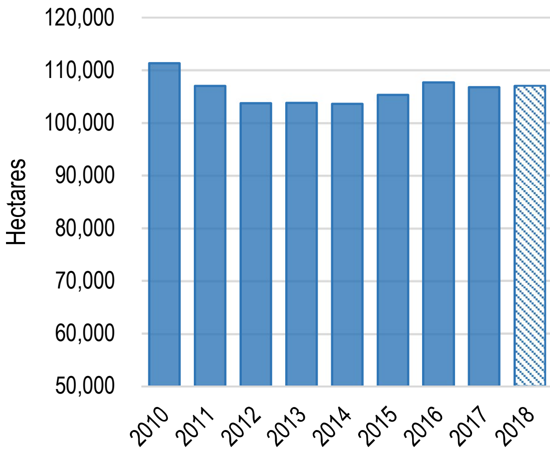
***Figure 26**. Amite BioEnergy Catchment Area – Timberland Area by Stand Origin (2010-2018)*



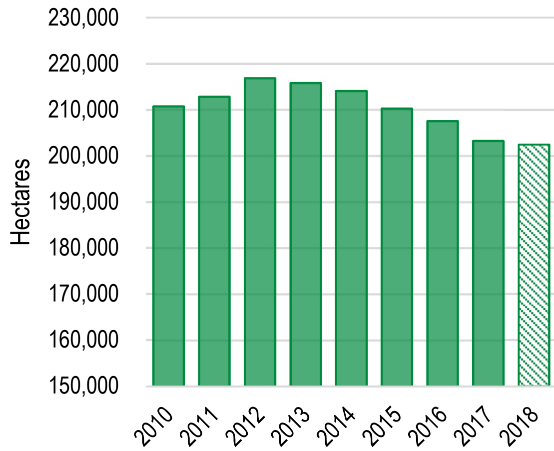
(a) Planted Pine



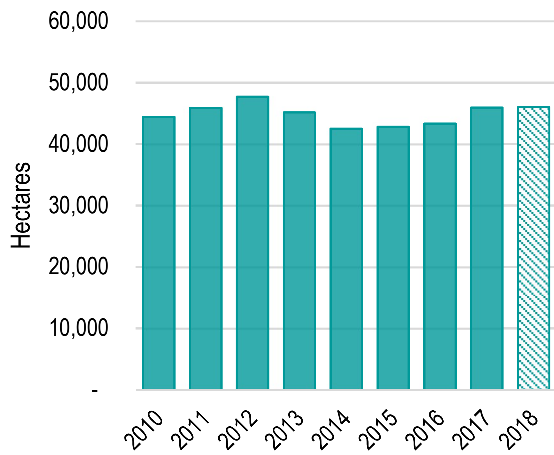
(b) Planted Hardwood



(c) Naturally Regenerated Pine



(d) Naturally Regenerated Hardwood



(e) Naturally Regenerated Mixed Pine-Hardwood

Comparing changes in timberland area amongst major ownership group, privately-owned timberland experienced the largest gain, increasing from 462,426 hectares in 2010 to 472,305 hectares in 2017, or a net increase of 9,879 hectares (+2.1%). Timberland owned by state and locally authorities increased 4,971 hectares (+25.1%) from 2010 to 2017, while National Forest timberland decreased 10,453 hectares (-15.5%). Other federal timberland also declined, decreasing 405 hectares (-96.5%) from 2010 to 2017.

***Table 18**. Amite BioEnergy Catchment Area - Timberland Area by Ownership Group (2010 vs. 2017)*

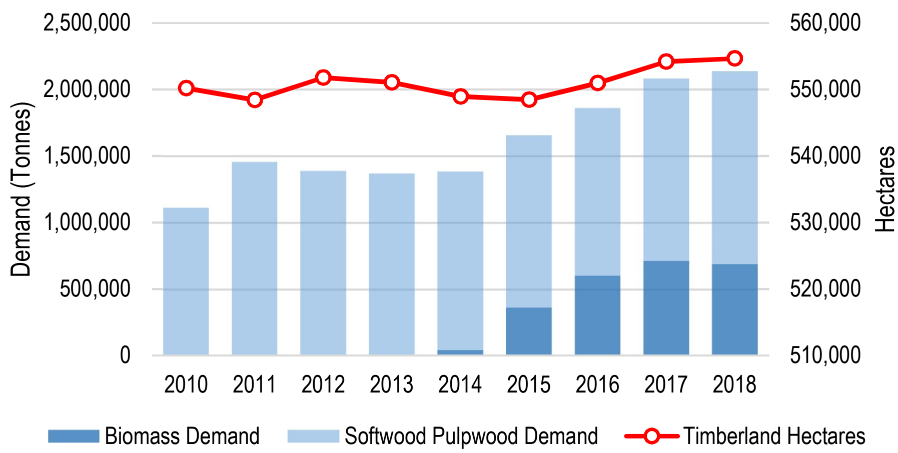
Ownership Group	Timberland Hectares		Net Change	
	2010	2017	Acres	%
National Forest	67,534	57,081	-10,453	-15.5%
Other Federal	420	15	-405	-96.5%
State and Local	19,805	24,776	+4,971	+25.1%
Private	462,426	472,305	+9,879	+2.1%
Total	**550,184**	**554,176**	**+3,992**	**+0.7%**

Source: USDA - US Forest Service

Figure 27 provides a side-by-side comparison of biomass demand and total softwood pulpwood demand versus timberland area (hectares) in the catchment area from 2010-2018. Looking at this figure, no relationship appears evident between timberland area and demand from 2010-2014. However, timberland area has closely tracked both biomass demand and total softwood pulpwood demand since 2015.

A correlation analysis of timberland area, biomass demand, and total softwood pulpwood demand identified a moderately strong positive correlation between timberland area and both biomass demand (correlation coefficient = 0.65) and total softwood pulpwood demand (correlation coefficient = 0.68) from 2010 to 2018. However, we'd like to note that correlation and causation are not the same and that there is insufficient evidence to suggest that increases in demand are responsible or have caused increases in timberland area.

***Figure 27**. Timberland Area vs. Biomass Demand & Total Softwood Pulpwood Demand (2010-2018)*



**Timberland area projected at 554,657 hectares in 2018. Note that this projected value is based on historical changes in forest area and local market trends.*

***Table 19**. Correlation Analysis - Timberland Area, Biomass Demand, & Total Softwood Pulpwood Demand (2010-2018)*

	Biomass Demand	Total Softwood Pulpwood Demand	Timberland Area
Biomass Demand	1		
Total Softwood Pulpwood Demand	0.95	1	
Timberland Area	0.65	0.68	1

5.1.3 *Changes in Timber Inventory*

According to US Forest Service data, total growing stock inventory on timberland in the Amite BioEnergy catchment area increased from 78.5 million m^3 in 2010 to 89.6 million m^3 in 2017, or a net increase of 11.1 million m^3 (+14% total; +1.9% per year average).

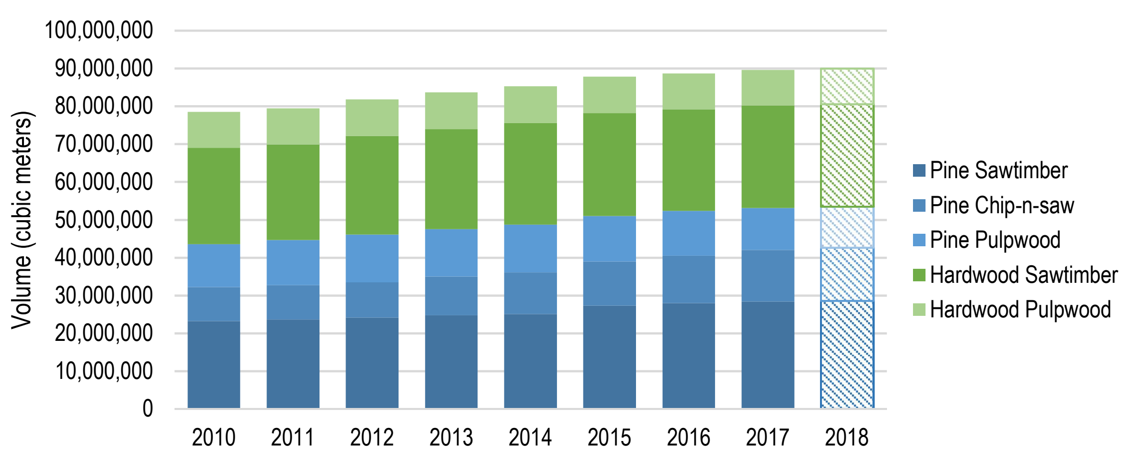
Table 20 provides timber inventory estimates from 2010 through 2017, the latest available, by major timber product. Of the five major timber products, pine sawtimber inventory increased the largest amount, increasing 5.1 million m^3 (+22% total; +2.9% per year average) from 23.2 million m^3 in 2010 to 28.3 million m^3 in 2017. Over this same period, pine chip-n-saw inventory increased 4.7 million m^3 (+52% total; +6.1% per year average) while hardwood sawtimber inventory increased 1.6 million m^3 (+6% total; +0.9% per year average). Pine pulpwood inventory decreased 0.3 million m^3 (-3% total; -0.4% per year average) from 2010-2017; hardwood pulpwood inventory decreased only marginally (<1%).

Table 20*. Amite BioEnergy Catchment Area - Timber Inventory by Major Timber Product (m³): 2010-2018**

	Softwood			Hardwood		
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
2010	23,191,373	8,996,752	11,375,507	25,455,306	9,488,403	78,507,341
2011	23,636,265	9,051,844	11,928,328	25,234,709	9,621,159	79,472,305
2012	24,104,384	9,346,273	12,576,083	26,156,670	9,585,029	81,768,438
2013	24,687,992	10,291,080	12,544,173	26,385,265	9,756,209	83,664,718
2014	25,058,467	10,999,404	12,652,394	26,826,115	9,715,839	85,252,219
2015	27,274,561	11,652,206	12,034,500	27,180,042	9,681,454	87,822,762
2016	27,935,556	12,507,147	11,885,873	26,842,883	9,450,701	88,622,160
2017	28,321,102	13,655,272	11,080,622	27,097,259	9,460,035	89,614,290
2018	28,547,670	14,051,899	10,882,247	27,068,944	9,403,389	89,954,149

Source: USDA - US Forest Service
**projected values*

Figure 28*. Timber Inventory by Major Timber Product (2010-2018)*



We'd like to note that the significant increases in both pine sawtimber and pine chip-n-saw inventories, as well as the decrease in pine pulpwood inventory, are in line with trends in timber production and reforestation through the 2000s, considering the natural progression (development) of planted forests. Strong economic growth in the US through the 1990s and mid-2000s brought growth in the forest products industry and increased demand for forest products. Through the early and mid-2000s, investment in the timber industry grew in anticipation of sustained market conditions moving forward, particularly given the above-average (financial) returns that timber management and investment had provided up to that point. So, in part, the growth of both pine sawtimber and pine chip-n-saw inventories since 2010 can be linked to investment in the timber industry back in the 1990s and 2000s (considering planted pine can reach sawtimber grade in as little as 25 years and chip-n-saw grade in less than 20 years).

However, the bursting of the US housing bubble and Great Recession that followed saw Southern pine lumber production decline 37% and US paper and paperboard production decline a combined 14% from 2006-2009[4]. The decline in both production and overall wood demand ultimately drove timber prices downwards, and the effects of reduced harvest levels in combination with declining investment in the timber industry help explain the reduction on pine pulpwood inventory since 2010 (considering planted pine can reach pulpwood grade in as quickly as 12 years).

[4] **Source:** Southern Forest Products Association (SFPA); American Forest & Paper Association (AF&PA)

Figure 29 provides a side-by-side comparison of biomass demand and total softwood pulpwood demand versus pine pulpwood inventory in the catchment area from 2010-2018. Looking at this figure, an inverse relationship appears to exist between pine pulpwood inventory and both biomass demand and total softwood pulpwood demand, particularly since 2014.

A correlation analysis identified a moderately strong negative correlation between pine pulpwood inventory and both biomass demand (correlation coefficient = -0.69) and total softwood pulpwood demand (correlation coefficient = -0.61) from 2010 to 2018. However, total inventory has increased since 2010, and there is more evidence to suggest that the decline in pine pulpwood inventory is linked to age class and the natural cycle of forest development and management, not to increased biomass demand.

In this catchment area, timber management is primarily focused on the production of sawtimber grade timber, and with this type of management regime, pulpwood is removed (via thinning) as a stand ages to allow for increased growth and timber to move up in product class. And this is exactly what we see in the Amite BioEnergy catchment area. Pine pulpwood inventory declined 12% from 2014-2017; however, over this same period, the proportion of sawtimber (i.e. pine chip-n-saw or pine sawtimber) increased, with pine chip-n-saw inventory increasing 24%.

***Figure 29**. Pine Pulpwood Inventory vs. Biomass Demand & Total Softwood Pulpwood Demand (2010-2018)*

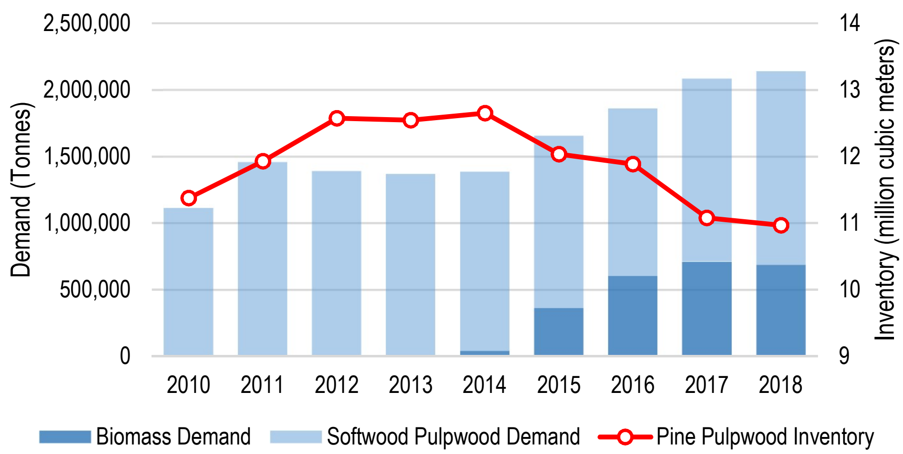


***Table 21**. Correlation Analysis – Pine Pulpwood Inventory, Total Timber Inventory, Biomass Demand, & Total Softwood Pulpwood Demand (2010-2018)*

	Biomass Demand	Total Softwood Pulpwood Demand	Pine Pulpwood Inventory	Total Inventory
Biomass Demand	1			
Total Softwood Pulpwood Demand	0.95	1		
Pine Pulpwood Inventory	-0.69	-0.61	1	
Total Inventory	0.89	0.89	-0.36	1

5.1.4 *Changes in Annual Timber Growth*

Average annual growth of total growing stock Inventory in the catchment area has declined since 2010. According to US Forest Service data, net growth in timber volume totaled 6.0 million m^3 in 2010, decreasing to 5.1 million m^3 in 2017, the latest available, or an overall decrease of 15% over this period.

Table 22 breaks down annual growth estimates from 2010-2017 by major timber product. Of the five major timber products, annual growth of pine pulpwood decreased the greatest over this period, decreasing from 2.0 million m^3 in 2010 to 1.2 million m^3 in 2017 (-23% total). However, note that this decrease in annual growth is linked to both changes in pine pulpwood inventory as well as to changes in age and diameter class structure of the forest. Recall that pine pulpwood inventory has declined while pine chip-n-saw inventory has increased. This indicates or suggests the forest is in a state of transition, with pine pulpwood moving up in product class (to pine chip-n-saw). So, with pine pulpwood moving up in product class, pine pulpwood inventory and therefore annual growth of pine pulpwood has declined.

Annual growth of pine sawtimber also declined, falling from 1.5 million m^3 in 2010 to 1.3 million m^3 in 2017 (-12% total). However, annual growth of pine chip-n-saw increased from 1.1 million m^3 in 2010 to 1.2 million m^3 in 2017 (+16% total).

***Table 22**. Annual Volume Growth by Major Timber Product (m^3): 2010-2017*

Year	Softwood			Hardwood		Total
	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	
2010	1,474,594	1,060,055	1,969,384	724,150	741,555	5,969,737
2011	1,364,737	972,519	1,851,437	641,645	695,050	5,525,388
2012	1,206,404	933,146	1,995,955	748,194	600,362	5,484,060
2013	1,200,526	998,339	1,955,422	704,172	601,793	5,460,252
2014	1,191,308	1,060,492	1,952,166	702,363	598,363	5,504,691
2015	1,322,215	1,134,810	1,884,568	682,981	569,091	5,593,666
2016	1,282,597	1,183,596	1,770,162	615,858	522,803	5,375,016
2017	1,300,327	1,234,305	1,521,250	543,521	510,093	5,109,497
2018	1,320,158	1,271,108	1,473,092	560,506	507,259	5,132,122

Source: USDA US Forest Service
**projected values*

***Figure 30**. Net Annual Growth of Total Growing Stock Timber on Timberland (2010-2017)*

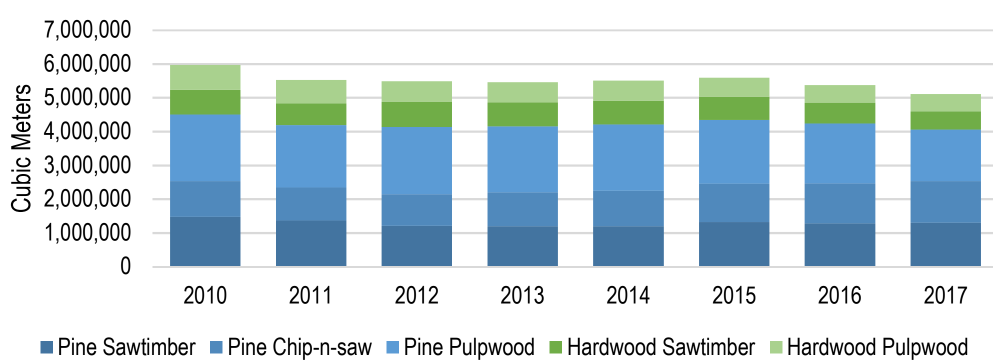
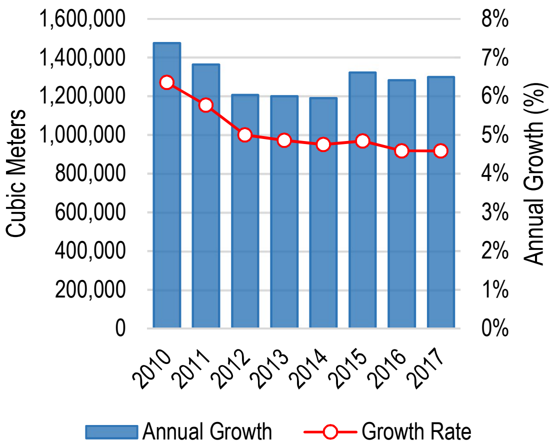
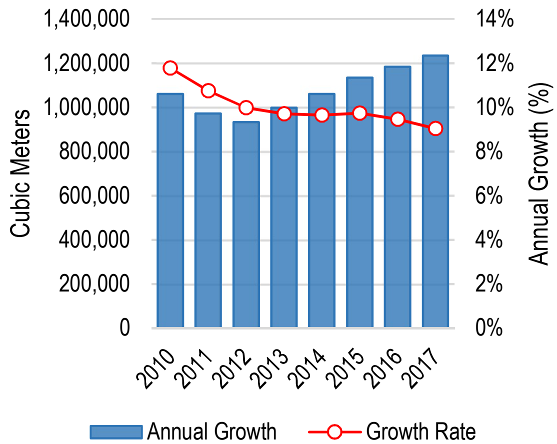


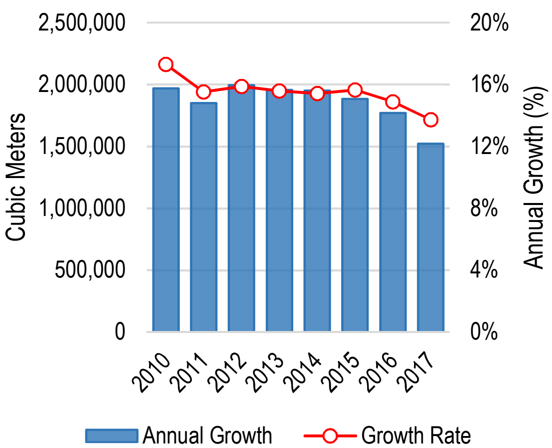
***Figure 31**. Net Annual Growth of Growing Stock Timber by Major Timber Product (2010-2017)*



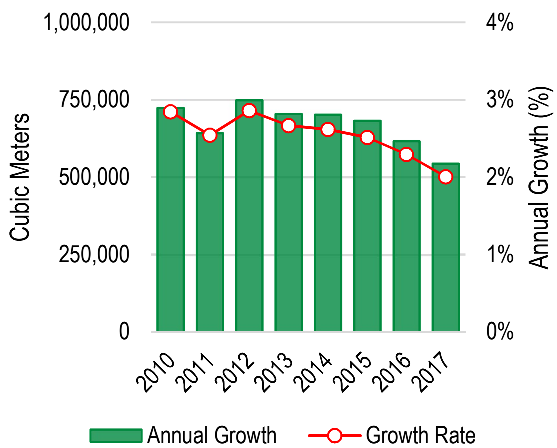
(a) Pine Sawtimber



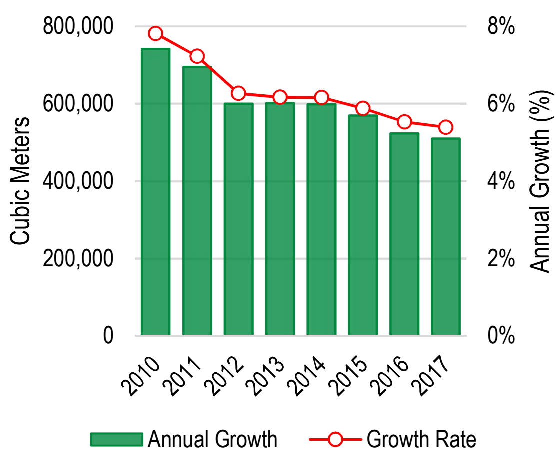
(b) Pine Chip-n-saw



(c) Pine Pulpwood



(d) Hardwood Sawtimber



(e) Hardwood Pulpwood

The figures on the preceding page show net annual volume growth (growth less any mortality) from 2010-2017 for each of the five major timber products. But we'd like to draw your attention to the major pine products, specifically.

Figure 31(c) shows annual growth of pine pulpwood from 2010-2017, and what you'll observe is a downward trend, specifically since 2012. From 2012-2017, annual growth of pine pulpwood decreased 24%. However, over this same period, annual growth of pine chip-n-saw (see Figure 29(b)) trended upward, increasing 32% from 2012-2017. We've documented that total timber inventory has increased in the catchment area since 2010, and this increase in combination with these annual growth trends provide indication of two thing. First, that the forest is aging. And second, that the forest is also in a state of transition – pine pulpwood is moving up in product class to pine chip-n-saw.

Growth Rates

Table 23 provides average annual growth rates by major product from 2010-2017. These rates are also shown in Figure 31 on the following page. What you'll notice is that these rates have declined for all five major products since 2010.

Note that declining growth rates are representative of an aging forest. To elaborate, if we consider just the three major pine products, US Forest Service data indicates that the average age of pine sawtimber inventory has increased, that pine chip-n-saw has moved closer to the transition point where it moves up in product class to pine sawtimber, and that pine pulpwood has moved closer to the transition point where it moves up in product class to pine chip-n-saw. In general, timber growth rates decline with age, and this is what the data suggests has happened in the catchment area. Not that overall productivity has declined, but that the average age of the forest has increased and, as such, average growth rates have declined.

Table 23*. Average Annual Growth Rate by Major Timber Product (2010-2017)*

Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
2010	6.4%	11.8%	17.3%	2.8%	7.8%	7.6%
2011	5.8%	10.7%	15.5%	2.5%	7.2%	7.0%
2012	5.0%	10.0%	15.9%	2.9%	6.3%	6.7%
2013	4.9%	9.7%	15.6%	2.7%	6.2%	6.5%
2014	4.8%	9.6%	15.4%	2.6%	6.2%	6.5%
2015	4.8%	9.7%	15.7%	2.5%	5.9%	6.4%
2016	4.6%	9.5%	14.9%	2.3%	5.5%	6.1%
2017	4.6%	9.0%	13.7%	2.0%	5.4%	5.7%

Source: USDA - US Forest Service

Per Acre Growth

Table 24 provides average annual per hectare volume growth estimates in the catchment area from 2010-2017. Over this period, total annual per hectare growth decreased from 10.9 m^3 to 9.2 m^3 per year, with average per hectare growth decreasing for four of the five major timber products. However, per hectare growth increased for pine chip-n-saw, from an average of 1.9 m^3 per year in 2010 to 2.2 m^3 per year in 2017.

The increase in per hectare growth for pine chip-n-saw in combination with the decrease in growth per hectare for pine pulpwood provides further evidence of not only an aging forest, but also of pine pulpwood transitioning and moving up in product class to pine chip-n-saw.

***Table 24**. Average Per Hectare Volume Growth by Major Timber Product (Cubic Meters/Hectare/Year): 2010-2017*

Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
2010	2.68	1.93	3.58	1.32	1.35	10.85
2011	2.49	1.77	3.38	1.17	1.27	10.08
2012	2.19	1.69	3.62	1.36	1.09	9.94
2013	2.18	1.81	3.55	1.28	1.09	9.91
2014	2.17	1.93	3.56	1.28	1.09	10.03
2015	2.41	2.07	3.44	1.25	1.04	10.20
2016	2.33	2.15	3.21	1.12	0.95	9.76
2017	2.35	2.23	2.75	0.98	0.92	9.22

Source: USDA - US Forest Service

Figure 32 provides a side-by-side comparison of biomass demand and total softwood pulpwood demand versus annual growth of both pine pulpwood and pine chip-n-saw in the catchment area from 2010-2018. Similar to the relationship that was found with pine pulpwood inventory, an inverse relationship also appears to exist between pine pulpwood growth and both biomass demand and total softwood pulpwood demand, particularly since 2014.

Correlation analysis confirms this inverse relationship, identifying a strong negative correlation between annual growth of pine pulpwood and both biomass demand (correlation coefficient = -0.89) and total softwood pulpwood demand (correlation coefficient = -0.93) from 2010 to 2018. However, analysis also identifies a strong positive correlation between annual growth of pine chip-n-saw and both biomass demand (correlation coefficient = 0.94) and total softwood pulpwood demand (correlation coefficient = 0.85) over this same period. See Table 25.

These strong (positive and negative) correlation coefficients do not suggest that increases in biomass demand have caused decreases in annual growth of pine pulpwood and increases in annual growth of pine chip-n-saw. Rather, they provide indication of a forest where pine pulpwood is transitioning to pine chip-n-saw. As timber ages and moves from pine pulpwood to pine chip-n-saw, growth rates and marginal annual growth start to decline. And on the other side of the transition, pine chip-n-saw growth rates and marginal annual growth increase as the relative age of pine chip-n-saw declines with the entry of younger timber into this product class.

***Figure 32**. Annual Net Growth of Pine Pulpwood & Pine Chip-n-saw vs. Biomass Demand & Total Softwood Pulpwood Demand (2010-2018)*

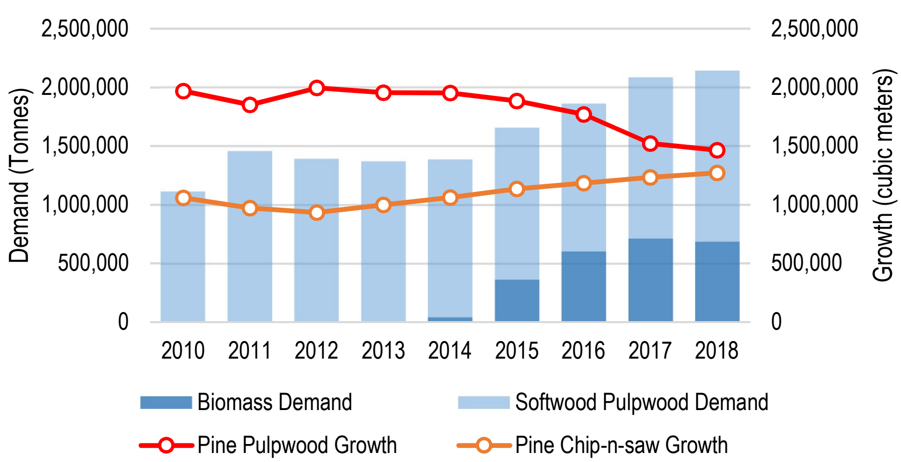


***Table 25**. Correlation Analysis – Pine Pulpwood Annual Growth, Pine Chip-n-saw Annual Growth, Total Annual Growth, Biomass Demand, & Total Softwood Pulpwood Demand (2010-2018)*

	Biomass Demand	Total Softwood Pulpwood Demand	Pine Pulpwood Annual Growth	Pine Chip-n-saw Annual Growth	Total Annual Growth
Biomass Demand	1				
Total Softwood Pulpwood Demand	0.95	1			
Pine Pulpwood Annual Growth	-0.89	-0.93	1		
Pine Chip-n-saw Annual Growth	0.94	0.85	-0.86	1	
Total Annual Growth	-0.73	-0.88	0.81	-0.59	1

5.1.5 *Changes in Annual Removals*

Annual removals of total growing stock timber in the catchment area increased each year from 2010-2017. According to US Forest Service data, annual removals of growing stock timber in the catchment area increased 71% (+997,699 m^3) from 1,413,271 m^3 in 2010 to 2,410,970 m^3 in 2017, the latest available, or an average increase of 7.9% per year over this period.

In terms of historical context, total annual removals averaged approximately 3.1 million m^3 per year through the 1990s, and just under 2.3 million m^3 per year through the 2000s. Total annual removals averaged just under 2. million m^3 per year from 2010-2017, which was down approximately 14% compared to the 2000s average and down 36% compared to the 1990s average.

Table 26 breaks down annual removal estimates from 2010 through 2017 by major timber product. Of the five major timber products, annual removals of pine chip-n-saw increased the greatest over this period, more than tripling from 150,998 m^3 in 2010 to 492,744 m^3 in 2017. Over this same period, annual removals of pine sawtimber increased 68% (+7.7% per year average) from 395,577 m^3 in 2010 to 663,956 m^3 in 2017. Annual removals of pine pulpwood increased 65% (+7.4% per year average) from 511,985 m^3 in 2010 to 846,472 m^3 in 2017.

***Table 26**. Annual Removals by Major Timber Product (m^3): 2010-2017*

	Softwood			Hardwood		
Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
2010	395,577	150,998	511,985	341,889	12,822	1,413,271
2011	596,292	331,942	456,282	364,100	41,336	1,789,952
2012	553,992	355,855	571,789	293,328	80,510	1,855,473
2013	612,449	350,459	628,536	311,189	101,434	2,004,067
2014	601,453	389,864	676,420	270,457	98,350	2,036,545
2015	641,408	431,912	722,953	251,353	90,308	2,137,934
2016	629,931	415,601	751,908	292,577	97,855	2,187,873
2017	663,956	492,744	846,472	311,916	95,882	2,410,970
2018	692,330	518,231	869,120	317,588	95,882	2,493,150

Source: USDA - US Forest Service
**Hood Consulting projected values*

***Figure 33**. Annual Removals by Year (2010-2017)*

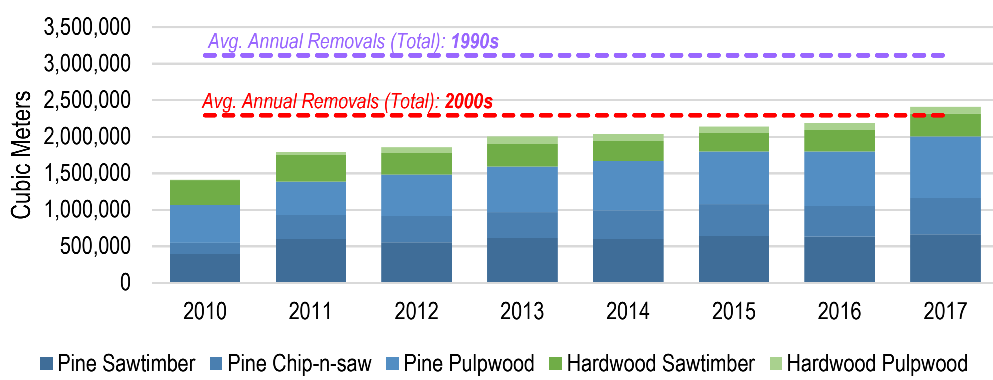
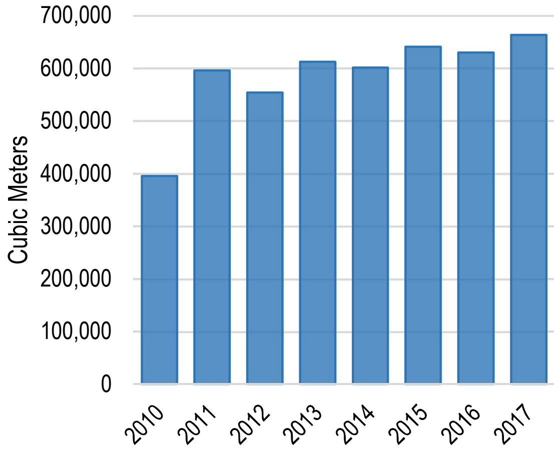
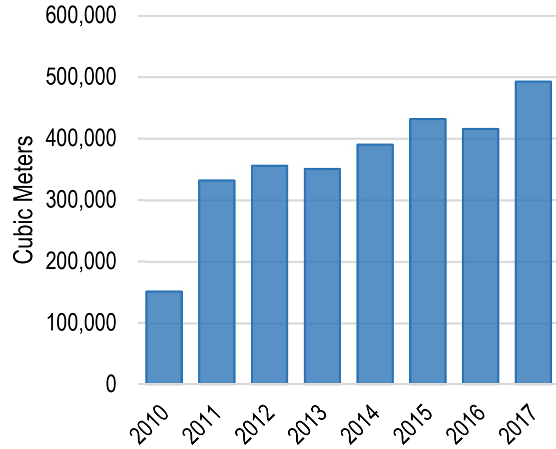


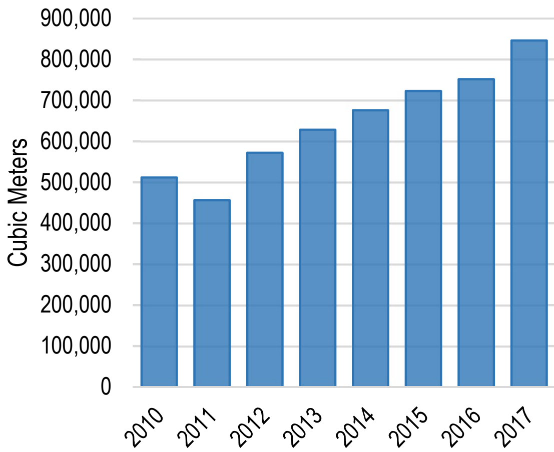
***Figure 34**. Annual Removals by Major Timber Product (2010-2017)*



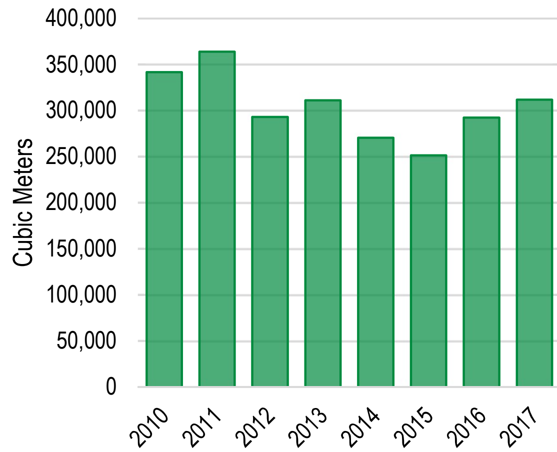
(a) Pine Sawtimber



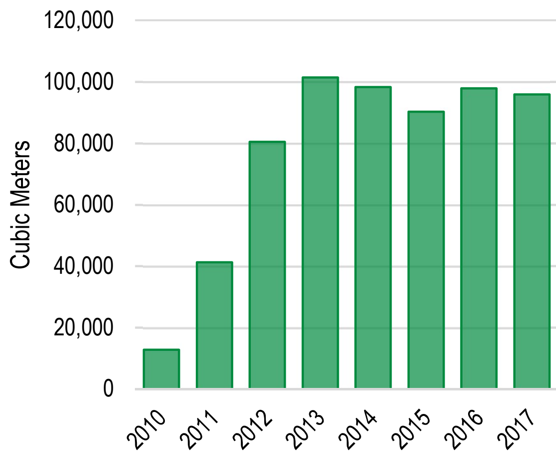
(b) Pine Chip-n-saw



(c) Pine Pulpwood



(d) Hardwood Sawtimber



(e) Hardwood Pulpwood

Figure 35 provides a side-by-side comparison of biomass demand and total softwood pulpwood demand versus pine pulpwood removals in the catchment area from 2010-2018. Since pine pulpwood removals should be representative of softwood pulpwood demand, we'd expected these two to be very strongly (positively) correlated, and that's exactly what this figure shows. A correlation analysis confirmed the relationship, identifying a strong positive correlation (correlation coefficient = 0.88) between pine pulpwood removals and total softwood pulpwood.

Correlation analysis also identified a strong positive correlation between pine pulpwood removals and biomass demand (correlation coefficient = 0.90). See Table 27 for correlation analysis details.

***Figure 35**. Annual Removals of Pine Pulpwood vs. Biomass Demand & Total Softwood Pulpwood Demand (2010-2018)*

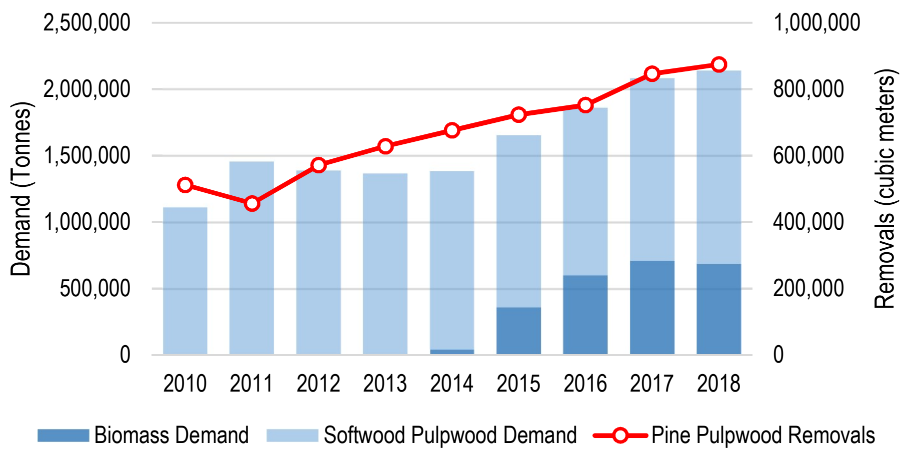


***Table 27**. Correlation Analysis – Pine Pulpwood Removals, Total Removals, Biomass Demand, & Total Softwood Pulpwood Demand (2010-2018)*

	Biomass Demand	*Total Softwood Pulpwood Demand*	*Pine Pulpwood Removals*	*Total Removals*
Biomass Demand	1			
Total Softwood Pulpwood Demand	0.95	1		
Pine Pulpwood Removals	0.90	0.88	1	
Total Removals	0.83	0.92	0.92	1

***Table 28**. Amite BioEnergy Catchment Area - Timber Inventory, Growth, Removals, & Mortality (2010-2018)*

Volume Category	Year	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood	Total
				Cubic Meters			
Inventory	2018	28,547,670	14,051,899	10,882,247	27,068,944	9,403,389	89,954,149
	2017	28,321,102	13,655,272	11,080,622	27,097,259	9,460,035	89,614,290
	2016	27,935,556	12,507,147	11,885,873	26,842,883	9,450,701	88,622,160
	2015	27,274,561	11,652,206	12,034,500	27,180,042	9,681,454	87,822,762
	2014	25,058,467	10,999,404	12,652,394	26,826,115	9,715,839	85,252,219
	2013	24,687,992	10,291,080	12,544,173	26,385,265	9,756,209	83,664,718
	2012	24,104,384	9,346,273	12,576,083	26,156,670	9,585,029	81,768,438
	2011	23,636,265	9,051,844	11,928,328	25,234,709	9,621,159	79,472,305
	2010	23,191,373	8,996,752	11,375,507	25,455,306	9,488,403	78,507,341
Growth	2018	1,320,158	1,271,108	1,473,092	560,506	507,259	5,132,122
	2017	1,300,327	1,234,305	1,521,250	543,521	510,093	5,109,497
	2016	1,282,597	1,183,596	1,770,162	615,858	522,803	5,375,016
	2015	1,322,215	1,134,810	1,884,568	682,981	569,091	5,593,666
	2014	1,191,308	1,060,492	1,952,166	702,363	598,363	5,504,691
	2013	1,200,526	998,339	1,955,422	704,172	601,793	5,460,252
	2012	1,206,404	933,146	1,995,955	748,194	600,362	5,484,060
	2011	1,364,737	972,519	1,851,437	641,645	695,050	5,525,388
	2010	1,474,594	1,060,055	1,969,384	724,150	741,555	5,969,737
Removals	2018	692,330	518,231	869,120	317,588	95,882	2,493,150
	2017	663,956	492,744	846,472	311,916	95,882	2,410,970
	2016	629,931	415,601	751,908	292,577	97,855	2,187,873
	2015	641,408	431,912	722,953	251,353	90,308	2,137,934
	2014	601,453	389,864	676,420	270,457	98,350	2,036,545
	2013	612,449	350,459	628,536	311,189	101,434	2,004,067
	2012	553,992	355,855	571,789	293,328	80,510	1,855,473
	2011	596,292	331,942	456,282	364,100	41,336	1,789,952
	2010	395,577	150,998	511,985	341,889	12,822	1,413,271
Mortality	2018	115,505	46,666	120,821	369,998	92,893	745,883
	2017	114,636	50,446	133,273	344,002	94,890	737,247
	2016	112,981	36,868	120,970	393,043	91,925	755,785
	2015	104,212	35,631	91,645	364,435	88,164	684,087
	2014	111,830	37,016	73,045	390,519	85,634	698,044
	2013	116,680	40,122	75,012	422,885	89,307	744,005
	2012	121,713	49,547	85,530	474,668	84,699	816,156
	2011	78,014	22,175	62,980	470,505	80,360	714,034
	2010	56,070	15,982	68,255	550,591	91,855	782,754

Source: USDA - US Forest Service

**projected values*

5.1.6 *Changes in Raw Material Costs*

Historically, Amite BioEnergy raw material purchases have included three different products: pine pulpwood (roundwood), pine sawmill chips (sawmill residuals), and pine in-woods chips. As such, our examination of raw material costs will focus on how prices for these specific timber products have changed in the catchment area since 2010. However, in this section, we also include hardwood pulpwood as well as both pine and hardwood sawtimber to see how prices of all the different major timber products have changed and trended in the catchment area since 2010.

Note that only delivered timber prices (including chip and residual prices) are included and examined in this section.

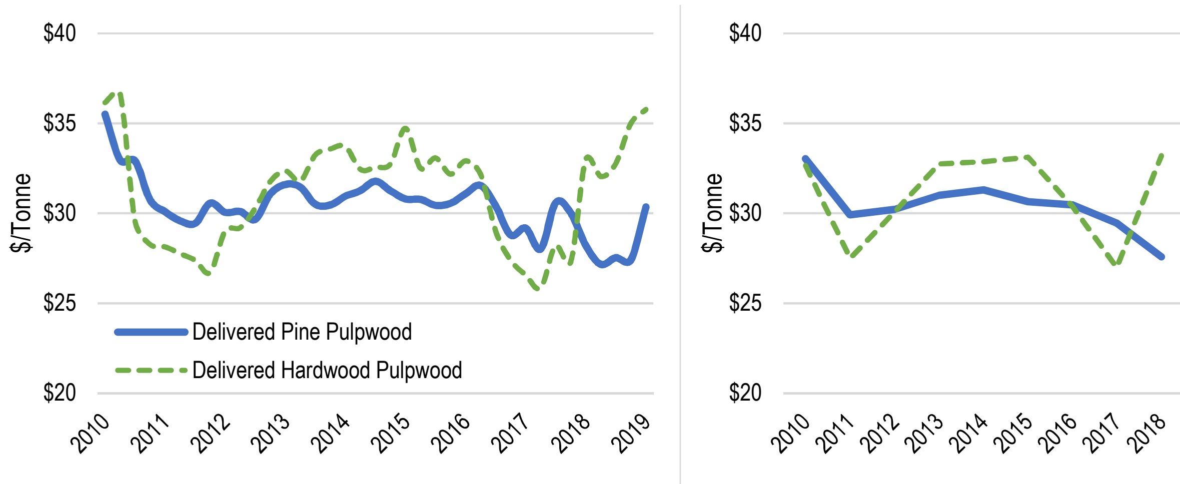
Delivered Pulpwood, Chip & Sawmill Residual Prices

Prices for delivered pine and hardwood pulpwood as well as pine sawmill chips and in-woods debarked pine chips all spiked in 1Q 2010 due largely to near-record levels of rainfall in this region in 4Q 2009 (wet conditions limited accessibility to wood, resulting in a short-term supply shortage that drove prices upward). However, markets readjusted over the months that followed and prices of each of these products fell back in line with respective pre-weather-related shortage trends by the end of 2010.

Trends/changes with delivered pulpwood, chips, and sawmill residual prices:

- Delivered Pine Pulpwood. Prices increased 4.7% (+1.5% per year average) from $29.92 per tonne in 2011 to $31.31 per tonne in 2014. However, delivered pine pulpwood prices have declined since 2014, decreasing an average of 3.1% per year (-11.9% overall) to $27.58 per tonne in 2018.
- Delivered Hardwood Pulpwood. Prices increased 19.1% from $27.50 per tonne in 2011 to $32.74 per tonne in 2013, leveling out and averaging $32.91 per tonne from 2013 through 2015. Delivered hardwood pulpwood priced dipped in 2016 and 2017 but rebounded and averaged $33.20 per tonne in 2018.
- Pine Sawmill Chips (Sawmill Residuals). Prices averaged $29.16 per tonne in 2011, falling to $28.14 per tonne in 2012. However, prices have trended upwards since, increasing an average of 1.5% per year over the last six years and to $29.88 per tonne in 2018.
- In-Woods Debarked Pine Chips. As with pine sawmill chips, in-woods debarked pine chip prices also fell from 2010 to 2012 (to $34.89 per tonne). However, since that time, prices have remained relatively flat, increasing only marginally to $35.15 per tonne in 2018 and averaging $35.28 per tonne over the last six years.

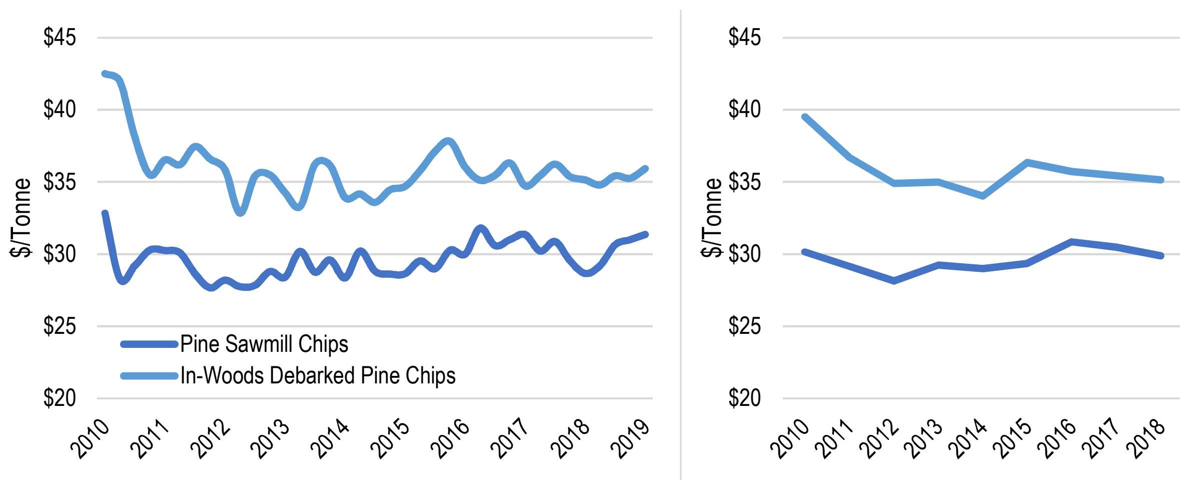
***Figure 36**. Amite BioEnergy Catchment Area - Delivered Pine & Hardwood Pulpwood Prices ($/Tonne)*



(a) Quarterly Average (1Q 2010 – 1Q 2019)

(b) Annual Average (2010 – 2018)

***Figure 37**. Amite BioEnergy Catchment Area - Pine Sawmill Chip & In-Woods Debarked Pine Chip Prices ($/Tonne)*



(a) Quarterly Average (1Q 2010 – 1Q 2019)

(b) Annual Average (2010 – 2018)

Figure 38 provides a side-by-side comparison of biomass demand and total softwood pulpwood demand versus delivered pine pulpwood, pine sawmill chip, and in-woods debarked pine chip prices in the catchment area from 2010-2018. Intuitively, what we might expect to see is prices and demand moving in the same direction, and that generally appears to be the case with pine sawmill chip (sawmill residual) prices and biomass demand; however, both delivered pine pulpwood and in-woods debarked pine chip prices have actually declined in recent years (despite the increase in biomass demand).

A correlation analysis of biomass demand and these raw material prices in the Amite BioEnergy catchment area identifies a moderately strong negative correlation between biomass demand and delivered pine pulpwood prices (correlation coefficient = -0.65), a very weak negative correlation between biomass demand and in-woods debarked pine chip prices (correlation coefficient = -0.19), and a moderately strong positive correlation between biomass demand and pine sawmill chip prices (correlation coefficient = 0.70).

***Figure 38**. Delivered Pine Pulpwood, Pine Sawmill Chip, & In-Woods Debarked Pine Chip Prices vs. Biomass Demand & Total Softwood Pulpwood Demand (2010-2018)*

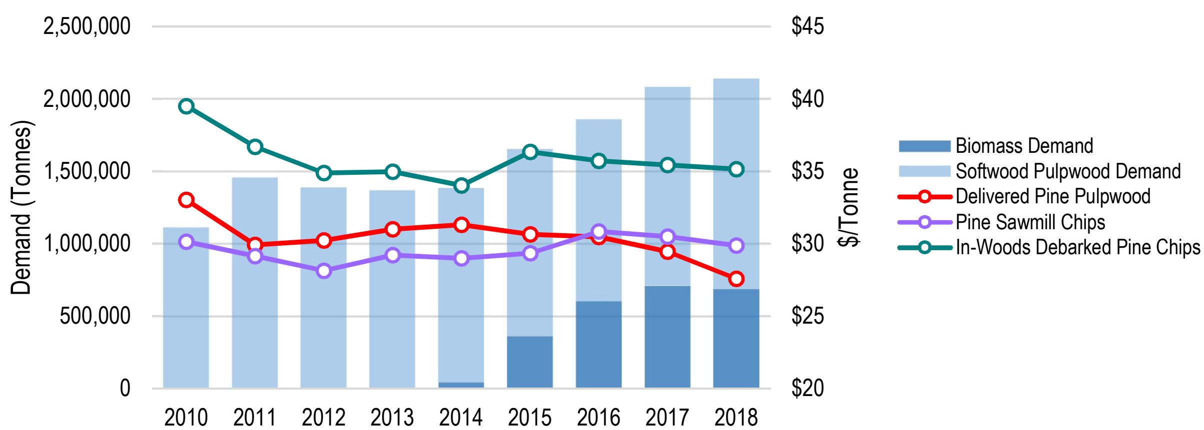


***Table 29**. Correlation Analysis – Delivered Pine Pulpwood Prices, Pine Sawmill Chip Prices, In-Woods Debarked Pine Chip Prices, Biomass Demand, & Total Softwood Pulpwood Demand (2010-2018)*

	Biomass Demand	Total Softwood Pulpwood Demand	Delivered Pine Pulpwood Prices	Pine Sawmill Chip Prices	In-Woods Debarked Pine Chip Prices
Biomass Demand	1				
Total Softwood Pulpwood Demand	0.95	1			
Delivered Pine Pulpwood Prices	-0.65	-0.83	1		
Pine Sawmill Chip Prices	0.70	0.51	-0.05	1	
In-Woods Debarked Pine Chip Prices	-0.19	-0.38	0.52	0.34	1

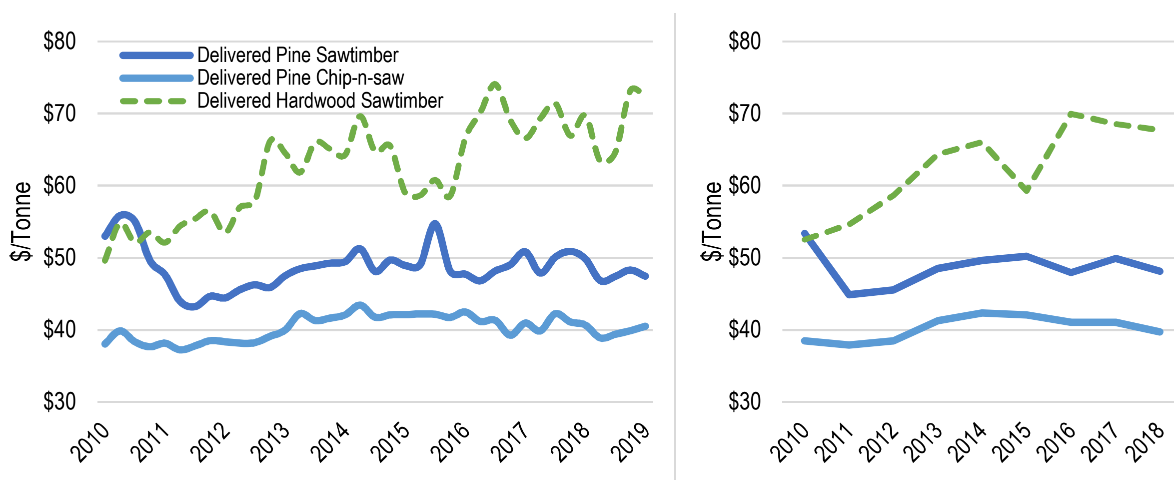
Delivered Sawtimber Prices

Figure 39 provides historical prices for both delivered pine and hardwood sawtimber as well as delivered pine chip-n-saw. We'd like to first point out the decline of delivered pine sawtimber prices through 2010 and into 2011, which was connected to the downward market shift resulting from the bursting of the US housing bubble in 2006-2007 and the subsequent Great Recession that followed. Since this shift in price level finally concluded in 2011, it's from this point forward that we focus our assessment of delivered pine sawtimber price trends.

Trends/changes with delivered sawtimber prices:

- Delivered Pine Sawtimber. Prices bottomed out in 2011 at $44.87 per tonne, down 15.9% from $53.37 per tonne in 2010. Delivered pine sawtimber prices rebounded a bit over the four years that followed, increasing 11.9% (+2.8% per year average) to $50.21 per tonne in 2015. However, prices have been declining slowly since, decrease an average of 1.4% per year since to $48.10 per tonne in 2018.
- Delivered Pine Chip-n-saw. Prices remained nearly unchanged from 2010 through 2012, averaging $38.28 per tonne over this 3-year period before increasing more than 10% to $42.34 per tonne in 2014. However, delivered pine chip-n-saw prices have been on a downward slide since, decreasing an average of 1.6% per year to $39.71 per tonne in 2018.
- Delivered Hardwood Sawtimber. Prices averaged $52.51 per tonne in 2010, increasing an average of 4.9% per year (+33.2% overall) to $69.96 per tonne in 2016. However, delivered hardwood sawtimber prices have held steady (decreased only slightly), averaging $68.74 per tonne from 2016 through 2018.

***Figure 39**. Amite BioEnergy Catchment Area - Historic Delivered Sawtimber Prices ($/Tonne)*



(a) Quarterly Average (1Q 2010 – 1Q 2019)

(b) Annual Average (2010 – 2018)

Figure 40 provides a side-by-side comparison of delivered pine sawtimber and chip-n-saw prices versus softwood sawlog demand in the catchment area from 2010-2018. Looking at this figure, both delivered pine sawtimber and chip-n-saw prices appeared to generally track softwood sawlog demand from 2010 through around 2014; however, that relationship has disappeared since then and prices have held flat (decreased slightly) while softwood sawlog demand has continued to increase.

A correlation analysis of delivered pine sawtimber prices, delivered pine chip-n-saw prices, and softwood sawlog demand confirms these relationships, or lack thereof. No correlation was found between delivered pine sawtimber price and softwood sawlog demand (correlation coefficient = 0.04) while only a moderate positive correlation was found between delivered pine chip-n-saw price and softwood sawlog demand.

Note that no correlation (or only a very weak positive correlation) was found between biomass demand and both delivered pine sawtimber and chip-n-saw prices in the catchment area. See Table 30 for correlation analysis details.

***Figure 40**. Delivered Pine Sawtimber & Pine Chip-n-saw Prices vs. Softwood Sawlog Demand (2010-2018)*

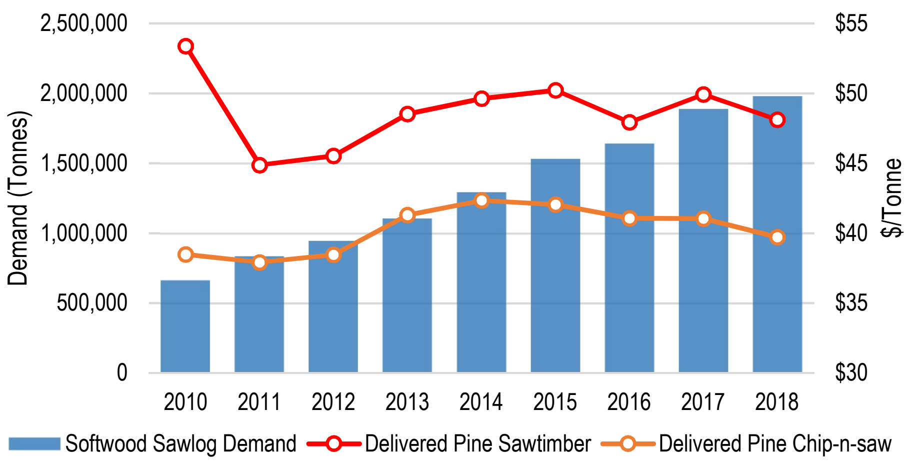


***Table 30**. Correlation Analysis – Delivered Pine Sawtimber Prices, Delivered Pine Chip-n-saw Prices, Biomass Demand, & Softwood Sawlog Demand (2010-2018)*

	Biomass Demand	*Softwood Sawlog Demand*	*Delivered Pine Sawtimber Price*	*Delivered Pine Chip-n-saw Price*
Biomass Demand	1			
Softwood Sawlog Demand	0.93	1		
Delivered Pine Sawtimber Price	0.10	0.04	1	
Delivered Pine Chip-n-saw Price	0.33	0.55	0.34	1

Figure 41 provides a side-by-side comparison of delivered hardwood sawtimber price and hardwood sawlog demand in the catchment area from 2010-2018. Looking at this figure, delivered hardwood sawtimber price has generally increased while hardwood sawlog demand has ultimately decreased, indicating an inverse relationship. A correlation analysis confirmed this relationship, identifying a moderately strong negative correlation between delivered hardwood sawtimber price and hardwood sawlog demand (correlation coefficient = -0.59).

However, keep in mind there are numerous hardwood species and that wood quality is an important factor, especially depending on hardwood product end-use. And in this market, demand for high-quality hardwood sawlogs remains relatively high and has held hardwood sawtimber prices near record highs for the last several years.

Figure 41*. Delivered Hardwood Sawtimber Prices vs. Hardwood Sawlog Demand (2010-2018)*

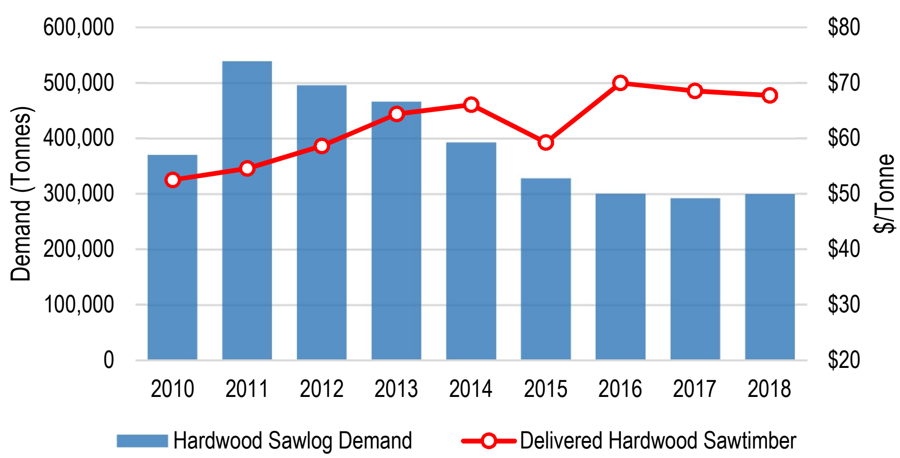


Table 31*. Correlation Analysis – Delivered Hardwood Sawtimber Prices, Biomass Demand, & Hardwood Sawlog Demand (2010-2018)*

	Biomass Demand	Hardwood Sawlog Demand	Delivered Hardwood Sawtimber Price
Biomass Demand	1		
Hardwood Sawlog Demand	-0.84	1	
Delivered Hardwood Sawtimber Price	0.71	-0.59	1

5.2 Market Outlook: 2019-2022

There have been four major announcements related to mill openings and closings in the Amite BioEnergy catchment area that stand to impact this market moving forward. These include:

- Georgia-Pacific (GP) announced in January of 2019 that the company would be exiting the communication papers business, and, as a result, it would permanently shut down the communication papers machines, related converting assets, as well as the woodyard, pulp mill, and a significant portion of the energy complex at its Port Hudson, Louisiana, facility. Final shutdown occurred in March of 2019; however, GP continues to operate the consumer tissue and towel business operations at the facility.

  The Port Hudson mill is located approximately 65 kilometers southwest of the Amite BioEnergy pellet mill in East Baton Rouge Parish, Louisiana. The shuttering of the communication papers business eliminates an estimated 725,000 tonnes per year of roundwood demand that had previously been sourced from within Amite BioEnergy's catchment area.

- Alternative Energy Development (AED) announced in October 2018 that the company had commenced construction on a new wood pellet mill in Gallman, Mississippi. Construction is expected to take 14 months, with the plant scheduled to begin operating in early 2020. At full capacity, the plant will be capable of producing 500,000 metric tons of wood pellets per year.

  The AED plant is located approximately 120 kilometers northeast of the Amite BioEnergy pellet mill in Copiah County, Mississippi. Once fully operational, an estimated 275,000-375,000 tonnes of roundwood per year, or 30-40% of the mill's annual wood demand, is expected to be sourced from within Amite BioEnergy's catchment area.

- Velocys plc announced in October of 2017 plans to build its first US biorefinery in Natchez, Mississippi. At full production, the facility will produce an estimated 1,400 barrels per day of low sulfur diesel, or approximately 19 million gallons per year. To meet production needs, the facility will require approximately 2,000 green tons per day of pine, or more than 635,000 tonnes annually. The company is currently in the planning stages; however, Velocys expects to complete construction of the new facilityand commence operations in 2024.

  The Velocys biorefinery is to be located approximately 65 kilometers northwest of the Amite BioEnergy pellet mill in Adams County, Mississippi, at the former International Paper pulp/paper mill site. Although this facility is not expected to be operational until 2024, once open, an estimated 400,000-500,000 tonnes, or 65-80% of the mill's annual wood demand, is expected to be sourced from within Amite BioEnergy's catchment area.

- Rex Lumber announced in June 2019 that the company has decided to curtail production at its southern yellow pine sawmill in Brookhaven, Mississippi, reducing lumber production by 20%. The company cites current market conditions as the reason for the curtailment.

  The Rex Lumber sawmill is located approximately 80 kilometers northeast of the Amite BioEnergy pellet mill in Lincoln County, Mississippi. The curtailment eliminates an estimated 45,000 tonnes of annual wood demand from within Amite BioEnergy's catchment area.

5.2.1 *Wood Demand Outlook*

In the Amite BioEnergy catchment area, based on these announcements and other expected production changes, we anticipate total wood demand to decline an estimated 8% in 2019, due in large part to the shutdown that occurred at Georgia-Pacific's Port Hudson mill as well as to the production curtailment at Rex Lumber in Brookhaven, Mississippi.

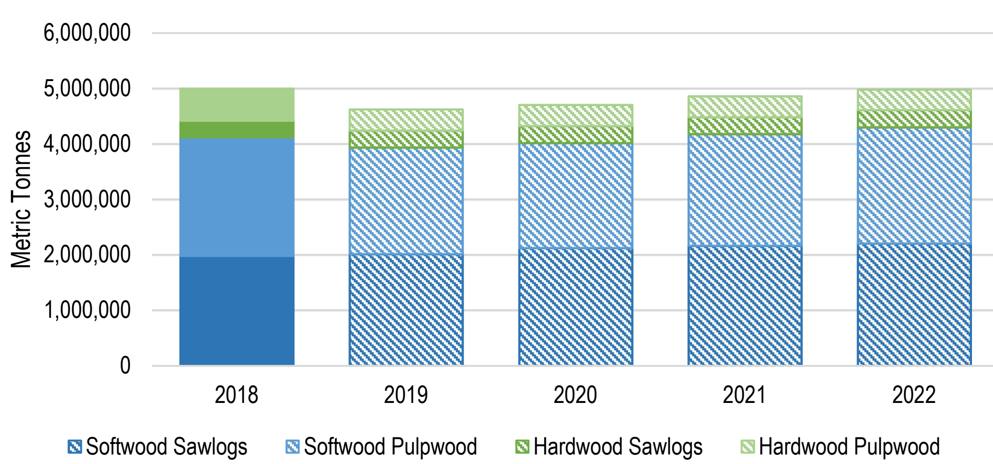
However, with the construction of Alternative Energy Development's pellet mill in Gallman, Mississippi, and anticipated increases in softwood sawlog demand over the next several years, we project a majority of the lost demand to be regained and for total wood demand in the catchment area to increase to nearly 5.0 million tonnes in 2022, which is down marginally (<1%) compared to 2018 levels.

***Table 32**. Amite BioEnergy Catchment Area - Projected Wood Demand (2019-2022)*

Product	2018	2019	2020	2021	2022
		Catchment Area – Annual Wood Demand (Tons)			
Sawlogs:					
Softwood	1,980,676	2,014,544	2,119,620	2,162,013	2,205,253
Hardwood	299,326	302,320	305,342	308,396	311,480
Total Sawlogs	2,280,002	2,316,864	2,424,962	2,470,409	2,516,733
Pulpwood:					
Softwood	2,137,855	1,923,169	1,898,747	2,015,949	2,092,766
Hardwood	583,164	380,686	376,879	373,110	369,379
Total Pulpwood	2,721,019	2,303,855	2,275,627	2,389,059	2,462,146
Total	**5,001,021**	**4,620,718**	**4,700,590**	**4,859,468**	**4,978,878**

**Hood Consulting projected values*

***Figure 42**. Projected Wood Demand (2019 – 2022)*



Amite BioEnergy pellet mill wood purchases (and total pellet production) are assumed to increase modestly (4-5%) over the next several years. And with the anticipated startup and ramp-up of the AED pellet mill in Gallman, we project total biomass-related wood demand in the catchment area to increase nearly 15% from 2018-2022 (see Table 33).

We'd like to note, however, that due to the shutdown at Georgia-Pacific's Port Hudson pulp mill, total softwood pulpwood demand in the catchment area is projected to decrease approximately 10% in 2019. The anticipated increases in biomass demand will help recapture some of the lost demand, increasing total softwood pulpwood demand to a just over 2.1 million tonnes in 2022, which is still down roughly 2% compared to 2018 levels.

***Table 33**. Amite BioEnergy Catchment Area - Projected Biomass & Total Softwood Pulpwood Demand (2019-2022)*

Wood Demand	2018	2019	2020	2021	2022
			Projected Wood Demand (Tonnes)		
Biomass Demand	685,802	623,237	597,334	713,002	788,232
Other Softwood Pulpwood Demand	1,452,053	1,299,932	1,301,414	1,302,947	1,304,535
Total Softwood Pulpwood Demand	**2,137,855**	**1,923,169**	**1,898,747**	**2,015,949**	**2,092,766**

**projected values*

5.2.2 *Raw Material Price Outlook*

Raw material purchases for the Amite BioEnergy pellet mill have historically included three different materials: pine pulpwood (roundwood), pine sawmill chips (sawmill residuals), and pine in-woods chips. Since these specific raw materials are expected to constitute total wood purchases moving forward, our price forecasts focus specifically on these three products.

- 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 only marginal changes in delivered pine pulpwood prices from 2019 through 2022. Delivered pine pulpwood prices are forecasted to increase in 2019 (primarily due to the extreme wet conditions that drove prices upwards early in the year) but decline in 2020 and 2021 before increasing again in 2022 with the increased demand attributed to the new AED pellet mill. Overall, delivered pine pulpwood prices are forecasted to average $27.64 per tonne from 2019-2022, up less than 1% from the 2018 average of $27.58 per tonne.

- Pine Sawmill Chips. Pine sawmill chip prices are forecasted to increase more than 2% in 2019 and continue to increase, albeit at a decreasing rate, over the three years that follow – to $31.10 per tonne in 2022. Overall, pine sawmill chip prices are forecasted to average $30.88 per tonne from 2019-2022, up a little more than 3% from the 2018 average of $29.87 per tonne.

- In-Woods Debarked Pine Chips. In-woods debarked pine chip prices are forecasted to increase each of the next four years and to $36.55 per tonne in 2022. This represents an approximately 4% increase over the 2018 average of $35.15 per tonne. Overall, in-woods debarked pine chip prices are forecasted to average $36.31 per tonne from 2019-2022, up a little more than 3% from the 2018 average.

***Table 34**. Forecasted Delivered Pine Pulpwood, Pine Sawmill Chip & In-Woods Debarked Pine Chip Prices ($/Tonne): 2019-2022*

Year	Delivered Pine Pulpwood	Pine Sawmill Chips	In-Woods Debarked Pine Chips
2010	33.03	30.14	39.51
2011	29.92	29.16	36.70
2012	30.22	28.14	34.89
2013	31.01	29.23	34.98
2014	31.32	28.99	34.03
2015	30.64	29.35	36.35
2016	30.47	30.84	35.73
2017	29.45	30.49	35.44
2018	27.58	29.87	35.15
2019	28.21	30.56	35.92
2020	27.50	30.86	36.29
2021	27.16	31.02	36.46
2022	27.70	31.10	36.55

**projected 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 Amite BioEnergy catchment area.

***Figure 43**. Price Forecast: Delivered Pine Pulpwood (2019-2022)*

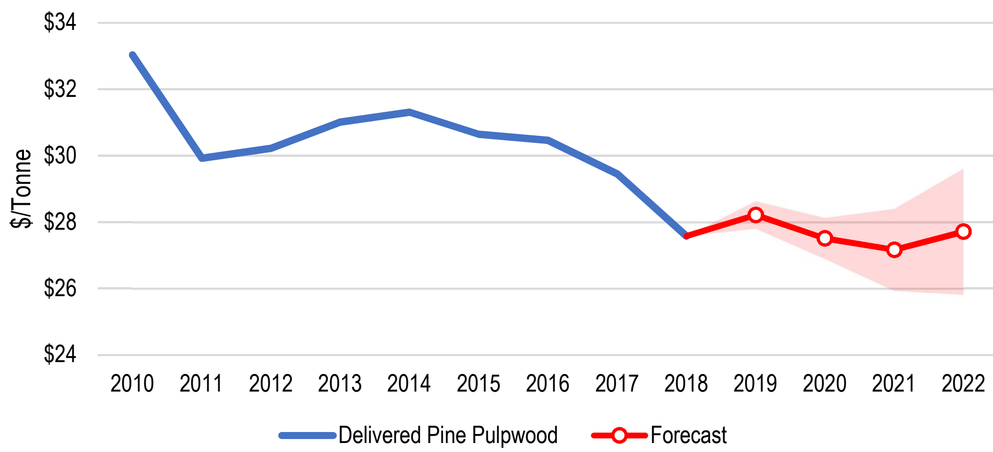


***Figure 44**. Price Forecast: Pine Sawmill Chips (2019-2022)*

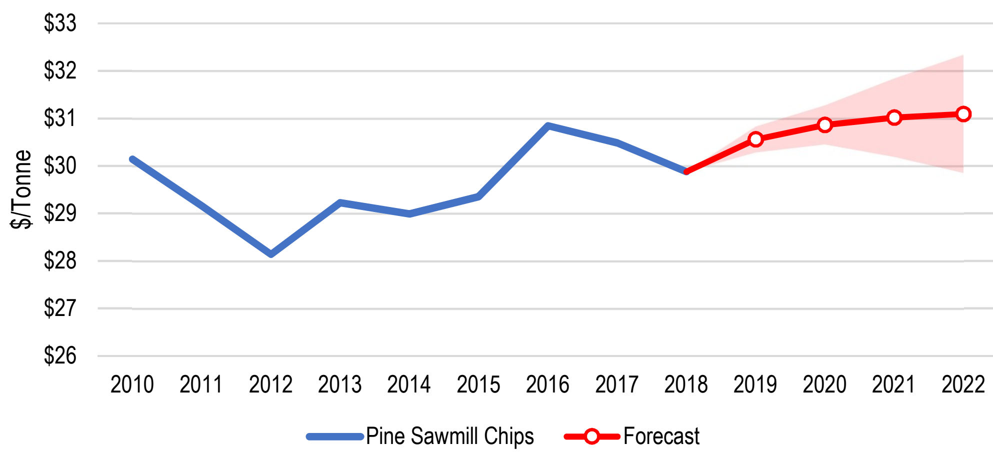


***Figure 45**. Price Forecast: In-Woods Debarked Pine Chips (2019-2022)*

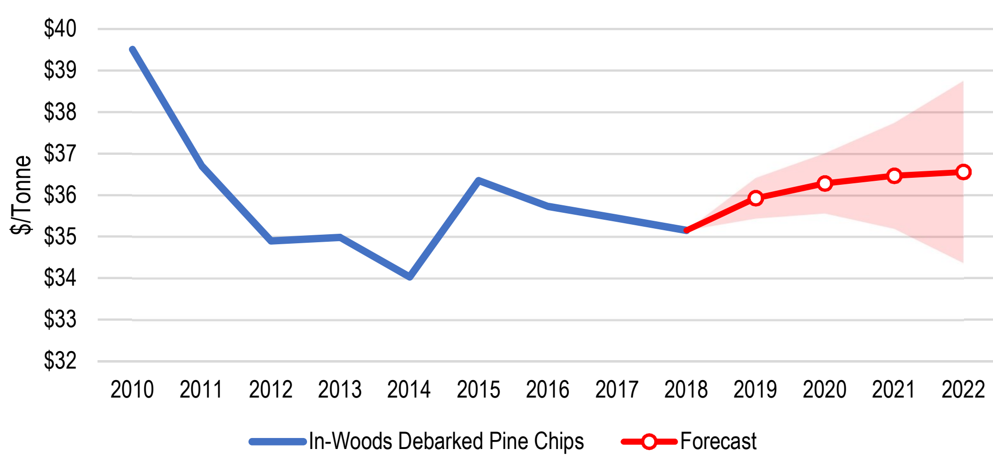


Table 35 provides a breakdown of historic and projected prices from 2014 through 2022 for the three specific raw material products consumed by Amite BioEnergy. Note that these raw material prices are not actual per unit costs incurred by the mill, but rather average market prices for the catchment area.

Also included in this table is the calculated weighted average per unit raw material cost based on the actual distributions of Amite BioEnergy raw material purchases. This weighted average price is intended to show how Amite BioEnergy's raw material costs are forecasted to change given the anticipated changes in wood demand and timber (raw material) prices in the catchment area over the next four years.

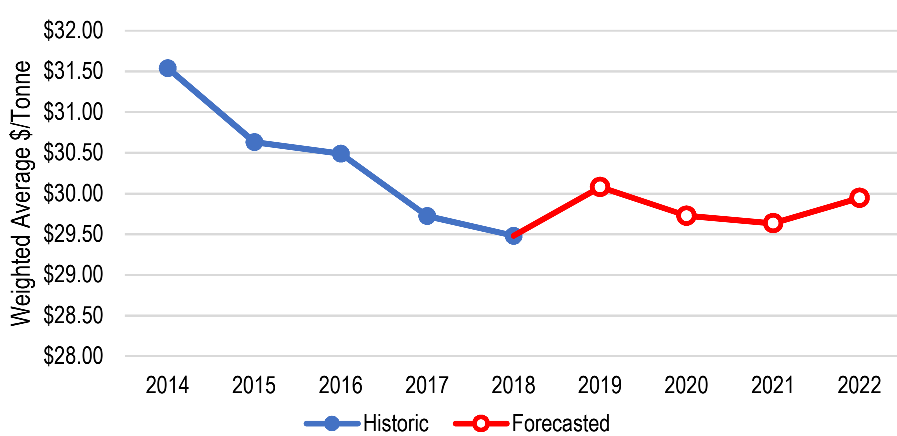
This weighted average per unit cost of raw materials for the Amite BioEnergy pellet mill averaged $26.74 per ton in 2018. Based on our price forecasts and anticipated changes in raw material purchases, the average per unit raw material cost is projected to increase 2.0% in 2019 but decline slightly in both 2020 and 2021 before increasing (modestly) in 2022. Overall, the average per unit cost of raw materials at the Amite BioEnergy pellet mill is forecasted to average $27.08 per ton from 2019-2022, up 1.2% compared to the 2018 weighted average per unit cost.

***Table 35**. Amite BioEnergy Raw Material Per Unit Price Projections*

	Price Per Tonne			
Year	Pine Pulpwood	Sawmill Residuals	In-Woods Chips	Weighted Average
2014	31.32	28.99	34.03	31.54
2015	30.64	29.35	36.35	30.63
2016	30.47	30.84	35.73	30.49
2017	29.45	30.49	35.44	29.72
2018	27.58	29.87	35.15	29.48
2019	28.21	30.56	35.92	30.08
2020	27.50	30.86	36.29	29.73
2021	27.16	31.02	36.46	29.63
2022	27.70	31.10	36.55	29.94

*projected/forecasted

***Figure 46**. Historic & Projected Raw Material Per Unit Weighted Average Cost ($/Tonne)*



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 Amite BioEnergy catchment area and on our professional expertise and market knowledge.

- Changes in Forest Area

  Despite relatively poor market conditions (particularly for forest landowners) since 2010, US Forest Service data shows that overall timberland hectares increased (<1%) in the Amite BioEnergy catchment area from 2010-2017. Also, important to note is that total planted pine acres increased 15,305 hectares (+9%) over this period. To us, this indicates two things. First, land not formerly classified as timberland has been converted to timberland, and second, that harvested timberland continues to be replanted (predominantly in pine).

  As this relates to Amite BioEnergy specifically, the increase in timberland provides great indication that more than adequate supply will be available for future consumption (at least over the short to mid-term).

- Changes in Timber Inventory, Growth, & Removals

  Total removals in the catchment area increased 71% from 2010-2017, and while total annual growth declined 14% over this period, growth still exceeded removals by a wide margin and total growing stock inventory increased 14% from 2010-2017.

  Another way to gauge long-term resource availability and market sustainability is to examine growth-to-removal ratios. In this catchment area, total softwood growth-to-removals declined from 4.25 in 2010 to 2.02 in 2017. More specifically, softwood pulpwood (i.e. pine pulpwood) growth-to-removals declined from 3.85 in 2010 to 1.80 in 2017. (Recall that a value of >1 indicates growth exceeds removals, signifying oversupply). So, while this ratio has come down since 2010, a value of 1.80 still indicates that annual growth of softwood pulpwood is nearly 2x that of annual removals.

  For Amite BioEnergy, this indicates, firstly, that current harvest levels (demand) are sustainable, and secondly, that softwood pulpwood demand (including biomass-related wood demand) can increase much further without jeopardizing the long-term sustainability of this market. However, we anticipate a decline in softwood pulpwood demand in the Amite BioEnergy catchment area in 2019 due to the recent shutdown at Georgia-Pacific's Port Hudson pulp mill, and this decrease in demand means greater wood availability for Amite BioEnergy and likely a reduction in overall raw material costs.

- Changes in Wood Demand

Total wood demand in the Amite BioEnergy catchment area doubled from 2010-2018. Over this same period, softwood pulpwood demand increased an estimated 92% - largely attributed to construction and startup of the Amite BioEnergy pellet mill. However, the previously mentioned shutdown at Georgia-Pacific's Port Hudson pulp mill is expected to reduce total softwood pulpwood demand by approximately 10% in this catchment area in 2019.

But with the anticipated startup of the Alternative Energy Development (AED) pellet mill in Gallman, Mississippi, which is presently expected to occur sometime late in 2020, some of the lost softwood pulpwood demand will be regained. But ultimately, total softwood pulpwood demand in the catchment area is projected to be 2% lower in 2022 than it was in 2018.

For the Amite BioEnergy pellet mill, decreased demand (reduced competition) for softwood pulpwood should translate to lower raw material costs.

- Changes in Raw Material Prices

Amite BioEnergy raw material purchases included three different products: pine pulpwood (roundwood), pine sawmill chips (sawmill residuals), and pine in-woods chips. Delivered pine pulpwood prices in the catchment area have trended downward since 2010, decreasing an average of 2.2% per year from 2010 through 2018. Pine sawmill chip prices, which trended upwards from 2012 through 2016, have retreated a bit the last several years, decreasing 3.1% from 2016 through 2018. And in-woods debarked pine chip prices have remained relatively flat, increasing <1% overall from 2012 through 2018.

The outlook for Amite BioEnergy in terms of raw material costs is positive. Prices for all three of these products did increase in 1Q 2019; however, these increases were largely due to extreme wet conditions that constrained supply in the short term. But given the expected decline in softwood pulpwood demand over the next several years, we expect overall raw material costs to decline as well.

- Changes in Management/Harvesting Practices

As part of this market analysis, Hood Consulting examined management practices to see how harvesting activities have changed since 2010. We also interviewed multiple loggers to get their perspective and account of how logging and logging practices have changed since 2010.

The general notion is that thinnings (which provide a majority of the raw material that Amite BioEnergy purchases and utilizes) decline when timber markets are weak, and both the research and logger interviews conducted provided evidence to support this. In this market, delivered pine pulpwood prices declined 12% from 2014-2018, and over this same period, TimberMart-South data shows that the total number of acres thinned as a percentage of total acres harvested declined from roughly 60% to 45%. The loggers interviewed also provided confirmation of this, with two of the individuals noting specifically that their logging companies have reduced the amount of thinnings they conduct as pine pulpwood prices have declined.

But one of the other major takeaways we got from our logger interviews, and something Drax and Amite BioEnergy will likely find important, is the concern these loggers expressed. More than one of the loggers interviewed said they expect some logger attrition to occur due to the shutdown at G-P Port Hudson and the production curtailment at Rex Lumber, and that more and more attrition will likely occur if delivered timber prices move any lower (it will be too difficult for loggers to be profitable, and as a result they will decide to exit the industry). So, while reduced wood demand in this catchment area may be good for Amite BioEnergy (in terms of reduced buyer competition), if timber prices fall much further and the snowball effect includes a reduced logger workforce, then this could impact Amite BioEnergy wood procurement.

- 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, and our correlation analysis identified an inverse relationship between these two in the catchment area. In other words, an increase in biomass demand corresponded to a decrease in raw material prices. This opposes intuitive thought – that prices and demand should move in the same direction. However, the supply side of supply and demand provides the explanation.

When demand increases (as has happened in the catchment area), the only way for prices to decrease is for an even larger increase in supply to occur – and that's what has happened in this catchment area (and in most timber markets across the US South). Timber production decreased substantially with the bursting of the US housing bubble in the mid-2000s and the Great Recession that followed; however; timber inventories continued to grow. Specifically, pine pulpwood inventory in the catchment area increased more than 11% from 2010-2014. And even though pine pulpwood inventory has declined in this market since that time, oversupply still persists, and this is the primary reason pine pulpwood prices have decreased despite an increase in demand.

Our summation is that the inverse relationship found between biomass demand and raw material prices points more towards unrelation than causation. The evidence we gathered suggests (over)supply, not demand, is currently the greatest factor driving changes in raw material prices.

7. **Annex 1** – Project Scaling Procedures, Methodology, & Costs

The Amite BioEnergy catchment area analysis represents a 'pilot project/proof of concept' to be replicated throughout Drax's supply chain in accordance with Drax's initiative to roll out and implement a more extensive monitoring program. In addition to Amite BioEnergy, Drax has two additional wood pellet facilities in the US South:

- Morehouse BioEnergy in Bastrop, Louisiana
- LaSalle BioEnergy in Urania, Louisiana

Drax Power Station biomass pellet feedstock is also sourced from other regions and countries, including:

- Canada
- Baltic States (Estonia, Latvia, and Lithuania)
- Portugal

7.1 Project Scaling Procedures & Methodology

Replication of the Amite BioEnergy catchment area analysis for both the Morehouse BioEnergy and LaSalle BioEnergy pellet mills can be done with relative ease, as US Forest Service inventory data, wood demand data, and TimberMart-South pricing data is readily available and attainable for each respective mill's fiber catchment area. Also, Hood Consulting's network of loggers provides access to industry professionals in these markets, allowing us to gather area-specific information regarding trends and changes in management and harvest practices.

Regarding Drax's sourcing regions in Canada, the Baltic States, and Portugal, the data and information required to monitor these sourcing regions can be attained from each respective country's ministry of forestry and well as from the Food and Agriculture Organization of the United Nations (FAO) and other sources.

The methodology behind subsequent catchment area or sourcing region analyses would follow that of the Amite BioEnergy catchment area analysis. This includes data collection and analysis that details or provides the following:

- Changes in forest area and forest composition
- Changes in timber inventory, growth, and removals
- Changes in wood demand (including biomass-related wood demand)
- Changes in raw material prices
- Changes in management and harvesting practices
- Long-term market sustainability
- Relationships or linkages between changes in wood demand (biomass demand) and changes in forest area
- Relationships or linkages between changes in wood demand (biomass demand) and changes in raw material prices
- Identification of anticipated changes in wood demand, including the impact these anticipated changes will have on Drax's future raw material costs

Due to the US Forest Service's data collection and release schedule, updated inventory, growth, and removal estimates are not typically provided every year. However, Hood Consulting continuously tracks changes in wood demand. In addition, TimberMart-South provides updated market price reports every quarter. An important part of the monitoring process includes tracking changes in both wood demand and raw material prices, so we would recommend updating these portions of the catchment area analysis every year. However, complete updates (including updated inventory data) are likely limited to every other year.

7.2 Projected Costs & Timeline

The cost to conduct catchment area analyses for Morehouse BioEnergy and LaSalle BioEnergy would be in line with that of the Amite BioEnergy catchment area analysis. However, since a template for this type of report has been established with the Amite BioEnergy catchment area analysis, there are likely some related cost savings to be had. Turnaround time on this type of market or catchment area analysis is 6-8 weeks for each report.

Regarding annual updates to the wood demand and raw material price portions of one of these analyses (including an updated market outlook with 3-5-year forecasts), we anticipate a turnaround time of only 1-2 weeks for a given catchment area. More importantly, our estimated cost to provide such an update is 25-35% that of a full report or a complete report update.

For additional cost details or questions regarding project scaling and timeline, please contact Harrison Hood at 601-540-8602 or by email at hbhood@hoodconsultingllc.com.

Appendix A. Quarterly Stumpage Prices, Delivered Timber Prices, Sawmill Residual Prices, & Pulp Quality Chip Prices (1Q 2010 – 1Q 2019)

Amite BioEnergy Catchment Area - Historic Quarterly Stumpage Prices ($/Tonne)

Year	Quarter	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
2010	1	33.92	18.53	14.83	32.53	17.19
2010	2	43.61	19.50	12.59	32.90	15.13
2010	3	32.87	17.59	9.65	33.05	6.66
2010	4	29.87	16.68	10.36	31.74	7.20
2011	1	26.85	17.11	9.73	26.31	7.00
2011	2	24.01	15.74	8.50	31.81	5.52
2011	3	22.13	15.71	8.79	36.10	4.57
2011	4	25.13	16.57	10.25	36.78	5.57
2012	1	26.29	17.10	9.70	30.35	6.79
2012	2	25.42	15.76	9.44	33.01	7.46
2012	3	25.44	15.77	9.55	37.27	9.02
2012	4	26.05	16.81	10.34	42.03	10.00
2013	1	27.76	19.38	11.60	45.00	11.20
2013	2	26.60	18.58	10.65	42.46	10.54
2013	3	26.79	17.28	9.66	47.40	11.89
2013	4	26.52	18.10	8.91	46.43	11.88
2014	1	29.00	19.39	9.98	43.66	11.67
2014	2	27.18	19.24	10.00	46.30	10.73
2014	3	28.18	18.88	9.58	43.05	10.03
2014	4	28.98	19.68	9.90	42.91	9.60
2015	1	29.75	19.16	10.59	39.67	9.73
2015	2	27.29	18.65	9.59	36.44	9.87
2015	3	27.95	18.03	8.93	38.62	8.98
2015	4	25.98	18.51	8.95	37.27	9.57
2016	1	26.83	19.33	9.61	52.82	9.76
2016	2	27.88	18.78	9.50	53.54	8.60
2016	3	26.37	19.53	8.64	52.29	7.23
2016	4	28.22	18.55	8.21	47.93	6.96
2017	1	28.76	20.48	8.94	43.83	8.39
2017	2	28.06	20.32	8.59	44.86	6.64
2017	3	28.52	20.55	7.64	43.49	6.75
2017	4	30.53	19.27	8.26	44.93	8.27
2018	1	29.45	19.15	7.96	47.92	12.87
2018	2	28.65	19.36	7.71	45.55	12.25
2018	3	27.51	18.71	6.71	44.42	11.83
2018	4	27.94	17.46	6.64	48.51	12.81
2019	1	27.70	19.49	8.17	51.59	15.81

Source: TimberMart-South

Amite BioEnergy Catchment Area - Historic Quarterly Delivered Timber Prices ($/Tonne)

Year	Quarter	Pine Sawtimber	Pine Chip-n-saw	Pine Pulpwood	Hardwood Sawtimber	Hardwood Pulpwood
2010	1	52.99	38.04	35.51	49.60	36.16
2010	2	55.84	39.86	32.96	54.81	36.64
2010	3	55.03	38.34	32.92	52.11	29.54
2010	4	49.60	37.65	30.74	53.53	28.26
2011	1	47.64	38.15	30.08	52.10	28.13
2011	2	43.97	37.23	29.59	54.39	27.76
2011	3	43.22	37.78	29.44	55.40	27.38
2011	4	44.65	38.50	30.57	56.46	26.72
2012	1	44.43	38.36	30.05	53.46	29.02
2012	2	45.58	38.16	30.10	57.03	29.20
2012	3	46.25	38.23	29.66	57.88	30.29
2012	4	45.87	39.11	31.07	66.16	31.77
2013	1	47.50	39.97	31.60	64.54	32.35
2013	2	48.48	42.25	31.46	61.83	31.80
2013	3	48.88	41.29	30.50	65.98	33.25
2013	4	49.25	41.62	30.47	65.09	33.58
2014	1	49.45	42.09	30.95	64.26	33.71
2014	2	51.26	43.43	31.26	69.63	32.44
2014	3	48.10	41.76	31.78	64.71	32.56
2014	4	49.68	42.08	31.25	65.52	32.74
2015	1	48.93	42.11	30.80	59.00	34.72
2015	2	49.04	42.21	30.78	58.64	32.51
2015	3	54.72	42.16	30.45	60.78	33.08
2015	4	48.14	41.73	30.56	58.57	32.18
2016	1	47.73	42.48	31.09	66.54	32.92
2016	2	46.80	41.17	31.55	70.11	32.17
2016	3	48.16	41.33	30.42	74.09	29.02
2016	4	49.03	39.25	28.79	69.11	27.39
2017	1	50.83	40.95	29.18	66.55	26.57
2017	2	47.87	39.86	28.02	69.29	25.86
2017	3	50.08	42.24	30.59	71.40	28.22
2017	4	50.87	41.11	30.02	66.93	27.30
2018	1	49.87	40.68	28.21	69.71	32.99
2018	2	46.84	38.89	27.16	63.37	32.04
2018	3	47.42	39.39	27.54	64.58	32.77
2018	4	48.29	39.89	27.40	73.18	34.99
2019	1	47.44	40.50	30.36	72.39	35.77

Source: TimberMart-South

Amite BioEnergy Catchment Area - Sawmill Residuals & Pulp Quality Chip Prices ($/Tonne - FOB Point of Production)

Year	Quarter	Pine Sawmill Chips	Pine Chip Mill Chips	In-Woods Debarked Pine Chips	Hardwood Sawmill Chips	Hardwood Chip Mill Chips
2010	1	32.83	41.54	42.51	25.58	42.96
2010	2	28.26	41.30	41.96	25.17	43.99
2010	3	29.20	38.64	38.07	27.50	39.75
2010	4	30.28	39.25	35.48	27.52	41.60
2011	1	30.25	38.23	36.53	27.97	41.61
2011	2	30.08	37.70	36.20	27.54	39.53
2011	3	28.64	39.57	37.46	26.35	37.49
2011	4	27.66	38.70	36.60	25.95	38.12
2012	1	28.19	39.62	35.85	26.26	37.40
2012	2	27.73	38.87	32.84	26.96	39.02
2012	3	27.83	39.31	35.41	28.94	38.64
2012	4	28.79	41.26	35.48	29.61	40.17
2013	1	28.38	41.15	34.26	29.49	39.87
2013	2	30.18	39.22	33.29	30.78	39.88
2013	3	28.74	38.71	36.23	28.20	38.05
2013	4	29.60	38.40	36.16	30.08	40.68
2014	1	28.34	39.14	33.91	28.23	41.07
2014	2	30.20	39.32	34.16	28.16	41.17
2014	3	28.80	38.97	33.58	28.38	41.95
2014	4	28.60	38.56	34.46	27.39	41.14
2015	1	28.64	37.99	34.69	28.11	41.15
2015	2	29.53	37.61	35.78	29.99	39.08
2015	3	28.98	38.25	37.13	28.52	40.79
2015	4	30.27	37.13	37.81	29.99	39.28
2016	1	29.99	37.73	36.02	30.63	39.94
2016	2	31.80	37.69	35.11	33.80	40.44
2016	3	30.58	36.94	35.47	30.99	39.44
2016	4	31.01	36.03	36.31	31.68	37.92
2017	1	31.35	35.24	34.72	30.18	37.30
2017	2	30.20	35.37	35.44	31.80	38.15
2017	3	30.86	36.11	36.23	31.40	36.86
2017	4	29.52	36.88	35.36	31.66	36.75
2018	1	28.65	36.34	35.14	31.88	37.79
2018	2	29.21	35.62	34.79	31.83	40.55
2018	3	30.64	35.42	35.43	30.02	41.79
2018	4	31.00	36.00	35.25	29.96	44.19
2019	1	31.36	37.00	35.92	31.68	46.50

Source: TimberMart-South

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

Log Rule and Weight Equivalents

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

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

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

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

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

English & Metric Conversions

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

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

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

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

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

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

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

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

1 acre = 0.405 hectares

1 mile = 1.609 kilometers

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

Glossary of Terms

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

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

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

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

Commercial species: Tree species suitable for industrial wood products.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Saw log: A log meeting minimum standards of diameter, length, and defect, including logs at least 8 feet long, sound and straight, and with a minimum diameter inside bark of 6 inches for softwoods and 8 inches for hardwoods, or meeting other combinations of size and defect specified by regional standards.

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

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

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

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

Timberland: Forest land that is producing or is capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation. (Note: Areas qualifying as timberland are capable of producing in excess of 20 cubic feet per acre per year of industrial wood in natural stands. Currently inaccessible and inoperable areas are included.)

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

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

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

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

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

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

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